# AMENDMENT TO OAKLAND ZOO MASTER PLAN: SUBSEQUENT MITIGATED NEGATIVE DECLARATION/ADDENDUM

DRAFT
Volume 2 - Appendices

Prepared for City of Oakland
February 2011

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VOLUME 2

# APPENDICES

**Appendix A: 1998 Mitigated Negative Declaration**

**Appendix B: 1998 Master Plan Conditions of Approval and Mitigation Measures**

**Appendix C: 1998 Mitigation Measures, City of Oakland Standard Conditions of Approval, and 2011 Subsequent Mitigated Negative Declaration/ Addendum Mitigation Measures Applicable to Proposed Master Plan Amendment**

**Appendix D: Analysis of Oakland Zoo Attendance**

**Appendix E: Photo Viewpoint Locations**

**Appendix F: Air Quality Technical Report**

**Appendix G: Biological Resources**

G-1 Status of the Alameda Whipsnake in Knowland Park for the Proposed Expansion of the Oakland Zoo (Swaim Biological, Inc., 2011)

G-2 Habitat Enhancement Plan at the Oakland Zoo California Exhibit and Upper Knowland Park (Environmental Collaborative, 2010b)

G-3 *Alameda Whipsnake Habitat Evaluation* (Swaim Biological, Inc. 2009)

G-4 California Exhibit Tree Diagram and Tree Survey (PJA, 2010)

**Appendix H: Climate Change Technical Report**

**Appendix I: Drainage Report**

**Appendix J: Noise**

J-1 Operational Noise Data

J-2 Construction Noise Data

J-3 Sound Barrier Examples

**Appendix K: Transportation Study Technical Appendices**

X-1 Intersection Turning Movement Counts and Pneumatic Hose Counts

X-2 Intersection Level of Service Calculation Worksheets

X-3 Peak Hour Signal Warrant Worksheets

X-4 ACCMA Model Outputs

X-5 Oakland Zoo Traffic Volumes

X-6 Seasonal Variation and Attendance Growth Adjustment Factors

APPENDIX

A

# 1998 MITIGATED NEGATIVE DECLARATION

File No. ER960036
Ref No. ________

# City of Oakland
# Oakland, California

## INITIAL STUDY AND ENVIRONMENTAL REVIEW CHECKLIST
**California Environmental Quality Act (CEQA)**

**I. PROJECT PROPONENT:** Dr. Joel Parrott, Executive Director, Oakland Zoo
East Bay Zoological Society

**II. PROJECT NAME:** Oakland Zoo in Knowland Park Master Plan

**III. PROJECT ADDRESS AND LOCATION:** 9777 Golf Links Road, Oakland, CA 94605
The Zoo is located in south Oakland, east of Interstate-580 and adjacent to Anthony Chabot Regional Park.

**IV. LEAD AGENCY:** City of Oakland
Community and Economic Development Agency
Zoning Division
1330 Broadway, 2nd Floor
Oakland, CA 94612

Agency Contact: Anu Raud    Telephone No. (510) 238-6346

**V. ENVIRONMENTAL DETERMINATION:**

On the basis of this initial environmental evaluation:

☐ I find that the proposed project *could not* have a significant effect on the environment, and a Negative Declaration will be prepared.

☒ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because the attached *mitigation measures* have been incorporated into the project. Therefore, a **Mitigated Negative Declaration** will be prepared.

☐ I find that the proposed project *may* have a significant effect on the environment, and an **Environmental Impact Report** (EIR) is required to assess the effects on the environment.

WILLIE YEE
Environmental Review Officer

By: ANU RAUD
Environmental Review Coordinator

Anu Raud    3-28-97
Signature    Date

# VI. DESCRIPTION OF THE PROJECT

## BACKGROUND

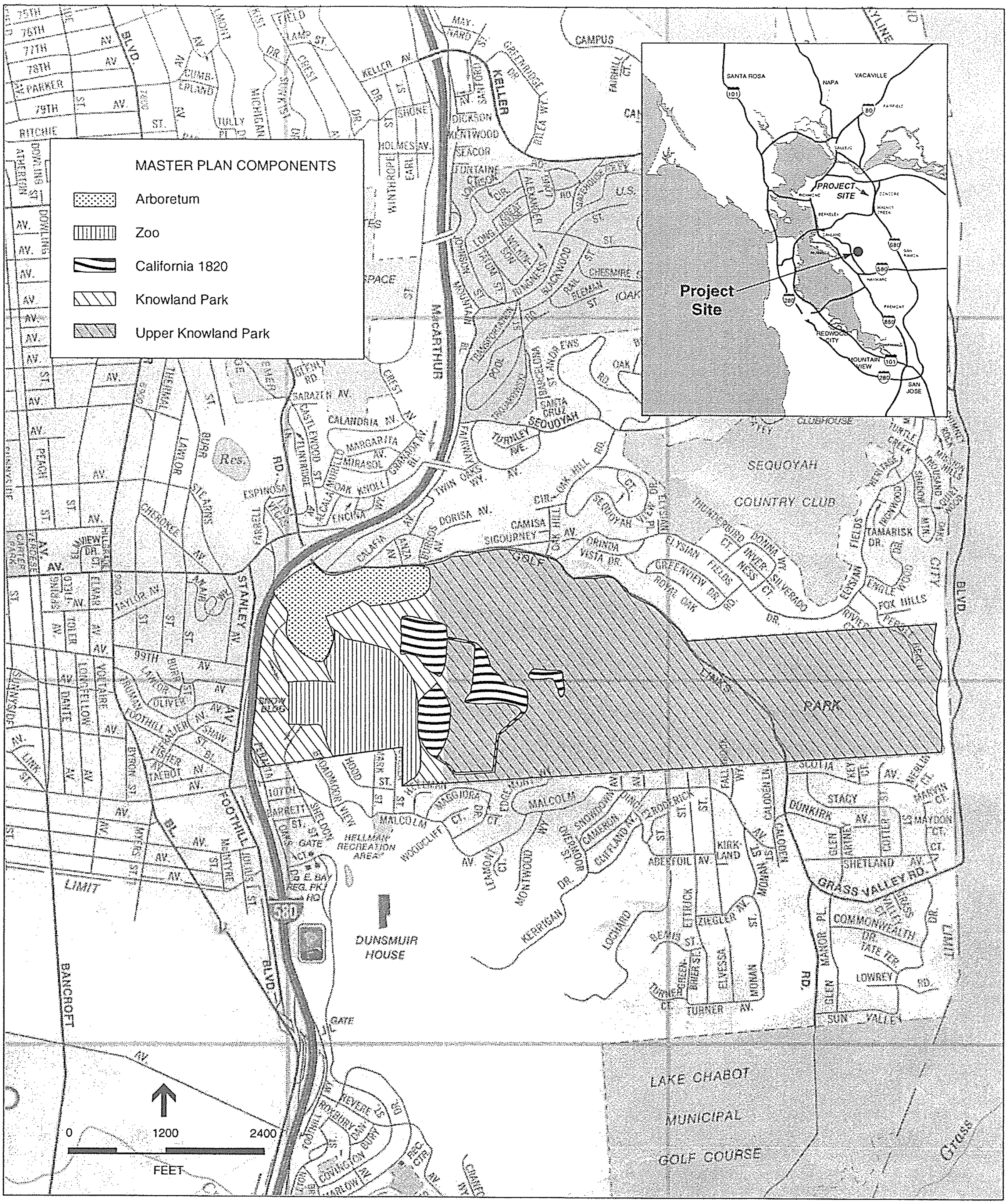
The East Bay Zoological Society (EBZS) has prepared an updated Master Plan for the Oakland Zoo in Knowland Park to provide expanded programs and facilities to meet future growth needs. The proposed Master Plan is an update of an earlier Master Plan prepared in 1990. This Master Plan represents a refinement of the earlier planning document. Extensive environmental studies of the site have been conducted to identify sensitive resources. Utilizing these studies, the Master Plan update has been designed to minimize or avoid impacts to sensitive resources. The Master Plan provides a development program for new facilities to be constructed over the next 20 years. The EBZS also has applied for a Major Conditional Use Permit.

## THE PROJECT

The Oakland Zoo in Knowland Park (the Park) is composed of three unique landscape environments: the Arboretum, the Zoo, and Upper Knowland Park. The Park totals 443 acres of which 350 acres are in the undeveloped Upper Knowland Park, 56 acres are within the Arboretum, and 37 acres are in the Zoo (see Figure 1: Master Plan Components). The 1996 Master Plan is designed to minimize disturbance to undeveloped lands by clustering new development and efficiently using existing developed areas. The Master Plan would preserve approximately 73% (325 acres) of the site as open space. The remaining 27% (118 acres) of the site represents existing and planned development for zoological and recreational use. The Master Plan proposes new development affecting 118 acres. Of this, approximately 25 acres of undeveloped lands located in Upper Knowland Park would be developed and the remaining 93 acres would consist of improvements and new projects within the developed 37-acre Zoo and 56-acre Arboretum. Table 1 presents a breakdown of existing and proposed development.

**TABLE 1: EXISTING AND PROPOSED AREAS OF DEVELOPMENT**

| | Existing (acres) | Proposed (acres) |
|---|---|---|
| Undeveloped Lands | 350 | 325 |
| Arboretum | 56 | 56 |
| Zoo | 37 | 37 |
| California 1820 | 0 | 25 |
| Total | 443 | 443 |




*SOURCE: Amphion Environmental, Inc.*

**Figure 1**
Master Plan Components

The proposed projects included in the Master Plan are based on future growth needs for the expansion of programs and facilities. New development is planned to be in compliance with the standards set forth in the Americans with Disabilities Act (ADA). The Master Plan also proposes habitat enhancement and revegetation with native plants throughout the Park as the proposed new development is implemented. The natural oak woodland, native grasslands, coast scrub and riparian woodland communities will be augmented by plants of appropriate oaks, redwoods, bay trees, bunch grasses, shrub species and others, such as eucalyptus, French broom and other exotic plants are removed.

## MAJOR COMPONENTS OF THE MASTER PLAN

The Master Plan is organized into three major components: Arboretum, Zoo, and California 1820. Presented below is a brief description of each component. The Arboretum and Zoo are existing areas in the Park and would undergo facility improvements. California 1820 represents a new development and would include construction in undeveloped land areas. Figure 2 shows the project site plan.

### Arboretum

The existing Arboretum includes an international collection of trees planted by Frederick Talbot, an early Bay Area lumber and shipping magnate whose estate was located in this portion of the Zoo. Group and individual picnic areas are currently dispersed throughout the meadow and knoll. Parking facilities are available for 335 cars; and an additional 183 spaces are available in an overflow parking lot.

Improvements proposed by the Master Plan include:

- Center for Science and Environmental Education including approximately 16,695 square feet consisting of four classrooms (each 35 seating capacity), library, offices (relocating existing staff from temporary office facilities), a small theater (40 seating capacity), and auditorium (143 seating capacity). Existing parking facilities will be used for staff and visitors; and three new parking spaces will be provided for the three Zoo Mobiles.
- Three new picnic shelters.
- Removal of existing restrooms from riparian corridor and construction of a new restroom.
- Pedestrian hiking trail connecting the meadow with Upper Knowland Park.
- Existing one-way access road widened to 30 feet to accommodate two-way traffic and bicycle/ pedestrian lane.
- New plantings installed as Arboretum ages.

### Zoo

The Zoo contains exhibits of exotic animals in natural habitats, a children's rides area, and a Children's Zoo. Over the next ten years the animal exhibits will be arranged to highlight three major environmental themes: the African Savanna, Tropical Rainforests of the World, and California 1820. The African Savanna and Tropical Rainforests of the World are planned to be located in the existing boundaries of the Zoo, and the proposed California 1820 exhibit would be located in both the Zoo and Upper Knowland Park.


SOURCE: *Amphion Environmental, Inc.*

**Figure 2**
Site Plan

Parking facilities are available for 556 cars. The Snow Building is presently available for parties and receptions, and its adjacent parking lot can accommodate 26 cars.

Improvements proposed by the Master Plan include:

- In the African Savanna, a new trail extending from the existing elephant exhibit to the center of the Zoo will be constructed. Along this trail new exhibits will include warthog, green monkeys and hyena, and overlooks will provide opportunities to view the lions, impala, greater kudu and baboon exhibits.
- In the African Savanna, a small African village will provide visitor services including a restroom, food service, and cultural hut adjacent to existing elephant exhibit.
- In the Tropical Rainforest, additional dense plantings will be added to the existing exhibits along Rainforest trails to create a tropical environment. Graphics, state-of-the-art enrichment tools and interactive displays for educational and interpretive purposes will be installed.
- Australian Walk About will include a new visitor pathway and provide a new home in an area of tall eucalyptus trees for the Zoo's existing wallabies, wallaroos and large flightless emus
- Improvements and upgrades to existing Children's Zoo.
- Improvements to the Snow Building including upgraded kitchen and restroom facilities.
- Paving existing overflow parking lots (292 spaces) in the future to accommodate attendance increases.
- A wall located along the southerly boundary across from the main parking area to screen parking from adjacent residences and provide a sound barrier.
- Improved Safari Restaurant and gift center.
- Improved main entrance including landscaping, new ticket booths, new signage and banners.
- Improved secondary entrance (Summer entrance) including landscaping, new ticket booth, signage and banners.
- Other improvements and upgrades to the Zoo.

## California 1820

California 1820 will be located primarily in Upper Knowland Park and represents new development on approximately 25 acres of undeveloped land. The central theme focuses on regional extinction, featuring native California species which occurred prior to the Gold Rush. Five ecological units will be highlighted by the exhibits: grassland, chaparral, oak woodland, riparian and canyon.

Improvements proposed by the Master Plan include:

- Canyon Exhibit featuring golden eagle, jaguar, bald eagle, white tailed deer, bobcat, great horned owl, walk-through aviary and California reptile.
- River Exhibit featuring grizzly bear, Tule elk, river otter, great blue heron and sand crane.
- American Bison, cougar, barn owl, and grey wolf exhibits.
- California Interpretive Center providing viewing platform and interpretive exhibits.
- Off-site Breeding area.

- Paving of existing fire road to accommodate shuttle bus.

PROJECT PHASING

The Master Plan presents a development program for the next 20 years. Project phasing will occur in three primary phases: Phase I - Center for Science and Environmental Education; Phase II - California 1820; and Phase III - on-going improvements.

Phase I - Development of Center for Science and Environmental Education. Construction of this facility is planned for the Spring of 1997 with completion of construction and occupation of the facility scheduled to occur in December 1997.

Phase II - Development of the California 1820 exhibit which is planned to commence in 2000 with completion in 2001.

Phase III - On-going Park enhancements and maintenance will occur commencing in the Spring of 1997 and continue throughout the 20-year planning horizon of the Master Plan. The type of activities that will occur include exhibit improvements and relocations, landscaping, renovations, and maintenance

PARK OPERATIONS

The Park is open daily from 10:00 a.m. to 4:00 p.m. The Park is closed on Thanksgiving and Christmas days; and may close when weather conditions are severe. The Snow Building is available for rental by the public on a daily basis for daytime and evening events. Events at the Snow Building may not extend beyond 2:00 a.m.

## VII. DESCRIPTION OF THE ENVIRONMENTAL SETTING

The Park is located off of Golf Links Road and is situated between I-580 to the west and Chabot Regional Park to the east. The Proposed Master Plan represents a plan for the entire 443-acre Park property. The site comprises gently rolling to hilly terrain with oak woodland dispersed on the slopes of ridges. Existing development comprises the Zoo and Arboretum, located at the westerly end of the property; and the undeveloped open space of Upper Knowland Park which encompasses the eastern portion of the property.

The Park is within the One-Family Residential (R-30) Zone. The R-30 zone permits the development of permanent residential activities and civic activities that can be classified as either essential service or limited childcare. The development proposed by the Master Plan may be permitted upon the granting of a conditional use permit. The project would be required to obtain approval by the Oakland Planning Commission of a Major Conditional Use Permit. The Commission's action would be appealable to the City Council.

## VIII. ENVIRONMENTAL EFFECTS

*(CEQA requires that an explanation of all answers except No Impacts be provided along with this checklist, including a discussion of ways to mitigate any significant effects identified. A "No Project" answer must be adequately supported by the referenced information sources cited. As defined here, a significant effect is considered a substantial adverse effect.)*

| **Earth.** Will the project result in: | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 1. Unstable earth conditions, including mudslides, landslides or changes in geologic substructures either on or off-site? | ☐ | ☒ | ☐ | ☐ |

**Comment**

A geotechnical report prepared by Harza for the Center for Science and Environmental Education and African Savanna Exhibit and field observations, indicate the presence of unstable slopes on the site. In addition, the site is located in an area designated as "most susceptible to landsliding on "Map 1D Landslide Potential" in the *Oakland General Plan Update Land-Use and Transportation Element Technical Report #6.* Unstable slopes can be undermined by seismic activity, heavy precipitation, cutting and filling activities, and over burden leading to landslides and mudslides. Slope failure could pose hazards to people, animals and Park facilities. These hazards can be increased if structures and facility improvements are not properly designed and constructed. Impacts associated with slope failure could be significant but can be mitigated to less than significant levels through conformance with the following engineering and design standards and procedures.

**Mitigation Measures**

1a) The geotechnical report prepared for the Center for Science and Environmental Education and the African Savanna Exhibit recommended the use of retaining walls, the creation of keyed and benched slopes, proper slope gradients, proper fill compaction, removal of expansive soils and the development of proper drainage facilities to reduce slope failure. These recommendations as well as any additional suggestions from the City of Oakland Building and Engineering Departments shall be adhered to.

1b) City of Oakland standards for engineering controls and slope stabilization outlined in the Oakland Grading Ordinance shall be adhered to prior to and during facility and roadway construction.

1c) Additional geotechnical studies shall be required prior to design and construction of the remaining proposed Master Plan buildings, roads and facilities.

1d) All proposed facilities shall be constructed in conformance with the Uniform Building Code and California Amendments, and incorporate specific engineering design recommendations from the geotechnical and soils reports.

1e) Close construction inspection, testing and quality control shall be performed by the proposed geotechnical engineer or engineering geologist to ensure that site grading plans and geotechnical recommendations criteria are adequate and appropriate.

**Significance after Mitigation:** Less than significant.

**Source:** ESA, *Oakland Zoo Master Plan Update Special Studies Preliminary Geology Study Technical Report*, September 1995.
Harza, *Fault Rupture Hazard and Geotechnical Investigation for Environmental Education Center and Building Additions Oakland Zoo, Oakland, California*, April 29, 1994.
Naval Medical Center Oakland and City of Oakland, *Draft EIS/EIR for the Disposal and Reuse of the Naval Medical Center Oakland*, September 1996.
City of Oakland, *Oakland General Plan Update, Land Use and Transportation Element, Technical Report #6*, October 1995.
City of Oakland, *Chabot Observatory and Science Center, Draft EIR*, August 28, 1995.
City of Oakland, *Ordinance No. 10312, Article 6, Grading, Excavation and Fill.*
U.S.G.S., 7.5 Minute Series (Topographic) Map, Oakland East Quadrangle.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 2. Any increase in wind or water erosion of soils, either on or off-site, due to increased water runoff caused by conversion of pervious to impervious surfaces or to other factors? | ☐ | ☒ | ☐ | ☐ |

**Comment**

The Master Plan proposes new facilities and roadways on varying degrees of slope. Steeper slopes generally have a higher erosion potential than flatter slopes. There are high levels of erosion on the areas of the site with steep slopes.

Conversion of pervious surfaces to impervious surfaces, such as building foundations and pavement, could increase on-site erosion. However, the amount of surface area proposed to be converted would not be substantial to significantly increase on-site erosion. In addition, unvegetated areas on the site, such as the Shuttle Road, are currently susceptible to substantial erosion due to surface water runoff. In fact, paving these unvegetated areas and installing drainage controls, as proposed in the Master Plan, would substantially reduce on-site erosion.

Construction activities may also induce short-term erosion impacts. However, project compliance with Ordinance No. 10312 and the recommended mitigation measures will reduce potential erosion impacts to a less than significant level.

### Mitigation Measures

2a) Facilities and infrastructure improvements should be designed to control runoff so that it is not directed over unprotected slopes. Drainage improvements shall be designed to adequately collect surface water runoff and convey it to the proper storm drain system.

2b) The construction contractor shall use water bars, temporary swales and culverts, mulch and june netting, silt fences, straw bales and sediment traps to prevent surface water from eroding soil and transporting it to nearby creeks and natural drainages. These and other methods as outlined in the California Stormwater Best Management Practice Handbook, Construction Activity, shall be implemented to reduce erosion.

2c) Grading and construction activities shall be restricted to the dry season. Exposed surface areas shall be watered down, especially during construction, to reduce wind erosion.

2d) Erosion control methods and implementation procedures shall be monitored during construction and modified as conditons warrant.

**Significance after Mitigation:** Less than significant.

**Source:** Harza, *Fault Rupture Hazard and Geotechnical Investigation for Environmental Education Center and Building Additions Oakland Zoo, Oakland, California*, April 29, 1994.
Naval Medical Center Oakland and City of Oakland, *Draft EIS/EIR for the Disposal and Reuse of Naval Medical Center Oakland*, September 1996.
City of Oakland, *Oakland General Plan Update, Land Use and Transportation Element, Technical Report #6*, October 1995.
City of Oakland, *Ordinance No. 10312, Article 6, Grading, Excavation and Fill.*
U.S.G.S., 7.5 Minute Series (Topographic) Map, Oakland East Quadrangle.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 3. Changes in deposition or erosion that result in changes in siltation, deposition or erosion which may modify the channel of a creek, inlet, lake, or any other waterway? | ☐ | ☒ | ☐ | ☐ |

### Comment

There are several intermittent and ephemeral waterways located throughout the site. In addition, Arroyo Viejo Creek, a perennial waterway flows along the northern boundary of the site. Erosion during construction and uncontrolled surface water runoff has the potential to increase soil deposition, resulting in water quality degradation and potential changes to channel capacity and flow patterns. Construction activities must be in compliance with Ordinance No. 10312 and the recommended mitigation measures would reduce these potential impacts to a less than significant level.

**Mitigation Measures**

3a) Mitigation Measures 2a - 2d shall be implemented.

**Significance after Mitigation:** Less than significant.

**Source:** ESA, *Oakland Zoo Master Plan Update Special Studies Preliminary Geology Study Technical Report*, September 1995.
Harza, *Fault Rupture Hazard and Geotechnical Investigation for Environmental Education Center and Building Additions Oakland Zoo, Oakland, California*, April 29, 1994.
City of Oakland, *Ordinance No. 10312, Article 6, Grading, Excavation and Fill.*
U.S.G.S., 7.5 Minute Series (Topographic) Map, Oakland East Quadrangle.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 4. Major changes in topography or ground surface relief features, or disruptions, displacements, compaction or overcovering of the soil? | ☐ | ☒ | ☐ | ☐ |

**Comment**

Although minimal grading would be required to construct new facilities and recontour the proposed Shuttle Road, significant alterations to topography and ground surface relief would not occur as a result of the proposed project because facilities have been designed to accommodate the existing natural topography.

The geotechnical report prepared by Harza for the Center for Environmental Science and Education and the African Savanna Exhibit indicated the presence of expansive soils beneath these sites. These soils may be present at other locations beneath the Zoo property and be subject to settlement. Facilities and roads constructed on these soils, if not properly designed and engineered, could be susceptible to damage. This is considered a potentially significant impact.

**Mitigation Measures**

4a) Implement the recommendations from the Harza report such as removal of expansive soils, clearing of rich compressible organic soils and use of appropriately engineered fill materials shall be adhered to for the development of the Center for Science and Education and the African Savanna Exhibit.

4b) Additional geotechnical and soils studies for the presence of expansive soils shall be required prior to design and construction of the remaining buildings, roads and facilities proposed by the Master Plan.

4c) New structures and facilities proposed by the Master Plan shall incorporate the recommendations of the additional geotechnical reports and any additional requirements from the City of Oakland.

**Significance after Mitigation:** Less than significant.

**Source:** ESA, *Oakland Zoo Master Plan Update Special Studies Preliminary Geology Study Technical Report*, September 1995.
Harza, *Fault Rupture Hazard and Geotechnical Investigation for Environmental Education Center and Building Additions Oakland Zoo, Oakland, California*, April 29, 1994.
U.S.G.S., 7.5 Minute Series (Topographic) Map, Oakland East Quadrangle.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 5. Construction on loose fill or other unstable land that might expose people or property to geologic hazards, such as earthquakes, liquefaction or ground failure, or similar seismic hazards? | ☐ | ☒ | ☐ | ☐ |

### Comment

The Park is located in the San Francisco Bay region, an area with potential for periodic seismic activity. There are approximately four active faults within a 40-mile radius of the project site. The Harza geotechnical study identified that the sites for the Center for Science and Environmental Education and the African Savanna exhibit would be located within the Alquist Priolo Earthquake Hazard Zone of the Hayward Fault. Fault trenching undertaken by HARZA found no evidence of any faulting or displacement at either site. The Hayward Fault Zone runs north to south beneath the western portion of the Park. A supplemental geotechnical investigation for the Center for Science and Environmental Education prepared by Kleinfelder identified that the site for the Center is located about 50 feet from the active Hayward Fault. The entire Park site is located in an area with extreme groundshaking and landslide potential in the event of a large magnitude earthquake. Due to the proximity of the Hayward Fault, it is likely that intense groundshaking and high peak ground accelerations would occur on the site as a result of a major earthquake event. Consequently, considerable structural and non-structural damage to buildings, roadways and facilities would be likely. In addition, significant risk of injury to people and animals during a seismic event would be present. Although seismic hazards are potentially significant, there are several engineering and design modifications as well as precautionary procedures that can be implemented to reduce these seismic hazards.

The low intensity land use of the site as a Zoo-Park is consistent with the City of Oakland's policy for land use in areas of high seismic risk. The limited number of proposed structures in the Master Plan would also reduce the potential for seismic-related risks to structures and people.

### Mitigation Measures

5a) The geotechnical recommendations in the Harza report for the Center for Science and Environmental Education and the African Savanna Exhibit located within the Alquist Priolo Zone shall be incorporated into the final design and siting of these facilities.

Geotechnical recommendations in the supplemental Kleinfelder report shall also be incorporated into the final design of the Center.

5b) Geotechnical evaluations shall be performed for each additional facility proposed by the Master Plan and recommendations to reduce seismic related hazards shall be incorporated into the design and siting of these new facilities.

5c) All proposed structures shall be designed and constructed in accordance with the Uniform Building Code and California Amendments. The interpretation of the applicability of the appropriate UBC standard for each proposed structure shall be determined by the Oakland Building and Engineering staff at the time of preliminary plan submittal.

5d) Proper earthquake-resistant techniques for securing indoor fixtures, machinery and furnishings within proposed structures shall be used during construction to minimize the risk of damage or injury from toppled objectives.

5e) The Zoo's Emergency Preparedness and Response Plan, and Animal Capture Plan shall be updated as proposed facilities are developed.

**Significance after Mitigation:** Less than significant.

**Source:** Harza, *Fault Rupture Hazard and Geotechnical Investigation for Environmental Education Center and Building Additions Oakland Zoo, Oakland, California*, April 29, 1994.
Kleinfelder, *Geotechnical Investigation Report Proposed Center for Science and Environmental Education Oakland Zoo, Oakland, California*, November 22, 1996.
Naval Medical Center Oakland and City of Oakland, *Draft EIS/EIR for the Disposal and Reuse of Naval Medical Center Oakland*, September 1996.
City of Oakland, *Oakland General Plan Update, Land Use and Transportation Element, Technical Report #6*, October 1995.
City of Oakland, *Chabot Observatory and Science Center*, Draft EIR, August 28, 1995.
City of Oakland, *Oakland Zoo Master Plan Update Special Studies Preliminary Geology Study Technical Report*, September 1995.
City of Oakland, *Land Use Element of the Oakland Comprehensive Plan*, April 1980.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 6. Construction within one-quarter mile of an earthquake fault? | ☐ | ☒ | ☐ | ☐ |

**Comment**

As mentioned under Comment #5 above, the Hayward Fault Zone runs through the western portion of the Park. The mitigation measures discussed in relation to question #5 would apply to this question, and would significantly reduce seismic-related risks.

**Source:** *ESA, Oakland Zoo Master Plan Update Special Studies Preliminary Geology Study Technical Report*, September 1995.
Harza, *Fault Rupture Hazard and Geotechnical Investigation for Environmental Education Center and Building Additions Oakland Zoo, Oakland, California*, April 29, 1994.
Naval Medical Center Oakland and City of Oakland, *Draft EIS/EIR for the Disposal and Reuse of Naval Medical Center Oakland*, September 1996.
City of Oakland, *Oakland General Plan Update, Land Use and Transportation Element, Technical Report #6*, October 1995.
City of Oakland, Chabot Observatory and Science Center Draft EIR, August 28, 1995.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 7. Substantial depletion of a nonrenewable natural resource or inhibition of its extraction? | ☐ | ☐ | ☐ | ☒ |

**Comment**

The proposed Master Plan Update would not result in a substantial depletion of a nonrenewable natural resource or inhibit its extraction. Implementation of the Master Plan would include the disturbance of less than ten acres of topsoil with no significant mineral and/or agricultural value.

**Source:** Harza, *Fault Rupture Hazard and Geotechnical Investigation for Environmental Education Center and Building Additions Oakland Zoo, Oakland, California*, April 29, 1994.
City of Oakland, *Oakland General Plan Update, Land Use and Transportation Element, Technical Report #6*, October 1995.

| **Air.** Will the project result in: | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 8. Substantial air emissions, deterioration of ambient air quality or the creation of objectionable odors? | ☐ | ☒ | ☐ | ☐ |

### Comment

The San Francisco Bay Area air basin is currently designated as a non-attainment area with respect to state standards for ozone ($O_3$) and inhalable particulate matter ($PM_{10}$). Therefore, a project-generated violation of the $O_3$ and/or $PM_{10}$ state standards at nearby air monitoring stations is considered a significant impact. Project-related exposure of sensitive receptors to substantial pollutant concentrations is also considered a significant impact. In addition, the BAAQMD recommends various thresholds and tests of significance (BAAQMD, 1996). For reactive organic gases and nitrogen oxides ($NO_x$), a net increase of 80 lbs/day is considered significant, while for sulfur oxides ($SO_x$), a net increase of 150 pounds per day (lbs/day) is considered significant. For $PM_{10}$, an increase of 80 lbs/day is considered significant, and for carbon monoxide (CO), an increase of 550 lbs/day of CO would be considered significant if it leads to a possible local violation of CO standards (i.e., a "hot spot").

Land uses such as schools, children's day care centers, hospitals, and convalescent homes are considered to be more sensitive than the general public to poor air quality because the population groups associated with these uses have increased susceptibility to respiratory distress. Persons engaged in strenuous work or exercise also have increased sensitivity to poor air quality. Residential areas are considered more sensitive to air quality conditions compared to commercial and industrial areas because people generally spend longer periods of time at their residences, with associated greater exposure to ambient air quality conditions. Recreational uses would also be considered sensitive compared to commercial and industrial areas due to the greater exposure to ambient air quality conditions. Sensitive receptors in the project vicinity include Park patrons and residential uses located adjacent to the southern Park boundary.

Construction of proposed Master Plan facilities would generate dust ($PM_{10}$) due to earthmoving activities and vehicle travel over unpaved surfaces. Construction activities would also generate short-term emissions of criteria pollutants associated with equipment exhaust emissions. This would be a short-term adverse impact, and would be potentially significant depending on the areal extent of construction at any given time. The nearest sensitive receptors are residents of the neighborhood adjacent to the southern Park boundary. Although prevailing winds are westerly, it is possible that dust could be carried occasionally into the adjacent neighborhood by a northerly or northwesterly wind.

The BAAQMD does not require quantification of construction emissions (BAAQMD, 1996), but considers any project's construction-related impacts to be less-than-significant if required dust-control measures are implemented. The extent of dust-control measures required by the BAAQMD depends on the size of the project. The BAAQMD specifies "basic control measures" for all construction sites, "enhanced control measures" for construction sites greater than four acres, and "optional control measures" for construction sites that are large in area or located near sensitive receptors.

Implementation of the proposed Master Plan would result in a total disturbance at Master Plan buildout of less than ten acres. Project development would be phased, with individual project areas resulting in surface disturbance of less than four acres.[1] Thus, the project would be subject to BAAQMD basic control measures. Construction-related $PM_{10}$ emissions are considered to be potentially significant at the local and regional level.

Equipment exhaust emissions during construction would result from vehicular traffic generated by the construction activities, including automobiles transporting workers to and from the project site, and from construction equipment and machinery. Similar to dust emissions, the equipment activity level would be related to project size and extent of earthmoving requirements in site preparation. Emission levels for construction activities would vary depending on the type of equipment, duration of use, operation schedules, and the number of construction workers. Although these emissions, in combination with other existing emissions sources, would temporarily contribute to local air quality degradation, these emissions would be minor, having a less-than-significant impact. As indicated above, the projects that would be implemented under the Master Plan are limited in their earthmoving requirements.

During operation, the Park would have stationary (e.g., boilers for heating, combustion activities) and mobile (vehicle trips to, from, and within the Park) sources of air pollutants. Most stationary sources would be permitted by the BAAQMD, and would not be considered a significant source of air pollution. The only new mobile source emissions associated with Master Plan implementation would be the propane-powered shuttle buses. There would be up to 36 shuttle bus trips per day along the 1.2-mile loop road, with an average of 18 to 20 daily trips. This low number of trips combined with use of propane fuel would result in insignificant increases in zoo-related mobile source emissions.

Motor vehicle trips associated with an increase in Park attendance would be the main source of operational emissions of criteria air pollutants. Mobile source emissions were calculated using EMFAC7F emission factors for year 2005, an average trip length of 7.9 miles (BAAQMD, 1996), a projected 16% increase in estimated attendance levels by year 2000 (over baseline levels), and a projected 38% increase in estimated attendance levels by year 2010 (over baseline levels), and worst-case emissions (peak weekend day during the peak month) are presented as follows:

---

[1] There would be minimal surface disturbance (less than one acre for each project) associated with new animal exhibits (limited to fence installation and construction of shelters), the shuttle road for shuttle buses, widening of Zoo Drive, and the California Interpretive Center. Construction of the proposed Shuttle Road would generally follow the existing fire road, minimizing surface disturbance (with only small areas of fill required to accommodate a wider roadbed in some locations). The California Interpretive Center would have a foundation design that retains surface topography, which would minimize grading requirements. Construction of the Trail along Arroyo Viejo Creek would result in minor amounts of grading (less than 0.25 acre) to accommodate the trail on currently undeveloped land. The proposed Center for Science and Environmental Education would be the largest building to be constructed under the Master Plan and would result in disturbance of less than two acres.

**TABLE 2: PROJECT-RELATED ESTIMATED DAILY REGIONAL EMISSIONS**

| Pollutant | Project-Related Emission (pounds/day)[a] | | | Significance Threshold[b] |
|---|---|---|---|---|
| | Baseline 1995 | 2000 | 2101 | |
| Carbon Monoxide | 118 | 92 | 59 | 550 lbs/day |
| Reactive Organic Gases | 9 | 7 | 4 | 80 lbs/day |
| Nitrogen Oxides | 16 | 14 | 14 | 80 lbs/day |
| Particulate Matter ($PM_{10}$) | 11 | 13 | 16 | 80 lbs/day |

[a] Based on California Air Resources Board model URBEMIS5 using EMFAC7F1.1 emission factors.
[b] Bay Area Air Quality Management District, 1996.

Although implementation of the Master Plan would result in traffic increases in the future, project-related emissions (except $PM_{10}$) are projected to decrease by up to 50% by year 2010, due to decreases in projected emission rates. There would be an increase in $PM_{10}$ emissions, but this increase would be insignificant since emissions would be well below the significance threshold. Project-related emissions would be below BAAQMD significance thresholds for all other mobile source emissions, and therefore, no significant local or regional air quality impacts would occur with implementation of the Master Plan.

Implementation of the proposed Master Plan could result in a reduction in emissions from some existing sources. Under the proposed Master Plan, the existing one-way Zoo Drive (providing access to the main entrance) would be widened to provide two-way ingress and egress to the Park. Existing residential receptors along the southern boundary and exit road could experience a reduction in emissions from egressing vehicles since egressing vehicles could use Zoo Drive under the proposed Master Plan and school buses (which now travel up to the main entrance and parking lot) would be directed to the lower entrance and parking lots adjacent to the proposed Center for Science and Environmental Education near the northern boundary. In addition, the existing Zoo overflow parking lot and fire road (proposed Shuttle Road) are unpaved and an existing source of dust emissions. Proposed paving of the overflow parking lot and Shuttle Road would reduce existing dust emissions currently associated with these two facilities.

Compost piles located in the Zoo in the lower canyon area (north of the existing fire road/proposed Shuttle Road near the overflow parking lot) are an existing source of moderate odors. The current compost piles are less than four feet in height, covered with straw, and are occasionally aerated. Under the proposed Master Plan, the compost operation would be relocated about 100 feet to the south, to an area adjacent to the overflow parking lot. Although the composting operation would be relocated slightly nearer to adjacent residences, it would be setback approximately 500 feet from the nearest residence; and this would not significantly increase nuisance odor potential at residences. A new composting system will be used which would reduce odor potential. This new system would contain the materials within long, air- and water-tight bags that speed decomposition while eliminating odors and the potential for water quality degradation.

**Mitigation Measures**

8a) The following Basic Dust Control Measures shall be implemented at all construction sites:

- Water all active construction areas at least twice daily.
- Cover all trucks hauling soil, sand, and other loose debris *or* require all trucks to maintain at least two feet of freeboard.
- Pave, apply water three times daily, or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites.
- Sweep daily (with water sweepers) all paved access roads, parking areas and staging areas at construction sites.
- Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.

**Significance after Mitigation:** Less than significant.

**Source:** Bay Area Air Quality Management District (BAAQMD), *BAAQMD CEQA Guidelines, Assessing the Air Quality Impacts of Projects and Plans*, 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 9. Alteration of air movement, moisture, temperature, or any change in climate, either locally or regionally? | ☐ | ☐ | ☐ | ☒ |

**Comment**

No buildings or activities required by the Master Plan would be capable of altering wind, moisture, or temperature in public areas. The relatively small scale of the project would not be capable of changing the micro and/or regional climate.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| **Water**. Will the project result in: | | | | |
| 10. Discharge into surface waters resulting in substantial degradation of surface water quality, including but not limited to turbidity, absorption rates, drainage patterns, or the rate or amount of surface runoff? | ☐ | ☒ | ☐ | ☐ |

**Comment**

The project site is located within the Arroyo Viejo Creek Watershed. There are several intermittent and ephermal waterways scattered throughout the site. In addition, Arroyo Viejo Creek, a perennial waterway, flows along the northern boundary of the site. Erosion during project construction activities has the potential to increase soil deposition in these waterways, resulting in increased water turbidity, and potential changes to channel capacity and morphology. However, project compliance with Ordinance No. 10312 and the recommended mitigation measures will reduce potential impacts to a less than significant level.

Construction of the proposed Trail and picnic facilities in the vicinity of Arroyo Viejo Creek could temporarily affect the creek water quality, and pose changes to channel capacity and morphology. This is considered a short term potentially significant impact, however, implementation of the recommended mitigation measures would reduce impacts to a less than significant leve.

The conversion of pervious to impervious surfaces through the development of facilities, roadways and paths has the potential to alter existing drainage patterns, and increase the rate and amount of surface runoff. Although these changes are expected to be minimal, they are considered to be potentially significant.

An increase in impervious surfaces at the site has the potential to alter absorption rates. However, recharge over much of the site including the ridgetops and slopes below, is presently limited by steepness and shallow/clayey soils. Therefore, significant impacts to absorption rates would not be likely.

The manure handling operations would be relocated out of the existing perennial stream located within the River Exhibit, thereby potentially enhancing overall water quality. In addition, the existing restrooms located in the drainage swale in the Arboretum would be relocated adjacent to the meadow and parking lot thereby potentially enhancing water quality in this drainage.

Development of the California 1820 Exhibit area, has the potential to impact the natural flow patterns, and degrade water quality in the intermittent drainages within these areas and is considered to be a potentially significant impact.

**Mitigation Measures**

To mitigate for increased water turbidity the following mitigation measure shall be implmented:

10a) Mitigation Measures 2a - 2d shall be implemented.

To mitigate for the potential degradation of water quality of Arroyo Viejo Creek, the following mitigation measures shall be implemented:

10b) The proposed Trail and picnic facilities shall be sited at least 100 feet away from the high water level of the creek.

10c) In the event of a proposed creek crossing and/or the need to access the creekbed during construction, proper permitting and noticing requirements of the Regional Water Quality Control Board, the California Department of Fish and Game and the U.S. Fish and Wildlife Department shall be followed.

To mitigate for potential impacts of the conversion of pervious to impervious surfaces the following mitigation measures shall be implemented:

10d) Project infrastructure improvements shall be designed and sited to adequately control and handle increased surface water runoff. These improvements shall be approved by the City of Oakland Engineering Department, the California Department of Fish and Game and the East Bay Municipal District.

To mitigate for potential project impacts to natural flow waters and degradation of water quality in intermittent drainages, the following mitigation measures shall be implemented:

10e) Proposed facilities and animal night houses shall be sited at least 100 feet away from drainage channels.

10f) In the event that drainage channels cannot be avoided, the project applicant shall comply with the appropriate notification, permitting and monitoring requirements of the Regional Water Quality Control Board, the California Department of Fish and Game, the U.S. Department of Fish and Wildlife, the City of Oakland, Alameda County, and the East Bay Municipal District.

**Significance after Mitigation:** Less than significant.

**Source:** Naval Medical Center Oakland and City of Oakland, *Draft EIS/EIR Disposal and Reuse for the Naval Medical Center Oakland*, September 1996.
City of Oakland, *Oakland General Plan Update, Land Use and Transportation Element, Technical Report #6*, October 1995.
City of Oakland, *Chabot Observatory and Science Center*, Draft EIR, August 28, 1995.
City of Oakland, *Ordinance No. 10312, Article 6, Grading, Excavation and Fill.*
Oakland Zoo Education Department, Proposed Restoration Plan for the Knowland Park Branch of Arroyo Viejo Creek, Development Plan and EIR, 1993-4.

U.S.G.S., 7.5 Minute Series (Topographic) Map, Oakland East Quadrangle.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 11. Alterations to the course of flood waters, or the exposure of people or property to water related hazards such as flooding or tidal waves? | ☐ | ☒ | ☐ | ☐ |

**Comment**

The project site is not located within a 100 year floodplain as determined by the Federal Emergency Management Act. However, Arroyo Viejo Creek is susceptible to flooding downstream near the Bay. Surge discharges as a result of flushing of the proposed River Exhibit facility may pose downstream flooding in the Arroyo Viejo watershed if the following mitigation measure is not implemented.

**Mitigation Measure**

11a) See Mitigation Measure 10e.

**Significance after Mitigation:** Less than significant.

**Source:** Naval Medical Center Oakland, and City of Oakland, *Draft EIS/EIR for the Disposal and Reuse of Naval Medical Center Oakland*, September 1996.
City of Oakland, Chabot Observatory and Science Center Draft EIR, August 28, 1995.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 12. Change in groundwater quantity, through direct addition or withdrawal, or interception of an aquifer by cuts or excavation? | ☐ | ☐ | ☐ | ☒ |

**Comment**

There would be no changes in groundwater quantity or interception of an aquifer by cuts or excavation as a result of the project, since there are no proposed wells associated with the Master Plan, and groundwater is not available at the depths of proposed grading.

**Source:** Naval Medical Center Oakland and City of Oakland, *Draft EIS/EIR for the Disposal and Reuse of Naval Medical Center Oakland*, September 1996.
City of Oakland, *Chabot Observatory and Science Center Draft EIR*, August 28, 1995.

| **Biotic.** Will the project result in: | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 13. Reduction in quantity or diversity of plant and animal species in the project vicinity, interfere with migratory or other natural movement patterns, degrade existing habitats or require extensive vegetation removal? | ☐ | ☒ | ☐ | ☐ |

**Comment**

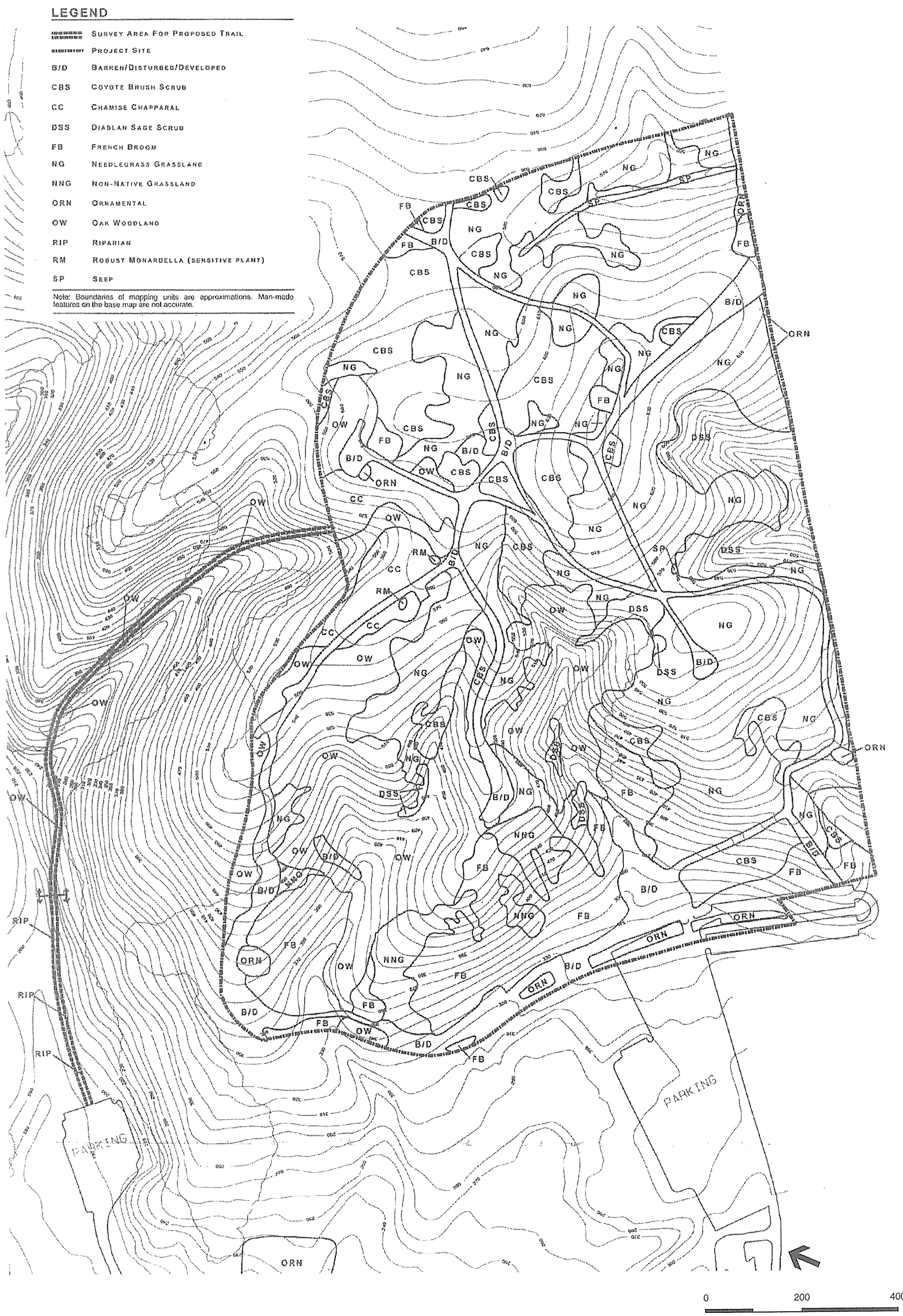
A comprehensive biological report, *Biotic Resources Survey: The Oakland Zoo at Knowland Park*, dated November 1996 was prepared by Cheung Environmental Consulting and used in analyzing potential project impacts. This document is on file at the City of Oakland's Community and Economic Development Agency and available for public review. Please refer to it for a detailed discussion of plant and wildlife species that occur on the project site. Figure 3, on the following page, shows the natural communities and plants in the study area.

***Plants***

The proposed project would result in the commitment of approximately 25 acres to buildings, exhibits, and landscaped areas to develop the California 1820 Exhibit area. Of this 25 acres, approximately 5 - 10 acres are already committed to ongoing Zoo operations including a fire road, composting area, and the existing Bison enclosure. The remaining acreage consists of natural grassland, shrubland and oak woodland.

The areas proposed for the Trail, Interpretive Center, Off-site Breeding Area, and Shuttle Road would experience a complete loss of habitat while the animal exhibit areas may retain some characteristics of natural vegetation. The heaviest impact would occur in the new Bison Exhibit, where it is expected that the grasslands would be entirely eliminated, some trees and shrubs would be lost as a result of browsing, and woody plant regeneration would be halted. Other California 1820 Exhibits that do not feature large grazing animals would be less impacted. Loss of needlegrass grassland, oak woodland, and several types of shrublands are considered to be a potentially significant impact.

Development of individual exhibits proposed as part of the California 1820 Exhibit area and the Center for Science and Environmental Education would result in the removal of trees. The City of Oakland's Tree Preservation Ordinance governs the removal of trees protected by ordinance and requires a tree removal permit. Trees located within the areas designated for development of the California 1820 Exhibit area and the Center for Science and Environmental Education were surveyed and trees eligible for protection under the




SOURCE: *Cheung Environmental Consulting*

**Figure 3**

Natural Communities & Sensitve Plants
in California 1820 Exhibit Area

Ordinance identified. Approximately 98 protected trees (73 native and 25 non-native) would be removed to develop the California 1820 Exhibit area and 67 non-native trees would be removed to develop the Center for Science and Environmental Education.

Appendix A includes the results of the tree survey completed for the project. The loss of protected trees is considered to be a significant impact.

**Mitigation Measure**

13a) The proposed Master Plan would include the implementation of a Habitat Enhancement Plan that would enhance oak woodlands, native grasslands, coastal scrub and riparian woodland, and remove eucalyptus, French broom and other exotic plants from the California 1820 Exhibit area and Upper Knowland Park. The Habitat Enhancement Plan should include the following:

- An annual assessment of the species and distribution of invasive non-native weeds (examples of invasive species would include artichoke thistle, French broom, giant reed, German ivy, pampas grass, Algerian ivy, acacia and eucalyptus). The assessment would include a map and estimate of abundance of weeds.
- A management element for the control of each weedy species. Methods used for each species should be based on currently accepted best available practices, including hand-pulling, cutting followed by topical application of suitable herbicide, use of livestock, removal or burning of cut plant materials, and so on. The justification for the control methods used should be explained, and a tracking system maintained to document areas treated, methods used, and effectiveness of the result.
- A revegetation element for areas where heavy infestations of weeds comprise a significant portion of the existing vegetation. The riparian zone of lower Arroyo Viejo Creek, for example, is so dominated by non-natives that planting of indigenous tree and shrub species following the removal of weeds is needed to speed up the restoration process. This element would include a tracking system for areas treated, a record of the source and species of plant materials used, methods of installation and maintenance, and an assessment of the success of each effort.

13b) A Tree Protection and Revegetation Plan shall be prepared to protect, replace, and preserve trees on the project site. The Plan shall include the following:

- Native trees lost to development shall be replanted at a minimum ratio of 3:1. Non-native trees shall be replanted at a minimum ratio of 1:1.
- Every 10 years, prepare a census of trees qualifying for protection under the Oakland Tree Protection Ordinance within the project area. The census will document the condition of such trees, and recommend actions to extend the life and health of the trees. Recommended actions could include protective devices for reduction of vandalism, excessive treading by pedestrians or rubbing of bark, modification of drainage, erosion or sedimentation to protect trees, and

modification of irrigation patterns to reduce pathogens. Recommendations and actions taken would be reported to the City of Oakland and the Department of Fish and Game.

- Protection of oaks in Upper Knowland Park outside of the developed areas of the Zoo will be addressed through the development of a management element for Upper Knowland Park. Since a closed-canopy oak woodland is a "fire-safe" vegetation type and is visually pleasing, the maximum natural extent of oak woodland may be the management goal. Management practices needed to achieve and maintain oak woodland or forest are: a minimum of grazing livestock, especially during the dry months; few fires; and slope stability. Maintenance of oak woodland would dovetail with weed control measures discussed under Mitigation Measure 13a.

**Significance after Mitigation:** Less than significant.

***Wildlife***

The quantity of some animal species would potentially be decreased by project construction and degradation of habitat for small vertebrates and invertebrates in enclosures such as the Bison Exhibit. However, the Habitat Enhancement Plan and preservation of open space to the east of the California 1820 Exhibit proposed by the Master Plan would reduce potential impacts to less than significant levels.

Small vertebrates such as Pacific treefrogs and invertebrate species living in Arroyo Viejo Creek may be temporarily impacted by sedimentation of the creek due to construction of the proposed viewing platforms. Project compliance with Ordinance No. 10312 and the recommended mitigation measures would reduce potential impacts to a less than significant level.

Vehicle and pedestrian traffic on the proposed paved shuttle road could interfere with diurnal movements of wildlife species in the project area, including deer and several reptile species in the area. The Master Plan's requirement that a maximum speed of 10 miles per hour will be observed and development of an educational program to inform the shuttle drivers and Zoo personnel driving to the off-site breeding exhibit to watch for and yield to all wildlife would reduce this impact to a level less than significant.

**Mitigation Measures**

13c) Although mitigations recommended by the Master Plan to minimize impacts to wildlife due to vehicle and pedestrian traffic would reduce potential impacts to less than significant, the following mitigation measure would further reduce the impact. If feasible, the Shuttle Road should be a maximum of 15 feet in width with no curbs or gutters to reduce potential impacts to the Alameda whipsnake.

13d) To mitigate for the potential impacts to small vertebrates from construction of the viewing platforms, the platforms shall be constructed in the dry season (late summer/ fall), and native riparian species shall be planted in areas disturbed by construction activities and mitigation measures 2a - 2d included under the Earth section of this Initial Study shall be implemented.

**Significance after Mitigation:** Less than significant.

**Source:** Cheung Environmental Consulting, *Biotic Resources Survey: The Oakland Zoo at Knowland Park*, November 1996.
Cheung Environmental Consulting, Tree Surveys conducted Summer 1995, and January, 1997.
City of Oakland, *Oakland Municipal Code, Article 6.*

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 14. Reduce the numbers of any unique, rare or endangered species of plants or animals? | ☐ | ☒ | ☐ | ☐ |

**Comment**

***Plants***

The Shuttle Road, as proposed, would remove a colony of rare and endangered robust monardella (*Monardella villosa ssp. globosa*) near the proposed Interpretive Center. This would be considered a significant impact.

**Mitigation Measures**

14a) The Shuttle Road should be re-routed to avoid the robust monardella colony. A buffer of a minimum of 25 feet shall be established between any project soils disturbance and the existing colony.

14b) The Bison Exhibit boundary shall be revised to exclude the robust monardella colony; alternatively, the robust monardella shall be protected with a perimeter fence providing a 25-foot buffer around the colony.

**Significance after Mitigation:** Less than significant.

**Source:** Cheung Environmental Consulting, *Biotic Resources Survey: The Oakland Zoo at Knowland Park*, November 1996.
City of Oakland, *Ordinance No. 10312, Article 6, Grading, Excavation and Fill.*

***Wildlife***

*Alameda Whipsnake.* Although no State-threatened Alameda whipsnakes were observed during field visits, most of the project site has all or most of the habitat features which are suitable for the Alameda whipsnake and would be considered potential habitat. Several of the proposed components of the Master Plan would have no impact on the Alameda whipsnake because they are either located in unsuitable habitat or are being constructed within the boundaries of the existing Zoo and Arboretum. These include the Tropical Rain

Forests of the World, Arboretum, Children's Zoo, African Savannah, and the Center for Science and Environmental Education.

Impacts to the Alameda whipsnake would potentially be significant unless mitigation is incorporated. If present on the site, the Alameda whipsnake could be expected to use portions of nearly all of the habitats on site, including chamise chaparral, Diablan sage scrub, Coyote brush scrub, grassland, oak woodland, and possibly some of the areas of French broom. Potential impacts to the Alameda whipsnake include:

- Direct mortality during grading to construct the shuttle road.

- Loss of potential Alameda whipsnake habitat. Table 3 identifies the maximum acreage of potential Alameda whipsnake habitat in each exhibit and in the area outside of the exhibit but enclosed by the proposed Shuttle Road. The level of impact in each of the areas identified will vary. For example, potential whipsnake habitat in the Bison exhibit is expected to be severely impacted due to trampling of the vegetation or denuding of the slopes by the bison. Impacts in the Canyon and River Exhibits are expected to be moderate.

  Impacts in the Gray wolf exhibit are expected to be less severe as only minor modification of the habitats within these exhibits will take place. Alameda whipsnakes may be consumed or harmed by exhibit animals. Impacts to the habitat in the project area enclosed by the Shuttle Road, but outside of the exhibits would be minimal. Creation of the proposed hiking trail would result in removal of chamise chaparral habitat. No acreage of potential Alameda whipsnake habitat to be removed for Trail construction was calculated because of the small size of the area to be removed and habitat enhancement benefits the Trail would provide by opening what is currently a dense closed-canopy stand of chamise chaparral and because of the other mitigation measures which shall be implemented.

- Potential restriction of movement into and out of the area enclosed by the Shuttle Road and increased risk of road mortality due to vehicle traffic on the Shuttle Road.

- Potential for spread of French broom. French broom typically occurs in dense closed-canopy stands that allow little light penetration and minimal habitat value for the whipsnake. French broom, which is present in several areas on the project site can invade high quality whipsnake habitat and degrade its value. Some of the stands of broom on the site are more open and are in close proximity to high quality whipsnake habitat. These stands may currently provide some value as whipsnake habitat, if whipsnakes are present on the site.

  However, in the long run, removal of as much broom as possible from the site and measures to prevent its spread would benefit the whipsnake.

*Special-Status Birds.* Although not observed on the project site, Cooper's hawk and sharp-shinned hawk potentially occur on the site and Cooper's hawk potentially nest there. If nests are present during construction of the Shuttle Road and creek-viewing platforms, this would be considered a potentially significant impact.

*Special-Status Invertebrates.* Two invertebrates, the San Francisco Lacewing and the Bridge's Coast Range snail have some potential to occur in the riparian and woodland areas. Impacts to these species would be avoided by the Master Plan's proposed careful siting of project components in woodland and riparian habitats. No foreign material would be used in construction of the proposed Trail and it would be as narrow as possible. This would minimize potential impacts to the travel of the snails, if present.

**TABLE 3: ALAMEDA WHIPSNAKE HABITAT POTENTIALLY IMPACTED BY PROJECT**

| Exhibit or Location | Acreage of Habitat Types | | | | | |
|---|---|---|---|---|---|---|
| | Chamise Chaparral | Diablan Sage Scrub | Coyote Brush Scrub | French Broom | Grassland | Oak Woodland |
| Bison /Interpretive Center | 3.6 | 0.0 | 0.7 | 0.0 | 3.5 | 0.0 |
| Off-site Breeding Areat | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | .8 |
| Gray Wolf Exhibit | 0.0 | 0.4 | 1.4 | 0.2 | 1.5 | 0.2 |
| River Exhibit | 0.0 | 0.2 | 0.3 | 5.6 | 5.0 | 0.5 |
| Canyon Exhibit | 0.0 | 0.0 | 0.0 | 4.2 | 0.9 | 7.3 |
| **TOTAL WITHIN EXHIBITS** | **3.6** | **0.6** | **2.4** | **10.0** | **10.9** | **8.8** |
| Habitat Enclosed by Shuttle Road but Outside Exhibits | 0.0 | 1.3 | 5.8 | 4.0 | 18.9 | 28.0 |
| **TOTAL** | **3.6** | **1.9** | **8.2** | **14.0** | **29.8** | **36.8** |

### Mitigation Measures

To mitigate for the potential direct mortality to Alameda whipsnakes, loss of Alameda whipsnake habitat, the restriction of movement of Alameda whipsnakes, and the spread of French broom, the following measures shall be implemented.

14c) Obtain a Permit for Management of a rare or threatened species pursuant to Fish and Game Code Section 2081. The Management Permit will include all details of a Mitigation and Monitoring Plan which will be prepared by the East Bay Zoological Society. The Mitigation and Monitoring Plan will be subject to approval by the California Department of Fish and Game and the U. S. Fish and Wildlife Service. A summary of the measures to be incorporated into the Mitigation and Monitoring Plan are presented below.

14d) All removal of scrub or chaparral habitat shall be done by hand with axes or machetes. Chain saws could be used for larger shrubs.

14e) A biologist qualified to handle Alameda whipsnakes shall monitor all scrub or chaparral removal and all construction activities which may impact the Alameda whipsnake.

14f) Alameda whipsnake habitat shall be preserved in perpetuity on property owned by the East Bay Zoological Society and contiguous to the east of the California 1820 Exhibit area. Numerous large areas of scrub and/or chaparral habitat are present in the proposed mitigation area and these appear to provide an adequate amount of habitat to offset impacts within the project site. The amount of habitat preserved shall be in accordance with current requirements of the California Department of Fish and Game.

14g) To reduce the potential for mortality on the shuttle road to a level less than significant, a maximum speed of 10 miles per hour shall be required and shuttle drivers and personnel driving to the off-site breeding exhibit will be instructed to watch for and yield to all wildlife. The road shall also be a maximum of 15 feet in width with no curbs or gutters. Specially designed "snake crossings" under the shuttle road may also be required.

14h) Measures will be taken to prevent the spread of French broom on the site and to remove as much French broom from the site as possible in order to keep it from degrading higher quality whipsnake habitat.

To mitigate for potential impacts to special status birds, the following measure shall be implemented:

14i) Prior to construction of the creek-viewing platforms, and construction of the Shuttle Road through woodland areas, surveys for nesting Cooper's hawks should be conducted. If no nests are present, construction can proceed. If a nest is present in the vicinity of the site for the viewing platforms, construction should be delayed until the young have fledged. Once the platforms and Shuttle Road are completed, their presence and the presence of hikers on the Trail would be considered a less than significant impact.

To mitigate for potential impacts to special status invertebrates, the following measure shall be implemented:

14j) During construction, dust control mitigation measures included in the Air Quality section of this Initial Study (8a) shall be implemented, which will reduce potential impacts to the air passages of San Francisco lacewings

**Significance after Mitigation:** Less than significant.

**Source:** Cheung Environmental Consulting, *Biotic Resources Survey: The Oakland Zoo at Knowland Park*, November 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 15. Introduction of new species of plants or animals into an area, or result in a barrier to the replenishment of existing plant species, or the migration or movement of animals? | ☐ | ☒ | ☐ | ☐ |

**Comment**

***Plants***

Grading and landscaping would create open, disturbed soil suitable for colonization by weeds. Operation of the Shuttle Bus and other vehicles (e.g., security and fire suppression) would import weed seeds into the California 1820 Exhibit area. Because the Interpretive Center, Off-site Breeding Area and new exhibits would be set within native habitat in Upper Knowland Park, some of these weeds will invade the native habitat, especially where soil disturbance has occurred. This would be a significant impact.

**Mitigation Measure**

15a) The operations and maintenance plan for the new exhibits shall include a weed management and control element. This should include monitoring the natural portions of Upper Knowland Park for infestations of non-native weeds, and implementation of control measures to prevent the weeds from degrading the natural vegetation.

**Significance after Mitigation:** Less than significant.

***Wildlife***

Potential impacts and recommended mitigation measures discussed under the wildlife section of Questions #13 and #14 are applicable.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 16. Deterioration to existing aquatic or wildlife habitat? | ☐ | ☒ | ☐ | ☐ |

**Comment**

***Plants***

Several seeps and springs exist in Knowland Park in or near the proposed California 1820 Exhibit area. The proposed Master Plan has sited exhibit areas to avoid these resources. The proposed Trail would parallel Arroyo Viejo Creek and cross one of its major tributaries, potentially resulting in degradation of this waterway from sedimentation and damage to riparian vegetation. This is considered a significant impact.

**Mitigation Measure**

16a) The Trail shall be constructed 100 feet from the creek bank and on the outer edges of the riparian vegetation. Streambed crossings shall consist of walkways constructed well above the banks. Creek viewing platforms located within the 100-foot buffer shall be located to minimize impacts to riparian vegetation. Disturbed riparian vegetation will be enhanced by removal of non-native species and planting and maintenance of indigenous species. Erosion control requirements contained in Ordinance No. 10312 would prevent sedimentation resulting from construction of the Trail and viewing platforms.

**Significance after Mitigation:** Less than significant.

***Wildlife***

Potential impacts and recommended mitigation measures discussed under the wildlife section of Questions #13 and #14 are applicable.

| Noise. Will the project result in: | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 17. Increase in existing ambient noise levels near sensitive noise receptors? | ☐ | ☐ | ☒ | ☐ |

**Comment**

The predominant source of noise at the project site and vicinity is motor vehicle traffic traveling on the I- 580 freeway. Other sources of noise primarily relate to activities associated with the Park (loading and unloading activities, cars and buses driving to the Zoo's main entrance, pedestrian activities, animals, etc.). Noise measurements collected at various locations along the southern Park boundary indicate that residences located adjacent to the southern boundary (near the parking lots and proposed Shuttle Road) are subject to noise levels of 55 to 60 dBA (Ldn), decreasing with distance from the I-580 freeway. Noise measurement data is presented in Table B-1 of Appendix B.

Noise measurement data indicate that daytime noise levels at the Zoo's main parking lot and overflow parking lot were higher on Saturday than on Friday. When the distance attenuation effects of freeway noise are considered with the collected noise data, it appears that existing Zoo-related activities at the main entrance parking lot increase ambient noise levels by 1 to 2 dBA in the vicinity of the southern Park boundary (refer to Appendix B for more discussion).

Human response to noise varies considerably from one individual to another. Effects of noise at various levels can include interference with sleep, concentration, and communication; physiological and psychological stress; and hearing loss. Given these effects, some land uses are considered more sensitive to ambient noise levels than others. Sensitive noise receptors are generally considered to be uses including hospitals, schools, and residences. Sensitive receptors in the project vicinity include residential uses located directly adjacent to the southern Park boundary and nearest the Zoo. Residential sideyards and backyards abut the Park property boundary. With the Zoo's main parking lot set back approximately 50 feet from the property line and residences set back a minimum of 15 feet, the closest distance between residential receptors and noise sources in the parking lot is approximately 65 feet. Along the northern Park boundary, there are multi-family residential uses on Mountain Boulevard that are located 500 to 600 feet north of the Park entrance. Single-family residences located on Golf Links Road are located approximately 700 to 800 feet from the Park entrance.

The City of Oakland, in its noise regulations, recognizes the variable sensitivity of certain activities to noise and thus, established noise exposure criteria defining acceptable noise levels. The City utilizes the land use compatibility noise guidelines recommended by the State of California and they are presented in Figure B-2 of Appendix B. For single-family residential uses, State guidelines indicate that noise levels up to 60 dBA (Ldn or CNEL) are considered normally acceptable. "Normally acceptable" is defined as satisfactory for the specified land use, assuming that normal conventional construction is used in buildings. Under most of these land use categories, overlapping ranges of acceptability and unacceptability are presented, leaving some ambiguity in areas where noise levels fall within the overlapping range. In this analysis, noise levels up to 60 dBA are considered normally acceptable for residential uses since residences in the project vicinity are currently subject to noise levels of 60 dBA or less. When existing noise measurement data are compared to City noise guidelines, noise levels at residences located along the southern Park boundary are considered normally acceptable for residential uses, even those located adjacent to the Zoo's main parking lot.

The potential significance of impacts identified in this Initial Study are defined by comparing existing and projected noise levels at the site and adjacent areas with two criteria: (1) the City-adopted state land use compatibility noise guidelines for all specified uses and City guidelines for extensive natural recreation areas; and (2) a determination of whether the incremental noise increase would be noticeable to most people. A 10-dBA incremental noise increase is perceived by most people to be a doubling in the loudness of a sound. A 5-dBA increase is readily noticed by most people, while a 3-dBA increase is marginally noticeable to most people. For this Initial Study, the proposed project would result in a significant impact if: (1) the project would result in noise increases of 3 dBA or more where noise levels are currently above acceptable levels or where the project would result in acceptability thresholds being exceeded; or (2) the project would result in a 5 dBA or greater noise increase even if the acceptability threshold has not been reached.

Implementation of the proposed Master Plan would have four primary effects on the existing noise environment along the Park's southern boundary: (1) projected increases in attendance levels would increase traffic noise at the Zoo's main entrance; (2) a new source of noise, shuttle buses, would be introduced along the proposed Shuttle Road in the California 1820 Exhibit area; (3) a noise decrease at the Zoo's main entrance parking lot would result from the redirection of school-related bus and vehicular traffic from the main entrance to the Zoo's secondary entrance adjacent to the proposed Center for Science and Environmental Education; and (4) the proposed two-way Park entry (Zoo Drive) would result in decreased use of the existing Park exit road (to 106th Avenue) and increased use of the Park entry road.

Projected increases in average and peak attendance levels would result in increased parking demand over existing levels. Since the Zoo's main parking lot is currently utilized on weekdays and weekends, no significant change in noise levels are anticipated. However, the overflow parking area is used less frequently and it is anticipated that this area would be used more frequently as attendance levels increase. Noise levels in the vicinity of the overflow parking lot are 57 dBA (Ldn; see Table B-1 of Appendix B), and the increased parking lot activity would result in a 1 to 2 dBA noise increase. This projected incremental increase is based on the measured noise levels that were attributable to activities at the main parking lot. Even with this increase, ambient noise levels would remain at acceptable levels for residential uses (less than 60 dBA [Ldn]). Therefore, the incremental increase is considered less-than-significant. It should be noted, however, that although most people would not perceive such an increase in ambient noise level, adjacent residents would notice the increased frequency of overflow parking lot use. The proposed provision of a six-foot high (minimum) solid wood or masonry fence along the southern Park boundary (as far east as the east edge of the Zoo's overflow parking lot) would reduce the potential for perceived disturbance by adjacent residents due to increased activity in the overflow parking lot vicinity.

The proposed Master Plan would introduce a new source of noise into the project area. Propane-powered shuttle buses would be used along the proposed Shuttle Road in the California 1820 Exhibit area. A maximum of 36 trips per day would travel along the Shuttle Road, and bus operation would occur during the daytime hours only. The Shuttle Road would be located well within the Park boundary (away from sensitive noise receptors) except for one 500-foot-long section which would extend along the southern Park boundary. Since this road section would be located approximately 100 feet north of the Park boundary, existing residences could be located as close as 150 feet from the roadway. Shuttle buses would travel downhill along this section of the loop road and the primary source of bus noise would be the brakes rather than the motor. No loudspeakers are proposed on the shuttle buses. It is anticipated that this level of shuttle bus activity would increase ambient noise levels by 0.2 dBA (Ldn) at existing residences located along the southern Park boundary adjacent to the Shuttle Road. Such an increase in ambient noise levels would not be perceptible to most people, and therefore, is not considered significant. In addition, even with this increase, ambient noise levels would remain within acceptable levels for residential uses (60 dBA [Ldn] or less).

Under the proposed Master Plan, school-related bus and vehicular traffic would be directed to the Arboretum parking lots located adjacent to the proposed Center for Science and Environmental Education rather than the Zoo's main entrance parking lot. Such redirection of traffic would result in a decrease in weekday noise at the main entrance parking lot. However, noise levels would increase in the vicinity of the Park entry due to increased bus and vehicular traffic activity at the Center. The existing seven to 12 buses per day would enter the Park at the same location (at Golf Links Road), but rather than travel up Zoo Drive to the Zoo's main entrance, school-related buses and vehicles would enter the loop road to the Center for Science and Environmental Education, remaining to the north of the Zoo. The closest sensitive receptors would be the single-family residences located approximately 1,000 to 1,200 feet to the north. These receptors are currently subject to school-related buses and vehicles as they enter the Park. However, under the Master Plan, these receptors would also be subject to these same buses/vehicles as they leave the Park, increasing the bus/vehicle traffic on Golf Links Road by seven to 12 trips per day. Such an increase in bus and vehicular traffic noise would not significantly change ambient noise levels at these residences due to the intervening distance, time of day (weekdays during the daytime hours only), and level of traffic already occurring in this vicinity.

The proposed two-way Zoo Drive would result in decreased use of the existing Park exit (to 106th Avenue) and increased use of the Park entrance. Implementation of the proposed project would result in a decrease in traffic noise at residences located adjacent to the Park exit and increase along the entrance. There are no sensitive receptors located adjacent to the Park entrance or the section of Golf Links Road between the entrance and freeway (where most Park-related traffic would travel). The closest residential receptors are on Mountain Boulevard approximately 500 feet from this road. At this distance, the incremental increase in traffic noise from the two-way entry is not expected to significantly alter ambient noise levels at these residential receptors.

**Source:** City of Oakland, *Oakland Comprehensive Plan Noise Element,* September 1974.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 18. Exposure of people to severe noise levels? | ☐ | ☒ | ☐ | ☐ |

**Comment**

Implementation of the Master Plan would result in short-term noise increases due to construction. For this Initial Study, the proposed project would result in a significant impact if exterior construction noise levels at the nearest residential receptors exceed 70 dBA during the daytime hours.

During project construction, temporary noise increases would result from the operation of heavy equipment. Project construction would occur at various locations around the Park. Construction of the Center for Science and Environmental Education, located in the Arboretum, would occur within 1,000 feet of the northern Park boundary. Construction would also occur along Zoo Drive, the Zoo's main entrance parking lot and overflow parking lot, and the California 1820 Exhibit area. Construction noise levels would fluctuate depending on the construction phase, equipment type and duration of use, distance between noise source and receptor, and presence or absence of barriers between noise source and receptor. To estimate probable noise impacts, typical equipment and construction techniques are assumed.

Construction noise sources range from about 76 to 85 dBA at 50 feet for most types of construction equipment with slightly higher levels of about 88 to 89 dBA for certain types of earthmoving (scrapers, pavers) and impact equipment (jack hammers). The highest noise levels would be generated by rock drills and pile drivers, which can generate noise peaks of approximately 98 and 101 dBA at 50 feet, respectively. The rate of attenuation is about six decibels (dBA) for every doubling of distance from a point source. Based on the small scale of proposed buildings shown on the Master Plan, it is anticipated that pile drivers or rock drills would not be required for project construction. Typical noise levels at 50 feet from the noise source for several types of construction equipment and potential noise attenuation with feasible noise controls are shown in Table B-2 of Appendix B.

Noise peaks generated by construction equipment could result in temporary disturbance (e.g., speech interference) to persons in adjacent buildings if the noise level in the interior of the building exceeds 45-50 dBA (Caltrans, 1991). At 60 dBA, sentence intelligibility decreases to approximately 97%. At 70 dBA, conversation becomes difficult even for very short speaker-listener distances (two to three feet). Based on these speech interference significance criteria, exterior noise levels exceeding 70 dBA are presumed to result in interior speech interference. This assumes a 20-dBA noise reduction that can be achieved with windows closed, and such a noise reduction could be maintained only on a temporary basis in some cases since windows must remain closed at all times.

The closest residences are located a minimum of approximately 65 feet from the southern Park boundary and 1,000 to 1,200 feet from the closest area of construction near the northern Park boundary. When construction occurs along the southern Park boundary in the Zoo's main entrance parking lot and overflow lot, construction noise peaks at residences to the south could reach levels that are approximately 2 dBA lower than those listed in Table B-2 of Appendix B. Noise peaks at the closest receptors adjacent to the southern Park boundary could reach 74 to 87 dBA, periodically exceeding the 70-dBA exterior speech interference noise criterion. This is considered a potentially significant impact.

### Mitigation Measure

18a) Project contractors shall be required to implement noise control techniques to minimize disturbance to adjacent or nearby sensitive noise receptors during project construction in the vicinity of the southern Park boundary:

1. The proposed solid wood or masonry fence along the southern Park boundary shall be constructed and completed prior to construction of proposed improvements to the main entrance parking lot and overflow parking lot.

2. Equipment and trucks used for project construction shall utilize the best available noise control techniques (e.g., improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures and/or acoustically-attenuating shields or shrouds, wherever feasible and necessary) in order to minimize construction noise impacts. Construction equipment shall not generate noise levels above 75-80 dBA at 50 feet as listed in Table B-2 of Appendix B, or as required by City ordinance, in order to provide acceptable interior noise levels at nearby or adjacent residential receptors.

3. Impact tools (e.g., jack hammers, pavement breakers, and rock drills) used for project construction shall be hydraulically or electrically powered wherever possible to avoid noise associated with compressed air exhaust from pneumatically-powered tools. However, where use of pneumatically powered tools is unavoidable, an exhaust muffler on the compressed air exhaust shall be used; this muffler can lower noise levels from the exhaust by up to about 10 dBA. External jackets on the tools themselves shall be used where feasible, and this could achieve a reduction of 5 dBA. Quieter procedures shall be used such as drilling rather than impact equipment whenever feasible.

4. During project construction, truck operations shall be prohibited during the nighttime hours (8 p.m. to 7 a.m.) and the operation of heavy equipment shall be limited to 7:30 a.m. to 7:30 p.m., Monday through Saturday, to minimize potential disturbance of adjacent and nearby residential receptors.

5. Stationary noise sources shall be located as far from sensitive receptors as possible. If they must be located near existing receptors, they should be adequately muffled to the extent feasible and enclosed within temporary sheds.

When construction occurs along the section of the uphill loop road that extends along the southern Park boundary, residences to the south (which would be approximately 150 feet away) would be subject to noise peaks of 70 to 80 dBA, periodically exceeding the 70-dBA criterion. However, the short-term nature of these noise peaks (two to four weeks for construction of this 500-foot long section of the Shuttle Road) and implementation of noise control measures listed above would reduce potential impacts to a less-than-significant level. Residential receptors located 1,000 feet or more from the northern Park boundary would not be significantly affected by construction noise; at 1,000 feet, the intervening distance would be adequate to maintain construction noise peaks at or below the 70-dBA criteria.

**Significance after Mitigation:** Less than significant.

**Source:** U.S. Environmental Protection Agency, *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*, 1971.
California Department of Transportation, Division of New Technology, Materials & Research, *Noise, Technical Analysis Notes,* March 1991.

**Light and Glare.** Will the project result in:

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 19. Produce new light or glare in areas sensitive to light and glare (i.e., residents near industrial and commercial uses, freeways, and parks)? | ☐ | ☐ | ☒ | ☐ |

**Comment**

New development proposed under the Master Plan would introduce limited night lighting on the project site. The proposed Center for Science and Environmental Education would provide for educational opportunities such as classes and lectures that may occur during the evening hours. The facility would be located in the Arboretum. Night lighting would be screened by surrounding trees and vegetation and would not be visible to adjacent residences. Other development would consist primarily of animal exhibits designed to provide a natural environment, the Interpretive Center, the Off-site Breeding Area, and improvements and upgrades to existing facilities; these facilities would not include night lighting. New facilities would be sited to minimize their visibility to adjacent residences. Potential light and glare impacts are considered to be less than significant.

**Source:** East Bay Zoological Society, *Oakland Zoo in Knowland Park Master Plan*, October 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 20. Produce shade and shadow, or otherwise diminish sunlight or solar access? | ☐ | ☐ | ☐ | ☒ |

**Comment**

Development proposed by the Master Plan would consist of low-rise, small-scale buildings and animal exhibits designed to provide a natural habitat. New development would not affect the sunlight or solar access available to adjacent residences.

**Source:** East Bay Zoological Society, *Oakland Zoo in Knowland Park Master Plan*, October 1996.

**Land Use and Socioeconomics Factors.** Will the project result in:

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 21. Conflict with approved plans for the area or the Oakland Comprehensive Plan or alter the present or planned land use of an area? | ☐ | ☐ | ☐ | ☒ |

**Comment**

The project would expand and enhance existing facilities at the Park. The proposed Master Plan is consistent with the Open Space, Conservation and Recreation (OSCAR) Element of the General Plan. It would provide additional recreational opportunities for the community and would enhance habitat conservation at the site. The Master Plan would preserve about 73 percent of the project site as permanent open space. The project site is zoned R-30 and will require a Major Conditional Use Permit to meet the requirements of the zoning ordinance.

**Source:** City of Oakland, *Open Space and Conservation and Recreation Element, Oakland General Plan*, October 1995.
Oakland Zoological Society, The Oakland Zoo in Knowland Park Master Plan, October 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 22. Require relocation of residents and/or businesses, or affect existing housing or create a demand for additional housing? | ☐ | ☐ | ☐ | ☒ |

**Comment**

The project consists of the updating of the Zoo's Master Plan which includes the proposed enhancement and expansion of recreation and environmental education facilities. The project would not result in the relocation of residents or businesses.

**Source:** Oakland Zoological Society, *The Oakland Zoo in Knowland Park Master Plan*, October 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 23. Cause a substantial alteration in neighborhood land use, density or character? | ☐ | ☐ | ☐ | ☒ |

**Comment**

The Master Plan would expand and enhance existing Park facilities and would preserve about 73 percent of the project site as permanent open space. Development proposed under the Master Plan would consist of educational facilities, new animal exhibits, and the upgrade of existing facilities. Structures would be sited to minimize their visibility from adjacent properties. Implementation of the Master Plan would not cause a substantial alteration to neighborhood land use, density or character.

**Source:** Oakland Zoological Society, *The Oakland Zoo in Knowland Park Master Plan*, October 1996.

| <u>**Human Health and Risk of Upset**</u>. Will the project involve: | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 24. The risk of an explosion or the release of hazardous substances, including oil, pesticides, chemicals or radiation, in the event of an accident that could create or expose people to potential health hazards? | ☐ | ☐ | ☐ | ☒ |

**Comment**

New development proposed by the Master Plan would not involve the use or disposal of potentially hazardous materials. The existing veterinary hospital uses compressed oxygen gas, x-ray film and developer, and autoclave sterilizer and pharmaceuticals. The oxygen gas tank is handled and refilled by an off-site vendor using safe practices. The x-ray film and developer is removed and disposed of by Diagnostic X-ray. The sterilizer uses heat only, and no ethylene oxide is required. Pharmaceuticals are dispensed by a veterinarian and no radioactive materials (e.g., x-ray tracers) are used in the veterinary hospital.

**Source:** Project Application for The Oakland Zoo in Knowland Park Master Plan November 12, 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 25. Possible interference with an emergency response plan or emergency evacuation plan? | ☐ | ☐ | ☐ | ☒ |

**Comment**

The Zoo's Emergency Preparedness and Response Plan and Animal Capture Plan address emergency situations at the Zoo; e.g. health emergencies, animal escapes, fire, earthquake. This plan would be updated to incorporate the new facilities and programs developed under the Master Plan. The Master Plan would not conflict with the City's Multi-Hazard Functional Plan (City Emergency Plan).

**Source:** City of Oakland, *Multi-Hazard Functional Plan (City Emergency Plan).*
Oakland Zoo, *Emergency Preparedness and Response Plan.*
Oakland Zoo, *Animal Capture Plan.*

| **Transportation/Circulation.** Will the project result in: | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 26. Substantially increase vehicular movement resulting in traffic hazards to motor vehicles, bicyclists, or pedestrians; or create a demand for new parking facilities? | ☐ | ☐ | ☒ | ☐ |

**Comment**

The proposed project would result in an increase to vehicle traffic both on and off the site. The majority of the projected increase in vehicle movements would occur during non-peak periods and would not result in a hazard to vehicles, bicycles, or pedestrians. Master Plan proposed site circulation and access improvements would be sufficient to meet the estimated project peak demand. A discussion of project vehicle trip generation, local traffic operations, proposed access and circulation improvements, project parking demand and related safety issues is provided below.

***Project Generated Traffic***

Project attendance and vehicle trip generation estimates are shown in Table 4. The forecasts for years 2000 and 2010 are based on an annual attendance growth rate of two percent.[2]

[2] The two percent annual growth rate represents a conservative figure for a projected annual growth rate over the next 15 years. The average attendance growth rate for other Zoos located in the Western U.S. over the past ten years has been less than 1.5%.

**TABLE 4: PARK ATTENDANCE AND TRAFFIC PROJECTIONS (Based on Two Percent Annual Growth Rate)**

| | Baseline - 1994 | Year 2000 | Year 2010 |
|---|---|---|---|
| **Annual Attendance** | 307,645 | 346,460 | 422,330 |
| Average Month[a] | 24,610 | 27,720 | 33,785 |
| Peak Month[b] | 42,455 | 47,810 | 58,280 |
| Average Weekday | 530 | 595 | 725 |
| Average Weekend | 1,505 | 1,695 | 2,065 |
| Peak Weekday | 1,150 | 1,395 | 1,580 |
| Peak Weekend | 2,030 | 2,285 | 2,785 |
| **Vehicle Trips** | **Baseline - 1994** | **Year 2000** | **Year 2010** |
| *Average Weekday Daily* | 188 | 212 | 259 |
| Peak Hour - In | 45 | 51 | 62 |
| Peak Hour - Out | 53 | 59 | 72 |
| *Average Weekend* | | | |
| Daily | 537 | 605 | 737 |
| Peak Hour - In | 128 | 144 | 176 |
| Peak Hour - Out | 150 | 169 | 206 |
| *Peak Weekday* | | | |
| Daily | 411 | 463 | 565 |
| Peak Hour - In | 98 | 111 | 135 |
| Peak Hour - Out | 115 | 130 | 158 |
| *Peak Weekend* | | | |
| Daily | 724 | 816 | 994 |
| Peak Hour - In | 173 | 195 | 237 |
| Peak Hour - Out | 203 | 228 | 278 |

a October
b July

A 1994 base year attendance figure as well as 1995 vehicle counts and surveys[3] were used to develop estimates of project vehicle trip generation.

Park attendance varies on a seasonal as well as a daily basis. Table 4 shows estimates for peak and average month conditions on weekdays and weekends. Average conditions are representative of September when about eight percent of the Parks's annual attendance occurs. Peak month conditions occur in July with approximately 13.8 percent of annual attendance. During average months weekly attendance is higher on weekends with 55 percent of the weekly total than on weekdays with 45 percent of the weekly total. This trend is reversed during peak months with the higher percentage (57 percent) of the seven day total occurring on weekdays.

3 Oakland Zoo traffic counts and vehicle occupancy surveys conducted by ESA. 7/2/95.

Forecast peak hour vehicle trips were determined based on visitor vehicle occupancy rates surveyed at the Park in 1995.[4] The surveys found that occupancy rates averaged approximately 2.8 persons per arriving vehicle and 3.0 persons per departing vehicle.

The difference between average vehicle occupancies is related to a higher percentage of families going to the Zoo than using the picnic / recreational area located in the Arboretum. It is important to note that peak hour vehicle activity is different for arriving and departing traffic. The Park is open from 10:00 a.m. to 4:00 p.m. daily. The peak hour for arriving vehicles generally occurs between noon and 2:00 p.m. under all conditions. Vehicle departures tend to peak between 3:00 p.m. and 5:00 p.m. on weekends and between 2:00 p.m. and 4:00 p.m. on weekdays.

The projected increase in Park attendance in the years 2000 and 2010 would result in an increase in traffic. The net increases in peak hour traffic (arrivals / departures) for average and peak month conditions is summarized in Table 5.

***Area Traffic Operations***

Existing traffic operations in the study area during the weekday afternoon peak hour (5:00 p.m. to 6:00 p.m.) are characterized as congested and unacceptable at the unsignalized intersections of Golf Links Road / I-580 northbound ramps and Golf Links Road / 98th Avenue. Traffic counts taken in 1995 for *the Disposal and Reuse of Naval Medical Center Oakland EIS/EIR*, determined the unsignalized intersections at 98th Avenue / I-580 southbound on-ramp and Mountain Boulevard /Golf Links Road both currently operate at acceptable levels of service C or better during the afternoon commute hour. The level of service (LOS) of an intersection is a measure of its ability to satisfy travel demand and is defined by the average seconds of delay per vehicle. LOS ranges from A, representing no undue delays, to F, representing a very high level of congestion and delay. The City of Oakland considers LOS D or better conditions as acceptable. LOS criteria are detailed in Appendix C.

The congested intersections at Golf Links Road / I-580 northbound ramps and Golf Links Road / 98th Avenue are currently being signalized as part of the 98th Avenue Improvements project. Signals have been installed at both locations but are not yet operational. Once signalized, both intersections are expected to operate at acceptable LOS C conditions during the afternoon commute period. With the completion of the improvements currently underway, study area afternoon traffic would operate without major congestion or delay.

As shown in Table 4, the highest increase in peak hour Park traffic arrivals and departures would occur on weekends during peak season (summer months) at a time when surrounding area traffic is much lower than on weekdays. The weekend Park traffic would be accommodated at acceptable levels of service at the four intersections described above.

During weekdays, departing Park traffic would add vehicle trips to the afternoon peak hour commute. However, the Park weekday peak hour (4:00 - 5:00 p.m.) for exiting vehicles does not coincide with the peak hour of background commute traffic (5:00 - 6:00 p.m.) in the study area. Weekday traffic exiting the Park during the peak summer months is

[4] Ibid.

currently 115 vehicles (between 4:00 and 5:00 p.m.). The majority of these vehicles have left the area well in advance of the start of the afternoon commute hour. Year 2010 peak month, peak hour departing Park traffic is estimated at 158 vehicles, an increase of 43 vehicle trips over existing summer conditions. As with existing Park operations, the departing traffic would leave the study area prior to the start of the afternoon peak hour commute. The impact of existing Park traffic on background peak hour traffic is and will continue to be minor and will have no measurable effect on off-site study area peak hour traffic operations.

The impact of departing Park vehicles on traffic operations at the unsignalized intersection of Mountain Boulevard/Golf Links Road would continue to be within acceptable limits for the following reasons:

- The intersection currently operates at LOS C or better at all approaches during the afternoon commute peak hour.
- Traffic departing the Park between 4:00 p.m. and 5:00 p.m. will do so against lower non peak hour levels of through (east-west) background traffic.
- Internal circulation planned for the Park will require vehicles parked in the Zoo parking lots to exit via 106th Avenue which is the current pattern for all Park vehicles. With this circulation pattern, the majority of Park visitors will continue to exit onto 106th Avenue.
- Traffic signal installations currently underway at the I-580 ramps will improve traffic operations in the area and will provide additional time (gaps in through traffic) for northbound left-turns at the Mountain Boulevard/Golf Links Road intersection.

**TABLE 5: NET INCREASES IN BASELINE (1994) - PEAK HOUR TRAFFIC**

| | Year 2000 | Year 2010 |
|---|---|---|
| **Average Month - Weekday** | | |
| Peak Arrivals | +6 | +17 |
| Peak Departures | +6 | +19 |
| **Average Month - Weekend** | | |
| Peak Arrivals | +16 | +48 |
| Peak Departures | +19 | +56 |
| **Peak Month - Weekday** | | |
| Peak Arrivals | +13 | +37 |
| Peak Departures | +15 | +43 |
| **Peak Month - Weekend** | | |
| Peak Arrivals | +22 | +64 |
| Peak Departures | +25 | +75 |

Future project traffic generated during the afternoon commute hour would not have a measurable impact on off-site vehicle operations for the following reasons:

1. Park closed one hour prior to weekday peak commute hour.
2. Distribution of exiting visitor vehicles to the Malcolm Drive exist.
3. Local roadway improvements (signal installation) currently under construction.

### *Pedestrian Circulation*

Weekend and weekday observations[5] indicate that the inbound (one-way) Zoo Drive off of Golf Links Road experience a very low level of pedestrian activity. The existing road travels uphill (steep in places) to the Zoo. No sidewalk is provided, although a pedestrian path is located on the uphill side of the road. Currently, pedestrian activity occurs primarily at the Zoo's main entrance parking lot where visitors leave their parked cars and walk from the parking lot directly to the Zoo entrance. Pedestrians occasionally use the pedestrian path along the one-way Zoo Drive, walking from the Park entrance up Zoo Drive to the Zoo. Until recently, an AC transit bus stop was located at the Park entry, however, this stop has been discontinued. Pedestrian activity also occurs at the parking lots located in the Arboretum where visitors leave their parked cars and walk to the picnic facilities available in the Arboretum. Pedestrians have direct access to the Arboretum grounds from the parking lots.

Pedestrian activity would increase as a result of projected increases in Park attendance. Implementation of the Master Plan would provide for improved pedestrian facilities. Zoo Drive would be widened to 30 feet to accommodate two-way traffic and a paved pedestrian/bicycle path. With the development of the Center for Science and Environmental Education, pedestrian activity would increase at the Arboretum parking lots. A bus loading zone in front of the Center would provide drop off and pick-up for school children and other groups attending this facility. This would provide safe access for groups of pedestrians, particularly school children, by eliminating the need to walk from the parking lot to the Center's entrance.

A secondary Zoo entrance (Summer entrance) is located adjacent to the site of the proposed Center for Science and Environmental Education and near the existing Children's Zoo. This entrance is open during the summer months during peak attendance periods. The secondary Zoo entrance would be available throughout the year to groups attending the Center for Science and Environmental Education. This would eliminate the need to transport groups from the Arboretum up Zoo Drive to the main Zoo entrance.

### *Bicycle Circulation*

A the present time, Zoo Drive does not include a bicycle lane, bicycles must ride on the existing roadway. According to Park staff, there is little bicycle activity at the Park. Bicycle racks are provided at the main Zoo entrance, but are rarely used. No bicycle activity was observed at the Parking during two visits made in January 1997. The proposed widening of Zoo Drive would include a paved bicycle/pedestrian lane. Bicyclists would use this lane as they ride up Zoo Drive to the main Zoo entrance. During peak periods in the summer months, the secondary Zoo entrances would be open. The Master Plan proposes improvements for this entrance including bicycle racks. Bicycle improvements proposed by the Master Plan could accommodate potential increases in bicycle activity at the Park.

[5] WSA site observations, January 13 and 24, 1997.

### *Project Parking Demand*

There are about 900 existing parking spaces at the Park. The spaces are centrally located near the main entrance with 565 spaces located in the Zoo's main and overflow parking lots and 335 spaces in the Arboretum. A peak parking demand survey conducted in July of 1995[6] determined that peak hour for parking at the Zoo occurred at 2:00 p.m. and that peak demand was for 480 parking spaces.

Using the same growth factor approach (two percent per year) as for the attendance and traffic projections, the peak parking demand would increase to 530 spaces in year 2000 and to 660 spaces in year 2010. The existing parking supply would accommodate peak season, peak hour parking demand to the year 2010.

**Source:** East Bay Zoological Society, *The Oakland Zoo in Knowland Park Master Plan*, October 1996.
ESA, *Oakland Zoo Master Plan Update Preliminary Circulation and Parking Analysis Technical Report*, September 1, 1995.
Site visits January 13 and 24, 1996.
Naval Medical Center Oakland and City of Oakland, *Draft EIS/EIR for the Disposal and Reuse of Naval Medical Center Oakland*, September 1996.
Oakland Zoo Attendance Figures: 1992-1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 27. Alterations to present patterns of circulation or movement of people and/or goods, or alterations to waterborne, rail or air traffic? | ☐ | ☐ | ☒ | ☐ |

### Comment

The proposed project would alter the existing patterns of vehicle access and circulation at the site. Zoo Drive, which currently is one-way, would be widened to 30 feet to accommodate two-way traffic and a bicycle/pedestrian lane. The construction of the Center for Science and Environmental Education would introduce vehicle and pedestrian activity to a new location. The project access and circulation measures are described and evaluated below.

### *Access Improvement*

Existing access to the Park is off of Golf Links Road along a one-way road (Zoo Drive) which serves the Arboretum, Snow Building and the Zoo's main parking lot. The project proposes to widen Zoo Drive and make the road and the Golf Links entry a two-way facility. The existing exit road which connects to 106th Avenue and I-580 would remain a one-way (exit only) facility.

6 ESA survey conducted on Sunday, July 2,1995 from 10:00 a.m. to 5:00 p.m.

### *Circulation Improvements*

As described above, circulation to the Park entryway off of Golf Links Road would be improved to accommodate two-way traffic. This circulation pattern would improve conditions for the residential areas located in the vicinity of the current Park exit. The opportunity for Park traffic to exit via Golf Links Road would reduce vehicle volumes at the 106th Avenue exit. The new two-way entrance would allow traffic at the Arboretum to exit onto Golf Links Road rather than go up Zoo Drive and exit onto 106th Avenue. Additionally, internal circulation for Park staff would be improved, since they could now drive down Zoo Drive to access Park facilities at the Arboretum rather than what they presently do which is to leave the Park, exit onto 106th Avenue, and then drive north to reenter the Park at Golf Links. Traffic leaving the Zoo parking lots, however, would continue to be directed to exit onto 106th Avenue.

The proposed Center for Science and Environmental Education would be accessed via a loop road off of Zoo Drive. The loop road would be located approximately 600 feet from the Park entry and would provide paved aprons at the Center to serve as bus loading zones. According to Park staff, bus activity ranges between seven to 12 buses per day. Buses would remain parked on the loop road near the Center or would park in the nearby parking lots and pick-up passengers at pre arranged times at the Center. Bus circulation and loading at the main entrance would continue to occur at the north side of the main parking lot, closest to the entrance.

As part of the California 1820 Exhibit area, a shuttle system is proposed for an existing unpaved fire road on the eastern side of the Park. The proposal would improve the existing fire road to a paved 15-foot wide shuttle route. The paved Shuttle Road would access a number of planned exhibit sites and would not be open to private vehicles. An additional benefit of the roadway upgrade would be enhanced fire and service vehicle access as well as faster emergency response times to this area of the Park.

### *Neighborhood Traffic Concerns*

Residents of neighborhoods located in the vicinity of the Park exit at 106th Avenue, Peralta Oaks Drive and Malcolm Avenue have in the past voiced concerns about potentially unsafe traffic conditions caused by excessive vehicle speeds along Malcolm Avenue. While exiting Park traffic is not likely to be traveling at excessive speeds, local concern is focused on the intersection at 106th Avenue, Peralta Oaks and the Park exit road. Vehicles headed west (down hill) on Malcolm Avenue at high speeds are perceived to pose a greater risk of collision with Park and other traffic at this intersection.

The access and circulation improvements proposed for the project would result in a decrease in vehicles using the existing site exit. The problem of excessive vehicle speeds on Malcolm Avenue is an enforcement issue which can best be addressed by the City of Oakland.

### Mitigation Measure

27a) To prevent traffic from the Zoo parking lots from exiting onto Golf Links Road via Zoo Drive, appropriate traffic barriers and signage shall be installed.

**Significance after Mitigation:** Less than significant.

**Source:** Public meeting on Draft Master Plan, October 3, 1996.
City of Oakland, Memorandum dated August 1, 1996; Re: Traffic Issues on Malcolm Ave.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 28. Have a substantial impact on existing transportation systems or circulation patterns? | ☐ | ☐ | ☒ | ☐ |

**Comment**

See Comment #26, and #27 above.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| **Public Services and Utilities.** Will the project have an effect upon, or result in a need for new or altered public services in any of the following areas: | | | | |
| 29. Impose a burden on public services or facilities including fire, solid waste disposal, police, schools, or parks? | ☐ | ☐ | ☒ | ☐ |

**Comment**

Access to the hilly terrain in the Upper Knowland Park area for fire protection is a significant concern of the Oakland Fire Department. The Shuttle Road has been designed in coordination with the City's Fire Marshall and would provide improved access to this part of the Park property. The Shuttle Road would provide all-weather access and be designed to support a fire truck with proposed grades of two to 20 percent. An additional leg to the fire road network on the Park property would link with the existing Snowden Avenue fire access road to mitigate the 20 percent grades. The Fire Marshall has indicated that this would provide adequate access to the development for fire protection purposes.

The Park maintains a 24-hour security force on the premises. Estimated increases in attendance are not expected to result in significant impacts on police services.

The Park provides its own trash collection and compaction. A compacting truck transports the trash to the Altamont Landfill on a weekly basis. Recyclables, including glass, paper, cardboard, and aluminum cans are separated and picked up once a week by an outside service. Implementation of the Master Plan is not expected to result in a significant increase in trash. Animal waste is composted on site. There would be an increase in the number of animals with the implementation of the Master Plan, and consequently the amount of animal waste also would increase. A new composting system would be installed that will contain the waste material in air- and water-tight plastic bags that speed decomposition. This new system would be capable of efficiently accommodating additional animal waste on site.

The Zoo presently offers environmental education programs for Oakland school children and would offer additional programs with implementation of the Master Plan. This represents a benefit to the Oakland School District.

**Source:** Meeting with Jerry Blueford, Fire Marshall, December 19, 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 30. Impose a burden on existing utilities including roads, electricity, gas, water and sewers? | ☐ | ☐ | ☒ | ☐ |

**Comment**

Water and sewer service are provided by East Bay Municipal Utility District (EBMUD). The expansion of facilities and animal exhibits would result in an increase in water consumption and wastewater generation. The proposed River Exhibit would require approximately 60,000 gallons of water which would be recirculated within the exhibit, and replaced on a quarterly basis, resulting in a demand of 240,000 gallons per year. The Center for Science and Environmental Education and new food service and restroom facilities would result in additional water demand. The installation of state-mandated water conserving plumbing fixtures at the these new facilities (low-flow plumbing and drinking fountains with self-closing valves) would have the potential of reducing the water demand for these facilities.

The project would not require the extension of any public utility lines to the site. Existing access to the Park is adequate and would not require improvement. Construction of new utility lines would be limited to on-site improvements and would not result in any new construction off site. An EBMUD right-of-way runs across Park property and contains 16-inch and 30-inch transmission water mains. Construction proposed by the Master Plan would comply with EBMUD's request that a minimum vertical and horizontal clearance of one foot and three feet, respectively, be maintained from other underground utilities/improvements and a pipeline cover of between three and one-half and six feet be maintained.

**Source:** Dr. Joel Parrott, Executive Director, Oakland Zoo,
EBMUD letter dated October 8, 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| **Cultural Resources.** Will the project: | | | | |
| 31. Destroy, deface or alter a structure, object, natural feature or site of prehistoric, architectural, archaeological or aesthetic significance? | ☐ | ☐ | ☐ | ☒ |

**Comment**

A literature review and archaeological field inspection on the site has been completed. The literature review revealed there are no recorded prehistoric or historic sites on the Zoo property. The results of the field inspection concluded there is no evidence of aboriginal use and/or occupation of the proposed are of development or the general vicinity. The report concluded that earthmoving activities associated with implementation of the Master Plan would have no effect on prehistoric cultural resources.

Although not a recorded site, the Historical Park and Arboretum includes tree which are the remnants from the Frederick Talbot estate. Additionally, a caretakers house is located in the Historical Park. The age of this structure is unknown. Under the proposed Master Plan, the Historical Park and Arboretum would continue in their present role and would not be adversely affected by the Master Plan. The caretakers house would remain on site and would continue to be occupied by Zoo staff.

**Source:** Holman & Associates, *Literature Review and Archaeological Field Inspection of the Proposed Oakland Zoo Master Plan Expansion Area, Oakland, Alameda County, California*, June 11, 1996.
East Bay Zoological Society, *The Oakland Zoo in Knowland Park Master Plan*, October 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 32. Result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object? | ☐ | ☐ | ☐ | ☒ |

**Comment**

See Comment #31 above.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| **Aesthetics.** Will the project result in: | | | | |
| 33. Involve an increase of 100 feet or more in the height of any structure over any previously existing adjacent structure? | ☐ | ☐ | ☐ | ☒ |

**Comment**

Development proposed under the Master Plan would not result in the construction of any structure with an increase in height of 100 feet or more over adjacent structures on or off-site.

**Source:** East Bay Zoological Society, *The Oakland Zoo in Knowland Park Master Plan*, October 1996.

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| 34. The obstruction of any scenic vista or view open to the public? | ☐ | ☐ | ☐ | ☒ |

**Comment**

Development proposed by the Master Plan would be sited to minimize visibility from adjacent properties and would not result in the obstruction of any scenic vistas or view open to the public.

**Source:** East Bay Zoological Society, *The Oakland Zoo in Knowland Park Master Plan*, October 1996

| | Potentially Significant Impact | Potentially Significant Unless Mitigation Incorporated | Less Than Significant Impact | No Impact |
|---|---|---|---|---|
| **Energy.** Would the project: | | | | |
| 35. Use or encourage use of substantial quantities of fuel or energy? | ☐ | ☐ | ☐ | ☒ |

**Comment**

The proposed Center for Science and Environmental Education would be required to comply with the Title 24 Energy Conservation requirements of the Uniform Building Code. In addition, the scale of the proposed development and types of use activities is within the capacity of fuel and energy resources, both existing and planned, by Pacific Gas & Electric Company.

**Source:** Project Application for the Oakland Zoo in Knowland Park Master Plan, November 12, 1996.

## IX. MANDATORY FINDINGS OF SIGNIFICANCE

| | | | | |
|---|---|---|---|---|
| a. Does the project have the **potential to degrade** the quality of the environment, substantially reduce the habitat of an aquatic or wildlife species, cause a aquatic or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant of animal species, or eliminate important examples of the major periods of California history or prehistory? | ☐ | ☒ | ☐ | ☐ |
| b. Does the project have the potential to achieve **short-term**, to the disadvantage of long-term, environmental goals? (A short-term impact on the environment is one that occurs in a relatively brief, definitive period of time, while long-term impacts will endure well into the future.) | ☐ | ☒ | ☐ | ☐ |
| c. Does the project have impacts that are individually limited, but **cumulatively** considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect of the total of those impacts on the environment is significant.) | ☐ | ☐ | ☒ | ☐ |
| d. Does the project have environmental effects that would cause **substantial adverse effects** on human beings, either directly or indirectly? | ☐ | ☐ | ☐ | ☒ |

## X. DETERMINATION

On the basis of this initial environmental evaluation:

☐ I find that the proposed project *will not* have a significant effect on the environment, and a **Negative Declaration** will be prepared.

☒ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because the attached *mitigation measures* have been incorporated into the project. Therefore, a **Mitigated Negative Declaration** will be prepared.

☐ I find that the proposed project *may* have a significant effect on the environment, and an **Environmental Impact Report** is required to assess the effects on the environment.

Name ERIN GIBSON　　Date 3-28-97

Title Planner II

# APPENDIX A - TREE SURVEY

## OAKLAND ZOO IN KNOWLAND PARK MASTER PLAN
## DOCUMENTATION FOR TREE SURVEY, 1995 AND UPDATED IN 1997

In 1995, a tree survey was conducted to identify the number of trees that could be affected by project development. Trees were surveyed within the vicinity of the California 1820 Exhibit area and the Center for Science and Environmental Education. The preliminary site plan has since been revised resulting in changes in the location of the Center for Science and Environmental Education, Interpretive Center, Off-site Breeding Area, fence lines, and Shuttle Road. A second tree survey was conducted in January 1997 to identify the number of trees that could be affected by the site plan revisions. The total number of trees surveyed in the proposed areas of development are presented in the following spreadsheets; as well as spreadsheets presenting a preliminary list of trees that may be removed.

Field procedures are summarized below:

1. DBH measurements were taken with a centimeter DBH tape, so conversions may have some slight deviations.

2. Per Oakland tree ordinance survey, all trees whose sum of DBH stem measurements added up to 4 inches for oaks, and 9 inches for non-oaks were surveyed. (Several trees that were too small to meet the criteria were inadvertently included.)

3. Conventions used:
   - only stems larger than 1.6 in (4 cm) were measured.
   - if a stem was horizontal for a long distance, a diameter at 4-6 feet along the stem was taken, rather than at 4-4.5 ft off the ground, especially if the stem branched above.
   - if a diameter was clearly smaller if taken below a branching, this value was used, even if it was below breast height.
   - DBH were taken at or slightly below 4.5 feet, rather than above it.
   - stems with a visible connection, even at ground level, were considered a single tree.

4. Some oddities about the tree tags: first, there were some duplications of tag numbers. One, nos. 175-203, was used in the Environmental Education Center area. The other, nos. 175-200, was used along the Shuttle Road. Tag nos. 201-203 were missing from this group. Second, several tags were either missing from the set or, in one instance, lost before it was applied to a tree. Missing tags are noted in the printout.

5. Tags were generally put at eye level, although in the bison and tule elk enclosure, tags are higher and in a place where bison and tule elk would find them difficult to rub against.

6. Nearly all tags are the round, stamped aluminum type. A few in the bison enclosure are rectangular and are nailed in at both ends.

## OAKLAND ZOO IN KNOWLAND PARK TREE SURVEY

LAST DATE UPDATED: JAN. 23, 1997

ACACIA=ACACIA SP. - ACACIA
PIRA=PINUS RADIATA - MONTEREY PINE
QUAG=QUERCUS AGRIFOLIA - COAST LIVE OAK
PRUNUS=PRUNUS SP-PROBABLY P. DULCIS - ALMOND
UMCA=UMBELLULARIA CALIFORNICA - CALIFORNIA BAY
PICO=PINUS COULTERI - COULTER PINE
PSME=PSEUDOTSUGA MENZIESII - DOUGLAS-FIR
SAME=SAMBUCES MEXICANA - ELDERBERRY
OLIVE=ELEAGNUS ANGUSTIFOLIUS - RUSSIAN OLIVE

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | PIRA | PAVED ACCESS | 4 | 60.4 | 24.4 | 12.8 | 8.8 | 14.4 | | | | |
| 2 | ACACIA | PAVED ACCESS | 1 | 10.4 | 10.4 | | | | | | | |
| 3 | ACACIA | PAVED ACCESS | 2 | 8.7 | 8.7 | | | | TOO SMALL; LESS THAN 9 IN DBH | | | |
| 4 | ACACIA | PAVED ACCESS | 1 | 15.2 | 15.2 | | | | | | | |
| 5 | PIRA | PAVED ACCESS | 1 | 23.2 | 23.2 | | | | | | | |
| 6 | PIRA | PAVED ACCESS | 1 | 35.8 | 35.8 | | | | | | | |
| 7 | QUAG | PAVED ACCESS | 4 | 26.2 | 8.1 | 3.0 | 6.5 | 8.6 | | | | |
| 8 | PRUNUS | PAVED ACCESS | 3 | 12.4 | 7.4 | 3.1 | 2.0 | | | | | |
| 9 | PIRA | PAVED ACCESS | 1 | 13.7 | 13.7 | | | | | | | |
| 10 | PIRA | PAVED ACCESS | 1 | 19.6 | 19.6 | | | | | | | |
| 11 | PIRA | PAVED ACCESS | 6 | 58.5 | 15.6 | 12.0 | 5.9 | 6.1 | 10.0 | 8.9 | | |
| 12 | PIRA | PAVED ACCESS | 1 | 32.5 | 32.5 | | | | | | | |
| 13 | QUAG | SHUTTLE RD | 1 | 6.5 | 6.5 | | | | | | | |
| 14 | QUAG | SHUTTLE RD | 2 | 9.7 | 5.9 | 3.9 | | | | | | |
| 15 | QUAG | SHUTTLE RD | 2 | 3.4 | 3.4 | | | | | TOO SMALL; LESS THAN 4 IN DBH | | |
| 16 | PICO | SHUTTLE RD | 1 | 9.7 | 9.7 | | | | | | | |
| 17 | PICO | SHUTTLE RD | 2 | 12.6 | 8.2 | 4.3 | | | | | | |
| 18 | PIRA | SHUTTLE RD | 1 | 9.7 | 9.7 | | | | | | | |
| 19 | PIRA | SHUTTLE RD | 5 | 30.6 | 4.8 | 7.1 | 8.5 | 4.9 | 5.3 | | | |
| 20 | PIRA | SHUTTLE RD | 1 | 11.7 | 11.7 | | | | | | | |
| 21 | PIRA | SHUTTLE RD | 1 | 10.7 | 10.7 | | | | | | | |
| 22 | PIRA | SHUTTLE RD | 1 | 17.3 | 17.3 | | | | | | | |
| 23 | PIRA | SHUTTLE RD | 1 | 10.2 | 10.2 | | | | | | | |
| 24 | PIRA | SHUTTLE RD | 1 | 14.6 | 14.6 | | | | | | | |
| 25 | PIRA | SHUTTLE RD | 1 | 20.2 | 20.2 | | | | | | | |
| 26 | PIRA | SHUTTLE RD | 1 | 19.9 | 19.9 | | | | | | | |
| 27 | PIRA | SHUTTLE RD | 1 | 10.9 | 10.9 | | | | | | | |
| 28 | QUAG | SHUTTLE RD | 1 | 6.6 | 6.6 | | | | | | | |
| 29 | PIRA | SHUTTLE RD | 1 | 19.0 | 19.0 | | | | | | | |
| 30 | PIRA | SHUTTLE RD | 1 | 15.5 | 15.5 | | | | | | | |
| 31 | QUAG | SHUTTLE RD | 3 | 11.7 | 4.4 | 4.2 | 3.1 | | | | | |
| 32 | PIRA | SHUTTLE RD | 1 | 22.9 | 22.9 | | | | | | | |
| 33 | QUAG | SHUTTLE RD | 4 | 20.7 | 8.0 | 5.9 | 3.1 | 3.7 | | | | |
| 34 | QUAG | SHUTTLE RD | 2 | 12.9 | 9.2 | 3.7 | | | | | | |
| 35 | QUAG | NEW BISON | 1 | 13.6 | 13.6 | | | | | | | |
| 36 | QUAG | NEW BISON | 3 | 14.3 | 4.0 | 3.7 | 6.6 | | | | | |
| 37 | QUAG | NEW BISON | 2 | 19.9 | 7.7 | 12.2 | | | | | | |
| 38 | QUAG | NEW BISON | 1 | 6.0 | 6.0 | | | | | | | |
| 39 | QUAG | NEW BISON | 7 | 27.5 | 5.7 | 4.4 | 3.3 | 3.3 | 2.5 | 4.7 | 3.5 | |
| 40 | QUAG | NEW BISON | 3 | 26.4 | 12.9 | 10.6 | 2.9 | | | | | |
| 41 | QUAG | SHUTTLE RD | 5 | 36.6 | 8.7 | 3.7 | 2.3 | 8.6 | 13.3 | | | |
| 42 | QUAG | SHUTTLE RD | 1 | 16.4 | 16.4 | | | | | | | |
| 43 | QUAG | SHUTTLE RD | 3 | 17.0 | 6.1 | 5.7 | 5.2 | | | | | |
| 44 | QUAG | TOP, S OF RD | 3 | 21.9 | 7.9 | 7.6 | 6.3 | | | | | |
| 45 | QUAG | TOP, S OF RD | 1 | 9.7 | 9.7 | | | | | | | |
| 46 | QUAG | TOP, S OF RD | 2 | 4.4 | 2.2 | 2.2 | | | | | | |
| 47 | QUAG | TOP, S OF RD | 2 | 15.9 | 6.3 | 9.6 | | | | | | |
| 48 | QUAG | TOP, S OF RD | 2 | 5.8 | 3.6 | 2.2 | | | | | | |
| 49 | UMCA | TOP, S OF RD | 3 | 12.1 | 3.9 | 3.9 | 4.3 | | | | | |
| 50 | QUAG | TOP, S OF RD | 1 | 10.0 | 10.0 | | | | | | | |
| 51 | UMCA | TOP, S OF RD | 1 | 10.3 | 10.3 | | | | | | | |
| 52 | UMCA | TOP, S OF RD | 2 | 6.7 | 6.7 | | | | | TOO SMALL; LESS THAN 9 IN DBH | | |
| 53 | QUAG | TOP, S OF RD | 1 | 4.7 | 4.7 | | | | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 54 | UMCA | TOP, S OF RD | 5 | 22.0 | 3.7 | 4.7 | 4.4 | 5.4 | 3.7 | | | | | | | | |
| 55 | UMCA | TOP, S OF RD | 3 | 9.4 | 3.9 | 2.6 | 3.0 | | | | | | | | | | |
| 56 | UMCA | TOP, S OF RD | 3 | 10.7 | 4.3 | 3.2 | 3.2 | | | | | | | | | | |
| 57 | QUAG | TOP, S OF RD | 1 | 10.2 | 10.2 | | | | | | | | | | | | |
| 58 | QUAG | TOP, S OF RD | 7 | 28.7 | 5.9 | 3.9 | 2.2 | 5.7 | 3.7 | 4.4 | 2.7 | | | | | | |
| 59 | QUAG | TOP, S OF RD | 1 | 6.8 | 6.8 | | | | | | | | | | | | |
| 60 | QUAG | TOP, S OF RD | 1 | 5.9 | 5.9 | | | | | | | | | | | | |
| 61 | QUAG | TOP, S OF RD | 2 | 15.6 | 6.3 | 9.2 | | | | | | | | | | | |
| 62 | UMCA | TOP, S OF RD | 5 | 12.8 | 2.6 | 1.9 | 1.8 | 3.2 | 3.4 | | | | | | | | |
| 63 | QUAG | TOP, S OF RD | 2 | 22.1 | 14.6 | 7.5 | | | | | | | | | | | |
| 64 | QUAG | TOP, S OF RD | 3 | 13.5 | 4.1 | 2.1 | 7.2 | | | | | | | | | | |
| 65 | SAME | TOP, S OF RD | 6 | 20.0 | 2.8 | 4.4 | 6.9 | 1.6 | 1.6 | 2.8 | | | | | | | |
| 66 | SAME | TOP, S OF RD | 4 | 13.6 | 4.0 | 2.4 | 3.3 | 3.9 | | | | | | | | | |
| 67 | QUAG | TOP, S OF RD | 2 | 10.7 | 7.6 | 3.1 | | | | | | | | | | | |
| 68 | QUAG | TOP, S OF RD | 2 | 13.2 | 5.7 | 7.5 | | | | | | | | | | | |
| 69 | QUAG | TOP, S OF RD | 1 | 13.1 | 13.1 | | | | | | | | | | | | |
| 70 | QUAG | TOP, S OF RD | 2 | 26.3 | 16.1 | 10.2 | | | | | | | | | | | |
| 71 | QUAG | TOP, S OF RD | 1 | 4.1 | 4.1 | | | | | | | | | | | | |
| 72 | QUAG | TOP, S OF RD | 1 | 4.5 | 4.5 | | | | | | | | | | | | |
| 73 | QUAG | TOP, S OF RD | 6 | 72.7 | 13.5 | 14.3 | 11.1 | 13.2 | 10.6 | 10.1 | | | | | | | |
| 74 | QUAG | TOP, S OF RD | 2 | 11.3 | 4.1 | 7.2 | | | | | | | | | | | |
| 75 | QUAG | TOP, S OF RD | 3 | 12.3 | 4.3 | 4.6 | 3.3 | | | | | | | | | | |
| 76 | QUAG | E. DRAW, TOP | 1 | 13.4 | 13.4 | | | | | | | | | | | | |
| 77 | QUAG | E. DRAW, TOP | 1 | 13.3 | 13.3 | | | | | | | | | | | | |
| 78 | QUAG | E. DRAW, TOP | 2 | 10.0 | 4.5 | 5.5 | | | | | | | | | | | |
| 79 | QUAG | E. DRAW, TOP | 3 | 16.1 | 6.6 | 3.9 | 5.6 | | | | | | | | | | |
| 80 | QUAG | E. DRAW, TOP | 3 | 24.7 | 10.5 | 9.6 | 4.6 | | | | | | | | | | |
| 81 | UMCA | E. DRAW, TOP | 3 | 11.1 | 3.7 | 3.1 | 4.3 | | | | | | | | | | |
| 82 | UMCA | E. DRAW, TOP | 7 | 14.7 | 2.4 | 2.3 | 1.9 | 2.4 | 2.1 | 2.0 | 1.7 | | | | | | |
| 83 | QUAG | E. DRAW, TOP | 4 | 31.0 | 10.5 | 9.9 | 4.8 | 5.8 | | | | | | | | | |
| 84 | QUAG | E. DRAW, TOP | 2 | 17.4 | 10.8 | 6.6 | | | | | | | | | | | |
| 85 | PIRA | E. DRAW, TOP | 1 | 13.0 | 13.0 | | | | | | | | | | | | |
| 8 | UMCA | E. DRAW, TOP | 7 | 14.6 | 1.9 | 2.0 | 2.6 | 2.2 | 2.6 | 1.7 | 1.6 | | | | | | |
| 87 | OLIVE | ENV.ED.CTR. | 8 | 30.9 | 4.1 | 2.2 | 4.3 | 2.1 | 4.1 | 3.1 | 4.9 | 6.0 | | | | | |
| 88 | OLIVE | ENV.ED.CTR. | 3 | 11.6 | 4.4 | 3.1 | 4.0 | | | | | | | | | | |
| 89 | OLIVE | ENV.ED.CTR. | 13 | 50.8 | 7.0 | 6.1 | 4.0 | 3.8 | 2.4 | 1.7 | 2.4 | 1.9 | 3.9 | 3.1 | 5.7 | 3 | 5.6 |
| 90 | PIRA | ENV.ED.CTR. | 1 | 23.8 | 23.8 | | | | | | | | | | | | |
| 91 | QUAG | ENV.ED.CTR. | 2 | 9.4 | 4.6 | 4.8 | | | | | | | | | | | |
| 92 | PIRA | ENV.ED.CTR. | 1 | 22.5 | 22.5 | | | | | | | | | | | | |
| 93 | PIRA | ENV.ED.CTR. | 1 | 23.8 | 23.8 | | | | | | | | | | | | |
| 94 | QUAG | ENV.ED.CTR. | 3 | 30.7 | 10.9 | 11.7 | 8.1 | | | | | | | | | | |
| 95 | QUAG | ENV.ED.CTR. | 3 | 23.6 | 4.1 | 11.2 | 8.3 | | | | | | | | | | |
| 96 | QUAG | ENV.ED.CTR. | 2 | 6.2 | 4.3 | 1.9 | | | | | | | | | | | |
| 101 | QUAG | N OF TOP ACC. RD | 3 | 23.6 | 7.7 | 12.3 | 3.6 | | | | | | | | | | |
| 102 | QUAG | N OF TOP ACC. RD | 8 | 36.7 | 7.1 | 3.4 | 6.9 | 8.3 | 3.0 | 3.1 | 2.6 | 2.2 | | | | | |
| 103 | QUAG | N OF TOP ACC. RD | 2 | 26.7 | 14.7 | 12.0 | | | | | | | | | | | |
| 104 | QUAG | N OF TOP ACC. RD | 2 | 25.7 | 12.8 | 12.9 | | | | | | | | | | | |
| 105 | QUAG | N OF TOP ACC. RD | 1 | 10.4 | 10.4 | | | | | | | | | | | | |
| 106 | QUAG | N OF TOP ACC. RD | 2 | 12.0 | 2.9 | 9.1 | | | | | | | | | | | |
| 107 | QUAG | N OF TOP ACC. RD | 3 | 31.9 | 9.3 | 11.7 | 10.8 | | | | | | | | | | |
| 108 | QUAG | N OF TOP ACC. RD | 2 | 13.5 | 7.4 | 6.1 | | | | | | | | | | | |
| 109 | QUAG | N OF TOP ACC. RD | 2 | 20.6 | 14.1 | 6.5 | | | | | | | | | | | |
| 110 | QUAG | N OF TOP ACC. RD | 4 | 17.7 | 3.7 | 5.0 | 4.1 | 4.8 | | | | | | | | | |
| 111 | UMCA | E OF DOG AREA | 2 | 10.7 | 5.5 | 5.2 | | | | | | | | | | | |
| 112 | QUAG | E OF DOG AREA | 1 | 8.5 | 8.5 | | | | | | | | | | | | |
| 113 | QUAG | E OF DOG AREA | 1 | 13.5 | 13.5 | | | | | | | | | | | | |
| 114 | QUAG | E OF DOG AREA | 3 | 7.0 | 2.6 | 2.1 | 2.2 | | | | | | | | | | |
| 115 | QUAG | E OF DOG AREA | 2 | 15.4 | 7.8 | 7.6 | | | | | | | | | | | |
| 116 | QUAG | E OF DOG AREA | 1 | 8.0 | 8.0 | | | | | | | | | | | | |
| 117 | QUAG | E OF DOG AREA | 3 | 12.7 | 4.9 | 4.8 | 3.0 | | | | | | | | | | |
| 118 | QUAG | E OF DOG AREA | 5 | 15.3 | 3.9 | 2.2 | 2.1 | 1.9 | 5.2 | | | | | | | | |
| 119 | QUAG | E OF DOG AREA | 4 | 15.5 | 4.8 | 4.1 | 4.6 | 2.0 | | | | | | | | | |
| 120 | QUAG | E OF DOG AREA | 1 | 9.0 | 9.0 | | | | | | | | | | | | |
| 121 | QUAG | E OF DOG AREA | 5 | 29.9 | 7.5 | 6.7 | 2.6 | 5.9 | 7.3 | | | | | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122 | QUAG | E OF DOG AREA | 1 | 5.7 | 5.7 | | | | | | | |
| 123 | QUAG | E OF DOG AREA | 3 | 19.8 | 5.0 | 6.7 | 8.0 | | | | | |
| 124 | QUAG | E OF DOG AREA | 4 | 35.4 | 9.6 | 5.5 | 12.0 | 8.4 | | | | |
| 125 | QUAG | E OF DOG AREA | 1 | 15.6 | 15.6 | | | | | | | |
| 126 | QUAG | E OF DOG AREA | 5 | 48.3 | 10.8 | 4.3 | 7.9 | 15.9 | 9.3 | | | |
| 127 | QUAG | E OF DOG AREA | 6 | 19.8 | 4.0 | 2.3 | 4.1 | 3.2 | 2.0 | 4.2 | | |
| 128 | QUAG | E OF DOG AREA | 4 | 20.3 | 5.3 | 4.6 | 4.5 | 5.9 | | | | |
| 129 | QUAG | SHUTTLE RD W SIDE | 4 | 13.9 | 3.0 | 4.1 | 4.4 | 2.4 | | | | |
| 130 | QUAG | SHUTTLE RD W SIDE | 4 | 10.6 | 1.6 | 2.5 | 2.7 | 3.9 | | | | |
| 131 | QUAG | SHUTTLE RD W SIDE | 4 | 31.6 | 9.4 | 9.4 | 5.9 | 6.9 | | | | |
| 132 | QUAG | SHUTTLE RD W SIDE | 3 | 10.4 | 4.4 | 3.5 | 2.5 | | | | | |
| 133 | QUAG | SHUTTLE RD W SIDE | 3 | 16.1 | 4.4 | 7.1 | 4.6 | | | | | |
| 134 | QUAG | SHUTTLE RD W SIDE | 1 | 14.6 | 14.6 | | | | | | | |
| 135 | QUAG | SHUTTLE RD W SIDE | 1 | 8.5 | 8.5 | | | | | | | |
| 136 | QUAG | SHUTTLE RD W SIDE | 1 | 28.3 | 28.3 | | | | | | | |
| 137 | QUAG | SHUTTLE RD W SIDE | 5 | 42.7 | 8.9 | 16.0 | 4.1 | 8.1 | 5.6 | | | |
| 138 | QUAG | SHUTTLE RD W SIDE | 2 | 15.0 | 10.1 | 4.9 | | | | | | |
| 139 | QUAG | SHUTTLE RD W SIDE | 3 | 10.7 | 5.2 | 2.5 | 3.0 | | | | | |
| 140 | QUAG | SHUTTLE RD W SIDE | 4 | 49.8 | 10.4 | 12.2 | 13.0 | 14.3 | | | | |
| 141 | QUAG | SHUTTLE RD W SIDE | 2 | 12.4 | 3.0 | 9.4 | | | | | | |
| 142 | QUAG | SHUTTLE RD W SIDE | 2 | 5.2 | 3.6 | 1.6 | | | | | | |
| 143 | QUAG | SHUTTLE RD W SIDE | 2 | 19.4 | 13.1 | 6.3 | | | | | | |
| 144 | QUAG | SHUTTLE RD W SIDE | 3 | 32.2 | 9.3 | 12.6 | 10.3 | | | | | |
| 145 | QUAG | SHUTTLE RD W SIDE | 7 | 35.8 | 2.9 | 7.4 | 5.4 | 4.2 | 6.7 | 6.5 | 2.7 | |
| 146 | QUAG | SHUTTLE RD W SIDE | 4 | 50.6 | 13.5 | 9.2 | 14.9 | 13.0 | | | | |
| 147 | | NO TAG | | | | | | | | | | |
| 148 | QUAG | SHUTTLE RD W SIDE | 3 | 16.7 | 5.6 | 6.7 | 4.3 | | | | | |
| 149 | QUAG | SHUTTLE RD W SIDE | 1 | 6.9 | 6.9 | | | | | | | |
| 150 | QUAG | SHUTTLE RD W SIDE | 2 | 19.5 | 14.7 | 4.8 | | | | | | |
| 151 | QUAG | SHUTTLE RD W SIDE | 4 | 32.8 | 12.6 | 10.4 | 4.5 | 5.3 | | | | |
| 152 | QUAG | SHUTTLE RD W SIDE | 4 | 57.6 | 13.6 | 14.5 | 13.1 | 16.4 | | | | |
| 153 | QUAG | SHUTTLE RD W SIDE | 1 | 7.9 | 7.9 | | | | | | | |
| 154 | QUAG | SHUTTLE RD W SIDE | 2 | 7.4 | 3.6 | 3.9 | | | | | | |
| 155 | QUAG | SHUTTLE RD W SIDE | 2 | 23.0 | 12.8 | 10.2 | | | | | | |
| 156 | QUAG | SHUTTLE RD W SIDE | 1 | 18.8 | 18.8 | | | | | | | |
| 157 | QUAG | SHUTTLE RD W SIDE | 2 | 49.0 | 16.9 | 32.1 | | | | | | |
| 158 | QUAG | SHUTTLE RD W SIDE | 7 | 38.4 | 4.8 | 4.0 | 4.9 | 2.4 | 5.6 | 8.7 | 8.1 | |
| 159 | QUAG | SHUTTLE RD W SIDE | 1 | 5.0 | 5.0 | | | | | | | |
| 160 | QUAG | SHUTTLE RD W SIDE | 1 | 5.0 | 5.0 | | | | | | | |
| 161 | QUAG | SHUTTLE RD W SIDE | 2 | 33.0 | 10.6 | 22.5 | | | | | | |
| 162 | QUAG | SHUTTLE RD W SIDE | 1 | 20.1 | 20.1 | | | | | | | |
| 163 | QUAG | SHUTTLE RD W SIDE | 3 | 26.9 | 10.2 | 7.5 | 9.2 | | | | | |
| 164 | QUAG | SHUTTLE RD W SIDE | 2 | 21.1 | 9.1 | 12.0 | | | | | | |
| 165 | QUAG | SHUTTLE RD W SIDE | 4 | 53.2 | 15.4 | 15.9 | 12.7 | 9.3 | | | | |
| 166 | QUAG | SHUTTLE RD W SIDE | 8 | 47.8 | 5.3 | 5.7 | 8.9 | 4.8 | 6.5 | 6.1 | 6.2 | 4.3 |
| 167 | QUAG | SHUTTLE RD W SIDE | 3 | 26.9 | 10.4 | 11.4 | 5.1 | | | | | |
| 168 | QUAG | SHUTTLE RD W SIDE | 4 | 59.3 | 14.3 | 12.0 | 15.9 | 17.0 | | | | |
| 169 | QUAG | SHUTTLE RD W SIDE | 1 | 12.0 | 12.0 | | | | | | | |
| 170 | QUAG | SHUTTLE RD W SIDE | 1 | 15.7 | 15.7 | | | | | | | |
| 171 | QUAG | SHUTTLE RD W SIDE | 3 | 51.9 | 10.6 | 13.0 | 28.3 | | | | | |
| 172 | QUAG | SHUTTLE RD W SIDE | 6 | 43.1 | 8.3 | 7.1 | 7.3 | 6.8 | 7.2 | 6.5 | | |
| 173 | QUAG | SHUTTLE RD W SIDE | 4 | 35.1 | 9.4 | 2.9 | 5.9 | 16.9 | | | | |
| 174 | QUAG | SHUTTLE RD W SIDE | 1 | 7.2 | 7.2 | | | | | | | |
| 175 | ACACIA | ENV. ED. CTR. | 1 | 21.1 | 21.1 | | | | | | | |
| 176 | ACACIA | ENV. ED. CTR. | 1 | 31.1 | 31.1 | | | | | | | |
| 177 | PIRA | ENV. ED. CTR. | 1 | 12.9 | 12.9 | | | | | | | |
| 178 | ACACIA | ENV. ED. CTR. | 1 | 22.5 | 22.5 | | | | | | | |
| 179 | ACACIA | ENV. ED. CTR. | 1 | 21.3 | 21.3 | | | | | | | |
| 180 | ACACIA | ENV. ED. CTR. | 1 | 16.9 | 16.9 | | | | | | | |
| 181 | ACACIA | ENV. ED. CTR. | 6 | 23.1 | 5.4 | 3.7 | 4.8 | 2.3 | 4.4 | 2.5 | | |
| 182 | ACACIA | ENV. ED. CTR. | 4 | 11.5 | 3.6 | 1.5 | 2.6 | 3.9 | | | | |
| 183 | ACACIA | ENV. ED. CTR. | 3 | 15.3 | 4.4 | 5.6 | 5.4 | | | | | |
| 184 | ACACIA | ENV. ED. CTR. | 2 | 9.1 | 3.9 | 5.2 | | | | | | |
| 185 | ACACIA | ENV. ED. CTR. | 3 | 21.4 | 12.7 | 5.3 | 3.4 | | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 186 | ACACIA | ENV. ED. CTR. | 2 | 12.6 | 8.9 | 3.7 | | | | | |
| 187 | PIRA | ENV. ED. CTR. | 1 | 12.9 | 12.9 | | | | | | |
| 188 | PIRA | ENV. ED. CTR. | 1 | 11.9 | 11.9 | | | | | | |
| 189 | PIRA | ENV. ED. CTR. | 1 | 9.6 | 9.6 | | | | | | |
| 190 | PIRA | ENV. ED. CTR. | 1 | 14.2 | 14.2 | | | | | | |
| 191 | PIRA | ENV. ED. CTR. | 1 | 15.0 | 15.0 | | | | | | |
| 192 | PIRA | ENV. ED. CTR. | 1 | 13.3 | 13.3 | | | | | | |
| 193 | PIRA | ENV. ED. CTR. | 1 | 17.5 | 17.5 | | | | | | |
| 194 | PIRA | ENV. ED. CTR. | 1 | 13.2 | 13.2 | | | | | | |
| 195 | PIRA | ENV. ED. CTR. | 1 | 31.7 | 31.7 | | | | | | |
| 196 | OLIVE | ENV. ED. CTR. | 6 | 19.8 | 4.7 | 2.0 | 3.1 | 3.7 | 2.7 | 3.6 | |
| 197 | ACACIA | ENV. ED. CTR. | 4 | 16.6 | 4.1 | 4.8 | 4.6 | 3.1 | | | |
| 198 | PIRA | ENV. ED. CTR. | 1 | 16.6 | 16.6 | | | | | | |
| 199 | PIRA | ENV. ED. CTR. | 1 | 23.1 | 23.1 | | | | | | |
| 200 | PIRA | ENV. ED. CTR. | 1 | 18.8 | 18.8 | | | | | | |
| 201 | PIRA | ENV. ED. CTR. | 1 | 60.3 | 60.3 | | | | | | |
| 202 | PIRA | ENV. ED. CTR. | 1 | 55.7 | 55.7 | | | | | | |
| 203 | OLIVE | ENV. ED. CTR. | 5 | 26.2 | 5.5 | 4.0 | 6.7 | 3.5 | 6.4 | | |
| 175 | QUAG | SHUTTLE RD W SIDE | 3 | 24.3 | 4.8 | 10.4 | 9.1 | | | | |
| 176 | QUAG | SHUTTLE RD W SIDE | 4 | 25.5 | 7.9 | 3.1 | 7.0 | 7.5 | | | |
| 177 | QUAG | SHUTTLE RD W SIDE | 3 | 22.8 | 7.7 | 10.1 | 5.0 | | | | |
| 178 | QUAG | SHUTTLE RD W SIDE | 1 | 12.2 | 12.2 | | | | | | |
| 179 | QUAG | SHUTTLE RD W SIDE | 2 | 18.0 | 9.7 | 8.3 | | | | | |
| 180 | QUAG | SHUTTLE RD W SIDE | 2 | 8.6 | 5.4 | 3.2 | | | | | |
| 181 | QUAG | SHUTTLE RD W SIDE | 2 | 8.5 | 4.8 | 3.8 | | | | | |
| 182 | QUAG | SHUTTLE RD W SIDE | 4 | 17.6 | 5.9 | 3.7 | 3.9 | 4.1 | | | |
| 183 | QUAG | SHUTTLE RD W SIDE | 1 | 9.0 | 9.0 | | | | | | |
| 184 | QUAG | SHUTTLE RD W SIDE | 1 | 8.1 | 8.1 | | | | | | |
| 185 | QUAG | SHUTTLE RD W SIDE | 1 | 12.2 | 12.2 | | | | | | |
| 186 | QUAG | SHUTTLE RD W SIDE | 7 | 94.1 | 11.5 | 13.3 | 14.3 | 10.4 | 12.5 | 12.7 | 19.5 |
| 187 | QUAG | SHUTTLE RD W SIDE | 1 | 19.6 | 19.6 | | | | | | |
| 188 | QUAG | SHUTTLE RD W SIDE | 5 | 80.8 | 8.5 | 10.9 | 20.2 | 16.7 | 24.4 | | |
| 189 | QUAG | SHUTTLE RD W SIDE | 3 | 40.2 | 13.9 | 8.9 | 17.4 | | | | |
| 190 | QUAG | SHUTTLE RD W SIDE | 3 | 18.2 | 6.8 | 3.0 | 8.4 | | | | |
| 191 | QUAG | SHUTTLE RD W SIDE | 5 | 49.2 | 6.9 | 7.9 | 15.0 | 10.2 | 9.1 | | |
| 192 | QUAG | SHUTTLE RD W SIDE | 6 | 65.3 | 14.7 | 7.8 | 9.5 | 9.2 | 15.2 | 8.9 | |
| 193 | QUAG | SHUTTLE RD W SIDE | 2 | 4.4 | 2.8 | 1.7 | | | | | |
| 194 | QUAG | SHUTTLE RD W SIDE | 2 | 23.8 | 11.6 | 12.2 | | | | | |
| 195 | QUAG | SHUTTLE RD W SIDE | 1 | 16.6 | 16.6 | | | | | | |
| 196 | QUAG | SHUTTLE RD W SIDE | 4 | 51.1 | 18.2 | 5.4 | 16.1 | 11.5 | | | |
| 197 | QUAG | SHUTTLE RD W SIDE | 1 | 16.4 | 16.4 | | | | | | |
| 198 | QUAG | SHUTTLE RD W SIDE | 4 | 24.7 | 7.2 | 6.7 | 4.8 | 6.1 | | | |
| 199 | QUAG | SHUTTLE RD W SIDE | 3 | 7.1 | 2.6 | 2.0 | 2.6 | | | | |
| 200 | QUAG | SHUTTLE RD E SIDE | 6 | 69.8 | 9.8 | 10.7 | 18.9 | 5.9 | 11.4 | 13.0 | |
| 201-203--NO TAGS IN THIS GROUP | | | | | | | | | | | |
| 204 | QUAG | SHUTTLE RD E SIDE | 4 | 58.8 | 16.8 | 11.8 | 14.4 | 15.7 | | | |
| 205 | QUAG | SHUTTLE RD E SIDE | 1 | 14.5 | 14.5 | | | | | | |
| 206 | QUAG | SHUTTLE RD E SIDE | 3 | 45.2 | 12.7 | 13.1 | 19.4 | | | | |
| 207 | QUAG | SHUTTLE RD E SIDE | 3 | 32.9 | 8.7 | 12.8 | 11.5 | | | | |
| 208 | QUAG | SHUTTLE RD E SIDE | 4 | 47.5 | 18.3 | 8.5 | 6.5 | 14.3 | | | |
| 209 | QUAG | SHUTTLE RD E SIDE | 4 | 48.7 | 10.6 | 15.8 | 11.9 | 10.4 | | | |
| 210 | QUAG | SHUTTLE RD E SIDE | 6 | 80.9 | 12.0 | 22.2 | 12.6 | 12.3 | 13.5 | 8.3 | |
| 211 | QUAG | SHUTTLE RD E SIDE | 2 | 47.7 | 21.3 | 26.4 | | | | | |
| 212 | QUAG | SHUTTLE RD E SIDE | 4 | 42.7 | 8.8 | 15.2 | 8.5 | 10.2 | | | |
| 213 | QUAG | SHUTTLE RD E SIDE | 3 | 30.9 | 10.8 | 9.8 | 10.3 | | | | |
| 214 | QUAG | SHUTTLE RD E SIDE | 3 | 45.0 | 10.7 | 12.6 | 21.7 | | | | |
| 215 | QUAG | SHUTTLE RD E SIDE | 1 | 4.6 | 4.6 | | | | | | |
| 216 | QUAG | SHUTTLE RD E SIDE | 1 | 40.9 | 40.9 | | | | | | |
| 217 | QUAG | SHUTTLE RD E SIDE | 3 | 47.3 | 15.0 | 15.4 | 17.0 | | | | |
| 218 | QUAG | SHUTTLE RD E SIDE | 3 | 34.7 | 10.6 | 9.9 | 14.3 | | | | |
| 219 | QUAG | SHUTTLE RD E SIDE | 5 | 31.7 | 5.1 | 4.4 | 3.7 | 8.3 | 10.2 | | |
| 220 | QUAG | 1820 EXHIBIT | 3 | 30.3 | 15.5 | 2.4 | 12.4 | | | | |
| 221 | QUAG | 1820 EXHIBIT | 2 | 6.1 | 3.9 | 2.2 | | | | | |
| 222 | PRUNUS | 1820 EXHIBIT | 1 | 13.0 | 13.0 | | | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 223 | QUAG | 1820 EXHIBIT | 1 | 6.5 | 6.5 | | | | | | |
| 224 | QUAG | 1820 EXHIBIT | 1 | 6.5 | 6.5 | | | | | | |
| 225 | QUAG | 1820 EXHIBIT | 2 | 13.1 | 5.3 | 7.9 | | | | | |
| 226 | QUAG | 1820 EXHIBIT | 1 | 13.9 | 13.9 | | | | | | |
| 227 | QUAG | 1820 EXHIBIT | 4 | 19.2 | 6.7 | 7.6 | 2.5 | 2.4 | | | |
| 228 | QUAG | 1820 EXHIBIT | 3 | 15.2 | 5.5 | 3.1 | 6.5 | | | | |
| 229 | QUAG | 1820 EXHIBIT | 1 | 15.9 | 15.9 | | | | | | |
| 230 | QUAG | 1820 EXHIBIT | 1 | 20.7 | 20.7 | | | | | | |
| 231 | QUAG | 1820 EXHIBIT | 4 | 28.7 | 11.8 | 8.7 | 6.0 | 2.2 | | | |
| 232 | QUAG | 1820 EXHIBIT | 1 | 6.3 | 6.3 | | | | | | |
| 233 | QUAG | 1820 EXHIBIT | 2 | 12.8 | 9.5 | 3.3 | | | | | |
| 234 | QUAG | 1820 EXHIBIT | 2 | 13.1 | 4.4 | 8.7 | | | | | |
| 235 | QUAG | 1820 EXHIBIT | 1 | 5.7 | 5.7 | | | | | | |
| 236 | QUAG | 1820 EXHIBIT | 1 | 9.6 | 9.6 | | | | | | |
| 237 | QUAG | 1820 EXHIBIT | 1 | 4.1 | 4.1 | | | | | | |
| 238 | QUAG | 1820 EXHIBIT | 5 | 71.1 | 9.9 | 17.5 | 16.9 | 7.2 | 19.6 | | |
| 239 | QUAG | 1820 EXHIBIT | 1 | 9.4 | 9.4 | | | | | | |
| 240 | QUAG | 1820 EXHIBIT | 1 | 14.3 | 14.3 | | | | | | |
| 241 | QUAG | 1820 EXHIBIT | 1 | 10.2 | 10.2 | | | | | | |
| 242 | QUAG | 1820 EXHIBIT | 1 | 7.4 | 7.4 | | | | | | |
| 243 | QUAG | 1820 EXHIBIT | 2 | 10.1 | 7.0 | 3.1 | | | | | |
| 244 | QUAG | 2ND RAVINE, S | 4 | 41.2 | 13.2 | 8.7 | 14.1 | 5.3 | | | |
| 245 | QUAG | 2ND RAVINE, S | 4 | 44.2 | 14.3 | 11.1 | 10.4 | 8.4 | | | |
| 246 | QUAG | 2ND RAVINE, S | 1 | 6.3 | 6.3 | | | | | | |
| 247 | QUAG | 2ND RAVINE, S | 4 | 37.1 | 16.3 | 8.7 | 6.1 | 6.0 | | | |
| 248 | QUAG | 2ND RAVINE, S | 1 | 9.4 | 9.4 | | | | | | |
| 249 | UMCA | 2ND RAVINE, S | 2 | 5.3 | 5.3 | | | | TOO SMALL; LESS THAN 9 IN | | |
| 250 | QUAG | 2ND RAVINE, S | 1 | 11.1 | 11.1 | | | | | | |
| 251 | UMCA | 2ND RAVINE, S | 2 | 15.0 | 6.5 | 8.5 | | | | | |
| 252 | QUAG | 2ND RAVINE, S | 1 | 12.6 | 12.6 | | | | | | |
| 253 | QUAG | 2ND RAVINE, S | 1 | 9.0 | 9.0 | | | | | | |
| 254 | QUAG | 2ND RAVINE, S | 1 | 10.2 | 10.2 | | | | | | |
| 255 | QUAG | 2ND RAVINE, S | 1 | 6.9 | 6.9 | | | | | | |
| 256 | QUAG | 2ND RAVINE, S | 1 | 24.4 | 24.4 | | | | | | |
| 257 | QUAG | 2ND RAVINE, S | 1 | 7.4 | 7.4 | | | | | | |
| 258 | UMCA | 2ND RAVINE, S | 7 | 68.7 | 4.6 | 13.7 | 8.5 | 7.0 | 15.6 | 11.6 | 7.6 |
| 259 | UMCA | 2ND RAVINE, S | 4 | 61.1 | 17.1 | 14.8 | 14.6 | 14.6 | | | |
| 260 | QUAG | 2ND RAVINE, S | 1 | 11.5 | 11.5 | | | | | | |
| 261 | QUAG | 2ND RAVINE, S | 1 | 8.0 | 8.0 | | | | | | |
| 262 | QUAG | 2ND RAVINE, S | 1 | 14.3 | 14.3 | | | | | | |
| 263 | QUAG | BISON, E SIDE | 5 | 56.6 | 10.6 | 10.7 | 8.2 | 12.3 | 14.8 | | |
| 264 | QUAG | BISON, E SIDE | 7 | 98.3 | 12.8 | 20.2 | 12.3 | 9.7 | 11.1 | 14.2 | 18.1 |
| 265 | QUAG | BISON, E SIDE | 1 | 19.2 | 19.2 | | | | | | |
| 266 | QUAG | BISON, E SIDE | 1 | 23.8 | 23.8 | | | | | | |
| 267 | QUAG | BISON, E SIDE | 3 | 61.5 | 13.4 | 34.1 | 14.0 | | | | |
| 268 | QUAG | BISON, E SIDE | 2 | 40.0 | 31.1 | 8.9 | | | | | |
| 269 | QUAG | BISON, E SIDE | 1 | 26.4 | 26.4 | | | | | | |
| 270 | QUAG | BISON, E SIDE | 2 | 28.0 | 14.4 | 13.6 | | | | | |
| 271 | QUAG | BISON, E SIDE | 1 | 7.2 | 7.2 | | | | | | |
| 272 | QUAG | BISON, E SIDE | 1 | 14.4 | 14.4 | | | | | | |
| 273 | QUAG | BISON, E SIDE | 3 | 27.5 | 11.6 | 12.0 | 3.9 | | | | |
| 274 | QUAG | BISON, E SIDE | 1 | 20.9 | 20.9 | | | | | | |
| 275 | QUAG | BISON, E SIDE | 2 | 24.7 | 11.3 | 13.4 | | | | | |
| 276 | QUAG | BISON W SIDE | 4 | 42.3 | 11.9 | 7.8 | 11.3 | 11.3 | | | |
| 277 | QUAG | BISON W SIDE | 3 | 29.8 | 11.8 | 8.1 | 9.9 | | | | |
| 278 | QUAG | BISON W SIDE | 2 | 27.7 | 20.5 | 7.2 | | | | | |
| 279 | QUAG | BISON W SIDE | 2 | 27.2 | 17.2 | 10.1 | | | | | |
| 280 | QUAG | BISON W SIDE | 1 | 12.6 | 12.6 | | | | | | |
| 281 | QUAG | BISON W SIDE | 1 | 7.5 | 7.5 | | | | | | |
| 282 | QUAG | BISON W SIDE | 1 | 15.4 | 15.4 | | | | | | |
| 283 | QUAG | BISON W SIDE | 2 | 35.4 | 17.7 | 17.7 | | | | | |
| 284 | QUAG | BISON W SIDE | 1 | 22.2 | 22.2 | | | | | | |
| 285 | QUAG | BISON W SIDE | 1 | 9.3 | 9.3 | | | | | | |
| 286 | QUAG | BISON W SIDE | 1 | 20.4 | 20.4 | | | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | |
|---|---|---|---|---|---|---|---|---|
| 287 | QUAG | BISON W SIDE | 2 | 17.0 | 5.5 | 11.5 | | |
| 288 | QUAG | BISON W SIDE | 3 | 30.1 | 8.1 | 10.4 | 11.6 | |
| 289 | QUAG | BISON W SIDE | 1 | 12.3 | 12.3 | | | |
| 290 | QUAG | BISON W SIDE | 1 | 11.1 | 11.1 | | | |
| 291 | QUAG | BISON W SIDE | 2 | 21.5 | 16.9 | 4.6 | | |
| 292 | QUAG | BISON W SIDE | 2 | 10.6 | 6.8 | 3.8 | | |
| 293 | QUAG | BISON W SIDE | 2 | 16.7 | 12.7 | 3.9 | | |
| 294 | QUAG | BISON W SIDE | 2 | 10.6 | 4.9 | 5.6 | | |
| 295 | QUAG | BISON W SIDE | 1 | 7.1 | 7.1 | | | |
| 296 | QUAG | BISON W SIDE | 2 | 16.0 | 8.9 | 7.1 | | |
| 297 | QUAG | BISON W SIDE | 2 | 34.4 | 16.3 | 18.2 | | |
| 298 | QUAG | BISON W SIDE | 2 | 17.2 | 10.7 | 6.5 | | |
| 299 | QUAG | BISON W SIDE | 1 | 12.2 | 12.2 | | | |
| 300 | | NO TAG | | | | | | |
| 301 | QUAG | BISON W SIDE | 1 | 8.9 | 8.9 | | | |
| 302 | QUAG | BISON W SIDE | 2 | 36.1 | 17.6 | 18.6 | | |
| 303 | QUAG | BISON W SIDE | 1 | 7.7 | 7.7 | | | |
| 304 | QUAG | BISON W SIDE | 2 | 12.0 | 5.7 | 6.3 | | |
| 305 | QUAG | BISON W SIDE | 3 | 16.7 | 7.6 | 6.1 | 3.1 | |
| 306 | QUAG | BISON W SIDE | 2 | 10.3 | 6.9 | 3.4 | | |
| 307 | QUAG | BISON W SIDE | 1 | 4.4 | 4.4 | | | |
| 308 | QUAG | BISON W SIDE | 2 | 20.2 | 10.7 | 9.4 | | |
| 309 | QUAG | BISON W SIDE | 1 | 11.2 | 11.2 | | | |
| 310 | QUAG | BISON W SIDE | 3 | 20.4 | 7.1 | 6.1 | 7.2 | |
| 311 | QUAG | BISON W SIDE | 3 | 21.8 | 8.9 | 9.6 | 3.4 | |
| 312 | QUAG | BISON W SIDE | 3 | 21.1 | 6.5 | 6.8 | 7.9 | |
| 313 | QUAG | BISON W SIDE | 2 | 13.1 | 3.3 | 9.8 | | |
| 314 | QUAG | BISON W SIDE | 3 | 28.0 | 6.1 | 10.3 | 11.6 | |
| 315 | QUAG | BISON W SIDE | 2 | 15.3 | 7.6 | 7.6 | | |
| 316 | QUAG | BISON W SIDE | 2 | 15.5 | 4.8 | 10.7 | | |
| 317 | QUAG | BISON W SIDE | 3 | 27.0 | 9.7 | 11.9 | 5.5 | |
| 318 | QUAG | BISON W SIDE | 3 | 18.0 | 5.0 | 8.9 | 4.0 | |
| 319 | QUAG | BISON W SIDE | 1 | 8.3 | 8.3 | | | |
| 320 | QUAG | BISON W SIDE | 1 | 5.7 | 5.7 | | | |
| 321 | QUAG | BISON W SIDE | 2 | 33.7 | 18.6 | 15.1 | | |
| 322 | QUAG | 2ND RAVINE, S | 1 | 15.1 | 15.1 | | | |
| 323 | QUAG | 2ND RAVINE, S | 4 | 39.8 | 15.8 | 6.2 | 7.9 | 9.9 |
| 324 | QUAG | 2ND RAVINE, S | 2 | 13.4 | 7.7 | 5.7 | | |
| 325 | QUAG | 2ND RAVINE, S | 4 | 35.7 | 8.2 | 3.9 | 15.2 | 8.5 |
| 326 | QUAG | 2ND RAVINE, S | 1 | 11.1 | 11.1 | | | |
| 327 | QUAG | 2ND RAVINE, S | 2 | 32.2 | 10.6 | 21.6 | | |
| 328 | QUAG | 2ND RAVINE, S | 1 | 11.1 | 11.1 | | | |
| 329 | QUAG | 2ND RAVINE, S | 1 | 10.9 | 10.9 | | | |
| 330 | QUAG | 2ND RAVINE, S | 2 | 12.0 | 3.8 | 8.1 | | |
| 331 | QUAG | 2ND RAVINE, S | 1 | 9.3 | 9.3 | | | |
| 332 | QUAG | 2ND RAVINE, S | 1 | 24.2 | 24.2 | | | |
| 333 | UMCA | 2ND RAVINE, S | 1 | 19.2 | 19.2 | | | |
| 334 | QUAG | 2ND RAVINE, S | 1 | 15.2 | 15.2 | | | |
| 335 | QUAG | 2ND RAVINE, S | 1 | 7.0 | 7.0 | | | |
| 336 | QUAG | 2ND RAVINE, S | 2 | 6.5 | 4.5 | 2.0 | | |
| 337 | QUAG | 2ND RAVINE, S | 1 | 4.2 | 4.2 | | | |
| 338 | QUAG | 2ND RAVINE, S | 1 | 4.4 | 4.4 | | | |
| 339 | QUAG | 2ND RAVINE, S | 1 | 15.2 | 15.2 | | | |
| 340 | QUAG | 2ND RAVINE, S | 1 | 16.4 | 16.4 | | | |
| 341 | QUAG | 2ND RAVINE, S | 2 | 28.7 | 13.2 | 15.5 | | |
| 342 | QUAG | 2ND RAVINE, S | 3 | 37.1 | 10.2 | 20.4 | 6.5 | |
| 343 | UMCA | 2ND RAVINE, S | 2 | 13.1 | 7.8 | 5.3 | | |
| 344 | QUAG | 2ND RAVINE, S | 2 | 36.6 | 21.1 | 15.6 | | |
| 345 | QUAG | 2ND RAVINE, S | 2 | 31.3 | 10.9 | 20.4 | | |
| 346 | QUAG | 2ND RAVINE, S | 3 | 18.3 | 4.5 | 8.9 | 5.0 | |
| 347 | QUAG | 2ND RAVINE, S | 1 | 5.8 | 5.8 | | | |
| 348 | QUAG | 2ND RAVINE, S | 1 | 19.3 | 19.3 | | | |
| 349 | QUAG | 2ND RAVINE, S | 1 | 11.7 | 11.7 | | | |
| 350 | QUAG | 2ND RAVINE, S | 2 | 29.2 | 16.7 | 12.5 | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 351 | QUAG | 2ND RAVINE, S | 1 | 7.0 | 7.0 | | | | | |
| 352 | QUAG | 2ND RAVINE, S | 1 | 12.2 | 12.2 | | | | | |
| 353 | QUAG | 2ND RAVINE, S | 2 | 5.5 | 3.8 | 1.7 | | | | |
| 354 | QUAG | 2ND RAVINE, S | 1 | 4.3 | 4.3 | | | | | |
| 355 | QUAG | 2ND RAVINE, S | 1 | 13.6 | 13.6 | | | | | |
| 356 | QUAG | 2ND RAVINE, S | 4 | 42.7 | 12.2 | 9.8 | 10.0 | 10.7 | | |
| 357 | QUAG | 2ND RAVINE, S | 1 | 29.4 | 29.4 | | | | | |
| 358 | QUAG | 2ND RAVINE, S | 2 | 20.4 | 10.2 | 10.2 | | | | |
| 359 | QUAG | 2ND RAVINE, S | 1 | 22.9 | 22.9 | | | | | |
| 360 | QUAG | 2ND RAVINE, S | 4 | 77.2 | 20.3 | 16.5 | 24.9 | 15.5 | | |
| 361 | QUAG | 2ND RAVINE, S | 1 | 10.9 | 10.9 | | | | | |
| 362 | OLIVE | 2ND RAVINE, S | 3 | 13.0 | 3.0 | 3.5 | 6.5 | | | |
| 363 | QUAG | 2ND RAVINE, S | 2 | 5.7 | 3.3 | 2.4 | | | | |
| 364 | QUAG | 2ND RAVINE, S | 3 | 34.3 | 15.4 | 10.7 | 8.1 | | | |
| 365 | QUAG | 2ND RAVINE, S | 2 | 28.5 | 14.1 | 14.4 | | | | |
| 366 | QUAG | 2ND RAVINE, S | 2 | 30.2 | 17.0 | 13.2 | | | | |
| 367 | QUAG | 2ND RAVINE, S | 3 | 26.1 | 14.3 | 4.6 | 7.2 | | | |
| 368 | QUAG | 2ND RAVINE, S | 1 | 13.5 | 13.5 | | | | | |
| 369 | QUAG | 2ND RAVINE, S | 2 | 21.5 | 12.6 | 8.9 | | | | |
| 370 | QUAG | 2ND RAVINE, S | 3 | 29.3 | 13.0 | 10.1 | 6.2 | | | |
| 371 | QUAG | 2ND RAVINE, S | 3 | 25.2 | 15.1 | 6.6 | 3.5 | | | |
| 372 | QUAG | 2ND RAVINE, S | 1 | 8.7 | 8.7 | | | | | |
| 373 | QUAG | 2ND RAVINE, S | 3 | 29.1 | 10.0 | 9.8 | 9.3 | | | |
| 374 | QUAG | 2ND RAVINE, S | 4 | 59.5 | 14.2 | 15.7 | 17.9 | 11.7 | | |
| 375 | QUAG | 2ND RAVINE, S | 2 | 20.9 | 13.5 | 7.4 | | | | |
| 376 | QUAG | 2ND RAVINE, S | 3 | 20.4 | 6.1 | 11.2 | 3.1 | | | |
| 377 | QUAG | 2ND RAVINE, S | 2 | 13.8 | 10.1 | 3.7 | | | | |
| 378 | QUAG | 2ND RAVINE, S | 2 | 15.2 | 8.1 | 7.1 | | | | |
| 379 | QUAG | 2ND RAVINE, S | 1 | 8.6 | 8.6 | | | | | |
| 380 | QUAG | 2ND RAVINE, S | 4 | 50.7 | 16.9 | 8.1 | 12.6 | 13.1 | | |
| 381 | QUAG | 2ND RAVINE, S | 1 | 7.0 | 7.0 | | | | | |
| 382 | QUAG | 2ND RAVINE, S | 1 | 6.4 | 6.4 | | | | | |
| 383 | QUAG | 2ND RAVINE, S | 5 | 60.7 | 11.0 | 8.4 | 16.6 | 11.6 | 13.0 | |
| 384 | QUAG | 2ND RAVINE, S | 1 | 22.3 | 22.3 | | | | | |
| 385 | QUAG | 2ND RAVINE, S | 1 | 17.5 | 17.5 | | | | | |
| 386 | QUAG | 2ND RAVINE, S | 4 | 21.5 | 5.9 | 5.8 | 7.2 | 2.6 | | |
| 387 | QUAG | 2ND RAVINE, S | 2 | 19.2 | 11.6 | 7.6 | | | | |
| 388 | QUAG | 2ND RAVINE, S | 4 | 19.8 | 8.4 | 4.5 | 2.8 | 4.1 | | |
| 389 | QUAG | 2ND RAVINE, S | 1 | 9.7 | 9.7 | | | | | |
| 390 | QUAG | 2ND RAVINE, S | 2 | 42.3 | 9.1 | 33.3 | | | | |
| 391 | QUAG | 2ND RAVINE, S | 2 | 5.9 | 3.1 | 2.8 | | | | |
| 392 | QUAG | 2ND RAVINE, S | 2 | 24.4 | 11.0 | 13.4 | | | | |
| 393 | QUAG | 2ND RAVINE, S | 2 | 19.9 | 11.3 | 8.5 | | | | |
| 394 | QUAG | 2ND RAVINE, S | 2 | 15.6 | 11.5 | 4.1 | | | | |
| 395 | QUAG | 2ND RAVINE, S | 1 | 4.8 | 4.8 | | | | | |
| 396 | QUAG | 2ND RAVINE, S | 1 | 7.1 | 7.1 | | | | | |
| 397 | QUAG | 2ND RAVINE, S | 2 | 14.2 | 7.2 | 6.9 | | | | |
| 398 | QUAG | 2ND RAVINE, S | 3 | 38.1 | 13.6 | 14.0 | 10.5 | | | |
| 399 | QUAG | 2ND RAVINE, S | 1 | 9.2 | 9.2 | | | | | |
| 400 | QUAG | BISON, W SIDE | 2 | 21.5 | 10.0 | 11.5 | | | | |
| 401 | QUAG | BISON, W SIDE | 1 | 11.3 | 11.3 | | | | | |
| 402 | QUAG | BISON, W SIDE | 2 | 3.7 | 3.7 | | | | | TOO SMALL; LESS THAN 4 IN DBH |
| 403 | QUAG | BISON, W SIDE | 2 | 15.3 | 8.7 | 6.6 | | | | |
| 404 | QUAG | BISON, W SIDE | 1 | 7.8 | 7.8 | | | | | |
| 405 | QUAG | BISON, W SIDE | 1 | 13.5 | 13.5 | | | | | |
| 406 | QUAG | BISON, W SIDE | 2 | 10.5 | 5.0 | 5.5 | | | | |
| 407 | QUAG | BISON, W SIDE | 1 | 9.6 | 9.6 | | | | | |
| 408 | QUAG | BISON, W SIDE | 1 | 6.4 | 6.4 | | | | | |
| 409 | QUAG | BISON, W SIDE | 1 | 8.9 | 8.9 | | | | | |
| 410 | QUAG | BISON, W SIDE | 2 | 18.7 | 8.8 | 9.8 | | | | |
| 411 | QUAG | BISON, W SIDE | 1 | 7.1 | 7.1 | | | | | |
| 412 | QUAG | BISON, W SIDE | 1 | 10.3 | 10.3 | | | | | |
| 413 | QUAG | BISON, W SIDE | 1 | 15.7 | 15.7 | | | | | |
| 414 | QUAG | BISON, W SIDE | 1 | 9.1 | 9.1 | | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 415 | QUAG | BISON, W SIDE | 3 | 16.3 | 3.0 | 7.1 | 6.3 | | |
| 416 | QUAG | BISON, W SIDE | 1 | 16.5 | 16.5 | | | | |
| 417 | QUAG | BISON, W SIDE | 1 | 7.6 | 7.6 | | | | |
| 418 | QUAG | BISON, W SIDE | 1 | 7.2 | 7.2 | | | | |
| 419 | QUAG | BISON, W SIDE | 2 | 32.0 | 18.8 | 13.2 | | | |
| 420 | QUAG | BISON, W SIDE | 1 | 12.3 | 12.3 | | | | |
| 421 | QUAG | BISON, W SIDE | 1 | 13.0 | 13.0 | | | | |
| 422 | QUAG | BISON, W SIDE | 2 | 19.1 | 8.7 | 10.4 | | | |
| 423 | QUAG | BISON, W SIDE | 1 | 11.2 | 11.2 | | | | |
| 424 | QUAG | BISON, W SIDE | 1 | 7.9 | 7.9 | | | | |
| 425 | QUAG | BISON, W SIDE | 2 | 12.4 | 8.8 | 3.6 | | | |
| 426 | QUAG | BISON, W SIDE | 1 | 9.8 | 9.8 | | | | |
| 427 | QUAG | BISON, W SIDE | 1 | 8.7 | 8.7 | | | | |
| 428 | QUAG | BISON, W SIDE | 2 | 18.9 | 8.1 | 10.8 | | | |
| 429 | QUAG | BISON, W SIDE | 1 | 17.9 | 17.9 | | | | |
| 430 | QUAG | BISON, W SIDE | 1 | 8.7 | 8.7 | | | | |
| 431 | QUAG | BISON, W SIDE | 2 | 23.9 | 10.4 | 13.4 | | | |
| 432 | QUAG | BISON, W SIDE | 2 | 3.7 | 3.7 | | | | TOO SMALL; LESS THAN 4 IN DBH |
| 433 | QUAG | BISON, W SIDE | 1 | 10.9 | 10.9 | | | | |
| 434 | QUAG | BISON, W SIDE | 1 | 17.6 | 17.6 | | | | |
| 435 | QUAG | BISON, W SIDE | 1 | 9.1 | 9.1 | | | | |
| 436 | QUAG | BISON, W SIDE | 1 | 7.2 | 7.2 | | | | |
| 437 | QUAG | BISON, W SIDE | 2 | 13.7 | 4.9 | 8.7 | | | |
| 438 | QUAG | BISON, W SIDE | 2 | 11.7 | 7.7 | 4.0 | | | |
| 439 | QUAG | BISON, W SIDE | 1 | 5.0 | 5.0 | | | | |
| 440 | QUAG | BISON, W SIDE | 1 | 8.9 | 8.9 | | | | |
| 441 | QUAG | BISON, W SIDE | 1 | 16.8 | 16.8 | | | | |
| 442 | QUAG | BISON, W SIDE | 1 | 8.9 | 8.9 | | | | |
| 443 | QUAG | BISON, W SIDE | 1 | 16.8 | 16.8 | | | | |
| 444 | QUAG | BISON, W SIDE | 2 | 20.0 | 10.3 | 9.7 | | | |
| 445 | QUAG | BISON, W SIDE | 4 | 64.3 | 8.4 | 14.1 | 18.9 | 22.9 | |
| 446 | QUAG | BISON, W SIDE | 2 | 35.3 | 16.3 | 19.1 | | | |
| 447 | QUAG | BISON, W SIDE | 1 | 11.7 | 11.7 | | | | |
| 448 | QUAG | BISON, W SIDE | 1 | 11.5 | 11.5 | | | | |
| 449 | QUAG | BISON, W SIDE | 3 | 35.2 | 13.2 | 6.4 | 15.6 | | |
| 450 | QUAG | BISON, W SIDE | 1 | 15.7 | 15.7 | | | | |
| 451 | QUAG | BISON, W SIDE | 2 | 14.9 | 6.7 | 8.2 | | | |
| 452 | QUAG | BISON, W SIDE | 2 | 33.4 | 12.5 | 20.9 | | | |
| 453 | QUAG | BISON, W SIDE | 1 | 13.2 | 13.2 | | | | |
| 454 | QUAG | BISON, W SIDE | 1 | 20.1 | 20.1 | | | | |
| 455 | QUAG | BISON, W SIDE | 2 | 27.7 | 10.8 | 16.9 | | | |
| 456 | QUAG | BISON, W SIDE | 1 | 16.6 | 16.6 | | | | |
| 457 | QUAG | BISON, IN BROOM | 3 | 38.0 | 16.1 | 11.2 | 10.6 | | |
| 458 | QUAG | BISON, IN BROOM | 3 | 38.3 | 10.3 | 10.0 | 18.1 | | |
| 459 | QUAG | BISON, W SIDE | 3 | 34.3 | 11.9 | 10.2 | 12.2 | | |
| 460 | QUAG | BISON, W SIDE | 1 | 9.4 | 9.4 | | | | |
| 461 | QUAG | BISON, W SIDE | 1 | 9.6 | 9.6 | | | | |
| 462 | QUAG | BISON, W SIDE | 2 | 35.7 | 16.8 | 18.9 | | | |
| 463 | QUAG | BISON, W SIDE | 1 | 12.5 | 12.5 | | | | |
| 464 | QUAG | BISON, W SIDE | 2 | 15.1 | 9.3 | 5.9 | | | |
| 465 | QUAG | BISON, W SIDE | 2 | 21.4 | 9.1 | 12.3 | | | |
| 466 | QUAG | BISON, W SIDE | 2 | 21.3 | 12.7 | 8.6 | | | |
| 467 | QUAG | BISON, W SIDE | 1 | 12.7 | 12.7 | | | | |
| 468 | QUAG | BISON, W SIDE | 3 | 64.6 | 20.6 | 18.6 | 25.3 | | |
| 469 | QUAG | BISON, W, BROOM | 2 | 12.7 | 7.6 | 5.1 | | | |
| 470 | QUAG | BISON, ON ROAD | 1 | 18.4 | 18.4 | | | | |
| 471 | QUAG | BISON, ON ROAD | 4 | 61.4 | 9.8 | 14.5 | 15.5 | 21.5 | |
| 472 | QUAG | BISON, ON ROAD | 4 | 67.5 | 10.8 | 13.1 | 18.7 | 24.9 | |
| 473 | QUAG | BISON, ON ROAD | 1 | 25.6 | 25.6 | | | | |
| 474 | ACACIA | TOP OF SKY RIDE | 1 | 16.9 | 16.9 | | | | |
| 475 | ACACIA | TOP OF SKY RIDE | 1 | 11.5 | 11.5 | | | | |
| 476 | QUAG | BISON, W SIDE | 1 | 18.2 | 18.2 | | | | |
| 477 | QUAG | BISON, W SIDE | 1 | 11.4 | 11.4 | | | | |
| 478 | QUAG | BISON, W SIDE | 1 | 13.7 | 13.7 | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 479 | QUAG | BISON, W SIDE | 1 | 14.6 | 14.6 | | | | | | | | | | |
| 480 | QUAG | BISON, W SIDE | 1 | 23.6 | 23.6 | | | | | | | | | | |
| 481 | QUAG | BISON, W SIDE | 6 | 71.3 | 10.6 | 20.2 | 12.9 | 10.0 | 7.1 | 10.4 | | | | | |
| 482 | ACACIA | TOP OF SKY RIDE | 4 | 17.8 | 4.7 | 5.1 | 4.0 | 3.9 | | | | | | | |
| 483 | ACACIA | TOP OF SKY RIDE | 10 | 36.8 | 3.8 | 4.0 | 5.7 | 4.4 | 2.6 | 2.9 | 2.2 | 4.8 | 2.5 | 3.9 | |
| 484 | PIRA | TOP OF SKY RIDE | 1 | 23.0 | 23.0 | | | | | | | | | | |
| 485 | PIRA | TOP OF SKY RIDE | 1 | 10.7 | 10.7 | | | | | | | | | | |
| 486 | PIRA | TOP OF SKY RIDE | 1 | 19.4 | 19.4 | | | | | | | | | | |
| 487 | PIRA | TOP OF SKY RIDE | 2 | 26.1 | 15.6 | 10.5 | | | | | | | | | |
| 488 | PIRA | TOP OF SKY RIDE | 1 | 12.4 | 12.4 | | | | | | | | | | |
| 489 | PIRA | TOP OF SKY RIDE | 1 | 12.2 | 12.2 | | | | | | | | | | |
| 490 | PIRA | TOP OF SKY RIDE | 2 | 18.6 | 10.3 | 8.3 | | | | | | | | | |
| 491 | PIRA | TOP OF SKY RIDE | 2 | 17.9 | 17.9 | | | | | | | | | | FORKED; MEASURED BELOW |
| 492 | ACACIA | TOP OF SKY RIDE | 4 | 18.1 | 4.4 | 3.3 | 4.7 | 5.7 | | | | | | | |
| 493 | ACACIA | TOP OF SKY RIDE | 2 | 12.5 | 6.3 | 6.3 | | | | | | | | | |
| 494 | ACACIA | TOP OF SKY RIDE | 1 | 10.6 | 10.6 | | | | | | | | | | |
| 495 | OLIVE | ENV.ED.CTR. | 3 | 14.2 | 5.1 | 6.5 | 2.6 | | | | | | | | |
| 496 | ACACIA | ENV.ED.CTR. | 2 | 9.1 | 4.4 | 4.7 | | | | | | | | | |
| 497 | ACACIA | ENV.ED.CTR. | 7 | 25.4 | 5.9 | 2.3 | 4.3 | 2.0 | 4.3 | 3.9 | 2.7 | | | | |
| 498 | ACACIA | ENV.ED.CTR. | 6 | 21.2 | 3.2 | 4.0 | 2.2 | 5.5 | 3.1 | 3.1 | | | | | |
| 499 | QUAG | ENV.ED.CTR. | 1 | 24.0 | 24.0 | | | | | | | | | | |
| 500 | ACACIA | ENV.ED.CTR. | 1 | 9.4 | 9.4 | | | | | | | | | | |
| 501 | QUAG | UPR OLD BISON ENCL | 7 | 68.8 | 8.0 | 8.3 | 6.3 | 10.4 | 18.3 | 6.5 | 11.0 | | | | |
| 502 | QUAG | UPR OLD BISON ENCL | 2 | 28.9 | 10.2 | 18.7 | | | | | | | | | |
| 503 | QUAG | UPR OLD BISON ENCL | 4 | 36.2 | 6.4 | 9.3 | 13.7 | 6.8 | | | | | | | |
| 504 | QUAG | NEW BISON ENCL | 4 | 67.3 | 22.2 | 18.8 | 15.1 | 11.2 | | | | | | | |
| 505 | QUAG | NEW BISON ENCL | 4 | 48.7 | 13.1 | 14.2 | 9.2 | 12.2 | | | | | | | |
| 506 | QUAG | NEW BISON ENCL | 1 | 21.5 | 21.5 | | | | | | | | | | |
| 507 | QUAG | NEW BISON ENCL | 2 | 22.1 | 12.9 | 9.2 | | | | | | | | | |
| 508 | QUAG | NEW BISON ENCL | 2 | 23.5 | 9.7 | 13.8 | | | | | | | | | |
| 509 | QUAG | NEW BISON ENCL | 4 | 42.2 | 7.5 | 12.9 | 6:1 | 15.7 | | | | | | | |
| 510 | QUAG | NEW BISON ENCL | 2 | 17.1 | 8.3 | 8.8 | | | | | | | | | |
| 511 | QUAG | NEW BISON ENCL | 2 | 27.4 | 8.9 | 18.5 | | | | | | | | | |
| 512 | UMCA | NEW BISON ENCL | 3 | 18.7 | 7.3 | 5.5 | 5.9 | | | | | | | | |
| 513 | QUAG | NEW BISON ENCL | 3 | 32.5 | 12.2 | 13.6 | 6.7 | | | | | | | | |
| 514 | QUAG | NEW BISON ENCL | 3 | 54.1 | 8.9 | 14.5 | 20.7 | | | | | | | | |
| 515 | QUAG | NEW BISON ENCL | 3 | 15.1 | 5.4 | 6.7 | 3.0 | | | | | | | | |
| 516 | QUAG | NEW BISON ENCL | 3 | 23.3 | 8.6 | 7.6 | 7.1 | | | | | | | | |
| 517 | QUAG | NEW BISON ENCL | 2 | 17.5 | 7.9 | 9.6 | | | | | | | | | TREE TOPPLED OVER, WE TOOK HORIZ. MAIN TRUCKS |
| 518 | QUAG | NEW BISON ENCL | 2 | 44.7 | 35.8 | 8.9 | | | | | | | | | |
| 519 | QUAG | NEW BISON ENCL | 2 | 32.5 | 17.8 | 14.7 | | | | | | | | | |
| 520 | QUAG | NEW BISON ENCL | 9 | 100.2 | 7.1 | 8.5 | 4.3 | 11.3 | 12.8 | 11.1 | 15.4 | 15.5 | 14.2 | | |
| 521 | QUAG | NEW BISON ENCL | 3 | 41.4 | 11.9 | 14.8 | 14.7 | | | | | | | | |
| 522 | QUAG | NEW BISON ENCL | 2 | 21.2 | 10.0 | 11.2 | | | | | | | | | |
| 523 | QUAG | NEW BISON ENCL | 3 | 32.4 | 13.5 | 9.1 | 9.8 | | | | | | | | |
| 524 | QUAG | NEW BISON ENCL | 1 | 20.5 | 20.5 | | | | | | | | | | |
| 525 | QUAG | NEW BISON ENCL | 3 | 41.7 | 17.2 | 11.8 | 12.7 | | | | | | | | |
| 526 | QUAG | NEW BISON ENCL | 2 | 33.6 | 16.8 | 16.8 | | | | | | | | | |
| 527 | QUAG | NEW BISON ENCL | 2 | 29.3 | 17.1 | 12.2 | | | | | | | | | |
| 528 | QUAG | NEW BISON ENCL | 6 | 18.8 | 2.3 | 1.8 | 4.1 | 4.1 | 4.7 | 1.8 | | | | | |
| 529 | QUAG | NEW BISON ENCL | 1 | 6.0 | 6.0 | | | | | | | | | | |
| 530 | QUAG | NEW BISON ENCL | 2 | 32 | 21.1 | 10.9 | | | | | | | | | |
| 531 | QUAG | NEW BISON ENCL | 2 | 26.2 | 9.3 | 16.9 | | | | | | | | | |
| 532 | QUAG | NEW BISON ENCL | 1 | 9.7 | 9.7 | | | | | | | | | | |
| 533 | QUAG | NEW BISON ENCL | 2 | 20.0 | 11.0 | 9.0 | | | | | | | | | |
| 534 | QUAG | NEW BISON ENCL | 3 | 26.6 | 10.2 | 9.5 | 6.9 | | | | | | | | |
| 535 | QUAG | NEW BISON ENCL | 3 | 26.5 | 7.6 | 9.1 | 9.8 | | | | | | | | |
| 536 | QUAG | NEW BISON ENCL | 5 | 73.6 | 7.7 | 14.7 | 11.1 | 13.3 | 26.8 | | | | | | |
| 537 | QUAG | NEW BISON ENCL | 2 | 27.2 | 14.6 | 12.6 | | | | | | | | | |
| 538 | QUAG | NEW BISON ENCL | 2 | 9.2 | 6.6 | 2.6 | | | | | | | | | |
| 539 | QUAG | NEW BISON ENCL | 2 | 13.9 | 7.2 | 6.7 | | | | | | | | | |
| 540 | QUAG | NEW BISON ENCL | 3 | 26.1 | 10.8 | 7.0 | 8.3 | | | | | | | | |
| 541 | QUAG | 2ND RAVINE, BISON ENCL | 1 | 8.5 | 8.5 | | | | | | | | | | |
| 542 | QUAG | 2ND RAVINE, BISON ENCL | 1 | 6.6 | 6.6 | | | | | | | | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 543 | QUAG | 2ND RAVINE, BISON ENCL | 1 | 7.0 | 7.0 | | | | |
| 544 | QUAG | 2ND RAVINE, BISON ENCL | 1 | 4.1 | 4.1 | | | | |
| 545 | UMCA | 2ND REVINE, BISON END | 1 | 7.2 | 7.2 | | | | TOO SMALL; LESS THAN 9 IN. DBH |
| 546 | QUAG | 2ND RAVINE, BISON ENCL | 2 | 21.4 | 8.5 | 12.9 | | | |
| 547 | QUAG | 2ND RAVINE, BISON ENCL | 3 | 54.9 | 24.4 | 14.3 | 16.2 | | |
| 548 | QUAG | 2ND RAVINE, BISON ENCL | 2 | 15.7 | 7.9 | 7.8 | | | |
| 549 | QUAG | 2ND RAVINE, BISON ENCL | 1 | 4.2 | 4.2 | | | | |
| 550 | QUAG | 2ND RAVINE, BISON ENCL | 1 | 8.1 | 8.1 | | | | |
| 551 | QUAG | 2ND RAVINE, BISON ENCL | 3 | 19.7 | 9.9 | 3.7 | 6.1 | | |
| 552 | QUAG | 2ND RAVINE, BISON ENCL | 1 | 17.5 | 17.5 | | | | |
| 553 | QUAG | 2ND RAVINE, BISON ENCL | 2 | 22.7 | 18.1 | 4.6 | | | |
| 554 | QUAG | 2ND RAVINE, BISON ENCL | 2 | 10.3 | 5.9 | 4.4 | | | |
| 555 | QUAG | CTR RAVINE, BISON ENCL | 1 | 13.9 | 13.9 | | | | |
| 556 | QUAG | CTR RAVINE, BISON ENCL | 1 | 10.8 | 10.8 | | | | |
| 557 | QUAG | CTR RAVINE, BISON ENCL | 2 | 9.6 | 4.9 | 4.7 | | | |
| 558 | QUAG | CTR RAVINE, BISON ENCL | 1 | 14.5 | 14.5 | | | | |
| 559 | QUAG | CTR RAVINE, BISON ENCL | 3 | 21.0 | 11.2 | 4.1 | 5.7 | | |
| 560 | QUAG | CTR RAVINE, BISON ENCL | 1 | 4.3 | 4.3 | | | | |
| 561 | QUAG | CTR RAVINE, BISON ENCL | 3 | 8.9 | 2.2 | 3.5 | 3.2 | | |
| 562 | QUAG | CTR RAVINE, BISON ENCL | 2 | 20.7 | 10.3 | 10.4 | | | |
| 563 | QUAG | CTR RAVINE, BISON ENCL | 1 | 4.2 | 4.2 | | | | |
| 564 | QUAG | UPPER, N END BISON | 2 | 16.8 | 8.0 | 8.8 | | | |
| 565 | QUAG | UPPER, N END BISON | 2 | 21.6 | 9.1 | 12.5 | | | |
| 566 | QUAG | UPPER, N END BISON | 1 | 8.7 | 8.7 | | | | |
| 567 | QUAG | UPPER, N END BISON | 2 | 33.4 | 16.1 | 17.3 | | | |
| 568 | QUAG | UPPER, N END BISON | 3 | 38.6 | 12.4 | 11.5 | 14.7 | | |
| 569 | QUAG | UPPER, N END BISON | 2 | 28.5 | 14.6 | 13.9 | | | |
| 570 | QUAG | UPPER, N END BISON | 1 | 12.5 | 12.5 | | | | |
| 571 | QUAG | UPPER, N END BISON | 1 | 18.5 | 18.5 | | | | |
| 572 | QUAG | UPPER, N END BISON | 1 | 13.3 | 13.3 | | | | |
| 573 | QUAG | UPPER, N END BISON | 1 | 12.9 | 12.9 | | | | |
| 574 | QUAG | UPPER, N END BISON | 1 | 14.3 | 14.3 | | | | |
| 575 | QUAG | UPPER, N END BISON | 1 | 16.8 | 16.8 | | | | |
| 576 | QUAG | UPPER, N END BISON | 3 | 30.3 | 12.0 | 10.2 | 8.1 | | |
| 577 | QUAG | UPPER, N END BISON | 1 | 4.4 | 4.4 | | | | |
| 578 | QUAG | UPPER, N END BISON | 2 | 32.0 | 17.6 | 14.4 | | | |
| 579 | QUAG | UPPER, N END BISON | 1 | 14.8 | 14.8 | | | | |
| 580 | QUAG | UPPER, N END BISON | 2 | 16.2 | 9.2 | 7.0 | | | |
| 581 | QUAG | UPPER, N END BISON | 4 | 30.1 | 9.1 | 6.2 | 9.1 | 5.7 | |
| 582 | QUAG | UPPER, N END BISON | 1 | 20.0 | 20.0 | | | | |
| 583 | QUAG | UPPER, N END BISON | 4 | 53.5 | 12.4 | 19.5 | 8.4 | 11.4 | |
| 584 | QUAG | UPPER, N END BISON | 1 | 5.9 | 5.9 | | | | |
| 585 | QUAG | UPPER, N END BISON | 3 | 22.5 | 7.0 | 6.6 | 8.9 | | |
| 586 | UMCA | UPPER, N END BISON | 1 | 5.9 | 5.9 | | | | TOO SMALL; LESS THAN 9 IN. DBH |
| 587 | QUAG | UPPER, N END BISON | 3 | 28.7 | 24.0 | 2.7 | 2.0 | | |
| 588 | QUAG | SHUTTLE ROAD | 3 | 23.5 | 9.4 | 9.4 | 4.7 | | |
| 589 | QUAG | SHUTTLE ROAD | 4 | 26.1 | 7.2 | 6.6 | 6.1 | 6.2 | |
| 590 | QUAG | SHUTTLE ROAD | 2 | 5.9 | 3.5 | 2.4 | | | |
| 591 | QUAG | SHUTTLE ROAD | 4 | 21.5 | 3.9 | 8.5 | 5.0 | 4.1 | |
| 592 | QUAG | SHUTTLE ROAD | 3 | 29.4 | 8.9 | 5.9 | 14.6 | | |
| 593 | QUAG | OFF EXHB BREEDING AREA | 1 | 18.9 | 18.9 | | | | |
| 594 | QUAG | OFF EXHB BREEDING AREA | 2 | 25.2 | 12.6 | 12.6 | | | |
| 595 | QUAG | WOLF EXHB | 4 | 19.0 | 6.2 | 4.7 | 3.6 | 4.5 | |
| 596 | QUAG | WOLF EXHB | 1 | 11.1 | 11.1 | | | | |
| 597 | QUAG | WOLF EXHB | 2 | 16.4 | 12.7 | 3.7 | | | |
| 598 | QUAG | WOLF EXHB | 1 | 4.1 | 4.1 | | | | |
| 599 | QUAG | WOLF EXHB | 4 | 25.4 | 14.2 | 4.6 | 2.0 | 4.6 | |
| 600 | QUAG | OFF EXHB BREEDING AREA | 1 | 11.7 | 11.7 | | | | |
| 601 | QUAG | OFF EXHB BREEDING AREA | 1 | 7.4 | 7.4 | | | | |
| 602 | QUAG | OFF EXHB BREEDING AREA | 1 | 7.8 | 7.8 | | | | |
| 603 | QUAG | OFF EXHB BREEDING AREA | 1 | 10.4 | 10.4 | | | | |
| 604 | QUAG | OFF EXHB BREEDING AREA | 2 | 21.3 | 10.7 | 10.6 | | | |
| 605 | QUAG | OFF EXHB BREEDING AREA | 1 | 11.3 | 11.3 | | | | |
| 606 | QUAG | OFF EXHB BREEDING AREA | 2 | 12.4 | 6.0 | 16.4 | | | |

| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 607 | QUAG | OFF EXHB BREEDING AREA | 1 | 12.5 | 12.5 | | | | | |
| 608 | QUAG | OFF EXHB BREEDING AREA | 1 | 11.1 | 11.1 | | | | | |
| 609 | QUAG | OFF EXHB BREEDING AREA | 1 | 7.2 | 7.2 | | | | | |
| 610 | QUAG | OFF EXHB BREEDING AREA | 1 | 8.5 | 4.4 | 4.1 | | | | |
| 611 | QUAG | OFF EXHB BREEDING AREA | 1 | 8.0 | 8.0 | | | | | |
| 612 | QUAG | OFF EXHB BREEDING AREA | 1 | 7.2 | 7.2 | | | | | |
| 613 | QUAG | OFF EXHB BREEDING AREA | 1 | 14.4 | 14.4 | | | | | |
| 614 | QUAG | OFF EXHB BREEDING AREA | 1 | 4.6 | 4.6 | | | | | |
| 615 | QUAG | OFF EXHB BREEDING AREA | 1 | 8.4 | 8.4 | | | | | |
| 616 | QUAG | OFF EXHB BREEDING AREA | 3 | 83.0 | 27.0 | 35.0 | 21.0 | | | |
| 617 | QUAG | WOLF EXHB | 1 | 7.8 | 7.8 | | | | | |
| 618 | QUAG | WOLF EXHB | 2 | 15.4 | 7.4 | 8.0 | | | | |
| 619 | SAME | OFF EXHIBIT BREEDING | 1 | 8.5 | 8.5 | | | | | TOO SMALL; LESS THAN 9 IN. DBH |
| 620 | QUAG | OFF EXHIBIT BREEDING | 3 | 20.3 | 7.5 | 7.5 | 5.3 | | | |
| 621 | QUAG | OFF EXHIBIT BREEDING | 2 | 12.0 | 7.4 | 4.6 | | | | |
| 622 | UMCA | OFF EXHIBIT BREEDING | 1 | 11.9 | 11.9 | | | | | |
| 623 | QUAG | OFF EXHIBIT BREEDING | 3 | 23.6 | 6.8 | 7.7 | 9.1 | | | |
| 624 | QUAG | OFF EXHIBIT BREEDING | 2 | 20.7 | 10.9 | 9.8 | | | | |
| 625 | QUAG | WOLF EXHB | 2 | 6.3 | 4.1 | 2.2 | | | | |
| 626 | QUAG | WOLF EXHB | 3 | 11.2 | 6.5 | 1.9 | 2.8 | | | |
| 627 | QUAG | WOLF EXHB | 1 | 3.5 | 3.5 | | | | | TOO SMALL; LESS THAN 4 IN. DBH |
| 628 | QUAG | INTERPRETIVE CENTER | 3 | 8.0 | 4.1 | 2.1 | 1.8 | | | |
| 629 | QUAG | INTERPRETIVE CENTER | 2 | 8.6 | 4.5 | 4.1 | | | | |
| 630 | QUAG | INTERPRETIVE CENTER | 3 | 6.3 | 2.6 | 1.6 | 2.1 | | | |
| 631 | QUAG | INTREPRETIVE CENTER | 2 | 5.8 | 2.9 | 2.9 | | | | |
| 632 | QUAG | INTREPRETIVE CENTER | 3 | 7.3 | 3.1 | 2.2 | 2.0 | | | |
| 633 | QUAG | WOLF EXHB | 2 | 10.1 | 5.0 | 5.1 | | | | |
| 634 | QUAG | WOLF EXHB | 2 | 8.4 | 4.3 | 4.1 | | | | |
| 635 | QUAG | WOLF EXHB | 1 | 3.2 | 3.2 | TOO SMALL, LESS THAN 4 IN. DBH | | | | |
| 636 | QUAG | WOLF EXHB | 3 | 10.7 | 3.1 | 4.5 | 3.1 | | | |
| 637 | QUAG | ACCESS ROAD | 3 | 7.2 | 1.8 | 2.2 | 3.2 | | | |
| 638 | QUAG | ACCESS ROAD | 3 | 49.9 | 16.1 | 12.1 | 21.7 | | | |
| 639 | QUAG | ACCESS ROAD | 2 | 17.8 | 6.6 | 11.2 | | | | |
| 640 | QUAG | ACCESS ROAD | 3 | 18.1 | 4.7 | 4.8 | 8.6 | | | |
| 641 | QUAG | ACCESS ROAD | 2 | 23.1 | 14.4 | 8.7 | | | | |
| 642 | QUAG | ACCESS ROAD | 4 | 28.6 | 7.0 | 9.1 | 3.7 | 8.8 | | |
| 643 | QUAG | ACCESS ROAD | 1 | 13.7 | 13.7 | | | | | |
| 644 | QUAG | ACCESS ROAD | 1 | 23.2 | 23.1 | | | | | |
| 645 | QUAG | ACCESS ROAD | 5 | 39.8 | 9.2 | 9.1 | 5.5 | 6.4 | 9.6 | |
| 646 | QUAG | ACCESS ROAD | 5 | 59.0 | 8.5 | 11.9 | 16.1 | 12.6 | 9.9 | |
| 647 | QUAG | ACCESS ROAD | 1 | 13.4 | 13.4 | | | | | |
| 648 | QUAG | ACCESS ROAD | 3 | 30.8 | 11.4 | 12.5 | 6.9 | | | |
| 649 | QUAG | ACCESS ROAD | 3 | 18.5 | 6.6 | 5.0 | 6.9 | | | |
| 650 | QUAG | ACCESS ROAD | 3 | 40.5 | 11.0 | 14.2 | 15.3 | | | |
| 651 | QUAG | ACCESS ROAD | 1 | 12.2 | 12.2 | | | | | |
| 652 | QUAG | ACCESS ROAD | 3 | 35.2 | 11.2 | 12.8 | 11.2 | | | |
| 653 | QUAG | ACCESS ROAD | 1 | 17.1 | 17.1 | | | | | |
| 654 | QUAG | ACCESS RD ABV BISON | 1 | 11.9 | 11.9 | | | | | |
| 655 | QUAG | ACCESS RD ABV BISON | 2 | 22.7 | 12.2 | 10.5 | | | | |
| 656 | QUAG | ACCESS RD ABV BISON | 1 | 15.4 | 15.4 | | | | | |
| 657 | QUAG | ACCESS RD ABV BISON | 1 | 9.4 | 9.4 | | | | | |
| 658 | QUAG | ACCESS RD ABV BISON | 2 | 28.1 | 12.8 | 15.3 | | | | |
| 659 | QUAG | ACCESS RD ABV BISON | 1 | 12.7 | 12.7 | | | | | |
| 660 | QUAG | ACCESS RD ABV BISON | 1 | 9.6 | 9.6 | | | | | |
| 661 | QUAG | ACCESS RD ABV BISON | 1 | 4.3 | 4.3 | | | | | |
| 662 | QUAG | ACCESS RD ABV BISON | 1 | 8.8 | 8.8 | | | | | |
| 663 | QUAG | ACCESS RD ABV BISON | 1 | 7.8 | 7.8 | | | | | |
| 664 | QUAG | ACCESS RD ABV BISON | 4 | 39.0 | 7.8 | 9.4 | 13.3 | 8.5 | | |
| 665 | QUAG | ACCESS RD ABV BISON | 1 | 7.5 | 7.5 | | | | | |
| 666 | QUAG | ACCESS RD ABV BISON | 5 | 57.0 | 14.6 | 12.1 | 13.8 | 7.8 | 8.7 | |
| 667 | QUAG | ACCESS RD ABV BISON | 1 | 12.5 | 12.5 | | | | | |
| 668 | QUAG | ACCESS RD ABV BISON | 1 | 7.2 | 7.2 | | | | | |
| 669 | QUAG | ACCESS RD ABV BISON | 1 | 10.6 | 10.6 | | | | | |
| 670 | QUAG | ACCESS RD ABV BISON | 1 | 12.7 | 12.7 | | | | | |

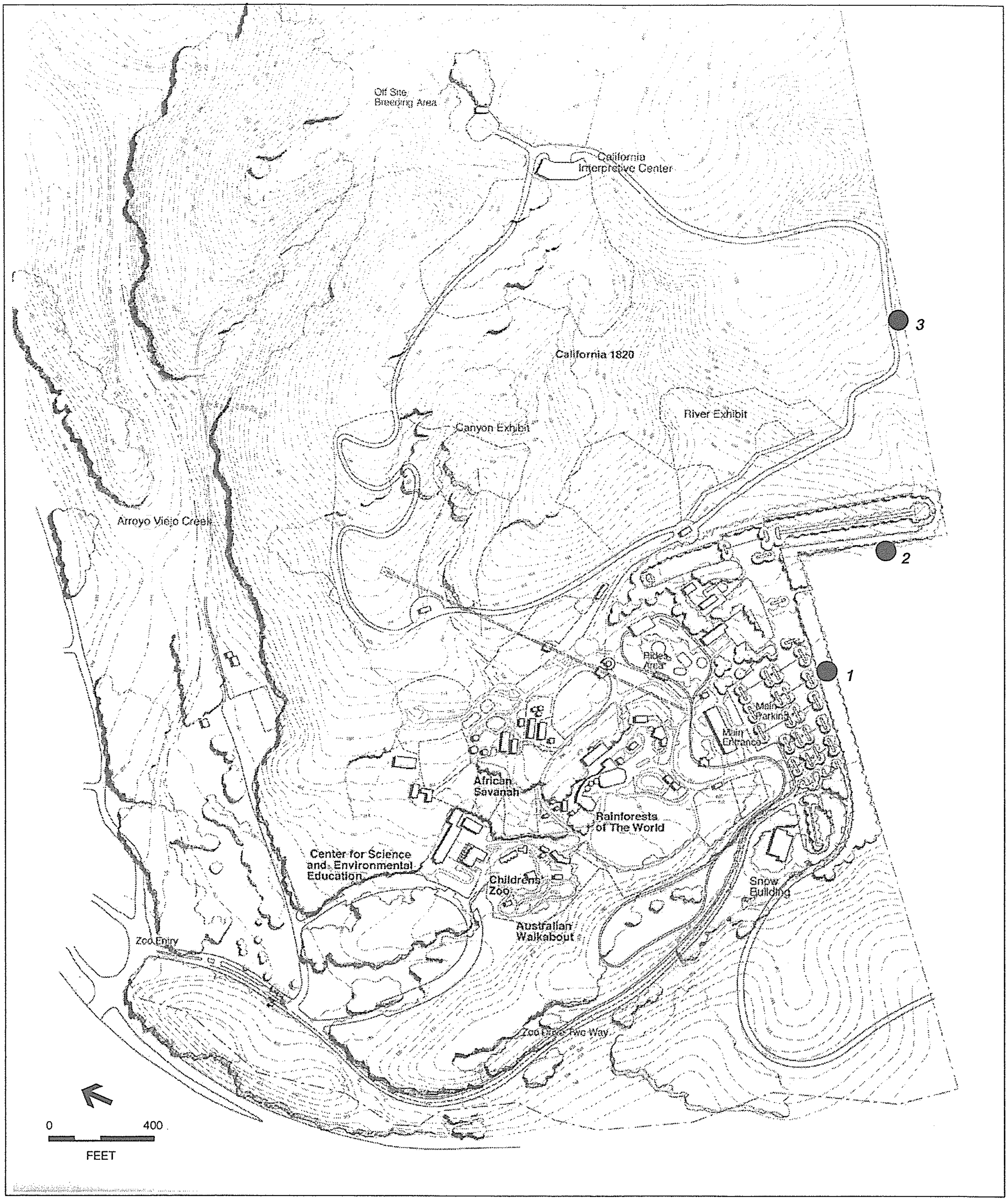
| TAG NO. | SPECIES | LOCATION | NO. STEMS | TOTAL DBH | DBH, IN INCHES, EACH STEM SEPARATE | | | |
|---|---|---|---|---|---|---|---|---|
| 671 | QUAG | ACCESS RD ABV BISON | 1 | 9.2 | 9.2 | | | |
| 672 | QUAG | ACCESS RD ABV BISON | 3 | 35.2 | 14.2 | 12.2 | 8.8 | |
| 673 | QUAG | ACCESS RD ABV BISON | 3 | 40.3 | 9.1 | 10.6 | 9.6 | 11.0 |
| 674 | QUAG | ACCESS RD ABV BISON | 2 | 25.1 | 11.6 | 13.5 | | |
| 675 | QUAG | ACCESS RD ABV BISON | 1 | 12.0 | 12.0 | | | |
| 676 | QUAG | ACCESS RD ABV BISON | 1 | 8.4 | 8.4 | | | |
| 677 | QUAG | ACCESS RD ABV BISON | 1 | 9.6 | 9.6 | | | |
| 678 | QUAG | ACCESS RD ABV BISON | 3 | 38.7 | 12.6 | 9.2 | 16.9 | |
| 679 | QUAG | ACCESS RD ABV BISON | 1 | 8.7 | 8.7 | | | |
| 680 | QUAG | ACCESS RD ABV BISON | 1 | 16.9 | 16.9 | | | |
| 681 | QUAG | ACCESS RD ABV BISON | 1 | 18.2 | 18.2 | | | |
| 682 | QUAG | UPR ACC. RD ABV BISON | 2 | 20.0 | 11.7 | 8.3 | | |
| 683 | QUAG | UPR ACC. RD ABV BISON | 1 | 14.9 | 14.9 | | | |
| 684 | QUAG | UPR ACC. RD ABV BISON | 2 | 11.7 | 7.5 | 4.2 | | |
| 685 | QUAG | UPR ACC. RD ABV BISON | 3 | 31.3 | 6.5 | 11.1 | 13.7 | |
| 686 | QUAG | UPR ACC. RD ABV BISON | 1 | 7.0 | 7.0 | | | |
| 687 | QUAG | UPR ACC. RD ABV BISON | 3 | 30.7 | 11.7 | 8.1 | 10.9 | |
| 688 | QUAG | UPR ACC. RD ABV BISON | 1 | 10.5 | 10.5 | | | |
| 689 | QUAG | UPR ACC. RD ABV BISON | 1 | 11.1 | 11.1 | | | |
| 690 | QUAG | UPR ACC. RD ABV BISON | 1 | 31.6 | 31.6 | | | |

# PRELIMINARY TREE REMOVAL LIST- CALIFORNIA 1820 EXHIBIT (2/3/97)

| TAG NO. | SPECIES | COMMON NAME | LOCATION | TOTAL DBH | |
|---|---|---|---|---|---|
| 1 | Pinus Radiata | Monterey Pine | Paved Access | 60.4" | |
| 2 | Acacia | Acacia | Paved Access | 10.4" | |
| 3 | Acacia | Acacia | Paved Access | 8.7" | TOO SMALL; LESS THAN 9 IN. DBH |
| 4 | Acacia | Acacia | Paved Access | 15.2" | |
| 5 | Pinus Radiata | Monterey Pine | Paved Access | 23.2" | |
| 6 | Pinus Radiata | Monterey Pine | Paved Access | 35.8" | |
| 7 | Quercus Agrifolia | Coast Live Oak | Paved Access | 26.2" | |
| 8 | Prunus Sp-Probably P. Dulcis | Almond | Paved Access | 12.4" | |
| 9 | Pinus Radiata | Monterey Pine | Paved Access | 13.7" | |
| 10 | Pinus Radiata | Monterey Pine | Paved Access | 19.6" | |
| 11 | Pinus Radiata | Monterey Pine | Paved Access | 58.5" | |
| 14 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 9.7" | |
| 15 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 3.4" | TOO SMALL; LESS THAN 4 IN. DBH |
| 16 | Pinus Coulteri | Coulter Pine | Shuttle Road | 9.7" | |
| 17 | Pinus Coulteri | Coulter Pine | Shuttle Road | 12.6" | |
| 18 | Pinus Radiata | Monterey Pine | Shuttle Road | 9.7" | |
| 19 | Pinus Radiata | Monterey Pine | Shuttle Road | 30.6" | |
| 20 | Pinus Radiata | Monterey Pine | Shuttle Road | 11.7" | |
| 21 | Pinus Radiata | Monterey Pine | Shuttle Road | 10.7" | |
| 22 | Pinus Radiata | Monterey Pine | Shuttle Road | 17.3" | |
| 23 | Pinus Radiata | Monterey Pine | Shuttle Road | 10.2" | |
| 24 | Pinus Radiata | Monterey Pine | Shuttle Road | 14.6" | |
| 25 | Pinus Radiata | Monterey Pine | Shuttle Road | 20.2" | |
| 26 | Pinus Radiata | Monterey Pine | Shuttle Road | 19.9" | |
| 27 | Pinus Radiata | Monterey Pine | Shuttle Road | 10.9" | |
| 28 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 6.6" | |
| 29 | Pinus Radiata | Monterey Pine | Shuttle Road | 19" | |
| 30 | Pinus Radiata | Monterey Pine | Shuttle Road | 15.5" | |
| 31 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 11.7" | |
| 32 | Pinus Radiata | Monterey Pine | Shuttle Road | 22.9" | |
| 33 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 20.7" | |
| 41 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 36.6" | |
| 42 | Quercus Agrifolia | Coast Life Oak | Shuttle Road | 16.4" | |
| 43 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 17" | |
| 105 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 10.4" | |
| 106 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 12" | |
| 107 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 31.9" | |
| 108 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 13.5" | |
| 109 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 20.6" | |
| 110 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 17.7" | |
| 121 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 29.9" | |
| 122 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 5.7" | |
| 123 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 19.8" | |
| 124 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 35.4" | |
| 125 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 15.6" | |
| 126 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 48.3" | |
| 127 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 19.8" | |
| 128 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 20.3" | |
| 129 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 13.9" | |
| 130 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 10.6" | |
| 131 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 31.6" | |
| 132 | Quercus Agrifiloa | Coast Live Oak | Shuttle Road | 10.4" | |
| 133 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 16.1" | |
| 134 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 14.6" | |
| 135 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 8.5" | |

# PRELIMINARY TREE REMOVAL LIST- CALIFORNIA 1820 EXHIBIT (2/3/97)

| | | | | | |
|---|---|---|---|---|---|
| 136 | Quercus Agrifoila | Coast Live Oak | Shuttle Road | 28.3" | |
| 137 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 42.7" | |
| 138 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 15.0" | |
| 141 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 12.4" | |
| 150 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 19.5" | |
| 166 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 47.8" | |
| 167 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 26.9" | |
| 168 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 59.3" | |
| 173 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 35.1" | |
| 174 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 7.2" | |
| 186 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 94.1" | |
| 187 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 19.6" | |
| 200 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 69.8" | |
| 204 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 58.8" | |
| 205 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 14.5" | |
| 206 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 45.2" | |
| 207 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 32.9" | |
| 212 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 42.7" | |
| 213 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 30.9" | |
| 218 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 34.7" | |
| 219 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 31.7" | |
| 264 | Quercus Agrifolia | Coast Live Oak | Bison, E. Side | 98.3" | |
| 305 | Quercus Agrifolia | Coast Live Oak | Bison, W. Side | 16.7" | |
| 469 | Quercus Agrifolia | Coast Live Oak | Bison, W. Side | 12.7" | |
| 470 | Quercus Agrifolia | Coast Live Oak | Bison, On Road | 18.4" | |
| 473 | Quercus Agrifolia | Coast Live Oak | Shuttle Road | 25.6" | |
| 474 | Acacia | Acacia | Shuttle Road | 16.9" | |
| 475 | Acacia | Acacia | Shuttle Road | 11.5" | |
| 481 | Quercus Agrifolia | Coast Live Oak | Bison, W. Side | 71.3" | |
| 588 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 23.5" | |
| 589 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 26.1" | |
| 590 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 5.9" | |
| 591 | Quercus Agrifolia | Coast Live Oak | Upper, N.End Bison | 21.5" | |
| 592 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 29.4" | |
| 593 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 18.9" | |
| 594 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 25.2" | |
| 595 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 19.0" | |
| 596 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 11.1" | |
| 597 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 16.4" | |
| 598 | Quercus Agrifolia | Coast Live Oak | Upper,N.End Bison | 4.1" | |
| 623 | Quercus Agrifolia | Coast Live Oak | Off Exhibit Breeding | 23.6" | |
| 624 | Quercus Agrifolia | Coast Live Oak | Off Exhibit Breeding | 20.7" | |
| 633 | Quercus Agrifolia | Coast Live Oak | Wolf Exhibit | 10.1" | |
| 634 | Quercus Agrifolia | Coast Live Oak | Wolf Exhibit | 8.4" | |
| 635 | Quercus Agrifolia | Coast Live Oak | Wolf Exhibit | 3.2" | TOO SMALL; LESS THAN 4 IN. DBH |
| 636 | Quercus Agrifolia | Coast Live Oak | Wolf Exhibit | 10.7" | |




*SOURCE: Geier & Geier Consulting, Inc.*

**Figure B-1**

Noise Measurement Locations

APPENDIX

# B

# 1998 MASTER PLAN CONDITIONS OF APPROVAL AND MITIGATION MEASURES

Exhibit C

## MODIFICATIONS TO CONDITIONS OF APPROVAL ATTACHED TO AND MADE A PART OF ZONING CASE NO. CM97-25

Modifications to the Planning Commission imposed Conditions of Approval are indicated **in bold/underlined print** for additions and ~~strikethrough print~~ for deletions.

1. The project shall be constructed and operated in accordance with the authorized use as described in ~~this~~ **the June 4, 1997 staff report to the Planning Commission**, and according to ~~the site plan and~~ elevations submitted on April 4, 1997, **and a revised site plan submitted on November 6, 1998;** provided further, that the project incorporate the revisions listed below as conditions of approval.

2. Applicable mitigation measures included and agreed upon by the applicant in the Mitigated Negative Declaration for the Oakland Zoo Master Plan project (ER96-36) are made a part of this approval, incorporated as conditions of approval by this reference. **These mitigation measures have been revised to incorporate changes from the post mediation agreement. The revised mitigation measures are made part of this approval and incorporated as conditions of approval by this reference (See Attachment A showing both original and revised mitigation measures).**

3. These conditions of approval shall be reproduced on page one of any plans submitted for a building permit for this project.

4. The project is approved pursuant to the Planning Code only and shall comply with all other applicable codes and requirements imposed by other affected departments. Minor changes to approved plans may be approved administratively by the Director of City Planning; major changes shall be subject to review and approval at a new public hearing by the City Planning Commission. ~~The final design of the California Interpretive Center shall be submitted to and approved by the Zoning Administrator prior to issuance of building permits.~~ **The Zoo will develop portions of the approved Master Plan in phases. These phased plans include a drainage plan, the tram road and the California 1820 exhibit.**

Specifically, the California 1820 exhibits will include double barrier enclosures and night houses for predators. There will be no animal exhibits developed between the southern perimeter of the tram road and the abutting residences. The approved drainage plan will be constructed as part of the construction of the tram road. The final design of the phased plans shall be submitted to and approved by the Zoning Administrator prior to issuance of any permits for the specific phase of development. The process for City of Oakland review shall be as follows: (1) 30 calendar days prior to submitting final plans to the Zoning Administrator, the Zoo shall provide the said plans to both the KPHA and SHRA neighborhood associations; (2) The Zoo shall provide the City documentation of the delivery of said plans to the two neighborhood associations; (3) Upon receipt of said plans, the City shall notify the KPHA and SHRA neighborhood representatives on file with the City and request comments; (4) The neighborhood associations shall submit written comments within 10 days of the City provided notice; (5) A decision on the final phased plans shall be made by the Zoning Administrator no sooner than 10 calendar days from the date notice was sent to the neighborhood associations by the City. It is the responsibility of the KPHA and SHNA to keep representatives names current with the City. The Zoo will stake the center line of the tram road location 30 calendar days prior to submitting the final plan for the tram road to the Zoning administrator for review.

5. ~~The proposed tram road shall be bermed and landscaped to provide visual screening from the abutting residential properties.~~

6. The applicant shall defend, indemnify, and hold harmless the City of Oakland, its agents, officers, and employees from any claim, action, or proceeding (including legal costs and attorney's fees) against the City of Oakland, its agents, officers or employees to attack, set aside, void or annul, an approval by the City of Oakland, the Office of Planning and Building, Planning Commission, or City Council. The City shall promptly notify the applicant of any claim, action or proceeding and the City shall cooperate fully in such defense. The City may elect, in its sole discretion, to participate in the defense of said claim, action, or proceeding.

7. The City Planning Commission reserves the right, after notice and public hearing, to alter Conditions of Approval or revoke this

conditional use permit if it is found that the approved activity is violating any of the Conditions of Approval or the provisions of the Zoning Regulations.

8. This permit shall become effective upon satisfactory compliance with the above conditions that are required within a one year time period. Any additional uses other than those approved with this permit will require a separate application and approval. Failure to exercise this approval ~~by June 4, 1998~~ within one year of approval by the City Council shall invalidate this approval, provided further, that upon written request the Director of City Planning may grant a one year extension of this date, with additional extensions subject to approval by the City Planning Commission.

9. ~~The applicant shall consult with all interested parties concerning the design and construction of the project, utilizing the services of a neutral third party facilitator as appropriate. All relevant factors, including but not limited to noise, traffic, drainage, and construction impacts, shall be considered in this consultation.~~

10. The applicant shall retain a consultant/engineer to pursue independent inspection of all attraction rides annually and shall make such inspection results available to the City upon request.

11. The perimeter fence will be located approximately as shown on the site plan submitted on November 6, 1998. The perimeter fence will be eight to ten feet (8-10') in height and painted black to minimize its visibility. In the locations where the perimeter fence crosses the two knolls (south of the CA 1820 Exhibit), the fence will be recessed in an engineered, graded swale thereby allowing neighbors an unobstructed view in all directions from the top of each knoll. The perimeter fence will be part of a phased plan or landscape plan and its exact location will be approved by the Zoning Administrator after a review following the same process as outlined in condition #4. The Zoo will stake the location of the perimeter fence (30) days prior to submittal of the final plan that includes the perimeter fence to the Zoning Administrator for review.

12. A landscaping and irrigation plan shall be submitted to and approved by the Zoning Administrator within one year of this approval and shall include a continuous landscaped buffer area that screens the main parking lot of the Zoo from the adjacent homes and is a minimum of 36 feet wide (except in the area adjacent to the Stella Street gate where the minimum width shall be 23 feet). The Zoo shall reevaluate the existing parking lot design to maximize the buffer area without decreasing the amount of parking particularly around the Stella Street gate. This landscape buffer shall be designed by a professional landscape architect. Installation of the landscape buffer shall be completed no later than April 2000 and shall be permanently maintained by the Zoo.

The proposed tram road shall be landscaped to shield the view of said tram road, to the maximum extent feasible as determined by the City Zoning Administrator, from the abutting residential properties, specifically the residents of lower Malcolm Street (e.g. Mark Street, Stella Street, Hellman Street, and Maggiora Drive). This landscaping shall consist of but not be limited to drought-tolerant-native trees and shrubs and fast-growing shrubs. The landscape and irrigation plan for the tram road will be developed in two phases and submitted to and approved by the Zoning Administrator. The first phase will be a landscape plan for those areas not affected by the grading for the tram road. This first phase of landscaping shall be installed at least 2 years before actual construction of the tram road commences and shall be permanently maintained by the Zoo. The second phase of landscaping within the areas graded for the tram road shall be developed in conjunction with the design of the tram road, including earthen berms for screening. The second phase of landscaping shall be installed within 90 days of the completed paving of the tram road. Review of the landscape plans shall follow the same process as outlined in condition #4.

13. As indicated on the revised site plan dated November 6, 1998, the Zoo shall relocate the Grizzly Bear enclosure from the River Exhibit to the Off-site Breeding area location. The Off-site Breeding area shall be relocated to the area on the Mesa behind the existing Off-site Breeding area.

14. The Zoo and the neighborhood associations will work with the City's Emergency Services Manager to educate area residents on the existing evacuation plan for the area and to develop any

additional procedures. The Zoo shall implement such procedures as determined by the City's Emergency Services Manager.

15. A signage plan shall be submitted to and approved by the Zoning Administrator and shall at a minimum include the following: (1) The Zoo shall install "No Backing In" signs for the parking spaces in the main parking lot that abut residential properties; (2) The Zoo shall install signs at the Sheldon Street gate (106th Ave. exit) advising visitors that they should use caution as they enter the residential area. These signs shall be installed in front of the exit gate to afford visitors time to read the signs prior to entering Sheldon Street; (3) The Zoo shall install a sign in the main parking lot advising exiting traffic that no trucks or buses shall use the 106th exit. The signage plan shall be approved and the signs installed within 2 months of the completion of changes to Zoo Drive that allow for two-way traffic.

16. The four emergency accesses located at Stella, Snowdown, Cameron and Ettrick shall only be used for emergency response and normal zoo maintenance activities. No construction trucks will use these accesses.

17. Noise from shuttle buses using the tram road is a matter of concern for residents living along the Zoo's southerly property line adjacent to the CA 1820 Exhibit. To provide the neighborhood associations with noise information and monitor the levels of noise generated by the tram the Zoo will undertake the following:

    (a) Prior to construction of the tram road, the Zoo's noise consultant in the presence of the representatives of KPHA and SHNA neighborhood associations, will take baseline noise readings at two points. The two points for noise readings will be along the property line that is south of the CA 1820 Exhibit and adjacent to the residential properties. These points will be agreed upon by the neighborhood representatives. These readings will establish a baseline noise condition that will be made available to the neighbors and will be submitted to the Zoning Administrator.

(b) At least one month before commencement of daily operation of the tram, the Zoo in the presence of the two neighborhood representatives, will take noise readings of the tram with passengers traveling along its road at the same locations used for the baseline noise readings. The number of passengers will be determined by the Zoning Administrator based on the capacity of the tram model. The results of the tram operation noise readings will be submitted to the Zoning Administrator and will be made available to the neighbors.

(c) If the operation of the tram increases the noise by more than 2 dBA over the baseline readings, the Zoo must mitigate so that the noise from the tram operation is 2 dBA or less.

(d) If at any time a different model of tram is used for the CA 1820 Exhibit new noise readings must be taken. Two sets of noise readings will be measured, one establishing the current baseline noise condition and the other establishing the level of noise with the tram in operation. These readings will be made at the same locations, at the same time and day(s) of the week as established for the readings in #1 and #2 above. Any new model of tram used in the CA 1820 Exhibit must meet the same noise standards as #3 above which requires that the noise from the tram operation be 2 dBA or less.

(e) After regular operation of the tram has begun two additional sets of noise readings will be taken by the Zoo's noise consultant in the presence of the two neighborhood representatives at the location selected under subsection (a). These noise readings will occur 6 months and 18 months after commencement of regular tram operation using the methodology presented under subsections (a) and (b). Any increase in noise over 2dBA will be mitigated by the Zoo.

(f) Neighborhood concerns regarding noise that occur after the noise readings taken 18 months following the start of regular tram operation will be communicated to the appointed Zoo Liaison and the Zoo Neighborhood Committee. The Zoo Neighborhood Committee will review noise concerns and complaints and make recommendations on further actions. If the KPHA or SHNA neighborhood organization finds that noise issues are not being adequately addressed by the Zoo Neighborhood Committee working with the Zoo, the complaint shall be brought to the City Planning Commission and a public hearing shall be held. The City Planning Commission will decide the disposition of the complaint.

Exhibit D

# OAKLAND ZOO IN KNOWLAND PARK MASTER PLAN UPDATE

## MITIGATION MEASURES

(Modifications to the Mitigation Measures imposed by the Planning Commission are indicated in **Bold Type** for additions and ~~Strikethrough Print~~ for deletions)

### EARTH MITIGATION MEASURES

1a) The geotechnical report prepared for the Center for Science and Environmental Education and the African Savanna Exhibit recommended the use of retaining walls, the creation of keyed and benched slopes, proper slope gradients, proper fill compaction, removal of expansive soils and the development of proper drainage facilities to reduce slope failure. These recommendations as well as any additional suggestions from the City of Oakland Building and Engineering Departments shall be adhered to.

1b) City of Oakland standards for engineering controls and slope stabilization outlined in the Oakland Grading Ordinance shall be adhered to prior to and during facility and roadway construction.

1c) Additional geotechnical studies shall be required prior to design and construction of the remaining proposed Master Plan buildings, roads and facilities.

1d) All proposed facilities shall be constructed in conformance with the Uniform Building Code and California Amendments, and incorporate specific engineering design recommendations from the geotechnical and soils reports.

1e) Close construction inspection, testing and quality control shall be performed by the proposed geotechnical engineer or engineering geologist to ensure that site grading plans and geotechnical recommendations criteria are adequate and appropriate.

2a) Facilities and infrastructure improvements should be designed to control runoff so that it is not directed over unprotected slopes. Drainage improvements shall be designed to adequately collect surface water runoff and convey it to the proper storm drain system. **A permanent storm drain shall be designed, installed, and maintained to catch water from the existing natural drainage pattern in Knowland Park above Stella Street. The water will be redirected to City storm drain system.**

2b) The construction contractor shall use water bars, temporary swales and culverts, mulch and june netting, silt fences, straw bales and sediment traps to prevent surface water from eroding soil and transporting it to nearby creeks and natural drainages. These and other methods as outlined in the California Stormwater Best Management Practice Handbook, Construction Activity, shall be implemented to reduce erosion.

2c) Grading and construction activities shall be restricted to the dry season. Exposed surface areas shall be watered down, especially during construction, to reduce wind erosion.

2d) Erosion control methods and implementation procedures shall be monitored during construction and modified as conditions warrant.

3a) Mitigation Measures 2a - 2d shall be implemented.

4a) Implement the recommendations from the Harza report such as removal of expansive soils, clearing of rich compressible organic soils and use of appropriately engineered fill materials shall be adhered to for the development of the Center for Science and Education and the African Savanna Exhibit.

4b) Additional geotechnical and soils studies for the presence of expansive soils shall be required prior to design and construction of the remaining buildings, roads and facilities proposed by the Master Plan.

4c) New structures and facilities proposed by the Master Plan shall incorporate the recommendations of the additional geotechnical reports and any additional requirements from the City of Oakland.

5a) The geotechnical recommendations in the Harza report for the Center for Science and Environmental Education and the African Savanna Exhibit located within the Alquist Priolo Zone shall be incorporated into the final design and siting of these facilities. Geotechnical recommendations in the supplemental Kleinfelder report shall also be incorporated into the final design of the Center.

5b) Geotechnical evaluations shall be performed for each additional facility proposed by the Master Plan and recommendations to reduce seismic related hazards shall be incorporated into the design and siting of these new facilities.

5c) All proposed structures shall be designed and constructed in accordance with the Uniform Building Code and California Amendments. The interpretation of the applicability of the appropriate UBC standard for each proposed structure shall be determined by the Oakland Building and Engineering staff at the time of preliminary plan submittal.

5d) Proper earthquake-resistant techniques for securing indoor fixtures, machinery and furnishings within proposed structures shall be used during construction to minimize the risk of damage or injury from toppled objectives.

5e) The Zoo's Emergency Preparedness and Response Plan, and Animal Capture Plan shall be updated as proposed facilities are developed. **The Zoo and Neighborhood (KPHA and SHRA) Associations will work together to educate the neighborhood about the Zoo's Emergency Preparedness and Response Plan and how it is implemented. This will be accomplished through written communication and a phone tree. The Zoo will provide a demonstration to the representatives of KPHA and SHRA of the safety of the animal enclosures in the case of a natural disaster.**

**5f) A balanced cut and fill grading plan shall be used for all project development so import and export of fill is minimized.**

AIR MITIGATION MEASURE

8a) The following Basic Dust Control Measures shall be implemented at all construction sites:

- Water all active construction areas at least twice daily.
- Cover all trucks hauling soil, sand, and other loose debris *or* require all trucks to maintain at least two feet of freeboard.
- Pave, apply water three times daily, or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites.
- Sweep daily (with water sweepers) all paved access roads, parking areas and staging areas at construction sites.
- Sweep streets daily (with water sweepers) if visible soil material is carried onto adjacent public streets.

WATER MITIGATION MEASURES

10a) Mitigation Measures 2a - 2d shall be implemented.

10b) The proposed Trail and picnic facilities shall be sited at least 100 feet away from the high water level of the creek.

10c) In the event of a proposed creek crossing and/or the need to access the creekbed during construction, proper permitting and noticing requirements of the Regional Water Quality Control Board, the California Department of Fish and Game and the U.S. Fish and Wildlife Department shall be followed.

10d) Project infrastructure improvements shall be designed and sited to adequately control and handle increased surface water runoff. These improvements shall be approved by the City of Oakland Engineering Department, the California Department of Fish and Game and the East Bay Municipal District.

10e) Proposed facilities and animal night houses shall be sited at least 100 feet away from drainage channels.

10f) In the event that drainage channels cannot be avoided, the project applicant shall comply with the appropriate notification, permitting and monitoring requirements of the Regional Water Quality Control Board, the California Department of Fish and Game, the U.S. Department of Fish and Wildlife, the City of Oakland, Alameda

11a) See Mitigation Measure 10e.

BIOTIC MITIGATION MEASURES

13a) The proposed Master Plan would include the implementation of a Habitat Enhancement Plan that would enhance oak woodlands, native grasslands, coastal scrub and riparian woodland, and remove eucalyptus, French broom and other exotic plants from the

California 1820 Exhibit area and Upper Knowland Park. The Habitat Enhancement Plan should include the following:

- An annual assessment of the species and distribution of invasive non-native weeds (examples of invasive species would include artichoke thistle, French broom, giant reed, German ivy, pampas grass, Algerian ivy, acacia and eucalyptus). The assessment would include a map and estimate of abundance of weeds.

- A management element for the control of each weedy species. Methods used for each species should be based on currently accepted best available practices, including hand-pulling, cutting followed by topical application of suitable herbicide, use of livestock, removal or burning of cut plant materials, and so on. The justification for the control methods used should be explained, and a tracking system maintained to document areas treated, methods used, and effectiveness of the result.

- A revegetation element for areas where heavy infestations of weeds comprise a significant portion of the existing vegetation. The riparian zone of lower Arroyo Viejo Creek, for example, is so dominated by non-natives that planting of indigenous tree and shrub species following the removal of weeds is needed to speed up the restoration process. This element would include a tracking system for areas treated, a record of the source and species of plant materials used, methods of installation and maintenance, and an assessment of the success of each effort.

13b) A Tree Protection and Revegetation Plan shall be prepared to protect, replace, and preserve trees on the project site. The Plan shall include the following:

- Native trees lost to development shall be replanted at a minimum ratio of 3:1. Non-native trees lost to development shall be replanted with native trees at a minimum ratio of 1:1.

- Every 10 years, prepare a census of trees qualifying for protection under the Oakland Tree Protection Ordinance within the project area. The census will document the condition of such trees, and recommend actions to extend the life and health of the trees. Recommended actions could include protective devices for reduction of vandalism, excessive treading by pedestrians or rubbing of bark, modification of drainage, erosion or sedimentation to protect trees, and modification of irrigation patterns to reduce pathogens. Recommendations and actions taken would be reported to the City of Oakland and the Department of Fish and Game.

- Protection of oaks in Upper Knowland Park outside of the developed areas of the Zoo will be addressed through the development of a management element for Upper Knowland Park. Since a close-canopy oak woodland is a "fire-safe" vegetation type and is visually pleasing, the maximum natural extent of oak woodland may be the management goal. Management practices needed to achieve and maintain oak woodland or forest are: a minimum of grazing livestock, especially during the dry months; few fires; and slope stability. Maintenance of oak woodland would dovetail with weed control measures discussed under Mitigation Measure 13a.

13c) Although mitigations recommended by the Master Plan to minimize impacts to wildlife due to vehicle and pedestrian traffic would reduce potential impacts to less than significant, the following mitigation measure would further reduce the impact. If feasible, the Shuttle Road should be a maximum of 15 feet in width with no curbs or gutters to reduce potential impacts to the Alameda whipsnake.

13d) To mitigate for the potential impacts to small vertebrates from construction of the viewing platforms, the platforms shall be constructed in the dry season (late summer/ fall), and native riparian species shall be planted in areas disturbed by construction activities and mitigation measures 2a - 2d included under the Earth section of this Initial Study shall be implemented.

14a) The Shuttle Road should be re-routed to avoid the robust monardella colony. A buffer of a minimum of 25 feet shall be established between any project soils disturbance and the existing colony.

14b) The Bison Exhibit boundary shall be revised to exclude the robust monardella colony; alternatively, the robust monardella shall be protected with a perimeter fence providing a 25-foot buffer around the colony.

14c) Obtain a Permit for Management of a rare or threatened species pursuant to Fish and Game Code Section 2081. The Management Permit will include all details of a Mitigation and Monitoring Plan which will be prepared by the East Bay Zoological Society. The Mitigation and Monitoring Plan will be subject to approval by the California Department of Fish and Game and the U. S. Fish and Wildlife Service. A summary of the measures to be incorporated into the Mitigation and Monitoring Plan are presented below.

14d) All removal of scrub or chaparral habitat shall be done by hand with axes or machetes. Chain saws could be used for larger shrubs.

14e) A biologist qualified to handle Alameda whipsnakes shall monitor all scrub or chaparral removal and all construction activities which may impact the Alameda whipsnake.

14f) Alameda whipsnake habitat shall be preserved in perpetuity on property owned by the East Bay Zoological Society and contiguous to the east of the California 1820 Exhibit area. Numerous large areas of scrub and/or chaparral habitat are present in the proposed mitigation area and these appear to provide an adequate amount of habitat to offset impacts within the project site. The amount of habitat preserved shall be in accordance with current requirements of the California Department of Fish and Game.

14g) To reduce the potential for mortality on the shuttle road to a level less than significant, a maximum speed of 10 miles per hour shall be required and shuttle drivers and personnel driving to the off-site breeding exhibit will be instructed to watch for and yield to all wildlife. The road shall also be a maximum of 15 feet in width with no curbs or gutters. Specially designed "snake crossings" under the shuttle road may also be required.

14h) Measures will be taken to prevent the spread of French broom on the site and to remove as much French broom from the site as possible in order to keep it from degrading higher quality whipsnake habitat.

14i) Prior to construction of the creek-viewing platforms, and construction of the Shuttle Road through woodland areas, surveys for nesting Cooper's hawks should be conducted. If no nests are present, construction can proceed. If a nest is present in the vicinity of the site for the viewing platforms, construction should be delayed until the young have fledged. Once the platforms and Shuttle Road are completed, their presence and the presence of hikers on the Trail would be considered a less than significant impact.

14j) During construction, dust control mitigation measures included in the Air Quality section of this Initial Study (8a) shall be implemented, which will reduce potential impacts to the air passages of San Francisco lacewings

15a) The operations and maintenance plan for the new exhibits shall include a weed management and control element. This should include monitoring the natural portions of Upper Knowland Park for infestations of non-native weeds, and implementation of control measures to prevent the weeds from degrading the natural vegetation.

16a) The Trail shall be constructed 100 feet from the creek bank and on the outer edges of the riparian vegetation. Streambed crossings shall consist of walkways constructed well above the banks. Creek viewing platforms located within the 100-foot buffer shall be located to minimize impacts to riparian vegetation. Disturbed riparian vegetation will be enhanced by removal of non-native species and planting and maintenance of indigenous species. Erosion control requirements contained in Ordinance No. 10312 would prevent sedimentation resulting from construction of the Trail and viewing platforms.

NOISE MITIGATION MEASURES

18a) Project contractors shall be required to implement noise control techniques to minimize disturbance to adjacent or nearby sensitive noise receptors during project construction in the vicinity of the southern Park boundary:

1. The proposed solid wood or masonry fence along the southern Park boundary shall be constructed and completed prior to construction of proposed improvements to the main entrance parking lot and overflow parking lot.

2. Equipment and trucks used for project construction shall utilize the best available noise control techniques (e.g., improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures and/or acoustically-attenuating shields or shrouds, wherever feasible and necessary) in order to minimize construction noise impacts. Construction equipment shall not generate noise levels above 75-80 dBA at 50 feet as listed in Table B-2 of Appendix B, or as required by City ordinance, in order to provide acceptable interior noise levels at nearby or adjacent residential receptors.

3. Impact tools (e.g., jack hammers, pavement breakers, and rock drills) used for project construction shall be hydraulically or electrically powered wherever possible to avoid noise associated with compressed air exhaust from pneumatically-powered tools. However, where use of pneumatically powered tools is unavoidable, an exhaust muffler on the compressed air exhaust shall be used; this muffler can lower noise levels from the

exhaust by up to about 10 dBA. External jackets on the tools themselves shall be used where feasible, and this could achieve a reduction of 5 dBA. Quieter procedures shall be used such as drilling rather than impact equipment whenever feasible.

4. During project construction, truck operations shall be prohibited during the nighttime hours (8 p.m. to 7 a.m.) and the operation of heavy equipment shall be limited to 7:30 a.m. to 7:30 p.m., Monday through Saturday, to minimize potential disturbance of adjacent and nearby residential receptors.

5. Stationary noise sources shall be located as far from sensitive receptors as possible. If they must be located near existing receptors, they should be adequately muffled to the extent feasible and enclosed within temporary sheds.

When construction occurs along the section of the uphill loop road that extends along the southern Park boundary, residences to the south (which would be approximately 150 feet away) would be subject to noise peaks of 70 to 80 dBA, periodically exceeding the 70-dBA criterion. However, the short-term nature of these noise peaks (two to four weeks for construction of this 500-foot long section of the Shuttle Road) and implementation of noise control measures listed above would reduce potential impacts to a less-than-significant level. Residential receptors located 1,000 feet or more from the northern Park boundary would not be significantly affected by construction noise; at 1,000 feet, the intervening distance would be adequate to maintain construction noise peaks at or below the 70-dBA criteria.

TRANSPORTATION/CIRCULATION MITIGATION MEASURE

26a) **Construction traffic shall only use existing improved public roads.**

27a) ~~To prevent traffic from the Zoo parking lots from exiting onto Golf Links Road via Zoo Drive, appropriate traffic barriers and signage shall be installed.~~ **To prevent heavy traffic from exiting the Zoo in one direction, traffic will be directed between Golf Links Road and 106th Avenue in order to balance the traffic flow. At no time will the Golf Links exit be closed to heavy traffic.**

APPENDIX C

# 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 SUBSEQUENT MITIGATED NEGATIVE DECLARATION/ ADDENDUM MITIGATION MEASURES APPLICABLE TO PROPOSED MASTER PLAN AMENDMENT

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

## AESTHETICS

***1998 Mitigation Measures***

None

***Standard Conditions of Approval***

**SCA-AES-1: Landscape Maintenance**

***Ongoing***

All required planting shall be permanently maintained in good growing condition and, whenever necessary, replaced with new plant materials to ensure continued compliance with applicable landscaping requirements. All required irrigation systems shall be permanently maintained in good condition and, whenever necessary, repaired or replaced.

**SCA-AES-2: Lighting Plan**

***Prior to issuance of an electrical or building permit***

The proposed lighting fixtures shall be adequately shielded to a point below the light bulb and reflector and that prevent unnecessary glare onto adjacent properties. Plans shall be submitted to the Planning and Zoning Division and the Electrical Services Division of Public Works Agency for review and approval. All lighting shall be architecturally integrated into the site.

***2011 Mitigation Measures***

None

## AIR QUALITY

***1998 Mitigation Measures***

None

***Standard Conditions of Approval***

**SCA-AIR-1: Dust Control**

**Construction-Related Air Pollution Controls (Dust and Equipment Emissions)**

***Ongoing throughout demolition, grading, and/or construction***

During construction, the project applicant shall require the construction contractor to implement all of the following applicable measures recommended by the Bay Area Air Quality Management District (BAAQMD):

a) Water all exposed surfaces of active construction areas at least twice daily (using reclaimed water if possible). Watering should be sufficient to prevent airborne dust from leaving the site. Increased watering frequency may be necessary whenever wind speeds exceed 15 miles per hour. Reclaimed water should be used whenever possible.

b) Cover all trucks hauling soil, sand, and other loose materials or require all trucks to maintain at least two feet of freeboard (i.e., the minimum required space between the top of the load and the top of the trailer).

c) All visible mud or dirt track-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping is prohibited.

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **AIR QUALITY (continued)** |
| d) Pave all roadways, driveways, sidewalks, etc. as soon as feasible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.<br>e) Enclose, cover, water twice daily or apply (non-toxic) soil stabilizers to exposed stockpiles (dirt, sand, etc.).<br>f) Limit vehicle speeds on unpaved roads to 15 miles per hour.<br>g) Idling times shall be minimized either by shutting equipment off when not is use or reducing the maximum idling time to five minutes (as required by the California airborne toxics control measure Title 13, Section 2485, of the California Code of Regulations. Clear signage to this effect shall be provided for construction workers at all access points.<br>h) All construction equipment shall be maintained and properly tuned in accordance with the manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation.<br>Post a publicly visible sign that includes the contractor's name and telephone number to contact regarding dust complaints. When contacted, the contractor shall respond and take corrective action within 48 hours. The telephone numbers of contacts at the City and BAAQMD shall also be visible. This information may be posted on other required on-site signage.<br>The enhanced measures below apply to construction projects involving 1) land uses that exceed the BAAQMD construction screening criteria (e.g., 240 or more multi-family residential units); 2) a demolition permit; 3) simultaneous occurrence of more than two construction phases (e.g., grading and building construction occurring simultaneously); 4) extension site preparation (i.e., over four acres in size); or 5) extensive soil transport (i.e., 10,000 or more cubic yards of soil import/export).<br>a) All exposed surfaces shall be watered at a frequency adequate to maintain minimum soil moisture of 12 percent. Moisture content can be verified by lab samples or moisture probe.<br>b) All excavation, grading, and demolition activities shall be suspended when average wind speeds exceed 20 mph.<br>c) Install sandbags or other erosion control measures to prevent silt runoff to public roadways.<br>d) Hydroseed or apply (non-toxic) soil stabilizers to inactive construction areas (previously graded areas inactive for one month or more).<br>e) Designate a person or persons to monitor the dust control program and to order increased watering, as necessary, to prevent transport of dust offsite. Their duties shall include holidays and weekend periods when work may not be in progress.<br>f) Install appropriate wind breaks (e.g., trees, fences) on the windward side(s) of actively disturbed areas of the construction site to minimize wind blown dust. Wind breaks must have a maximum 50 percent air porosity.<br>g) Vegetative ground cover (e.g., fast-germinating native grass seed) shall be planted in disturbed areas as soon as possible and watered appropriately until vegetation is established.<br>h) The simultaneous occurrence of excavation, grading, and ground-disturbing construction activities on the same area at any one time shall be limited. Activities shall be phased to reduce the amount of disturbed surfaces at any one time. |

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **AIR QUALITY (continued)** |
| i) All trucks and equipment, including tires, shall be washed off prior to leaving the site.<br>j) Site accesses to a distance of 100 feet from the paved road shall be treated with a 6 to 12 inch compacted layer of wood chips, mulch, or gravel.<br>k) Minimize the idling time of diesel-powered construction equipment to two minutes.<br>l) The project applicant shall develop a plan demonstrating that the off-road equipment (more than 50 horsepower) to be used in the construction project (i.e., owned, leased, and subcontractor vehicles) would achieve a project wide fleet-average 20 percent NOx reduction and 45 percent particulate matter (PM) reduction compared to the most recent California Air Resources Board (CARB) fleet average. Acceptable options for reducing emissions include the use of late model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, add-on devices such as particulate filters, and/or other options as they become available.<br>m) Use low VOC (i.e., ROG) coatings beyond the local requirements (i.e., BAAQMD Regulation 8, Rule 3: Architectural Coatings).<br>n) All construction equipment, diesel trucks, and generators shall be equipped with Best Available Control Technology for emission reductions of NOx and PM.<br>i) Off-road heavy diesel engines shall meet the CARB's most recent certification standard. |
| ***2011 Mitigation Measures*** |
| None |
| **BIOLOGICAL RESOURCES** |
| ***1998 Mitigation Measures (2011 revisions shown in underline and strike-out)*** |
| For the potential loss of natural habitat and native trees, the 1998 MND identified the following mitigation measures that would reduce the impact to a less-than-significant level:<br>13a) The proposed Master Plan would include implementation of a Habitat Enhancement Plan that would enhance oak woodlands, native grasslands, coastal scrub and riparian woodland, and remove eucalyptus, French broom and other exotic plants from the California 1820 Exhibit area and Upper Knowland Park. The Habitat Enhancement Plan should include the following:<br>• An annual assessment of the species and distribution of invasive nonnative weeds (examples of invasive species would include artichoke thistle, French broom, giant reed, German ivy, pampas grass, Algerian ivy, acacia and eucalyptus). The assessment would include a map and estimate of abundance of weeds.<br>• A management element for the control of each weedy species. Methods used for each species should be based on current accepted best available practices, including hand-pulling, cutting followed by topical application of suitable herbicide, use of livestock, removal or burning of cut plant materials, and so on. The justification for the control methods used should be explained, and a tracking system maintained to document areas treated, methods used, and effectiveness of the results. |

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**BIOLOGICAL RESOURCES (continued)**

- A revegetation element for areas where heavy infestations of weeds comprise a significant portion of the existing vegetation. The riparian zone of lower Arroyo Viejo Creek, for example, is so dominated by nonnative species that planting of indigenous tree and shrub species following the removal of weeds is needed to speed up the restoration process. This element would include a tracking system for areas treated, a record of the source and species of plant materials used, methods of installation and maintenance, and an assessment of the success of each effort.

13b) A Tree Protection and Revegetation Plan shall be prepared to protect, replace, and preserve trees on the project site. The Plan shall include the following:

- Native trees lost to development shall be replanted at a minimum ratio of 3:1. Non-native trees lost to development shall be replanted with native trees at a minimum ratio of 1:1.
- Every 10 years, prepare a census of trees qualifying for protection under the Oakland Tree Protection Ordinance within the project area. The census will document the condition of such trees, and recommend actions to extend the life and health of the trees. Recommended actions could include protective devices for reduction of vandalism, excessive treading by pedestrians or rubbing of bark, modification of drainage, erosion or sedimentation to protect trees, and modification of irrigation patterns to reduce pathogens. Recommendations and actions taken would be reported to the City of Oakland and the Department of Fish and Game.
- Protection of oaks in Upper Knowland Park outside of the developed areas of the Zoo will be addressed through the development of a management element for Upper Knowland Park. ~~Since a closed-canopy oak woodland is a "fire-safe" vegetation type and is visually pleasing, the maximum natural extent of oak woodland may be the management goal.~~ Management practices needed to achieve and maintain oak woodland and forest are: a minimum of grazing livestock, especially during the dry months; few fires; and slope stability. Maintenance of oak woodland would dovetail with weed control measures discussed under Mitigation Measure 13a and the need to provide adequate mitigation for the loss of grassland habitat as provided in the Habitat Enhancement Plan.
- The perimeter fence alignment and exhibit enclosure fencing shall be field-adjusted during installation to further reduce the need to remove protected trees and minimize disturbance in close proximity to the tree root systems. The final alignment of both the perimeter fencing and enclosure fencing shall be overseen by a certified arborist and adjustments made, where feasible, to minimize removal and damage to protected trees. Where tree removal is unavoidable, replacement plantings shall be provided consistent with the City's Standard Conditions of Approval.

For the potential loss of wildlife habitat and obstruction of wildlife movement opportunities, the 1998 MND identified the following mitigation measures that would reduce the impact to a less-than-significant level:

13c) The service road shall be a maximum of 15 feet in width and designed to accommodate crossing by Alameda whipsnake and other wildlife, where necessary, ~~Although mitigations recommended by the Master Plan to minimize impacts to wildlife due to vehicle and pedestrian traffic would reduce potential impacts to less than significant, the following~~

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **BIOLOGICAL RESOURCES (continued)** |

mitigation measure would further reduce the impact. If feasible, the service road Shuttle Road should be a maximum of 15 feet in width with no curbs or gutters to reduce potential impacts to the Alameda whipsnake.

For the potential direct mortality to Alameda whipsnakes and the loss of suitable habitat and interference with movement opportunities for this species if present on the site, the 1998 MND identified the following mitigation measures that would reduce the impact to a less-than-significant level:

14c) Obtain appropriate authorizations from resource agencies to address possible incidental take and a Permit for Management of a rare or threatened species pursuant to Fish and Game Code Section 2081 and Section 7 of the Endangered Species Act, as called for under SCA-BIO-10. The project applicant shall provide compensatory mitigation for impacts to Alameda whipsnake habitat. Such mitigation shall be provided at a ratio of no less than 1:1 (at least one acre for every acre of impact), subject to any increase in this ratio that may be required by the resource agencies. There is adequate area within Knowland Park to achieve this mitigation ratio. Subject to the approval of the resource agencies, mitigation shall be achieved through habitat restoration and enhancement within the California Exhibit boundaries, the Ecological Recovery Zone, and other locations within Knowland Park, at another restoration location with an Alameda whipsnake habitat restoration plan area approved by the U.S. Fish and Wildlife Service and the California Department of Fish and Game, through the purchase of mitigation credits at a mitigation bank within the East Bay region, or some combination of these options. The project applicant shall retain a qualified biologist to prepare an Alameda whipsnake Mitigation and Monitoring Plan in connection with the application for an incidental take authorization and Management Permit. The Management Permit will include all details of a Mitigation and Monitoring Plan which will be prepared by the East Bay Zoological Society. The Mitigation and Monitoring Plan will be subject to approval by the California Department of Fish and Game and the U.S. Fish and Wildlife Service. The Mitigation and Monitoring Plan shall include (a) a habitat restoration/creation performance standard of no net loss of habitat functions and values; (b) location of the mitigation site(s); (c) a detailed habitat restoration/creation plan for the mitigation site(s); (d) provisions for timing and methods for invasive species removal, controls on herbicide application, and worker training programs that, at a minimum and subject to the requirements of the resource agencies, meet the applicable requirements of the Invasive Species Control Element of the HEP; (f) provisions for interpretive programs and access restrictions; (g) revegetation provisions that include cover requirements, methods of installation and maintenance, a tracking system, a record of source and species of plant materials used in revegetation; and (h) success criteria to be used to evaluate whether the restoration/creation efforts have achieved the identified goals of the Mitigation and Monitoring Plan.

The proposed California Exhibit shall be modified to incorporate recommendations from the 2011 Status Report (Swaim Biological, Inc. 2011), which include removing the amphitheater from the stand of chamise-chaparral; restricting the California Interpretive Center ten feet to the east and limiting grading to within ten feet of the edge of the building; modifying and establishing controls to the bison/tule elk extension exhibit, and ensuring that the perimeter fence is permeable to allow for unrestricted movement of Alameda

| **1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT** |
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| **BIOLOGICAL RESOURCES (continued)** |

whipsnake through the area. Controls associated with the bison/tule elk exhibit shall include limiting the number of animals housed to 20 bison and 20 tule elk, maintaining protective cover by creating irrigated pasture outside woodland habitat, and placing rock outcrops and logs to serve as refugia for dispersing snakes. ~~A summary of the measures to be incorporated into the Mitigation and Monitoring Plan are presented below.~~

14d) All removal of scrub or chaparral habitat shall be done by hand with axes or machetes. Chain saws could be used for larger shrubs.

14e) A biologist qualified to handle Alameda whipsnakes shall monitor all scrub or chaparral removal and all construction activities which may impact the Alameda whipsnake.

14g) To reduce the potential for mortality on the service ~~shuttle~~ road to a level less than significant, a maximum speed of ten ~~10~~ miles per hour shall be required and all ~~shuttle drivers and~~ personnel driving ~~to the offsite breeding exhibit~~ will be instructed to watch for and yield to all wildlife. ~~The road shall also be a maximum of 15 feet in width with no curbs or gutters.~~ Specially designed "snake crossings" under the service ~~shuttle~~ road may also be required.

14h) Measures will be taken to prevent the spread of French broom on the site and to remove as much French broom from the site as possible in order to keep it from degrading higher quality whipsnake habitat.

For the potential introduction and spread of weed species, the 1998 MND identified the following mitigation measure that would reduce the impact to a less-than-significant level:

15a) The operations and maintenance plan for the new exhibits shall include a weed management and control element. This should include monitoring the natural portions of Upper Knowland Park for infestations of non-native weeds, and implementation of control measures to prevent the weeds from degrading the natural vegetation.

***Standard Conditions of Approval***

**SCA-BIO-1: Tree Removal During Breeding Season**

***Prior to issuance of a tree removal permit***

To the extent feasible, removal of any tree and/or other vegetation suitable for nesting of raptors shall not occur during the breeding season of March 15 and August 15. If tree removal must occur during the breeding season, all sites shall be surveyed by a qualified biologist to verify the presence or absence of nesting raptors or other birds.

Pre-removal surveys shall be conducted within 15 days prior to start of work from March 15 through May 31, and within 30 days prior to the start of work from June 1 through August 15. The pre-removal surveys shall be submitted to the Planning and Zoning Division and the Tree Services Division of the Public Works Agency. If the survey indicates the potential presences of nesting raptors or other birds, the biologist shall determine an appropriately sized buffer around the nest in which no work will be allowed until the young have successfully fledged. The size of the nest buffer will be determined by the biologist in consultation with the CDFG, and will be based to a large extent on the nesting species and its sensitivity to disturbance. In general, buffer sizes of 200 feet for raptors and 50 feet for other birds should suffice to prevent disturbance to birds nesting in the urban environment, but these buffers may be increased or decreased, as appropriate, depending on the bird species and the level of disturbance anticipated near the nest.

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**BIOLOGICAL RESOURCES (continued)**

**SCA-BIO-2: Tree Removal Permit**

***Prior to issuance of a demolition, grading, or building permit***

Prior to removal of any protected trees, per the Protected Tree Ordinance, located on the project site or in the public right-of-way adjacent to the project, the project applicant must secure a tree removal permit from the Tree Division of the Public Works Agency, and abide by the conditions of that permit.

**SCA-BIO-3: Tree Replacement Plantings**

***Prior to issuance of a final inspection of the building permit***

Replacement plantings shall be required for erosion control, groundwater replenishment, visual screening and wildlife habitat, and in order to prevent excessive loss of shade, in accordance with the following criteria:

a) No tree replacement shall be required for the removal of nonnative species, for the removal of trees which is required for the benefit of remaining trees, or where insufficient planting area exists for a mature tree of the species being considered.

b) Replacement tree species shall consist of *Sequoia sempervirens* (Coast Redwood), *Quercus agrifolia* (Coast Live Oak), *Arbutus menziesii* (Madrone), *Aesculus californica* (California Buckeye) or *Umbellularia californica* (California Bay Laurel) or other tree species acceptable to the Tree Services Division.

c) Replacement trees shall be at least of twenty-four (24) inch box size, unless a smaller size is recommended by the arborist, except that three fifteen (15) gallon size trees may be substituted for each twenty-four (24) inch box size tree where appropriate.

d) Minimum planting areas must be available on site as follows:

   i. For *Sequoia sempervirens*, three hundred fifteen square feet per tree;

   ii. For all other species listed in #2 above, seven hundred (700) square feet per tree.

e) In the event that replacement trees are required but cannot be planted due to site constraints, an in lieu fee as determined by the master fee schedule of the city may be substituted for required replacement plantings, with all such revenues applied toward tree planting in city parks, streets and medians.

f) Plantings shall be installed prior to the issuance of a final inspection of the building permit, subject to seasonal constraints, and shall be maintained by the project applicant until established. The Tree Reviewer of the Tree Division of the Public Works Agency may require a landscape plan showing the replacement planting and the method of irrigation. Any replacement planting which fails to become established within one year of planting shall be replanted at the project applicant's expense.

| 1998 MITIGATION MEASURES, CITY OF OAKLAND<br>STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES<br>APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **BIOLOGICAL RESOURCES (continued)** |

**SCA-BIO-4: Tree Protection During Construction**

***Prior to issuance of a demolition, grading, or building permit***

Adequate protection shall be provided during the construction period for any trees which are to remain standing, including the following, plus any recommendations of an arborist:

a) Before the start of any clearing, excavation, construction or other work on the site, every protected tree deemed to be potentially endangered by said site work shall be securely fenced off at a distance from the base of the tree to be determined by the Consulting Arborist. Such fences shall remain in place for duration of all such work. All trees to be removed shall be clearly marked. A scheme shall be established for the removal and disposal of logs, brush, earth and other debris which will avoid injury to any protected tree.

b) Where proposed development or other site work is to encroach upon the protected perimeter of any protected tree, special measures shall be incorporated to allow the roots to breathe and obtain water and nutrients. Any excavation, cutting, filing, or compaction of the existing ground surface within the protected perimeter shall be minimized. No change in existing ground level shall occur within a distance to be determined by the Consulting Arborist from the base of any protected tree at any time. No burning or use of equipment with an open flame shall occur near or within the protected perimeter of any protected tree.

c) No storage or dumping of oil, gas, chemicals, or other substances that may be harmful to trees shall occur within the distance to be determined by the Consulting Arborist from the base of any protected trees, or any other location on the site from which such substances might enter the protected perimeter. No heavy construction equipment or construction materials shall be operated or stored within a distance from the base of any protected trees to be determined by the tree reviewer. Wires, ropes, or other devices shall not be attached to any protected tree, except as needed for support of the tree. No sign, other than a tag showing the botanical classification, shall be attached to any protected tree.

d) Periodically during construction, the leaves of protected trees shall be thoroughly sprayed with water to prevent buildup of dust and other pollution that would inhibit leaf transpiration.

e) If any damage to a protected tree should occur during or as a result of work on the site, the project applicant shall immediately notify the Public Works Agency of such damage. If, in the professional opinion of the Consulting Arborist, such tree cannot be preserved in a healthy state, the Consulting Arborist shall require replacement of any tree removed with another tree or trees on the same site deemed adequate by the Tree Reviewer to compensate for the loss of the tree that is removed.

f) All debris created as a result of any tree removal work shall be removed by the project applicant from the property within two weeks of debris creation, and such debris shall be properly disposed of by the project applicant in accordance with all applicable laws, ordinances, and regulations.

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**BIOLOGICAL RESOURCES (continued)**

**SCA-BIO-5: Whipsnake Habitat, Biological Monitor**

***Prior to issuance of a demolition, grading, or building permit and ongoing throughout demolition, grading, and/or construction***

If the project is located within confirmed Alameda Whipsnake Habitat area, the project applicant shall hire an on-site biological site biological monitor shall instruct the project superintendent and the construction crews (primarily the clearing, demolition and foundation crews) of the potential presence, status and identification of Alameda Whipsnakes. The biological monitor shall also provide information to the Planning and Zoning Division on the steps to take if a whipsnake is seen on the project site, including who to contact, to ensure that whipsnakes are not harmed or killed, as regulation by the federal Endangered Species Act.

**SCA-BIO-6: Whipsnake Habitat, Placement of Debris**

***Prior to issuance of a demolition, grading, or building permit and throughout construction***

If the project is located within confirmed Alameda Whipsnake Habitat area, the project applicant shall ensure that the placement of construction debris is limited to the area immediate adjacent to the foundation of the proposed buildings or and to the area between the foundation and the street. Install flexible construction fencing at the limit of work line (approximately ten feet beyond the foundation of the proposed building other than in the direction of the street). Such construction fencing shall limit the placement of construction materials and construction debris to inside the fencing.

**SCA-BIO-7: Whipsnake Habitat, Barrier Fence**

***Prior to issuance of a demolition, grading, or building permit and throughout construction***

If the project is located within confirmed Alameda Whipsnake Habitat area, the project applicant shall install a solid fence to prevent whipsnakes from entering the work site. The snake barrier shall be constructed as follows and shall remain in place throughout the entire construction period:

a) Plywood sheets at least three feet in height above ground. Heavy duty geotextile fabric approved by U.S. Fish and Wildlife Service and California Department of Fish and Game may also be used for snake exclusion fences;
b) Buried four to six inches into the ground;
c) Soil back-filled against the plywood fence to create a solid barrier at the ground;
d) Plywood sheets maintained in an upright position with wooden or masonry stakes;
e) Ends of each plywood sheet overlapped to ensure a continuous barrier; and
f) An exclusion fence shall completely enclose the work site or construction area or approved traps shall be installed at the ends of exclusion fence segments to allow capture and relocation of Alameda whipsnake away from the construction area by a qualified biologist.

**1998 MITIGATION MEASURES, CITY OF OAKLAND
STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES
APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**BIOLOGICAL RESOURCES (continued)**

**SCA-BIO-8: Whipsnake Habitat, Downsloping Lots**

***Prior to issuance of a demolition, grading, or building permit and throughout construction***

If the project is located within confirmed Alameda Whipsnake Habitat area, the project applicant shall install erosion control devices, such as hay bales, at the downhill limit of construction line to prevent rocks and soil from moving downhill. No erosion control materials with plastic or nylon monofilament netting shall be used.

**SCA-BIO-9: Creek Protection Plan**

***Prior to and ongoing throughout demolition, grading and/or construction activities***

a) The approved creek protection plan shall be included in the project drawings submitted for a building permit (or other construction-related permit). The project applicant shall implement the creek protection plan to minimize potential impacts to the creek during and after construction of the project. The plan shall fully describe in plan and written form all erosion, sediment, stormwater, and construction management measures to be implemented on-site.

b) If the plan includes a stormwater system, all stormwater outfalls shall include energy dissipation that slows the velocity of the water at the point of outflow to maximize infiltration and minimize erosion. The project shall not result in a substantial increase in stormwater runoff volume or velocity to the creek or storm drains.

**SCA-BIO-10: Regulatory Permits and Authorization**

***Prior to issuance of a demolition, grading, or building permit within vicinity of the creek***

The project applicant shall obtain all necessary regulatory permits and authorizations from the U.S. Army Corps of Engineers (Corps), Regional Water Quality Control Board (RWQCB), California Department of Fish and Game, and the City of Oakland, and shall comply with all conditions issued by applicable agencies. Required permit approvals and certifications may include, but not be limited to the following:

a) U.S. Army Corps of Engineers (Corps): Section 404. Permit approval from the Corps shall be obtained for the placement of dredge or fill material in Waters of the U.S., if any, within the interior of the project site, pursuant to Section 404 of the federal Clean Water Act.

b) Regional Water Quality Control Board (RWQCB): Section 401 Water Quality Certification. Certification that the project will not violate state water quality standards is required before the Corps can issue a 404 permit, above.

c) California Department of Fish and Game (CDFG): Section 1602 Lake and Streambed Alteration Agreement. Work that will alter the bed or bank of a stream requires authorization from CDFG.

**SCA-BIO-11: Creek Monitoring**

***Prior to issuance of a demolition, grading, or building permit within vicinity of the creek***

A qualified geotechnical engineer and/or environmental consultant shall be retained and paid for by the project applicant to make site visits during all grading activities; and as a follow-up, submit to the Building Services Division a letter certifying that the erosion and sedimentation control measures set forth in the Creek Protection Permit submittal material have been instituted during the grading activities.

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**BIOLOGICAL RESOURCES (continued)**

**SCA-BIO-12: Creek Landscaping Plan**

***Prior to issuance of a demolition, grading, or building permit within vicinity of the creek***

The project applicant shall develop a final detailed landscaping and irrigation plan for review and approval by the Planning and Zoning Division prepared by a licensed landscape architect or other qualified person. Such a plan shall include a planting schedule, detailing plant types and locations, and a system for temporary irrigation of plantings.

a) Plant and maintain only drought-tolerant plants on the site where appropriate as well as native and riparian plants in and adjacent to riparian corridors. Along the riparian corridor, native plants shall not be disturbed to the maximum extent feasible. Any areas disturbed along the riparian corridor shall be replanted with mature native riparian vegetation and be maintained to ensure survival.

b) All landscaping indicated on the approved landscape plan shall be installed prior to the issuance of a Final inspection of the building permit, unless bonded pursuant to the provisions of Section 17.124.50 of the Oakland Planning Code.

c) All landscaping areas shown on the approved plans shall be maintained in neat and safe conditions, and all plants shall be maintained in good growing condition and, whenever necessary replaced with new plant materials to ensure continued compliance with all applicable landscaping requirements. All paving or impervious surfaces shall occur only on approved areas.

**SCA-BIO-13: Creek Dewatering and Aquatic Life**

***Prior to the start of and ongoing throughout any in-water construction activity***

a) If any dam or other artificial obstruction is constructed, maintained, or placed in operation within the stream channel, ensure that sufficient water is allowed to pass down channel at all times to maintain aquatic life (native fish, native amphibians, and western pond turtles) below the dam or other artificial obstruction.

b) The project applicant shall hire a biologist, and obtain all necessary State and federal permits (e.g. CDFG Scientific Collecting Permit), to relocate all native fish/native amphibians/pond turtles within the work site, prior to dewatering. The applicant shall first obtain a project-specific authorization from the CDFG and/or the USFWS, as applicable to relocate these animals. Captured native fish/native amphibians/pond turtles shall be moved to the nearest appropriate site on the stream channel downstream. The biologist/contractor shall check daily for stranded aquatic life as the water level in the dewatering area drops. All reasonable efforts shall be made to capture and move all stranded aquatic life observed in the dewatered areas. Capture methods may include fish landing nets, dip nets, buckets, and by hand. Captured aquatic life shall be released immediately in the nearest appropriate downstream site. This condition does not allow the take or disturbance of any state or federally listed species, nor state-listed species of special concern, unless the applicant obtains a project specific authorization from the CDFG and/or the USFWS, as applicable.

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**BIOLOGICAL RESOURCES (continued)**

**SCA-BIO-14: Creek Dewatering and Diversion**

***Prior to the start of any in-water construction activities***

If installing any dewatering or diversion device(s), the project applicant shall develop and implement a detailed dewatering and diversion plan for review and approval by the Building Services Division. All proposed dewatering and diversion practices shall be consistent with the requirements of the Streambed Alteration Agreement issued by the California Department of Fish and Game.

a) Ensure that construction and operation of the devices meet the standards in the latest edition of the Erosion and Sediment Control Field Manual published by the Regional Water Quality Control Board (RWQCB).

b) Construct coffer dams and/or water diversion system of a non-erodible material which will cause little or no siltation. Maintain coffer dams and the water diversion system in place and functional throughout the construction period. If the coffer dams or water diversion system fail, repair immediately based on the recommendations of a qualified environmental consultant. Remove devices only after construction is complete and the site stabilized.

c) Pass pumped water through a sediment settling device before returning the water to the stream channel. Provide velocity dissipation measures at the outfall to prevent erosion.

**SCA-BIO-15: Vegetation Management Plan on Creekside Properties**

***Prior to issuance of a demolition, grading, and/or construction and ongoing***

The project applicant shall submit a vegetation management plan for review and approval by the Planning and Zoning Division, Fire Services Division, and Environmental Services Division of the Public Works Agency that includes, if deemed appropriate, the following measures:

a) Identify and do not disturb a 20-foot creek buffer from the top of the creek bank. If the top of bank cannot be identified, leave a 50-foot buffer from the centerline of the creek or as wide a buffer as possible between the creek centerline and the proposed site development.

b) Identify and leave" islands" of vegetation in order to prevent erosion and landslides and protect nesting habitat.

c) Leave at least 6 inches of vegetation on the site.

d) Trim tree branches from the ground up (limbing up) and leave tree canopy intact.

e) Leave stumps and roots from cut down trees to prevent erosion.

f) Plant fire-appropriate, drought-tolerant, preferably native vegetation.

g) Err on the side of caution. If you don't know if a plant, tree or area is sensitive, ask for a second opinion before you cut.

h) Provide erosion and sediment control protection if cutting vegetation on a steep slope.

i) Leave tall shrubbery at least 3-feet high.

j) Fence off sensitive plant habitats and creek areas to protect from goat grazing.

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **BIOLOGICAL RESOURCES (continued)** |
| k) Obtain a tree protection permit for a protected tree (includes all mature trees except eucalyptus and Monterey pine).<br>l) Contact the City Tree Department (615-5850) for dead trees.<br>m) Do not clear-cut vegetation. This can lead to erosion and severe water quality problems and destroy important habitat.<br>n) Do not remove vegetation within 20-feet of the top of bank. If the top of bank cannot be identified, do not cut within 50-feet of the centerline of the creek or as wide a buffer as possible between the creek centerline and the proposed site development.<br>o) Do not trim/prune branches that are larger than 4 inches in diameter.<br>p) Do not remove tree canopy.<br>q) Do not dump cut vegetation in a creek.<br>r) Do not cut tall shrubbery to less than 3-feet high.<br>s) Do not cut of short vegetation (grasses, ground-cover) to less than 6-inches high. |
| ***2011 Mitigation Measures*** |
| **Mitigation Measure BIO-1:** The project applicant shall prepare a wetland delineation of the site which shall be verified by the U.S. Army Corps of Engineers to confirm the extent of jurisdictional waters on the site, including the reach of Arroyo Viejo Creek and the entire California Exhibit area. As required under SCA-BIO-10, the project applicant shall obtain all necessary regulatory permits and authorizations and shall comply with all conditions issued by applicable agencies. In the remote instance that the 950-square-foot potential seasonal wetland is considered a jurisdictional waters of the State by the Regional Water Quality Control Board, a mitigation program shall be developed and implemented by the project applicant. If required, the mitigation program shall provide for a minimum 1:1 on-site replacement for this potential seasonal wetland feature, the mitigation program shall be approved by the Regional Water Quality Control Board, and any created habitat shall be monitored for a minimum of three years or until all success criteria have been met. |
| **CULTURAL RESOURCES** |
| ***1998 Mitigation Measures*** |
| None |
| ***Standard Conditions of Approval*** |
| **52 Archaeological Resources**<br>***Ongoing throughout demolition, grading, and/or construction***<br>a) Pursuant to CEQA Guidelines section 15064.5 (f), "provisions for historical or unique archaeological resources accidentally discovered during construction" should be instituted. Therefore, in the event that any prehistoric or historic subsurface cultural resources are discovered during ground disturbing activities, all work within 50 feet of the resources shall be halted and the project applicant and/or lead agency shall consult with a qualified archaeologist or paleontologist to assess the significance of the find. If any find is determined to be |

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **CULTURAL RESOURCES (continued)** |

significant, representatives of the project proponent and/or lead agency and the qualified archaeologist would meet to determine the appropriate avoidance measures or other appropriate measure, with the ultimate determination to be made by the City of Oakland. All significant cultural materials recovered shall be subject to scientific analysis, professional museum curation, and a report prepared by the qualified archaeologist according to current professional standards.

b) In considering any suggested measure proposed by the consulting archaeologist in order to mitigate impacts to historical resources or unique archaeological resources, the project applicant shall determine whether avoidance is necessary and feasible in light of factors such as the nature of the find, project design, costs, and other considerations. If avoidance is unnecessary or infeasible, other appropriate measures (e.g., data recovery) shall be instituted. Work may proceed on other parts of the project site while measure for historical resources or unique archaeological resources is carried out.

c) Should an archaeological artifact or feature be discovered on-site during project construction, all activities within a 50-foot radius of the find would be halted until the findings can be fully investigated by a qualified archaeologist to evaluate the find and assess the significance of the find according to the CEQA definition of a historical or unique archaeological resource. If the deposit is determined to be significant, the project applicant and the qualified archaeologist shall meet to determine the appropriate avoidance measures or other appropriate measure, subject to approval by the City of Oakland, which shall assure implementation of appropriate measure measures recommended by the archaeologist. Should archaeologically-significant materials be recovered, the qualified archaeologist shall recommend appropriate analysis and treatment, and shall prepare a report on the findings for submittal to the Northwest Information Center.

**53 Human Remains**

***Ongoing throughout demolition, grading, and/or construction***

In the event that human skeletal remains are uncovered at the project site during construction or ground-breaking activities, all work shall immediately halt and the Alameda County Coroner shall be contacted to evaluate the remains, and following the procedures and protocols pursuant to Section 15064.5 (e)(1) of the CEQA Guidelines. If the County Coroner determines that the remains are Native American, the City shall contact the California Native American Heritage Commission (NAHC), pursuant to subdivision (c) of Section 7050.5 of the Health and Safety Code, and all excavation and site preparation activities shall cease within a 50-foot radius of the find until appropriate arrangements are made. If the agencies determine that avoidance is not feasible, then an alternative plan shall be prepared with specific steps and timeframe required to resume construction activities. Monitoring, data recovery, determination of significance and avoidance measures (if applicable) shall be completed expeditiously.

**54 Paleontological Resources**

***Ongoing throughout demolition, grading, and/or construction***

In the event of an unanticipated discovery of a paleontological resource during construction, excavations within 50 feet of the find shall be temporarily halted or diverted until the discovery is examined by a qualified paleontologist (per Society of Vertebrate Paleontology standards (SVP

| 1998 MITIGATION MEASURES, CITY OF OAKLAND<br>STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES<br>APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **CULTURAL RESOURCES (continued)** |
| 1995,1996)). The qualified paleontologist shall document the discovery as needed, evaluate the potential resource, and assess the significance of the find. The paleontologist shall notify the appropriate agencies to determine procedures that would be followed before construction is allowed to resume at the location of the find. If the City determines that avoidance is not feasible, the paleontologist shall prepare an excavation plan for mitigating the effect of the project on the qualities that make the resource important, and such plan shall be implemented. The plan shall be submitted to the City for review and approval. |
| ***2011 Mitigation Measures*** |
| None |
| **GEOLOGY AND SOILS** |
| ***1998 Mitigation Measures (2011 revisions shown in underline and strike-out)*** |
| For the potential short-term erosion impact, the 1998 MND concluded that compliance with the City's grading regulations (Ordinance No. 10312) codified in the Oakland Municipal Code as Section 15.04.780 along with the following mitigation measures would reduce the impact to a less-than-significant level:<br>2a) Facilities and infrastructure improvements should be designed to control runoff so that it is not directed over unprotected slopes. Drainage improvements shall be designed to adequately collect surface water runoff and convey it to the proper storm drain system. A permanent storm drain shall be designed, installed, and maintained to catch water from the existing natural drainage pattern in Knowland Park above Stella Street. The water will be redirected to City storm drain system.<br>2c) Grading and construction activities shall be restricted to the dry season. Exposed surface areas shall be watered down, especially during construction, to reduce wind erosion.<br>For the potential impact on water quality, channel capacity, and flow patterns in Arroyo Viejo Creek and the site's intermittent and ephemeral waterways due to construction-period erosion and uncontrolled surface water runoff, the 1998 MND concluded that compliance with the City's grading regulations (Ordinance No. 10312) codified in the Oakland Municipal Code as Section 15.04.780 and the following mitigation measure would reduce the impact to a less-than-significant level:<br>3a) Mitigation Measures 2a <u>and 2c</u> ~~through 2d~~ shall be implemented.<br>For the potential impact related to earthquake hazards, the following mitigation measures, as identified in the 1998 MND and modified by the City Council, were found to reduce the impact to a less-than-significant level:<br>5c) All proposed structures shall be designed and constructed in accordance with the Uniform Building Code and California Amendments. The interpretation of the applicability of the appropriate UBC standard for each proposed structure shall be determined by the Oakland Building and Engineering staff at the time of preliminary plan submittal.<br>5d) Proper earthquake-resistant techniques for securing indoor fixtures, machinery and furnishings within proposed structures shall be used during construction to minimize the risk of damage or injury from toppled objects. |

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**GEOLOGY AND SOILS (continued)**

5e) The Zoo's Emergency Preparedness and Response Plan and Animal Capture Plan shall be updated as proposed facilities are developed. The Zoo and Neighborhood (KPHA and SHRA) Associations will work together to educate the neighborhood about the Zoo's Emergency Preparedness and Response Plan and how it is implemented. This will be accomplished through written communication and a phone tree. The Zoo will provide a demonstration to the representatives of KPHA and SHRA of the safety of the animal enclosures in case of a natural disaster.

***Standard Conditions of Approval***

**SCA-GEO-1: Soils Report**

A preliminary soils report for each construction site within the project area shall be required as part of this project and submitted for review and approval by the Building Services Division. The soils reports shall be based, at least in part, on information obtained from on-site testing. Specifically the minimum contents of the report should include:

A. Logs of borings and/or profiles of test pits and trenches:
   a) The minimum number of borings acceptable, when not used in combination with test pits or trenches, shall be two (2), when in the opinion of the Soils Engineer such borings shall be sufficient to establish a soils profile suitable for the design of all the footings, foundations, and retaining structures.
   b) The depth of each boring shall be sufficient to provide adequate design criteria for all proposed structures.
   c) All boring logs shall be included in the soils report.

B. Test pits and trenches
   a) Test pits and trenches shall be of sufficient length and depth to establish a suitable soils profile for the design of all proposed structures.
   b) Soils profiles of all test pits and trenches shall be included in the soils report.

C. A plat shall be included which shows the relationship of all the borings, test pits, and trenches to the exterior boundary of the site. The plat shall also show the location of all proposed site improvements. All proposed improvements shall be labeled.

D. Copies of all data generated by the field and/or laboratory testing to determine allowable soil bearing pressures, sheer strength, active and passive pressures, maximum allowable slopes where applicable and any other information which may be required for the proper design of foundations, retaining walls, and other structures to be erected subsequent to or concurrent with work done under the grading permit.

E. Soils Report. A written report shall be submitted which shall include, but is not limited to, the following:
   a) Site description;
   b) Local and site geology;
   c) Review of previous field and laboratory investigations for the site;

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**GEOLOGY AND SOILS (continued)**

d) Review of information on or in the vicinity of the site on file at the Information Counter, City of Oakland, Office of Planning and Building;

e) Site stability shall be addressed with particular attention to existing conditions and proposed corrective attention to existing conditions and proposed corrective actions at locations where land stability problems exist;

f) Conclusions and recommendations for foundations and retaining structures, resistance to lateral loading, slopes, and specifications, for fills, and pavement design as required;

g) Conclusions and recommendations for temporary and permanent erosion control and drainage. If not provided in a separate report they shall be appended to the required soils report;

h) All other items which a Soils Engineer deems necessary;

i) The signature and registration number of the Civil Engineer preparing the report.

F. The Director of Planning and Building may reject a report that she/he believes is not sufficient. The Director of Planning and Building may refuse to accept a soils report if the certification date of the responsible soils engineer on said document is more than three years old. In this instance, the Director may be require that the old soils report be recertified, that an addendum to the soils report be submitted, or that a new soils report be provided.

**SCA-GEO-2: Geotechnical Report**

a) A site-specific, design level, landslide or liquefaction geotechnical investigation for each construction site within the project area shall be required as part of this project and submitted for review and approval by the Building Services Division. Specifically:

i. Each investigation shall include an analysis of expected ground motions at the site from identified faults. The analyses shall be accordance with applicable City ordinances and polices, and consistent with the most recent version of the California Building Code, which requires structural design that can accommodate ground accelerations expected from identified faults.

ii. The investigations shall determine final design parameters for the walls, foundations, foundation slabs, surrounding related improvements, and infrastructure (utilities, roadways, parking lots, and sidewalks).

iii. The investigations shall be reviewed and approved by a registered geotechnical engineer. All recommendations by the project engineer, geotechnical engineer, shall be included in the final design, as approved by the City of Oakland.

iv. The geotechnical report shall include a map prepared by a land surveyor or civil engineer that shows all field work and location of the "No Build" zone. The map shall include a statement that the locations and limitations of the geologic features are accurate representations of said features as they exist on the ground, were placed on this map by the surveyor, the civil engineer or under their supervision, and are accurate to the best of their knowledge.

v. Recommendations that are applicable to foundation design, earthwork, and site preparation that were prepared prior to or during the projects design phase, shall be incorporated in the project.

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **GEOLOGY AND SOILS (continued)** |
| vi. Final seismic considerations for the site shall be submitted to and approved by the City of Oakland Building Services Division prior to commencement of the project.<br>vii. A peer review is required for the geotechnical report. Personnel reviewing the geotechnical report shall approve the report, reject it, or withhold approval pending the submission by the applicant or subdivider of further geologic and engineering studies to more adequately define active fault traces.<br>Implementation of **SCA-GEO-2** shall include the following in the geotechnical investigation prepared for the proposed California Interpretive Center:<br>• The design-level geotechnical investigation shall identify methods for site preparation and grading to stabilize existing fill areas and prepare the site for foundation and retaining wall construction. Measures may include reworking of existing fill soils, removal of oversized concrete and debris from fill, and crushing of oversized materials.<br>• The design-level geotechnical investigation shall confirm and revise 2007 California Building Code seismic design parameters as presented in the SMND/Addendum.<br>• The geotechnical design investigation shall include design recommendations for retaining walls, foundations, concrete slabs, pavements, walkways, surface and subsurface drainage measures, and utility trench construction and backfill. The foundations are anticipated to be spread footings, thickened mat slabs, pier and grade beam and other conventional foundation types.<br>• The geotechnical investigation shall outline the details of geotechnical plan review. Recommendations of the project geotechnical engineer shall be included in the final construction drawings, as approved by the City of Oakland.<br>• The geotechnical investigation shall identify the geotechnical observation and testing services recommended during construction. During construction the geotechnical engineer shall perform observations and testing services and shall prepare a final report documenting results of his or her work.<br>• The City of Oakland shall provide peer review of the design-level geotechnical investigation and grading plan. The Oakland Zoo shall be responsible for the cost of the review. Revisions to the report and the design of project facilities shall be made to satisfy review comments by the City of Oakland peer reviewer.<br>• During the construction phase, cut slopes, keyways, and grading for the building pad that expose bedrock shall be mapped by the project engineering geologist. An as-graded geologic map shall be prepared showing the details of observed features and conditions.<br>• The geotechnical investigation shall include a map prepared by a land surveyor or civil engineer that shows the locations and elevation of key features (e.g., keyways, subdrains and their cleanouts, cut slopes, and cut pads). The map shall include a statement that the locations and limitations of the features are accurate representations of said features as they exist on the ground; were placed on this map by the surveyor, the civil engineer or under their supervision; and are accurate to the best of their knowledge.<br>• Final seismic considerations for the site shall be submitted to and approved by the City of Oakland Building Services Division prior to commencement of the project. |

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **GEOLOGY AND SOILS (continued)** |
| ***2011 Mitigation Measures*** |
| None |
| **GLOBAL CLIMATE CHANGE** |
| ***1998 Mitigation Measures*** |
| None |
| ***Standard Conditions of Approval*** |
| None |
| ***2011 Mitigation Measures*** |
| None |
| **HAZARDS AND HAZARDOUS MATERIALS** |
| ***1998 Mitigation Measures*** |
| None |
| ***Standard Conditions of Approval*** |
| **SCA-HAZ-1: Hazards Best Management Practices**<br>***Prior to commencement of demolition, grading, or construction***<br>The project applicant and construction contractor shall ensure that construction Best Management Practices (BMPs) are implemented as part of construction to minimize the potential negative effects to groundwater and soils. These shall include the following:<br>a) Follow manufacture's recommendations on use, storage, and disposal of chemical products used in construction;<br>b) Avoid overtopping construction equipment fuel gas tanks;<br>c) During routine maintenance of construction equipment, properly contain and remove grease and oils;<br>d) Properly dispose of discarded containers of fuels and other chemicals.<br>e) Ensure that construction would not have a significant impact on the environment or pose a substantial health risk to construction workers and the occupants of the proposed development. Soil sampling and chemical analyses of samples shall be performed to determine the extent of potential contamination beneath all UST's, elevator shafts, clarifiers, and subsurface hydraulic lifts when on-site demolition, or construction activities would potentially affect a particular development or building.<br>f) If soil, groundwater or other environmental medium with suspected contamination is encountered unexpectedly during construction activities (e.g., identified by odor or visual staining, or if any underground storage tanks, abandoned drums or other hazardous materials or wastes are encountered), the applicant shall cease work in the vicinity of the suspect material, the area shall be secured as necessary, and the applicant shall take all appropriate measures to protect human health and the environment. Appropriate measures shall include notification of regulatory agency(ies) and implementation of the actions described in the City's Standard Conditions of |

**1998 MITIGATION MEASURES, CITY OF OAKLAND
STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES
APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

## HAZARDS AND HAZARDOUS MATERIALS (continued)

Approval, as necessary, to identify the nature and extent of contamination. Work shall not resume in the area(s) affected until the measures have been implemented under the oversight of the City or regulatory agency, as appropriate.

**SCA-HAZ-2: Hazardous Materials Business Plan**

***Prior to handling, storage or transporting hazardous materials***

The project applicant shall submit a Hazardous Materials Business Plan for review and approval by Fire Prevention Bureau, Hazardous Materials Unit. Once approved this plan shall be kept on file with the City and will be updated as applicable. The purpose of the Hazardous Materials Business Plan is to ensure that employees are adequately trained to handle the materials and provides information to the Fire Services Division should emergency response be required. The Hazardous Materials Business Plan shall include the following:

a) The types of hazardous materials or chemicals stored and/or used on site, such as petroleum fuel products, lubricants, solvents, and cleaning fluids.

b) The location of such hazardous materials.

c) An emergency response plan including employee training information

d) A plan that describes the manner in which these materials are handled, transported and disposed.

***2011 Mitigation Measures***

None

## HYDROLOGY AND WATER QUALITY

***1998 Mitigation Measures (2011 revisions shown in underline and strike-out)***

To mitigate for increased water turbidity, the following mitigation measure shall be implemented:

10a) Mitigation Measures 2a and 2 c ~~-2d~~ shall be implemented.

***Standard Conditions of Approval***

**SCA-HYDRO-1: Stormwater Pollution Prevention Plan (SWPPP)**

***Prior to and ongoing throughout grading and construction activities***

The project applicant must obtain coverage under the General Construction Activity Storm Water Permit (General Construction Permit) issued by the State Water Resources Control Board (SWRCB). The project applicant must file a notice of intent (NOI) with the SWRCB. The project applicant will be required to prepare a Stormwater Pollution Prevention Plan (SWPPP) and submit the plan for review and approval by the Building Services Division. At a minimum, the SWPPP shall include a description of construction materials, practices and equipment storage and maintenance; a list of pollutants likely to contact stormwater; site-specific erosion and sedimentation control practices; a list of provisions to eliminate or reduce discharge of materials to stormwater; Best Management Practices (BMPs); and an inspection and monitoring program. Prior to the issuance of any construction-related permits, the project applicant shall submit to the Building Services Division a copy of the SWPPP as evidence of submittal of the NOI to the SWRCB. Implementation of the

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**HYDROLOGY AND WATER QUALITY (continued)**

SWPPP shall start with the commencement of construction and continue through the completion of the project. After construction is completed, the project applicant shall submit a notice of termination to the SWRCB.

**SCA-HYDRO-2: Drainage Plan for Projects on Slopes Greater Than 20 Percent**

***Prior to issuance of building (or other construction-related permit)***

The project drawings for a building permit (or other construction-related permit) shall contain a drainage plan to be reviewed and approved by the Building Services Division. The drainage plan shall include measures to reduce the post-construction volume and velocity of stormwater runoff to the maximum extent practicable. Stormwater runoff shall not be augmented to adjacent properties or creeks.

**SCA-HYDRO-3: Post-Construction Stormwater Management Plan**

***Prior to issuance of building permit (or other construction-related permit)***

The applicant shall comply with the requirements of Provision C.3 of the National Pollutant Discharge Elimination System (NPDES) permit issued to the Alameda Countywide Clean Water Program. The applicant shall submit with the application for a building permit (or other construction-related permit) a completed Stormwater Supplemental Form for the Building Services Division. The project drawings submitted for the building permit (or other construction-related permit) shall contain a stormwater pollution management plan, for review and approval by the City, to limit the discharge of pollutants in stormwater after construction of the project to the maximum extent practicable.

a) The post-construction stormwater pollution management plan shall include and identify the following:
   i. All proposed impervious surface on the site;
   ii. Anticipated directional flows of on-site stormwater runoff; and
   iii. Site design measures to reduce the amount of impervious surface area and directly connected impervious surfaces; and
   iv. Source control measures to limit the potential for stormwater pollution; and
   v. Stormwater treatment measures to remove pollutants from stormwater runoff; and
   vi. Hydromodification management measures so that post-project stormwater runoff does not exceed the flow and duration of pre-project runoff, if required under the NPDES permit.

b) The following additional information shall be submitted with the post-construction stormwater pollution management plan:
   i. Detailed hydraulic sizing calculations for each stormwater treatment measure proposed; and
   ii. Pollutant removal information demonstrating that any proposed manufactured/ mechanical (i.e., non-landscape-based) stormwater treatment measure, when not used in combination with a landscape-based treatment measure, is capable or removing the range of pollutants typically removed by landscape-based treatment measures.

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**HYDROLOGY AND WATER QUALITY (continued)**

All proposed stormwater treatment measures shall incorporate appropriate planting materials for stormwater treatment (for landscape-based treatment measures) and shall be designed with considerations for vector/mosquito control. Proposed planting materials for all proposed landscape-based stormwater treatment measures shall be included on the landscape and irrigation plan for the project. The applicant is not required to include on-site stormwater treatment measures in the post-construction stormwater pollution management plan if he or she secures approval from Planning and Zoning of a proposal that demonstrates compliance with the requirements of the City's Alternative Compliance Program.

Prior to final permit inspection, the applicant shall implement the approved stormwater pollution management plan.

**SCA-HYDRO-4: Maintenance Agreement for Stormwater Treatment Measures**

***Prior to final zoning inspection***

For projects incorporating stormwater treatment measures, the applicant shall enter into the "Standard City of Oakland Stormwater Treatment Measures Maintenance Agreement," in accordance with Provision C.3.e of the NPDES permit, which provides, in part, for the following:

i. The applicant accepting responsibility for the adequate installation/construction, operation, maintenance, inspection, and reporting of any on-site stormwater treatment measures being incorporated into the project until the responsibility is legally transferred to another entity; and

ii. Legal access to the on-site stormwater treatment measures for representatives of the City, the local vector control district, and staff of the Regional Water Quality Control Board, San Francisco Region, for the purpose of verifying the implementation, operation, and maintenance of the on-site stormwater treatment measures and to take corrective action if necessary. The agreement shall be recorded at the County Recorder's Office at the applicant's expense.

**SCA-HYDRO-5: Erosion, Sedimentation and Debris Control Measures**

***Prior to issuance of demolition, grading, or construction-related permit***

The project applicant shall submit an erosion and sedimentation control plan for review and approval by the Building Services Division. All work shall incorporate all applicable "Best Management Practices" (BMPs) for the construction industry, and as outlined in the Alameda Countywide Clean Water Program pamphlets, including BMP's for dust, erosion and sedimentation abatement per Chapter Section 15.04 of the Oakland Municipal Code. The measures shall include, but are not limited to, the following:

a) On sloped properties, the downhill end of the construction area must be protected with silt fencing (such as sandbags, filter fabric, silt curtains, etc.) and hay bales oriented parallel to the contours of the slope (at a constant elevation) to prevent erosion into the creek.

b) In accordance with an approved erosion control plan, the project applicant shall implement mechanical and vegetative measures to reduce erosion and sedimentation, including appropriate seasonal maintenance. One hundred (100) percent degradable erosion control fabric shall be installed on all graded slopes to protect and stabilize the slopes during construction and before permanent vegetation gets established. All graded areas shall be temporarily protected from erosion by seeding with fast growing annual species. All bare slopes must be covered with staked tarps when rain is occurring or is expected.

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **HYDROLOGY AND WATER QUALITY (continued)** |
| c) Minimize the removal of natural vegetation or ground cover from the site in order to minimize the potential for erosion and sedimentation problems. Maximize the replanting of the area with native vegetation as soon as possible.<br>d) All work in or near creek channels must be performed with hand tools and by a minimum number of people. Immediately upon completion of this work, soil must be repacked and native vegetation planted.<br>e) Install filter materials (such as sandbags, filter fabric, etc.) at the storm drain inlets nearest to the creek side of the project site prior to the start of the wet weather season (October 15); site dewatering activities; street washing activities; saw cutting asphalt or concrete; and in order to retain any debris flowing into the City storm drain system. Filter materials shall be maintained and/or replaced as necessary to ensure effectiveness and prevent street flooding.<br>f) Ensure that concrete/granite supply trucks or concrete/plaster finishing operations do not discharge wash water into the creek, street gutters, or storm drains.<br>g) Direct and locate tool and equipment cleaning so that wash water does not discharge into the creek.<br>h) Create a contained and covered area on the site for storage of bags of cement, paints, flammables, oils, fertilizers, pesticides, or any other materials used on the project site that have the potential for being discharged to the storm drain system by the wind or in the event of a material spill. No hazardous waste material shall be stored on site.<br>i) Gather all construction debris on a regular basis and place them in a dumpster or other container which is emptied or removed on a weekly basis. When appropriate, use tarps on the ground to collect fallen debris or splatters that could contribute to stormwater pollution.<br>j) Remove all dirt, gravel, refuse, and green waste from the sidewalk, street pavement, and storm drain system adjoining the project site. During wet weather, avoid driving vehicles off paved areas and other outdoor work.<br>k) Broom sweep the street pavement adjoining the project site on a daily basis. Caked-on mud or dirt shall be scraped from these areas before sweeping. At the end of each workday, the entire site must be cleaned and secured against potential erosion, dumping, or discharge to the creek.<br>l) All erosion and sedimentation control measures implemented during construction activities, as well as construction site and materials management shall be in strict accordance with the control standards listed in the latest edition of the Erosion and Sediment Control Field Manual published by the Regional Water Quality Board (RWQB).<br>m) Temporary fencing is required for sites without existing fencing between the creek and the construction site and shall be placed along the side adjacent to construction (or both sides of the creek if applicable) at the maximum practical distance from the creek centerline. This area shall not be disturbed during construction without prior approval of Planning and Zoning.<br>n) All erosion and sedimentation control measures shall be monitored regularly by the project applicant. The City may require erosion and sedimentation control measures to be inspected by a qualified environmental consultant (paid for by the project applicant) during or after rain events. If measures are insufficient to control sedimentation and erosion then the project applicant shall develop and implement additional and more effective measures immediately. |

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **HYDROLOGY AND WATER QUALITY (continued)** |
| j) Remove all dirt, gravel, refuse, and green waste from the sidewalk, street pavement, and storm drain system adjoining the project site. During wet weather, avoid driving vehicles off paved areas and other outdoor work.<br>k) Broom sweep the street pavement adjoining the project site on a daily basis. Caked-on mud or dirt shall be scraped from these areas before sweeping. At the end of each workday, the entire site must be cleaned and secured against potential erosion, dumping, or discharge to the creek.<br>l) All erosion and sedimentation control measures implemented during construction activities, as well as construction site and materials management shall be in strict accordance with the control standards listed in the latest edition of the Erosion and Sediment Control Field Manual published by the Regional Water Quality Board (RWQB).<br>m) Temporary fencing is required for sites without existing fencing between the creek and the construction site and shall be placed along the side adjacent to construction (or both sides of the creek if applicable) at the maximum practical distance from the creek centerline. This area shall not be disturbed during construction without prior approval of Planning and Zoning.<br>n) All erosion and sedimentation control measures shall be monitored regularly by the project applicant. The City may require erosion and sedimentation control measures to be inspected by a qualified environmental consultant (paid for by the project applicant) during or after rain events. If measures are insufficient to control sedimentation and erosion then the project applicant shall develop and implement additional and more effective measures immediately. |
| ***2011 Mitigation Measures*** |
| None |
| **LAND USE, RECREATION AND PLANNING** |
| ***1998 Mitigation Measures*** |
| None |
| ***Standard Conditions of Approval*** |
| None |
| ***2011 Mitigation Measures*** |
| None |
| **NOISE** |
| ***1998 Mitigation Measures*** |
| None |
| ***Standard Conditions of Approval*** |
| **SCA-NOISE-1: Days/Hours of Construction Operation**<br>***Ongoing throughout demolition, grading, and/or construction***<br>The project applicant shall require construction contractors to limit standard construction activities as follows:<br>Construction activities are limited to between 7:00 AM and 7:00 PM Monday through Friday, except that pile driving and/or other extreme noise generating activities greater than 90 dBA shall be limited to between 8:00 AM and 4:00 PM Monday through Friday. |

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**NOISE (continued)**

Any construction activity proposed to occur outside of the standard hours of 7:00 AM to 7:00 PM Monday through Friday for special activities (such as concrete pouring which may require more continuous amounts of time) shall be evaluated on a case by case basis, with criteria including the proximity of residential uses and a consideration of resident's preferences for whether the activity is acceptable if the overall duration of construction is shortened and such construction activities shall only be allowed with the prior written authorization of the Building Services Division.

Construction activity shall not occur on Saturdays, with the following possible exceptions:

i. Prior to the building being enclosed, requests for Saturday construction for special activities (such as concrete pouring which may require more continuous amounts of time), shall be evaluated on a case by case basis, with criteria including the proximity of residential uses and a consideration of resident's preferences for whether the activity is acceptable if the overall duration of construction is shortened. Such construction activities shall only be allowed on Saturdays with the prior written authorization of the Building Services Division.

ii. After the building is enclosed, requests for Saturday construction activities shall only be allowed on Saturdays with the prior written authorization of the Building Services Division, and only then within the interior of the building with the doors and windows closed.

No extreme noise generating activities (greater than 90 dBA) shall be allowed on Saturdays, with no exceptions.

No construction activity shall take place on Sundays or Federal holidays.

Construction activities include but are not limited to: truck idling, moving equipment (including trucks, elevators, etc) or materials, deliveries, and construction meetings held on-site in a non-enclosed area.

Applicant shall use temporary power poles instead of generators where feasible.

**SCA-NOISE-2: Noise Control**

***Ongoing throughout demolition, grading, and/or construction***

To reduce noise impacts due to construction, the project applicant shall require construction contractors to implement a site-specific noise reduction program, subject to the Planning and Zoning Division and the Building Services Division review and approval, which includes the following measures:

a) Equipment and trucks used for project construction shall utilize the best available noise control techniques (e.g., improved mufflers, equipment redesign, use of intake silencers, ducts, engine enclosures and acoustically-attenuating shields or shrouds, wherever feasible).

b) Except as provided herein, impact tools (e.g., jack hammers, pavement breakers, and rock drills) used for project construction shall be hydraulically or electrically powered to avoid noise associated with compressed air exhaust from pneumatically powered tools. However, where use of pneumatic tools is unavoidable, an exhaust muffler on the compressed air exhaust shall be used; this muffler can lower noise levels from the exhaust by up to about 10 dBA. External jackets on the tools themselves shall be used, if such jackets are commercially available and this could achieve a reduction of 5 dBA. Quieter procedures shall be used, such as drills rather than

| 1998 MITIGATION MEASURES, CITY OF OAKLAND<br>STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES<br>APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
|---|
| **NOISE (continued)** |

impact equipment, whenever such procedures are available and consistent with construction procedures.

c) Stationary noise sources shall be located as far from adjacent sensitive noise receptors as possible and they shall be muffled and enclosed within temporary sheds, or incorporate insulation noise barriers, or use other measures as determined by the City to provide equivalent noise reduction.

d) The noisiest phases of construction shall be limited to less than 10 days at a time. Exceptions may be allowed if the City determines an extension is necessary and all available noise reduction controls are implemented.

To implement SCA-NOISE-2, the project applicant shall have a qualified acoustical consultant prepare a noise reduction implementation plan for City review and approval. The goal of the plan is to reduce noise impacts during Phase 1 at Receptor 4 and Receptor 6 to below City standards. The project applicant shall implement the approved plan.

The approved noise reduction implementation plan shall incorporate one or more of the following sound reduction measures or equivalent sound reduction measures:

***Phase 1 Veterinary Medical Hospital.*** During construction activities, a 15-foot-high temporary sound barrier of 230 feet in length shall be placed between the proposed Veterinary Medical Hospital site and the southern and eastern residences. The sound barrier shall be placed at the edge of the parking lot closest to the Veterinary Medical Hospital location as shown in **Figure 3.9-1**. The sound barrier shall require a ten-foot return on each end and be oriented 45 degrees into the construction activities. Due to edge diffraction, the construction activities shall not approach the end of the wall returns by 50 feet. **Table 3.9-8** in **Subsection 3.9.5.2** below describes the temporary sound barrier wall height and the duration of the wall placement.

***Phase 1 Service Road.*** A 12-foot-high temporary sound barrier segment of 475 feet in length shall be placed along the edge of the service road segment where the road bends and is oriented nearest the southern residences as shown in **Figure 3.9-2** while roadway construction occurs. The sound barrier shall require a ten-foot return on each end and be oriented 45 degrees into the construction activities. Due to edge diffraction, the construction activities shall not approach the end of the wall returns by 50 feet. **Table 3.9-8** in **Subsection 3.9.5.2** below describes the temporary sound barrier wall height and the duration of the wall placement.

The temporary sound barrier shall be constructed of a sound blanket system hung on scaffolding to achieve the required height. This system is very effective in the reduction of construction noise and allows the ability to move or adjust the wall location. An alternative sound barrier design would consist of plywood installed atop a portable concrete K-Rail system. This alternative solution is effective in the reduction of noise and also allows the ability to move or adjust the wall location.

An alternative approach to the sound barrier would be to equip all of the heavy construction equipment used in the construction of the Veterinary Medical Hospital and the service road with acoustical silencers installed directly onto the construction equipment's exhaust system. This alternative mitigation solution would reduce the temporary construction noise impacts to below the City of Oakland's noise threshold limits.

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **NOISE (continued)** |
| **SCA-NOISE-3: Noise Complaint Procedures**<br>***Ongoing throughout demolition, grading, and/or construction***<br>Prior to the issuance of each building permit, along with the submission of construction documents, the project applicant shall submit to the Building Services Division a list of measures to respond to and track complaints pertaining to construction noise. These measures shall include:<br>a) A procedure and phone numbers for notifying the Building Services Division staff and Oakland Police Department; (during regular construction hours and off-hours);<br>b) A sign posted on-site pertaining with permitted construction days and hours and complaint procedures and who to notify in the event of a problem. The sign shall also include a listing of both the City and construction contractor's telephone numbers (during regular construction hours and off-hours);<br>c) The designation of an on-site construction complaint and enforcement manager for the project;<br>d) Notification of neighbors and occupants within 300 feet of the project construction area at least 30 days in advance of extreme noise generating activities about the type and estimated duration of the activity; and<br>e) A preconstruction meeting shall be held with the job inspectors and the general contractor/ on-site project manager to confirm that noise measures and practices (including construction hours, neighborhood notification, posted signs, etc.) are completed.<br>**SCA-NOISE-4: Operational Noise-General**<br>***Ongoing***<br>Noise levels from the activity, property, or any mechanical equipment on site shall comply with the performance standards of Section 17.120 of the Oakland Planning Code and Section 8.18 of the Oakland Municipal Code. If noise levels exceed these standards, the activity causing the noise shall be abated until appropriate noise reduction measures have been installed and compliance verified by the Planning and Zoning Division and Building Services. |
| ***2011 Mitigation Measures*** |
| None |
| **PUBLIC SERVICES AND UTILITIES** |
| ***1998 Mitigation Measures*** |
| None |
| ***Standard Conditions of Approval*** |
| **SCA-SERVICES-1: Waste Reduction and Recycling**<br>The project applicant will submit a Construction & Demolition Waste Reduction and Recycling Plan (WRRP) and an Operational Diversion Plan (ODP) for review and approval by the Public Works Agency. |

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**PUBLIC SERVICES AND UTILITIES (continued)**

***Prior to issuance of demolition, grading, or building permit***

Chapter 15.34 of the Oakland Municipal Code outlines requirements for reducing waste and optimizing construction and demolition (C&D) recycling. Affected projects include all new construction, renovations/alterations/modifications with construction values of $50,000 or more (except R-3), and all demolition (including soft demo). The WRRP must specify the methods by which the development will divert C&D debris waste generated by the proposed project from landfill disposal in accordance with current City requirements. Current standards, FAQs, and forms are available at www.oaklandpw.com/Page39.aspx or in the Green Building Resource Center. After approval of the plan, the project applicant shall implement the plan.

***Ongoing***

The ODP will identify how the project complies with the Recycling Space Allocation Ordinance, (Chapter 17.118 of the Oakland Municipal Code), including capacity calculations, and specify the methods by which the development will meet the current diversion of solid waste generated by operation of the proposed project from landfill disposal in accordance with current City requirements. The proposed program shall be in implemented and maintained for the duration of the proposed activity or facility. Changes to the plan may be re-submitted to the Environmental Services Division of the Public Works Agency for review and approval. Any incentive programs shall remain fully operational as long as residents and businesses exist at the project site.

**SCA-SERVICES-2: Fire Safety Phasing Plan**

***Prior to issuance of a demolition, grading, and/or construction and concurrent with any p-job submittal permit***

The project applicant shall submit a separate fire safety phasing plan to the Planning and Zoning Division and Fire Services Division for their review and approval. The fire safety plan shall include all of the fire safety features incorporated into the project and the schedule for implementation of the features. Fire Services Division may require changes to the plan or may reject the plan if it does not adequately address fire hazards associated with the project as a whole or the individual phase.

**SCA-SERVICES-3: Fire Safety**

***Prior to and ongoing throughout demolition, grading, and/or construction***

The project applicant and construction contractor will ensure that during project construction, all construction vehicles and equipment will be fitted with spark arrestors to minimize accidental ignition of dry construction debris and surrounding dry vegetation.

**SCA-SERVICES-4: Stormwater and Sewer**

***Prior to completing the final design for the project's sewer service***

Confirmation of the capacity of the City's surrounding stormwater and sanitary sewer system and state of repair shall be completed by a qualified civil engineer with funding from the project applicant. The project applicant shall be responsible for the necessary stormwater and sanitary sewer infrastructure improvements to accommodate the proposed project. In addition, the applicant shall be required to pay additional fees to improve sanitary sewer infrastructure if required by the Sewer

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **PUBLIC SERVICES AND UTILITIES (continued)** |
| and Stormwater Division. Improvements to the existing sanitary sewer collection system shall specifically include, but are not limited to, mechanisms to control or minimize increases in infiltration/inflow to offset sanitary sewer increases associated with the proposed project. To the maximum extent practicable, the applicant will be required to implement Best Management Practices to reduce the peak stormwater runoff from the project site. Additionally, the project applicant shall be responsible for payment of the required installation or hook-up fees to the affected service providers. |
| ***2011 Mitigation Measures*** |
| None |
| **TRANSPORTATION AND CIRCULATION** |
| ***1998 Mitigation Measures*** |
| The City Council adopted the following mitigation measures with the 1998 MND:<br>26a) Construction traffic shall only use existing improved public roads.<br>27a) To prevent heavy traffic from exiting the Zoo in one direction, traffic will be directed between Golf Links Road and 106$^{th}$ Avenue in order to balance the traffic flow. At no time will the Golf Links exit be closed to heavy traffic. |
| ***Standard Conditions of Approval*** |
| **SCA-TRANS-1: Construction Traffic and Parking**<br>***Prior to the issuance of a demolition, grading or building permit***<br>The project applicant and construction contractor shall meet with appropriate City of Oakland agencies to determine traffic management strategies to reduce, to the maximum extent feasible, traffic congestion and the effects of parking demand by construction workers during construction of this project and other nearby projects that could be simultaneously under construction. The project applicant shall develop a construction management plan for review and approval by the Planning and Zoning Division, the Building Services Division, and the Transportation Services Division. The plan shall include at least the following items and requirements:<br>a) A set of comprehensive traffic control measures, including scheduling of major truck trips and deliveries to avoid peak traffic hours, detour signs if required, lane closure procedures, signs, cones for drivers, and designated construction access routes.<br>b) Notification procedures for adjacent property owners and public safety personnel regarding when major deliveries, detours, and lane closures will occur.<br>c) Location of construction staging areas for materials, equipment, and vehicles at an approved location.<br>d) A process for responding to, and tracking, complaints pertaining to construction activity, including identification of an onsite complaint manager. The manager shall determine the cause of the complaints and shall take prompt action to correct the problem. Planning and Zoning shall be informed who the Manager is prior to the issuance of the first permit issued by Building Services. |

**1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT**

**TRANSPORTATION AND TRAFFIC (continued)**

e) Provision for accommodation of pedestrian flow.

f) Provision for parking management and spaces for all construction workers to ensure that construction workers do not park in on street spaces.

g) Any damage to the street caused by heavy equipment, or as a result of this construction, shall be repaired, at the applicant's expense, within one week of the occurrence of the damage (or excessive wear), unless further damage/excessive wear may continue; in such case, repair shall occur prior to issuance of a final inspection of the building permit. All damage that is a threat to public health or safety shall be repaired immediately. The street shall be restored to its condition prior to the new construction as established by the City Building Inspector and/or photo documentation, at the applicant's expense, before the issuance of a Certificate of Occupancy.

h) Any heavy equipment brought to the construction site shall be transported by truck, where feasible.

i) No materials or equipment shall be stored on the traveled roadway at any time.

j) Prior to construction, a portable toilet facility and a debris box shall be installed on the site, and properly maintained through project completion.

k) All equipment shall be equipped with mufflers.

l) Prior to the end of each work day during construction, the contractor or contractors shall pick up and properly dispose of all litter resulting from or related to the project, whether located on the property, within the public rights-of-way, or properties of adjacent or nearby neighbors.

**SCA-TRANS-2: Parking and Transportation Demand Management**

***Prior to issuance of a final inspection of the building permit***

The applicant shall submit for review and approval by the Planning and Zoning Division a Transportation Demand Management (TDM) plan containing strategies to reduce on-site parking demand and single occupancy vehicle travel. The applicant shall implement the approved TDM plan. The TDM shall include strategies to increase bicycle, pedestrian, transit, and carpools/vanpool use. All four modes of travel shall be considered. Strategies to consider include the following:

a) Inclusion of additional bicycle parking, shower, and locker facilities that exceed the requirement

b) Construction of bike lanes per the Bicycle Master Plan; Priority Bikeway Projects

c) Signage and striping onsite to encourage bike safety

d) Installation of safety elements per the Pedestrian Master Plan (such as cross walk striping, curb ramps, count down signals, bulb outs, etc.) to encourage convenient crossing at arterials

e) Installation of amenities such as lighting, street trees, trash receptacles per the Pedestrian Master Plan and any applicable streetscape plan.

f) Direct transit sales or subsidized transit passes

g) Guaranteed ride home program

| 1998 MITIGATION MEASURES, CITY OF OAKLAND STANDARD CONDITIONS OF APPROVAL, AND 2011 MITIGATION MEASURES APPLICABLE TO THE PROPOSED MASTER PLAN AMENDMENT |
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| **TRANSPORTATION AND TRAFFIC (continued)** |
| h) Pre-tax commuter benefits (checks)<br>i) On-site car-sharing program (such as City Car Share, Zip Car, etc.)<br>j) On-site carpooling program<br>k) Distribution of information concerning alternative transportation options<br>l) Parking spaces sold/leased separately<br>m) Parking management strategies; including attendant/valet parking and shared parking spaces |
| ***2011 Mitigation Measures*** |
| None |

APPENDIX

D

# ANAYLSIS OF OAKLAND ZOO ATTENDANCE

# ANALYSIS OF OAKLAND ZOO ATTENDANCE RELATED TO NEW CALIFORNIA EXHIBIT

*Prepared for*

**CITY OF OAKLAND**

**AND**

**OAKLAND ZOO**

*Prepared by*

**HAUSRATH ECONOMICS GROUP**

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***November 2010***

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# ANALYSIS OF OAKLAND ZOO ATTENDANCE RELATED TO NEW CALIFORNIA EXHIBIT

## PURPOSE AND APPROACH

The Oakland Zoo has applied for approval of an amendment to the approved Master Plan that would refine and make changes to the site plan for the new California Exhibit. As part of the efforts underway to evaluate the effects of the proposed amendment, Hausrath Economics Group (HEG) was asked to analyze and estimate the likely effects of the California Exhibit on Zoo attendance. The results provide input for environmental analysis of the exhibit proposal.

The likely effects of the new California Exhibit on attendance at the Oakland Zoo are estimated based on:

- visitor characteristics and attendance trends at the Oakland Zoo;
- consideration of the likely significance of the new exhibit in attracting visitors;
- relevant experience of other zoos and visitor attractions; and
- demographic trends and forecasts for the East Bay and surrounding Bay Area over the longer term.

The estimates draw from available information and analyses, and consideration of the range of factors involved. The results identify what can be reasonably anticipated to occur and summarize the rationale behind the estimates.

## CURRENT ZOO ATTENDANCE

Current attendance at the Oakland Zoo is approximately 630,000 visits per year, as of FY 2010.

The Oakland Zoo draws the majority of its visitors from the surrounding East Bay communities in Alameda and Contra Costa counties. Approximately 35 percent of visits are by people who live in Oakland and the nearby Inner East Bay cities of Berkeley, Albany, Piedmont, Alameda, San Leandro, and Emeryville. Another 35 percent of visits are by residents of the rest of Alameda and Contra Costa counties. The Zoo also attracts visitors from the rest of the Bay Area (about 11 percent) with the largest numbers from Santa Clara and Solano counties. From beyond the Bay Area, about seven percent of Zoo visits are by day visitors from adjacent counties at the outer fringes of the region (primarily San Joaquin County), and about 12 percent of visits are made by tourists, often in the company of Bay Area resident friends and family members. (See Table 1 for a summary of data from the Zoo visitor survey.)

**TABLE 1**
**BACKGROUND ON OAKLAND ZOO VISITORS**

| | |
|---|---|
| **Places of Residence** | |
| Inner East Bay/Alameda County /a/ | 35% |
| Rest of Alameda County | 18% |
| Contra Costa County | 17% |
| Rest of Bay Area | 11% |
| *Total Bay Area* | *81%* |
| Day Visitors – Adjacent Counties /b/ | 7% |
| Tourists /c/ | 12% |
| *Total Zoo Attendance* | *100%* |
| **Parties With Children** | |
| Parties/households with people <18 years | 81% |
| **Size of Parties** | |
| Average number of persons in party | 3.7 |
| - Adults | 1.9 |
| - Children | 1.8 |

/a/ Includes Oakland, Berkeley, Piedmont, Alameda, San Leandro, Albany, and Emeryville.
/b/ Includes Yolo, Sacramento, San Joaquin, Stanislaus, and Santa Cruz counties.
/c/ Tourists defined as visitors to the Bay Area who spend the night in accommodations other than their own homes including hotels, motels, and private homes of family and friends.

Source: Oakland Zoo Visitors Survey, 2003.

Zoo visitors consist overwhelmingly of families and/or small groups (including nannies and babysitters) with young children, with additional attendance coming from organized groups such as school children. According to the Zoo's Visitor Survey, 81 percent of parties visiting the Oakland Zoo include children, and these groups account for about 90 percent of Zoo attendance (as parties with children have more people per group than adult parties without children). As a comparison, just 31 percent of households in the Inner East Bay and 35 percent of households in the Bay Area overall include children. The average party overall (including parties with and without children) consists of 3.7 persons, about half adults and half children.

## Recent Trends in Attendance

The Oakland Zoo has been in a period of strong attendance since mid-2005/2006, as summarized in Table 2. The Zoo has had new things to offer, made improvements, and used events and programming to keep interest and attract visitors.

**TABLE 2**
**RECENT ATTENDANCE**
**AT OAKLAND ZOO**

| Year (year end 6/30) | Annual Attendance |
|---|---|
| 2004 | 470,000 |
| 2005 | 475,200 |
| 2006 | 636,800 |
| 2007 | 641,900 |
| 2008 | 653,400 |
| 2009 | 670,700 |
| 2010 | 629,300 |

Source: Oakland Zoo

The following summarize the range of improvements and events that have occurred at the Zoo over this period.

- The new Valley Children’s Zoo opened in July 2005 (FY 2006 in attendance data) and continued to be completed and “fine-tuned” through the next year.

- The new Baboon Cliffs exhibit opened in October 2009, followed by the Wild Australia exhibit, featuring a newly themed Outback Express Adventure Train, in 2010.

- Other Master Plan improvements continued to be made, including renovations and development of new animal exhibits and their night houses, visitor amenities, and landscape and maintenance improvements. Examples include a new exhibit for existing camels in winter 2007 and improvements to the chimpanzee exhibit in 2009.

- New animals were added and baby animals were born throughout the period. Examples include the acquisition of a Malayan Sun Bear, a giraffe, two black lemurs, 2 Dromedary camels (came as young sisters), ferrets, otters, goats, sheep, rabbits, and numerous birds, reptiles, and amphibians. Births have included squirrel monkeys, a baby giraffe, a spotted turtle, and numerous birds, reptiles, and amphibians.

- Programming and special events were added to attract additional visitors. During this period, education and community events and programs have occurred every month. The new Zoo Lights program was returned in the winter 2008 and continued in 2009 and 2010.

- Zoo hours were extended throughout the summer in 2008 and 2009 and scaled back to summer weekends only in 2010.

Zoo visitors surveyed in 2008 identified high levels of satisfaction and enthusiasm for the Oakland Zoo.[1] Nearly all reported that their zoo visit met their expectations, and almost all (80-90%) rated their overall satisfaction with their visit to the Zoo as excellent. This positive experience spreads to others via word-of-mouth and supports additional visitation. The majority of those surveyed also said they expected to return to the Zoo in the next six months, and those who did not gave distance as the prohibiting factor.

Recent high attendance also appears to be supported by the economic downturn/recession. Zoos in many cities, including Cincinnati, St. Louis, Baltimore, Kansas City, and Memphis, report higher attendance as consumers look for affordable entertainment closer to home.[2] More than 58 percent of the 120 members of the Association of Zoos and Aquariums responding to a recent survey reported attendance increases in 2008/2009.[2] The Oakland Zoo's attendance was the highest in 2009, and Zoo management attributes increases to the poor economy.

The Zoo's recent attendance pattern also illustrates the experience of zoos and other types of large attractions as documented in the literature/research and discussed in this report.

- ♦ The initial opening of new exhibits often results in a substantial increase in attendance. That occurred in FY 2006 with the opening of the Valley Children's Zoo in July 2005. The magnitude of the increase may also reflect somewhat lower attendance in the preceding years after the former Children's Petting Zoo was closed to allow for construction. In addition, the cumulative effect of the new Children's Zoo and master plan improvements begun in earlier years could have enhanced the overall visitor experience and exceeded visitor expectations, resulting in more repeat visits and positive recommendations to family and friends to also visit the Oakland Zoo.

[1] Oakland Zoo Visitor Satisfaction and Marketing Research, summer 2008.
[2] "Bear Economy is a Boon to Zoo Attendance" by Lisa Cornwell, Associated Press Writer, LJWorld-News (Lawrence, KS), June 30, 2009.

- In order for a zoo to experience sustained attendance increases over time, it must continue to provide new visitor draws. That occurred through 2009/2010 as described above, including additional master plan improvements, new exhibits, and continued programming and special events. The attendance data indicate that these improvements and events have supported continuing strong attendance at the Oakland Zoo.

  The sustained higher attendance appears to also reflect greater and more frequent visits to the Zoo after the new Children's Zoo opened. The Children's Zoo offers play areas and interactive exhibits that have encouraged households with smaller children to come more often and use this part of the Zoo as a park.

- The fact that attendance increased substantially in 2006 and has remained at a much higher level for the Oakland Zoo indicates that the Zoo appears to have moved to a new attendance level or plateau, based on its improved facilities, reputation, and visitor experience. Since 2005/2006, attendance has been in the 600,000s compared to the high 400,000s in earlier years, reflecting a significant increase.

- Typically initial, large increases in attendance with the opening of new exhibits are followed by a decline from peak attendance levels, once many people have visited the new exhibit(s) and the initial interest and excitement declines. That did not occur over the 2006-2009 period, due to continuing improvements and new exhibits at the Oakland Zoo. Attendance also was bolstered by the economic downturn, particularly in 2009. The somewhat lower attendance for 2010 may indicate the beginning of a decline in attendance to a more stabilized level after the recent series of improvements and economic effects. However, the sustained period of higher attendance, appears to indicate a stabilized level above that in 2004/2005, and somewhat below the highest levels in 2006-2009.

## THE NEW CALIFORNIA EXHIBIT

The new California Exhibit will represent an expansion of the developed zoo area to the northeast into a portion of upper Knowland Park. A proposed gondola people-moving system will transport visitors from the existing zoo area to the California Exhibit. The central theme of the new exhibit will focus on regional extinction, featuring native California animals and plants present before the Gold Rush.

The animal exhibits are to include:

- A grizzly bear exhibit;
- Wolf, jaguar, eagle, and condor exhibits;
- Mountain lion and black bear exhibits; and
- A beaver and waterfowl aviary.

Other features will include:

- Interpretive center;
- Small exhibit activity zone and children's play area;
- Interpretive kiosk, botanical exhibit, and bison/tule elk feeding station;
- Amphitheater; and
- Overnight camping area.

The new exhibit will be constructed in phases, with a substantial portion of the exhibit anticipated to be completed and opened to the public in September 2014. Full completion is anticipated in September 2015.

The California Exhibit is the last major component of the Oakland Zoo's approved 20-year Master Plan.

**POTENTIAL EFFECTS OF THE CALIFORNIA EXHIBIT ON OAKLAND ZOO ATTENDANCE**

The California Exhibit will represent a significant addition to the Oakland Zoo that should be attractive to visitors. It can be expected to increase Zoo attendance for several reasons.

- The size of the Zoo will be substantially larger with the new exhibit. There will be more to see and do there, and more room to accommodate more visitors.

- There will be a wider range of animals and habitats to view at the Zoo.

- The focus of the new exhibit on history, extinction, conservation, and ecology could broaden the appeal of the Zoo (across interests and across ages) and be attractive to Bay Area residents. It also provides new opportunities for educational programs.

- The addition of animal shows (in amphitheater) and trails, and new overnight camping facilities will broaden the experience and types of activities offered at the Zoo.

- The addition of a gondola to reach the California Exhibit could have positive benefits as well as disadvantages. The gondola ride itself can add interest, provide views, and enhance the overall visitor experience. On the other hand, there may be waiting times to ride the gondola on busy weekend and summer days, discouraging some visitors such as those with small children. The need to ride the gondola also limits the ability of visitors to freely come and go from the exhibit, possibly discouraging some visitors.

Overall, the new exhibit can be expected to result in an increase in Zoo attendance. The exhibit is likely to attract more people to visit the Zoo, potentially people from a wider area. The exhibit is also likely to increase the frequency of visits, with people coming more often as there will be more, different things to do and see at the Zoo.

**Relevant Experience of Other Zoos and Attractions**

The experience of other zoos is useful in considering how the opening of new exhibits can affect zoo attendance. Research based on review of articles and media coverage of U.S. zoo attendance trends as well as selected interviews provides the following findings:

- Attendance goes up when new exhibits are opened. Examples from U.S. zoos typically identify initial increases in attendance in the range of 10 to 25/30 percent. At the higher end, there have been initial increases in attendance of up to 40/45 percent for the high-profile exhibits with Giant Pandas from China.

- Initial increases in attendance decline from peak levels, as attendance stabilizes over time. Attendance may stabilize at a higher level for larger expansions and higher profile exhibits, or it may stabilize near or at attendance levels prior to the new exhibit.

- The zoos that have experienced sustained attendance increases continue to open new exhibits and visitor attractions, and use special events, the birth of baby animals, programming, and advertising to attract visitors. Zoo renovations, upkeep and maintenance, and good management are also important in maintaining the image and attractiveness of the zoo to visitors.

The following provide examples from selected zoos that support the findings above.

**Experience of Other U.S. Zoos With New Exhibits**

- The Minnesota Zoo set an attendance record in 2008/09, fueled by the opening of the Russia's Grizzly Coast exhibit. About 1.35 million people visited the Zoo from July 2008 to June 2009, a 16 percent increase over the previous year. The Zoo is expecting that attendance will remain strong with the opening of a new outdoor nature-based play area (the Woodland Adventure). After that, a new indoor African rainforest exhibit is planned, featuring bats, crocodiles, monkeys, and Red River hogs.

- The San Francisco Zoo had substantial attendance increases up through 2007, from 680,000 in 1995 to 990,000 in 2004 to 1.1 million in 2007, as the Zoo continued to open up new areas to the public and to add new exhibits. The Lemur Forest Exhibit was added in 2002 and the African Savannah Exhibit in 2004, in addition to experiencing a significant spike in attendance after the acquisition of two grizzly bears in late 2004 and the opening of the Grizzly Gulch Exhibit in 2007.

However, since that time (2007), attendance has fallen to around 865,000, probably reflecting several factors, including the stabilization of initial attendance spikes, competition from the re-opening of the rebuilt California Academy of Sciences, the unfortunate death and mauling from an escaped tiger (end of 2007), and cold/wet summer weather in 2010, as well as other factors (maybe even some competition from the improved Oakland Zoo).

♦ The Los Angeles Zoo opened its Campo Gorilla Preserve in November 2007. Immediately, the Zoo experienced a 25 percent increase in attendance from the previous month. Overall, annual attendance was up about 2.5 percent over the prior year: 1.565 million in FY 06/07 up to 1.602 million in FY 07/08. Attendance returned to 1.556 million the following year (FY 08/09).

♦ At the Columbus Zoo, attendance hit a record 2.21 million in 2009, an increase of 19 percent over another strong year where attendance increased to 1.86 million in 2008. The year 2009 saw the birth of a baby elephant and three lion cubs and other events, following the opening of a new exhibit/water recreation area, Zoombezi Bay, in 2008.

♦ At the Memphis Zoo, attendance increased 21 percent after the opening of the Teton Trek exhibit in 2009 (172,000 monthly visitors in October 2009 compared to 141,000 in October 2008). The exhibit interprets the Grand Teton and Yellowstone National Parks' ecosystem, and features grizzly bear cubs, wolves, elk, crane, swans, and other waterfowl. Before that, the Northwest Passage exhibit opened in March 2006, producing a spike in attendance of 30 percent (189,000 monthly visitors in March 2006 compared with 145,000 in March 2005).

♦ The Philadelphia Zoo has completed three significant renovations and improvements since 1996: Primate Reserve in 1996, Big Cat Falls in 2007, and the McNeil Avian Center in 2010. In each case, attendance in the year of opening increased by 10 percent, 14 percent, and 21 percent respectively. In all cases, attendance then declined in the following year or years, returning back to attendance levels prior to the improvements. The Big Cat Falls that opened in 2007, provides an example of the attendance patterns experienced: 1,089,000 in 2006, 1,244,000 in 2007 (14 percent increase), 1,130,000 in 2008, and 1,066,000 in 2009. Attendance jumped again in 2010 to 1,293,000 (21 percent increase) with the opening of the McNeil Avian Center.

**Experience of Four U.S. Zoos With Giant Pandas from China**

♦ At Zoo Atlanta, overall annual attendance grew from 850,000 in 1999 to 1.2 million in 2000, a 41 percent increase, after the acquisition of two Giant Pandas. The following year, attendance dropped to one million. Within one to two years after that, attendance had returned to near where it was before the Giant Panda exhibit.

- At the National Zoo in Washington, D.C., after the acquisition of a Giant Panda exhibit, attendance increased from two million in 2000 to 2.8 million in 2001, a 40 percent increase. However, by 2004, attendance stood at just 1.8 million visitors, less than it was before the acquisition of Giant Pandas, due partly to the lingering effects of 9/11. Then, in 2005, a baby Panda was born and attendance again increased substantially.

- The San Diego Zoo is a very large zoo and, thus, attendance was not as significantly affected by the initial acquisition of Giant Pandas in 1996. However, anecdotally, the Zoo noticed a gradual decline in interest and excitement about the panda exhibit over time.

- At the Memphis Zoo, year-over-year attendance spiked 46 to 48 percent in the first three months following the acquisition of a Giant Panda exhibit in 2003. The Zoo's attendance declined from that peak, but remained higher than before the arrival of the Pandas. Zoo officials were able to maintain relatively high attendance levels with the opening of a new exhibit in 2006 (described above).

### Experience of Other Large Attractions

The observation that, in order to experience sustained attendance increases over time, a zoo needs to continue to add new attractions, is further supported by the experience of other types of large attractions, including the Monterey Bay Aquarium and amusement parks, such as Great America in Santa Clara and Six Flags/Marine World in Vallejo, which continually add new exhibits, shows, and/or rides to keep visitors coming back and to attract new visitors. The same holds true for art museums, which typically display a permanent collection of artworks, but also host special temporary exhibits to provide something new to pique the interest of regular patrons and attract new visitors.

## Implications for the New California Exhibit

Based on experience of other U.S. zoos as well as that of the Oakland Zoo, it is likely that the opening of the new California Exhibit at the Oakland Zoo will result in a significant increase in attendance. It is estimated that, with the new California Exhibit, initial attendance will increase about 25 percent, which is at the higher end of the increases experienced by many other U.S. zoos with new exhibits because the new California Exhibit is anticipated to be a significant addition that will be attractive to visitors. The initial attendance increase is anticipated to be below the increases experienced for the highest profile Giant Panda exhibits that have been very popular with the public, as those animals are more familiar to the public and have tended to draw residents from a wide geographic area as well as tourists. As has occurred with other zoos, attendance during the initial years can be expected to be followed by a decline from peak attendance levels, once many people have seen the exhibit and the initial interest and excitement declines. Given the large scale of the exhibit and that it represents a significant expansion of the Oakland Zoo, attendance is anticipated to stabilize at a higher level than prior to the exhibit.

## ESTIMATES OF ATTENDANCE AT THE OAKLAND ZOO WITH AND WITHOUT THE CALIFORNIA EXHIBIT

Estimates of the likely effects of the new exhibit on Zoo attendance were developed in line with the analysis and considerations described above. For environmental analysis of the exhibit proposal, attendance estimates are desired for 2015 (near-term future) and 2035 (long-term future) both with and without the new California Exhibit. Attendance estimates without the new exhibit provide a future baseline for considering the effects of the new California Exhibit on attendance, both initially and as likely to stabilize over the longer term. The attendance estimates presented below identify what can be reasonably anticipated to occur, and highlight the assumptions and key factors involved.

### Assumptions

The estimates of future attendance reflect the following assumptions about the Oakland Zoo.

- The California Exhibit is the last major component of the Oakland Zoo's approved Master Plan. Once the new exhibit is developed, there will be no further expansions of the Zoo.

- Over time, the Zoo will devote efforts to maintaining and improving the Zoo and adding interest and attractions within its footprint under the approved Master Plan. Exhibits will be upgraded and changed over time, new animals will be acquired, facilities will be maintained and renovated, and programming and special events will be ongoing so as to continue to attract visitors and maintain the Zoo's good reputation.

The estimates of future attendance identify *average annual attendance patterns* over time. They are focused on the attendance effects of the Zoo's facilities and development. The estimates do not reflect specific year-to-year cycles and other events that could affect attendance in any particular year, such as economic cycles, weather patterns, and natural disasters. The future estimates also do not anticipate competition from any major, new attractions, as none have been identified.

### Future Attendance WITHOUT the California Exhibit

*In the near term*, Zoo attendance is expected to remain near the relatively high levels reached in the 2006-2010 period, and to level out somewhat to a longer-term stabilized level, following the completion of the recent series of improvements and recovery from the effects of the economic downturn. The estimates anticipate about a five percent decline in attendance by 2015, from 629,300 visits in 2010 to approximately 600,000 visits in 2015. The attendance estimates are shown in Table 3. It can be noted that the focus of the estimates is on the overall pattern from 2006 through 2015. The estimates for individual, future years from 2011-2015 are more difficult to predict and reflect the overall pattern, although their specific values could vary from the numbers shown.

*Over the longer term*, two types of off-setting effects are anticipated to result in relatively stable Zoo attendance over time.

- Over the longer term, there is likely to be a slow decline in attendance as the Zoo attempts to retain its attraction, but without the ability to expand and add major new exhibits. It is assumed that the Zoo will continue to maintain and improve the Zoo's attractions and facilities and to offer special events and new programming to maintain interest and attendance as much as possible. (Although not assumed in the attendance estimates, there also is more potential for new attractions to be developed in the East Bay over the long term that could compete with the Zoo for visitors and reduce the Zoo's market share.)

- Population growth and demographic trends are likely to support some slow growth of attendance in the long-term future. As described earlier, about 80 percent of the parties visiting the Zoo come with children, and these groups account for about 90 percent of Zoo attendance. While population growth is forecast for the future, demographic trends show the aging of the population such that children will decline as a share of the region's population, and will decline in absolute numbers in many of the central parts of the region, while older adults will increase substantially in their share of the population and in their absolute numbers throughout the region. The trends in the age distribution of the population are fairly dramatic, as summarized in Appendix Table A-1, included at the end of the report.[3]

  Through 2020, population growth is unlikely to contribute to increases in Zoo attendance as very little growth of the population of children is anticipated in the 2010 to 2020 period. However, in the longer term, 2020 to 2035, there is more growth of the population aged 0-14 years, although children continue to decline as a share of total population. Nevertheless, there is likely to be some increase in Zoo attendance as a result of the growth of children over that period.

Overall, the net effect of these two off-setting trends is anticipated to result in relatively stable attendance at the Zoo over the long term. Thus, the baseline attendance estimates for the Oakland Zoo *without* the California Exhibit reflect stable attendance of around 600,000 visits over the long term to 2035, as shown in Table 3. These estimates reflect the long-term, average pattern, although there will be variations from year to year throughout the period.

[3] Demographic trends for this analysis are those reflected in the ABAG *Projections 2009* data, as summarized in Table 5.

**TABLE 3**
**POTENTIAL FUTURE ATTENDANCE AT THE OAKLAND ZOO**
**WITH AND WITHOUT THE NEW CALIFORNIA EXHIBIT**
**(Long-term Attendance Patterns)**

| Year | **Without CA Exhibit** | **With California Exhibit** | | |
|---|---|---|---|---|
| FY year-end 6/30 | Base Attendance | Increase Over Base | | Total Attendance |
| 2010 (actual) | 629,300 | 0 | | 629,300 |
| 2011 | 626,000 | 0 | | 626,000 |
| 2012 | 618,000 | 0 | | 618,000 |
| 2013 | 610,000 | 0 | | 610,000 |
| 2014 | 604,000 | 0 | | 604,000 |
| 2015 | 600,000 | +120,000 /a/ | +20% | 720,000 |
| | *Stabilizes thereafter* | | | |
| 2016 | 600,000 | +150,000 /a/ | +25% | 750,000 |
| 2017 | 600,000 | +145,000 | +24% | 745,000 |
| 2018 | 600,000 | +135,000 | +23% | 735,000 |
| 2019 | 600,000 | +125,000 | +21% | 725,000 |
| 2020 | 600,000 | +120,000 | +20% | 720,000 |
| 2025 | 600,000 | +100,000 | +17% | 700,000 |
| | | *Stabilizes thereafter* | | |
| 2030 | 600,000 | +100,000 | +17% | 700,000 |
| 2035 | 600,000 | +100,000 | +17% | 700,000 |
| Total 2015-2025 (11 yrs.) | 6,600,000 | +1,295,000 | | 7,895,000 |
| Total 2026-2035 (10 yrs.) | 6,000,000 | +1,000,000 | | 7,000,000 |
| | 12,600,000 | +2,295,000 | | 14,895,000 |
| Average Annual, 2015-2035 | 600,000 | +109,290 | | 709,290 |

NOTE: The estimates of future attendance identify average annual attendance patterns over time, and are focused on the attendance effects of the new exhibit. There will be variations from year-to-year that are not reflected by these estimates.

/a/ A substantial portion of the exhibit is anticipated to be completed and open to the public in September 2014 (FY 2015 for attendance above), while full completion is anticipated for September 2015 (FY 2016 for attendance above). Thus, the estimates include an increase in attendance in 2015, prior to peak attendance for the first full year of the new exhibit in 2016.

Source: Hausrath Economics Group based on analysis and considerations described in the text.

**<u>Future Attendance WITH the California Exhibit</u>**

The new California Exhibit is expected to substantially increase Zoo attendance based on the analysis and considerations described earlier. The completion and opening of the new exhibit in September 2015 is estimated to result in an increase of 150,000 visits during the first full year of operation (FY 2016 for attendance), and by 145,000 visits during the second year (FY 2017). During the first year after completion, Zoo attendance is estimated to total about 750,000 visits and represent 25 percent higher attendance than the baseline scenario of 600,000 visits without the California Exhibit, as shown in Table 3.

The construction of the new exhibit is scheduled to occur in several phases, with a substantial portion of the exhibit anticipated to be completed and open to the public in September 2014 (FY 2015 for attendance) and with the full completion in September 2015 (FY 2016 for attendance). Thus, the attendance estimates in Table 3 also include an increase in attendance in 2015 prior to full completion in 2016.

The increases in attendance upon completion of the exhibit are anticipated to decline from peak levels and stabilize over time. Given the large scale of the exhibit and that it represents a significant expansion of the Zoo, attendance is estimated to stabilize at a higher level than would occur without the exhibit. The initial increase in attendance to 750,000 visits in 2016 (25 percent higher attendance) is estimated to decline to about 720,000 visits by 2020 (20 percent higher attendance), as shown in Table 3. Thereafter over the longer term, attendance is anticipated to stabilize at an average of around 700,000 visits per year. With the California Exhibit, future attendance of around 700,000 visits per year would include about 100,000 more visits than the 600,000 visits anticipated without the exhibit, representing about 17 percent higher attendance over the long term. Overall, the estimates of increased Zoo attendance with the new California Exhibit show a total of about 2.3 million additional visits over the 21 years from the initial, partial opening in 2015 through 2035.

The future attendance estimates with the new exhibit as described above, reflect consideration of the experience of other U.S. zoos with new exhibits, attendance trends at the Oakland Zoo, as well as the Zoo's market context within the East Bay and surrounding Bay Area.

- The initial attendance increases with the new exhibit (25 percent higher attendance and +150,000 visits) are at the higher end of increases experienced by many other U.S. zoos with new exhibits. The new California Exhibit is anticipated to be a significant addition that will be attractive to visitors. The estimated attendance increases are below those experienced for the higher profile Giant Panda exhibits, as those animals are more familiar to the public and have tended to draw residents from a wide geographic area as well as tourists.

- The longer-term future, stabilized attendance estimates with the new California Exhibit (17 percent higher attendance and +100,000 visits) are higher than have occurred with many other new exhibits at other zoos. The main reasons for higher estimates of long-term attendance are the large scale of the new exhibit, the fact that it represents a significant expansion of the Oakland Zoo, the high quality of exhibits and the good reputation of the Oakland Zoo, and the judgment that there would be market support for continued higher attendance from the Zoo's market area.

– The attendance estimates with the new California Exhibit also build on the recent success of the Oakland Zoo in adding exhibits, making improvements, and increasing Zoo attendance. The future attendance estimates with the new California Exhibit include relatively similar magnitudes of increased attendance as recently occurred (+150,000 visits initially with the California Exhibit compared to approximately +160,000 visits from 2005 to 2006 with the new Children's Zoo). However, the future estimates show a lower *percentage* increase in attendance (+25 percent compared to +34 percent) because the additional future visits will be added to a higher base of attendance at the Oakland Zoo.

Future attendance increases with the new exhibit also reflect the fact that as attendance at the Oakland Zoo increases over time and the Zoo captures a larger share of the market, it becomes more difficult to continue to attract additional visitors/visits, as many of those most interested in the Zoo are already visitors. This factor further supports the estimate of a lower percentage increase in attendance with the new exhibit in the future than occurred at the Zoo in the recent past. In addition, as mentioned earlier, the large increase in attendance from 2004/2005 to 2006 may also reflect unusually low attendance in the 2004/2005 period as the former Children's Petting Zoo had been closed to allow for construction of the new Valley Children's Zoo.

## Factors Affecting Attendance

The estimates of how the new California Exhibit will impact Zoo attendance reflect several factors and considerations that will affect the extent that attendance potentials are achieved.

♦ An Engaging and Interesting Exhibit

The California Exhibit is assumed to be a significant addition to the Oakland Zoo that will be very attractive to visitors.

♦ Marketing, Media Coverage, and Special Promotions

Achievement of the estimated additional visits depends on good media coverage and news reports, advertising and marketing efforts, and special promotions/events to make people aware of the new exhibit.

- Level of Admission Fees

  The Oakland Zoo is currently a relatively affordable attraction. In the future, admission fees are likely to show some increase due to inflation, both with and without the new exhibit. In addition, it is anticipated that there would be moderate charges for the new exhibit, collected as admission charges for the California Exhibit or higher total charges for the Zoo overall, collected at the entry gate. It is assumed that attendance at the Oakland Zoo is somewhat price-sensitive so that substantially higher admission charges relative to other Bay Area attractions could adversely affect attendance in the future.

# APPENDIX TABLE

**TABLE A-1**
**TRENDS IN THE AGE DISTRIBUTION OF BAY AREA POPULATION**

| Ages | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 |
|---|---|---|---|---|---|---|
| | | | **Population By Age** | | | |
| **0 – 14** | 1,363,500 | 1,383,100 | 1,387,900 | 1,468,900 | 1,547,100 | 1,590,900 |
| **15 – 24** | 913,100 | 950,300 | 955,300 | 939,800 | 928,200 | 994,700 |
| **25 – 64** | 4,046,100 | 4,188,700 | 4,304,700 | 4,360,300 | 4,457,800 | 4,569,900 |
| **65+** | 1,019,000 | 1,154,900 | 1,370,100 | 1,595,900 | 1,786,200 | 1,918,200 |
| **Total** | 7,341,700 | 7,677,000 | 8,018,000 | 8,364,900 | 8,719,300 | 9,073,700 |
| | | | **Percentage Distribution** | | | |
| **0 – 14** | 18.6% | 18.0% | 17.3% | 17.6% | 17.7% | 17.5% |
| **15 – 24** | 12.4% | 12.4% | 11.9% | 11.2% | 10.7% | 11.0% |
| **25 – 64** | 55.1% | 54.6% | 53.7% | 52.1% | 51.1% | 50.4% |
| **65+** | 13.9% | 15.0% | 17.1% | 19.1% | 20.5% | 21.1% |
| **Total** | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |

| | Change 2010-2015 | | Change 2015-2035 | |
|---|---|---|---|---|
| **0 – 14** | +19,600 | +1.4% | +207,800 | +15.0% |
| **15 – 24** | +37,200 | +4.1% | +44,400 | +4.7% |
| **25 – 64** | +142,600 | +3.5% | +381,200 | +9.1% |
| **65+** | +135,900 | +13.3% | +763,300 | +66.1% |
| **Total** | +335,300 | +4.6% | +1,396,700 | +18.2% |

| | Percent of Change 2010-2015 | Percent of Change 2015-2035 |
|---|---|---|
| **0 – 14** | 5.9% | 14.9% |
| **15 – 24** | 11.1% | 3.2% |
| **25 – 64** | 42.5% | 27.3% |
| **65+** | 40.5% | 54.6% |
| **Total** | 100.0% | 100.0% |

Source: ABAG *Projections 2009*.

APPENDIX

E

# PHOTO VIEWPOINT LOCATIONS


SOURCE: ENVIRONMENTAL VISION

0 500 1000 feet

1 Photo Viewpoint

Photo Viewpoint Locations


1. I-580 southbound looking south


2. Bishop O'Dowd High School looking southeast


3. 106th Ave. at MacArthur Blvd. looking northeast


4. Hood St. near Mark St. looking north

ENVIRONMENTAL VISION
031209

**Candidate Photos**
Oakland Zoo


5. Knowland Park trail looking west


6. Knowland Park trail looking west


7. Knowland Park trail looking southwest


8. Bemis Street looking northwest

**Candidate Photos**
Oakland Zoo

ENVIRONMENTAL VISION
031209


9. Golf Links Road looking southeast


10. Royal Oak Road looking south

APPENDIX

F

# AIR QUALITY TECHNICAL REPORT

**D R A F T**

# Air Quality Technical Report

Amendment to Oakland Zoo Master Plan:
Subsequent Mitigated Negative
Declaration/Addendum

Prepared for:
**Placemakers**
**Emeryville, California**

Prepared by:
**ENVIRON International Corporation**
**San Francisco, California**

Date:
**January 2011**

Project Number:
**03-23540A**

# Contents

## List of Tables



## List of Figures

**List of Appendices**

# Acronyms

| | |
|---|---|
| ABAG | Association of Bay Area Government |
| ACCMA | Alameda Contra Costa Medical Association |
| AF | Adjustment Factor |
| ARB | California Air Resources Board |
| ASF | Age-specific Sensitivity Factor |
| BAAQMD | Bay Area Air Quality Management District |
| CAAQS | California Ambient Air Quality Standards |
| Cal/EPA | California Environmental Protection Agency |
| Cal/OSHA | California Occupational Safety and Health Administration |
| CAP | Clean Air Plan |
| CAPCOA | California Air Pollution Control Officers Association |
| CARE | Community Air Risk Evaluation |
| CEC | California Energy Commission |
| CEQA | California Environmental Quality Act |
| CEUS | California Commercial End-Use Survey |
| CO | Carbon Monoxide |
| CPF | Cancer Potency Factor |
| DPF | Diesel Particulate Filter |
| DPM | Diesel Particulate Matter |
| EDMS | Emission Dispersion Modeling System |
| EF | emission factor |
| EMFAC | EMission FACtors model |
| FAA | Federal Aviation Administration |
| g/bhp-hr | grams per brake horsepower hour |
| HAP | Hazardous Air Pollutants |
| HC | Hydrocarbon |
| HHRA | Human Health Risk Assessment |
| HI | Hazard Index |
| HQ | Hazard Quotient |
| HRA | Health Risk Assessment |
| HRSA | Health Risk Screening Analysis |
| lbs | pounds |
| LST | Localized Significance Threshold |
| MEI | Maximally Exposed Individual |
| MEIR | Maximally Exposed Individual Resident |
| MEIW | Maximally Exposed Individual Worker |
| NED | National Elevation Dataset |
| $NO_X$ | Nitrous Oxide |
| NSR | New Source Review |
| OEHHA | Office of Environmental |
| PM | Particulate Matter |

| | |
|---|---|
| PMI | Point of Maximum Impact |
| PRIME | Plume Rise Model Enhancements |
| REL | Reference Exposure Level |
| ROG | Reactive Organic Gases |
| SCAQMD | South Coast Air Quality Management District |
| SFBAAB | San Francisco Bay Area Air Basin |
| SJVAPCD | San Joaquin Valley Air Pollution Control District |
| $SO_X$ | Sulfur Oxide |
| $SO_2$ | Sulfur Dioxide |
| TAC | Toxic Air Contaminant |
| TSD | Technical Support Document |
| URBEMIS | Urban Emissions Model |
| USEPA | United States Environmental Protection Agency |
| USGS | United States Geological Survey |
| VMT | Vehicle Miles Traveled |
| VOC | Volatile Organic Compound |

# 1 Introduction

The Oakland Zoo is proposing to amend the Oakland Zoo Master Plan (herein referred to as the "Project"). The Project would result in an expansion of the Oakland Zoo facilities including the development of a Veterinary Medical Hospital and the construction of exhibits and facilities comprising the California Exhibit. The Project is located within Knowland Park located in south Oakland east of Interstate 580 (Figure 1).

This technical report evaluates the potential impacts on air quality from implementation of the Project. This includes the potential for the Project to conflict with or obstruct implementation of the applicable air quality plan, to violate an air quality standard or contribute substantially to an existing or projected air quality violation, to result in a cumulatively considerable net increase of any criteria pollutant for which the Project region is in nonattainment, expose sensitive receptors to substantial pollutant concentrations, or create objectionable odors that would affect a substantial number of people. This report identifies both Project-level and cumulative environmental impacts. In addition, this report comprises a human health risk assessment (HHRA) to evaluate the potential health impacts associated with air emissions from 1) on-site construction activities, 2) on-site operational emissions, and 3) off-site mobile source emissions for the proposed Project. This HHRA has been conducted in support of a Subsequent Mitigated Negative Declaration/Addendum which is being prepared by The City of Oakland.

## 1.1 Objective and Methodology

The Bay Area Air Quality Management District (BAAQMD) attains and maintains air quality conditions in the San Francisco Bay Area Air Basin (SFBAAB) through a comprehensive program of planning, regulation, enforcement, technical innovation, and promotion of the understanding of air quality issues. The BAAQMD has developed guidance for California Environmental Quality Act (CEQA) related air quality assessments, described in the CEQA Guidelines. This is an advisory document that provides the Lead Agency, consultants, and project applicants with uniform procedures for addressing air quality in environmental documents. The Guidelines contains the following applicable components:

1. Criteria and thresholds for determining whether a project may have a significant adverse air quality impact;

2. Specific procedures and modeling protocols for quantifying and analyzing air quality impacts;

3. Methods available to mitigate air quality impacts;

4. Information for use in air quality assessments and environmental documents that will be updated more frequently such as air quality data, regulatory setting, climate, topography.

The June 2010 BAAQMD CEQA Air Quality Guidelines contain recommended thresholds for risks and hazards associated with an individual project located in the Bay Area that is undergoing environmental review pursuant to CEQA. In addition to the increase in animal exhibits and Zoo operational area, the Project includes both potential future siting of new permitted stationary sources consisting of the diesel generators and additional traffic associated with the increased Zoo operational area. In addition to the impacts of new on-site sources on on-site sensitive receptors and off-site receptors, the CEQA Guidelines recommend the evaluation of impacts of existing off-site stationary sources and mobile sources (major roadways and freeways) within a 1,000 foot "zone of influence" on any new sensitive receptors.

To meet these objectives, an HHRA was conducted consistent with the following guidance:

- Air Toxics Hot Spots Program Risk Assessment Guidelines: Part IV Technical Support Document for Exposure Assessment and Stochastic Analysis,[1]
- Air Toxics Hot Spots Program Risk Assessment Guidelines,[2]
- June 2010 BAAQMD CEQA Air Quality Guidelines,
- BAAQMD Air Toxics Risk Evaluation Procedure and Risk Management Policy,[3]
- BAAQMD Bay Area Air Quality Management District Staff Report,[4]
- BAAQMD Air Toxics New Source Review (NSR) Program Health Risk Screening Analysis (HRSA) Guidelines,[5]
- California Air Pollution Control Officers (CAPCOA) *Health Risk Assessment for Proposed Land Use Projects,*[6]
- United States Environmental Protection Agency (USEPA) *Risk Assessment Guidance for Superfund: Volume 1- Human Health Evaluation Manual (Part A)*. Interim Final,[7] and
- USEPA *Exposure Factors Handbook.*[8]

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[1] Cal/EPA. 2000. Air Toxics Hot Spots Program Risk Assessment Guidelines: Part IV Technical Support Document for Exposure Assessment and Stochastic Analysis. Office of Environmental Health Hazard Assessment. September

[2] Cal/EPA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August

[3] Bay Area Air Quality Management District (BAAQMD). 2000. Bay Area Air Quality Management Air Toxic Risk Evaluation Procedure (REP) and Risk Management Policy (RMP). February.

[4] BAAQMD. 2005. Bay Area Air Quality Management District Staff Report. Toxic Evaluation Section. June

[5] BAAQMD. 2010. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. January

[6] California Air Pollution Control Officers Association (CAPCOA). 2010. Health Risk Assessment for Proposed Land Use Projects. July 2009. http://www.capcoa.org/wp-content/uploads/downloads/2010/05/CAPCOA_HRA_LU_Guidelines_8-6-09.pdf

[7] United States Environmental Protection Agency (USEPA). 1989a. Risk Assessment Guidance for Superfund: Volume 1- Human Health Evaluation Manual (Part A). Interim Final. Washington, D.C. December.

[8] USEPA. 1997. Exposure Factors Handbook. EPA/600/P-95/002Fa. August

The results of the HHRA are compared with the BAAQMD significance thresholds for single source and cumulative impacts as follows:

Single Source:

- An excess lifetime cancer risk level of more than 10 in one million;
- A noncancer (i.e., chronic or acute) hazard index (HI) greater than 1.0; and
- An incremental increase in the annual average $PM_{2.5}$ (particulate matter less than 2.5 microns in aerodynamic diameter) of greater than 0.3 micrograms per cubic meter ($\mu g/m^3$).

Cumulative Impacts:

- An excess lifetime cancer risk level of more than 100 in one million;
- A noncancer (i.e., chronic) HI greater than 10.0; and
- An incremental increase in the annual average $PM_{2.5}$ of greater than 0.8 $\mu g/m^3$.

## 1.2 Report Organization

This report includes the following sections:

**Section 2** - An evaluation of criteria air pollutant mass emissions, including operational emissions from project-related and mobile sources and emissions from construction activities, using methodology provided in the June 2010 BAAQMD CEQA Guidelines,[9]

**Section 3** - An evaluation of mass emissions of toxic air contaminants (TACs) from operational emissions and emissions from construction activities. This section also presents the methodology and results of the HHRAs.

[9] Bay Area Air Quality Management District. 2010. California Environmental Quality Act, Air Quality Guidelines, June. Available online at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_June%202010.ashx

# 2 Criteria Pollutants Emissions Inventory

The criteria pollutant inventory takes into account operational emissions from fuel combustion (including building energy use and stationary engines), and emissions associated with vehicular travel to the Project by visitors and employees. The methodologies used to estimate the criteria pollutant emissions are described below. The estimated emissions are summarized below and a more detailed breakdown of these emissions is shown in Table 2.1.

| | ROG | NOx | PM 10 (exhaust) | PM 2.5 (exhaust) | SOx | CO |
|---|---|---|---|---|---|---|
| Construction, Average Daily Emissions (lb/day) | 2 | 4 | 0.02 | 0.02 | 0.01 | 3 |
| Operational, Maximum Annual Emissions (tons/yr) | 1.0 | 1.7 | 2.9 | 0.55 | 0.04 | 13 |
| Operational, Average Daily Emissions (lb/day) | 6 | 9 | 15.6 | 3.0 | 0.03 | 70 |

## 2.1 Annual Operational Criteria Pollutant Emissions

### 2.1.1 Stationary Diesel Fuel Combustion

The Project includes the installation of four standby diesel engines which will emit the criteria pollutants reactive organic gases (ROG), nitrogen oxide ($NO_x$), carbon monoxide (CO), sulfur oxide ($SO_x$) and particulate matter (PM). The engines include a fire service pump, a backup generator for the Veterinary Medical Hospital, and an auxiliary engine and emergency backup engine for the Gondola. The Oakland Zoo has committed to the use of Diesel Particulate Filters (DPFs) on these engines to achieve an emission rate of 0.01 grams per brake horsepower hour or less.[10] The engines will be operated a maximum of 35 hours per year for non-emergency purposes.

Emissions are calculated based on the engine size and emission factors (mass of pollutant per horsepower-hour). The anticipated size of each engine was provided by the Oakland Zoo. The emissions factors, maximum daily emissions, and annual emission are shown in Table 2.2. Table 2.3 shows the characteristics of these proposed engines.

[10] An emission rate of 0.01 g/bhp-hr is assumed to be achievable through the use of DPFs per the requirements of Title 17, California Code of Regulations section 93115. Section 6(a)(3). http://www.arb.ca.gov/diesel/ag/documents/finalreg101807.pdf

### 2.1.2 Natural Gas Combustion

Space and water heating for the Project buildings will be supplied through natural gas combustion on-site. Combustion of natural gas generates $NO_x$, CO, PM, lead (Pb), sulfur dioxide ($SO_2$), and volatile organic compounds (VOCs). The amount of gas combusted and the associated emissions per square foot of space vary with the type of building. The Oakland Zoo provided data summarizing the buildings planned for the Project and the area of floor space planned for each building, which includes the Veterinary Medical Hospital and California Interpretive Center. The California Interpretive Center includes a restaurant, gift shop, classroom space, office space, staff break room, locker room, library and interpretive center, and storage and mechanical rooms. In addition to these enclosed and conditioned buildings, the Project will include semi-enclosed spaces for the gondola and animal holding activities. While these spaces use electricity[11], they do not use natural gas.

Natural gas intensity values (natural gas combusted per square foot per year) were developed for building types planned for the Project using data from the California Commercial End-Use Survey (CEUS).[12,13] The CEUS data is based on a survey conducted in 2002 of existing buildings. Each building type has a characteristic electricity and natural gas use per square foot of building space (Table 2.4).

Baseline Title 24 usage rates shown in Table 2.4 have been adjusted to reflect improvements in Title 24 building codes since their introduction in 2002. California Energy Commission (CEC) discusses average savings for improvements from 2002 to 2005[14] as well as from 2005 to 2008.[15] These CEC average savings percentages were used to account for reductions in energy use due to Title 24. Table 2.4 also shows the average daily and annual emissions from the Project.

### 2.1.3 Mobile Sources

This section estimates criteria pollutant emissions from mobile sources associated with the Project. The mobile source emissions considered for this Project are from the expected typical daily operation of motor vehicles by visitors to the Project and by employees of the Project.[16]

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[11] Electricity use associated with these spaces is described in Section 4.1.2 of the Project's Climate Change Technical Report (ENVIRON 2011).

[12] California Energy Commission (CEC). California Commercial End-Use Survey Results. Data available from Itron Inc. at http://capabilities.itron.com/CeusWeb/Chart.aspx

[13] The detailed mapping of Project building types to CEUS building types is shown in Table 2.2 in the Project's Climate Change Technical Report (ENVIRON 2011)..

[14] CEC. *Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings.* 2003. Available Online at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF

[15] CEC. *Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings*. 2007. Available Online at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

[16] All visitor trips associated with the Project were conservatively assumed to be new.

ENVIRON estimated emissions based upon all miles traveled by additional visitors to the Zoo attributable to the Project, personnel employed within the Project, and additional commercial work trips associated with the project (e.g. delivery vehicles). The estimated increase in vehicle trips associated with the Project due to visitors and employees was provided to ENVIRON by AECOM.[17] Mobile emissions from the following components were estimated using the URBEMIS model: running emissions, startup emissions, idling emissions, hot soak emissions, diurnal emissions, and evaporative emissions. Trip lengths are based upon URBEMIS defaults for trip types for commercial land uses (commercial-based commute, commercial-based work, and commercial-based customer), allocated following the URBEMIS methodology. Total vehicle miles traveled (VMT) were calculated by multiplying the number of trips by the average trip length for each type of trip. Annual emissions were calculated in URBEMIS based on 2015 emission factors for the BAAQMD fleet mix. The details and assumptions are shown in Table 2.5. Criteria pollutant emissions associated with mobile sources for the Project are shown in Table 2.6. URBEMIS output files are included in Appendix A.

### 2.1.4 Manure Management and Composting

Management of manure has the potential to emit VOCs to a degree dependent on the specific animal source and the manure handling method. Manure from the majority of animals at the Project will be treated off-site. However, manure from the bison herd will be composted on-site and used on-site. VOC emissions from the management of bison manure were calculated using methodology approved for use in the San Joaquin Valley Air Pollution Control District[18,19] (SJVAPCD) as shown in Table 2.7. In the absence of a VOC emission factor for North American Bison, a factor was derived by scaling the VOC emission factor for dairy cattle by the relative volume of manure produced by the bison.

## 2.2 One- time Construction Related Emissions

This section describes the estimation of average daily criteria pollutant emissions from construction of the Project. There are two major components of construction for each phase of the Project: site grading, and building construction.[20] The building construction component can be broken down into three subcomponents: building construction, architectural painting, and asphalt paving. Emissions from these construction activities are largely attributable to fuel use from construction equipment, worker commuting and vendor commuting.

Exhaust emissions from on-site construction equipment, exhaust and evaporative emissions from mobile sources (i.e. transportation and worker commute), and off-gas emissions from architectural painting and asphalt paving were calculated. Table 2.8 explains the emissions categories and lists the criteria pollutants under each category.

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[17] Bill Burton of AECOM to ENVIRON by e-mail on 11/3/2010.
[18] San Joaquin Valley Air Pollution Control District. Dairy VOC and NH3 Emission Factors. 2005. http://www.valleyair.org/busind/pto/dpag/Dairy%20emission%20Factors.pdf
[19] The BAAQMD has not developed guidance for estimation of VOC emissions from manure management at this time.
[20] Many projects have a third phase, demolition. In this case, there are no existing structures to be demolished.

### 2.2.1 Criteria Pollutant Emissions from Construction Equipment

This section describes how emissions from off-road equipment used during grading, building construction, and paving are calculated.

The number and type of equipment, the duration of the different construction phases, and the total number of hours of use for each piece of equipment in each phase were provided by the Oakland Zoo (Appendix B1).[21] The Oakland Zoo has committed to use construction diesel equipment that meets the USEPA Tier 4 Interim PM emission standards[22] for the Project (i.e. either using Tier 4 engine or applying a PM filter to achieve equivalent emission rates). The annual average emissions from the construction equipment were calculated using the given equipment hours of operation, URBEMIS2007[23] default equipment horsepower and load factor[24], USEPA Tier 4 emission standard (for $PM_{10}$ and $PM_{2.5}$), and emission factors derived from OFFROAD2007[25] modeling output (for other criteria pollutants). The detailed calculation methodology and assumptions are explained in Table 2.9. The calculated total emissions from the construction equipment are summarized in Table 2.10. Calculated emissions account for the use of construction equipment that meets the USEPA Tier 4 Interim emission standards. The OFFROAD emission factors are shown in Appendix B2.

In order to evaluate potential short-term impacts from TACs, maximum hourly emissions of ROGs were also estimated. As noted above, the Oakland Zoo provided the total operating hours of each type of equipment during each quarter for construction of each part of the Project. Based on the activity data provided and the emissions characteristics of each type of equipment, ENVIRON estimated the likely worst case hour of emissions.[26] The ROG hourly emissions from the construction equipment were calculated using the average hourly activity during this hour, URBEMIS2007[27] default equipment horsepower and load factor, and emission factors derived from OFFROAD2007[28] modeling.

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21 Provided by Swinerton Management and Consulting on 11/11/2009. Additional Project specific equipment usage data were provided by the Oakland Zoo on 3/29/2010.
22 ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards. Available at: http://www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls
23 Urban Emissions Model (URBEMIS) (Version 8.7 – 2002 / Version 9.2.4 – 2008). Jones & Stokes Associates. Prepared for: South Coast Air Quality Management District. http://www.urbemis.com
24 ENVIRON conservatively did not take into account the 33% reductions in load factor associated with the revisions to ARB's In-Use Off-Road Equipment Regulation approved on December 17, 2010. http://www.arb.ca.gov/msprog/ordiesel/ordiesel.htm http://www.arb.ca.gov/msprog/ordiesel/documents/emissions_inventory_presentation_full_10_09_03.pdf
25 California Air Resources Board Mobile Source Emissions Inventory Program. December 2006. http://www.arb.ca.gov/msei/offroad/offroad.htm
26 Since the hour-by-hour operating schedule of the construction equipment is not known at this stage of planning, this is an approximation. ENVIRON assumed there was one piece of each type of equipment, consistent with the known quarterly operating hours of each equipment type. ENVIRON averaged the operating hours of each piece of equipment over the quarter to estimate the average hourly activity for each equipment type.
27 Urban Emissions Model (URBEMIS) (Version 8.7 – 2002 / Version 9.2.4 – 2008). Jones & Stokes Associates. Prepared for: South Coast Air Quality Management District. http://www.urbemis.com
28 California Air Resources Board Mobile Source Emissions Inventory Program. December 2006.

### 2.2.2 Criteria Pollutant Emissions from Construction Mobile Sources

Construction mobile source emissions are from material transporting, soil hauling, vendor trips, and worker commuting. Criteria pollutant emissions are emitted from these mobile sources in several ways: running emissions, startup emissions, idling emissions, hot soak emissions, diurnal emissions, and evaporative emissions. The majority of mobile source emissions are running emissions.

EMFAC2007[29] was used to generate the emission factors for all mobile sources. Emissions from material transporting and soil hauling trucks were calculated based on the given truck use data and those from worker commuting were calculated based on the given number of workers and the emission factors generated using EMFAC2007 (Appendix B3). The number of workers in each phase of the Project were provided by the Oakland Zoo (Appendix B1). Table 2.9 details the mobile source emissions calculation methodology and assumptions. The calculated mobile source emissions are summarized in Table 2.10.

Similar to trucks and worker commuting trips, criteria pollutants are emitted by vendor vehicle trips through exhaust (i.e. running, startup, and idling) and evaporative (hot soak, diurnal, and running loss) emissions. Generally the vendor trip data are not available, and the emissions from vendor trips are estimated separately based on the Project size and duration. However, given the level of detail of the equipment data, it was assumed that the listed trucks and associated hours of use associated with material transportation had already accounted for the use of vendor trucks. Therefore, the emissions from mobile source summarized in Table 2.10 represent the total emissions from on-site trucks, vendor truck, and worker commutes.

Similar to the evaluation of maximum hourly ROG emissions from construction equipment, the maximum hourly ROG emissions from construction related mobile source activities were evaluated. The maximum expected hourly emissions from mobile sources were estimated consistent with the approach described in Section 2.2.1. Average hourly activity during each quarter for each phase of construction was estimated. Using these activity assumptions in conjunction with emission factors generated using EMFAC 2007; the worst hour of ROG emissions was identified.

### 2.2.3 Criteria Pollutant Emissions from Architectural Coating

The ROG off-gas emissions from architectural coating presented in Table 2.10 were calculated using URBEMIS 2007 methodology which estimates ROG emissions resulting from the evaporation of solvents contained in paints, varnishes, primers, and other surface coatings. Architectural coating quantities are based on the square footage of Project buildings. For the Project it was assumed that only the California Interpretive Center and Veterinary Medical

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http://www.arb.ca.gov/msei/offroad/offroad.htm

[29] Emission Factors (EMFAC2007) model (Version 2.3). November 2006. California Air Resources Board. http://www.arb.ca.gov/msei/onroad/latest_version.htm

Hospital would be painted. Animal holding areas will not have architectural coatings. ROG contents of coatings are based on URBEMIS defaults specific to the BAAQMD.

### 2.2.4 Criteria Pollutant Emissions from Asphalt Paving

Asphalt paving emissions presented in Table 2.10 include ROG off-gas emissions, diesel exhaust emissions from off-road equipment, diesel exhaust emissions from on-road equipment, and worker commute trips. The exhaust emissions were discussed in the earlier sections. The off-gas emissions were calculated based on the paved areas using the URBEMIS methodology presented in Table 2.9. Unlike most urban developments, the Project is designed with very limited paved surface area. A Project specific total paved area of 3.25 acres[30] was used.

### 2.2.5 Grading Dust

The CEQA Guidelines do not contain a threshold for grading dust. However, the guidelines recommend the implementation of basic construction mitigation measures. The Project will incorporate all the basic measures described in the 2010 CEQA Guidelines and City of Oakland Standard Conditions of Approval.

### 2.2.6 Criteria Pollutant Emissions from Helicopter Operations

The Project proposes to use a helicopter for one day to erect the gondola during Phase II of the Project. Accordingly, the increased criteria pollutant emissions associated with the helicopter operation were estimated.

The criteria pollutant emissions for the helicopter were estimated using the Emission Dispersion Modeling System (EDMS) developed by Federal Aviation Administration (FAA).[31] The most recent version of the software, EDMS 5.1.2, (released in November 2009) calculates the emissions by operating modes including startup, taxi out, take off, climb out, approach, and taxi in. Because it is unclear what mode(s) best represent the helicopter operation at the Project, the one-day helicopter emissions were conservatively estimated by scaling the modeled emissions of the worst case mode. Details of the emission calculation are present in Table 2.11, and the electronic files of EDMS inputs and outputs are attached in Appendix B4.

The average daily emissions of criteria pollutants from all aspects of construction activity are summarized in Table 2.12.

## 2.3 Analysis of Air Quality Impact Due to $PM_{2.5}$ Emissions Associated with Construction and Operational Activities

In accordance with the CEQA Guidelines, ENVIRON conducted air dispersion modeling to estimate the increase in $PM_{2.5}$ concentrations associated with standby stationary diesel engine

[30] Personal Communication. Nik Haas-Dehejia of Oakland Zoo to ENVIRON on 2/10/2010.
[31] Emissions and Dispersion Modeling System (EDMS) was developed by the Federal Aviation Administration as a model designed to assess the air quality impacts of proposed airport development projects (http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model/)

emissions as characterized in Section 2.1.1 and with construction emissions as characterized in Section 2.2. The air dispersion analysis was performed in accordance with USEPA[32], ARB[33] and BAAQMD[34] modeling guidelines. The air dispersion analysis requires the following: 1) selection of the dispersion model, 2) selection of appropriate dispersion coefficients based on land use, 3) preparation of meteorological data, 4) evaluation of potential terrain considerations, 5) selection of receptor locations, and 6) identification of the source specific release parameters, operational schedule, and averaging time periods. The following sections describe each of these steps.

### 2.3.1 Construction Diesel Equipment

#### 2.3.1.1 Air Dispersion Modeling Selection and Parameters

Screening-level air dispersion modeling was performed to conservatively estimate $PM_{2.5}$ concentrations using USEPA's ISC-Prime (Plume Rise Model Enhancements) model (Version 04269) with screening meteorological data.[35] ISC-Prime is a steady-state Gaussian plume model which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial complex. This model can account for various source types (including point, area, line, and volume sources) and limited terrain adjustment. Screening meteorological data is used because it is considered representative of "worst-case" meteorological conditions and is likely to result in an overestimation of ambient air concentrations. The screening meteorological data examines a full range of meteorological conditions, including all stability classes and wind speeds to find maximum one-hour impacts. Thus, the use of ISC-Prime with screening meteorological parameters is acceptable for screening-level (*i.e*., conservative) air dispersion modeling for evaluating impacts from the Project. This approach has previously been approved for use by the BAAQMD in screening-level health risk assessments.

As a conservative screening approach, it was assumed that more than 50% of the area within a 3-kilometer radius of the proposed Project site classifies as rural land use, according to the land use definitions proposed by Auer (1978); as a result, rural dispersion coefficients were used.[36]

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[32] Guideline on Air Quality Models (Revised). 40 Code of Federal Regulations, Part 51, Appendix W. Office of Air Quality Planning and Standards.
[33] Cal/EPA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August.
[34] BAAQMD. 2010. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. January
[35] On November 9, 2005, the USEPA promulgated final revisions to the federal *Guideline on Air Quality Models*, in which they recommended that AERMOD be used for dispersion modeling evaluations of criteria air pollutant and toxic air pollutant emissions from typical industrial facilities. A one-year transition period commenced from the proposed effective date of December 9, 2005. Although that one year transition period has elapsed, AERMOD has not yet been officially adopted by the ARB or BAAQMD. Furthermore, the screening version of AERMOD (AERSCREEN) is still undergoing development and was not commercially available at the time of performing this work.
[36] Please note that the terms "urban" and "rural" used here relate to the characterization of land use for purposes of

An important consideration in an air dispersion modeling analysis is whether the terrain in the modeling area is flat or elevated (i.e., terrain above the effective height of the emission point). Elevated terrain can affect the results of a dispersion analysis involving point and volume sources, but does not affect the predicted results for area sources.[37] The area was modeled using elevated terrain algorithms to account for the varying topography around the Project. The National Elevation Dataset (NED) was obtained from the United States Geological Survey (USGS) and considered in the modeling across the entire modeling domain.

Project construction sources were modeled using adjacent volume sources based on the South Coast Air Quality Management District (SCAQMD) Localized Significance Threshold (LST) methodology.[38] Table 2.13 summarizes the modeled source groups. The source locations are presented in Figure 2.

A two-tier receptor grid was used to estimate the impacts in the general vicinity of the Project. The fine receptor grid with 20 meter spacing covers the off-construction site area (i.e. including on Project areas that have no construction activities) within the BAAQMD recommended area of influence (within a 1000 foot radius of the Project fence), and the coarse grid with 100 meter spacing covers an extended area within 1000 meters of the fine receptor grid. Receptors were also placed at Marshall Elementary School, located approximately 250 meters south of the nearest part of the construction zone. Receptor height was set at two meters following the SCAQMD LST Methodology. Figure 3 shows the modeled receptors for which dispersion coefficients were calculated using the model.

#### 2.3.1.2 Estimated Air Concentration at the Point of Maximum Impact

Screening-level air modeling dispersion factors (i.e., concentration per unit emission rate, sometimes called "chi-over-Q" ("χ/Q")), were estimated for the modeled dispersion sources (i.e., construction equipment) using ISC-Prime in conjunction with information about the locations of the sources and receptors. The simulated dispersion sources were given a unit emission rate (1 gram per second or 1 g/s) for the modeled sources.

In accordance with the CEQA Guidelines, annual average concentrations of $PM_{2.5}$ were evaluated. To estimate screening-level annual average dispersion coefficients, the maximum hourly average dispersion factors were multiplied by 0.1, as per the CEQA Guidelines. The $PM_{2.5}$ concentrations were then estimated by multiplying the modeled and adjusted maximum dispersion factors by their respective emissions from each source (Table 2.14)

air dispersion modeling, and do not necessarily relate to actual development in the area.

[37] U.S. EPA AERMOD Implementation Guide. March 2009 http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf

[38] South Coast Air Quality Management District. Finalized Local Significance Threshold Methodology Revised July 2008. http://www.aqmd.gov/ceqa/handbook/lst/Method_final.pdf

The estimated maximum annual average $PM_{2.5}$ air concentration is 0.01 µg/$m^3$ and is presented in Table 2.15.

### 2.3.2 Standby Stationary Diesel Engines

To evaluate the resulting concentration of $PM_{2.5}$, ENVIRON performed screening-level air dispersion modeling using USEPA's SCREEN3 model (Version 96043). SCREEN3 is a single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources, as well as concentrations in the cavity zone, and concentrations due to inversion break-up and shoreline fumigation. SCREEN3 examines a full range of meteorological conditions, including all stability classes and wind speeds to find maximum one-hour impacts. Thus, ENVIRON considers that the use of SCREEN3 is acceptable for screening-level (*i.e*., conservative) air dispersion modeling for evaluating impacts from the Project.

Similar to the construction modeling, ENVIRON used rural dispersion coefficients. ENVIRON ran the model using flat terrain and conservatively assumed both engine release height (Table 2.3) and receptor height to be zero (ground level). All four diesel engines were assumed to be co-located in order to identify the worst case concentration. The modeled source parameters and emission rates are summarized in Tables 2.16 and 2.17. The SCREEN3 model input and output files are presented in Appendix C2.

As presented in Table 2.17, the estimated maximum annual average $PM_{2.5}$ air concentration is 0.004 µg/$m^3$ which is well below the BAAQMD significance threshold of 0.3 µg/$m^3$.

## 2.4 Comparison to Air Quality Thresholds

### 2.4.1 Construction Emissions

The CEQA Guidelines contain Basic Construction Mitigation Measures for all proposed projects and Additional Construction Mitigation Measures for projects with construction emissions above the listed significance threshold

The average daily emissions of criteria pollutants from construction were compared to the Thresholds of Significance in the CEQA Guidelines. As presented in Table 2.12, average daily emissions of ROG, NOx, $PM_{10}$ and $PM_{2.5}$ are significantly below the proposed threshold and therefore the criteria pollutant emissions associated with the construction activity of the Project are not significant. Table 2.15 shows that the annual average $PM_{2.5}$ concentration increase due to the construction emissions is also significantly below the BAAQMD threshold of significance. The Project will implement the Basic Construction Mitigation Measures required for all projects. Additional Construction Mitigation Measures are not required since emissions will remain below BAAQMD significance levels.

### 2.4.2 Operational Emissions

The average daily and annual operational emissions are well below the thresholds of significance for Project operations for ROG, $NO_x$, and $PM_{10}$ in the CEQA Guidelines as presented in Table 2.1.[39] Table 2.17 shows that the increase in annual average $PM_{2.5}$ concentrations associated with the four emergency diesel generators is well below BAAQMD thresholds of significance.

Consistent with the City of Oakland Guidelines, the Project would not result in total emissions of ROG, NOx, or PM10 of 15 tons per year or greater; or 80 pounds (36 kilograms) per day or greater.

### 2.4.3 Odor Impacts

Potential sources of odor within the Project are the manure management system and the exhibit areas (enclosed animals). The CEQA Guidelines discuss screening distances for siting of potential odor sources near receptors or other odor sources. While the types of operations addressed do not include operations similar to the Zoo, the closest operation types, "Confined Animal Facility/Feed Lot/Dairy" and "Green Waste and Recycling Operations" both have screening distances of one mile.[40] Since the Project will be within one mile of residential receptors, potential odor impacts were fully assessed according to the CEQA Guidelines.

As noted above, the two potential sources of odors that are part of the Project are the manure management (composting) system, and the exhibits (animal enclosures). The manure management component consists of the addition of the manure from the herbivorous animals in the Project to the existing manure composting system for the remainder of the Zoo. The composting system is located in a maintenance area on a side road near the Zoo entrance. The composting area is more than 500 feet from the closest residences and separated from them by a buffer area with trees and other vegetation. The increase in manure throughput due to the Project will be less than 10%. There have been no odor complaints to the BAAQMD regarding the Zoo composting system since it began operating in 1993. The closest distance between a residence and the planned animal enclosures is greater than 500 feet, a distance comparable to that between the existing animal enclosures and the closest residences (350 feet and up). There have been no odor complaints regarding the existing Zoo animal enclosures.

The nature of the potential odor sources, distance from sensitive receptors, and absence of any complaint history from the existing animal enclosures and composting system represent substantial evidence that the Project does not represent a significant odor impact. Similarly, it is expected that the Project will not frequently create substantial objectionable odors affecting a substantial number of people, thus meeting the City of Oakland odor criterion.

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[39] BAAQMD 2010. pg. 2-3.

[40] Both of these operational types typically carry out both animal husbandry and composting operation on a larger scale than the Project.

### 2.4.4 Carbon Monoxide Impacts

The CEQA Guidelines include screening methodology for impacts from CO for proposed projects, designed to provide a conservative indication of the significance of Project emissions. CO is emitted directly from internal combustion engines and the highest ambient CO concentrations are generally found near congested transportation corridors and intersections. The CEQA Guidelines provide three screening criteria which, if met, indicate that the proposed project would result in a less-than-significant compact to localized CO concentrations.[41] These criteria are as follows:

1. Project is consistent with an applicable congestion management program established by the county congestion management agency for designated roads or highways, regional transportation plan, and local congestion management agency plans.

2. The project traffic would not increase traffic volumes at affected intersections to more than 44,000 vehicles per hour.

3. The project traffic would not increase traffic volumes at affected intersections to more than 24,000 vehicles per hour where vertical and/or horizontal mixing is substantially limited (e.g., tunnel, parking garage, bridge underpass, natural or urban street canyon, below-grade roadway).

The Project traffic analysis and forecasts were conducted in a manner compliant with the Alameda County Congestion Management Agency (ACCMA) guidelines, using the ACCMA travel demand model. The Project does not increase traffic volumes at affected intersections to more than 44,000 vehicles per hour or at intersections where vertical and/or horizontal mixing is substantially limited to more than 24,000 vehicles per hour. The Project consequently meets all of the listed screening criteria, so CO emissions would be less than significant.

The City of Oakland CEQA guidelines indicate that the Project should not contribute to CO concentrations exceeding the California Ambient Air Quality Standard (CAAQS) of 9 parts per million (ppm) averaged over eight hours and 20 ppm for one hour. The City of Oakland Guidelines are consistent with the CEQA Guidelines and state that localized CO concentrations should be estimated for projects in which (1) vehicle emissions of CO would exceed 550 lb/day; (2) intersections or roadway links would decline to LOS E or F; (3) intersections operating at LOS E or F will have reduced LOS; or (4) traffic volume increase on nearby roadways by 10% or more unless the increase in traffic volume is less than 100 vehicles per hour. This Project is estimated to result in average daily vehicle emissions of only 68 lbs/day and will not result in an increase in traffic volume of more than 100 vehicles per day at any intersection.

[41] BAAQMD. CEQA Air Quality Guidelines. June 2010. Section 3.3

# 3 Local Health Risks and Toxic Air Contaminants

CEQA Guidelines require an evaluation of health risk impacts from exposure to TACs. BAAQMD lists significance thresholds for project emissions, as well as for cumulative impacts from a project when combined with existing emissions from neighboring sources of TACs. Methods used to quantify TAC emissions associated with the Project and to assess associated health risks are described below, along with a comparison of calculated risks to the BAAQMD significance thresholds.

Emission levels of TACs from annual operation of the Project as well as from construction emissions were quantified. This section discusses the estimates of these emissions, resulting increases in ambient concentration, and associated risk.

## 3.1 Operational TAC Emissions

Operational TAC emissions associated with the Project are the DPM emissions from diesel engines.

Annual activity of the four diesel engines proposed for the Project was quantified as described in Section 2.1.1. These activity data were used to estimate DPM emissions from diesel generators. The resulting emissions from stationary diesel engines are shown in Table 3.1.

### 3.1.1 Comparison of Operational TAC Emissions to Thresholds

Maximum annual operation DPM emissions were compared to the thresholds defined in BAAQMD Regulation 2 Rule 5 Table 2-5-1 Toxic Air Contaminant Trigger Levels.[42] As shown in Table 3.1, no acute or chronic trigger levels are exceeded. Accordingly, further analysis of health impacts from operational sources is not needed.

In the Bay Area, there are a number of urban or industrialized communities where the exposure to TACs is relatively high in comparison to others. To address community risk from air toxics, the Air District initiated the Community Air Risk Evaluation (CARE) program in 2004 to identify locations with high levels of risk from TACs co-located with sensitive populations and use the information to help focus mitigation measures. The Project is not located within a CARE community.

## 3.2 Construction TAC Emissions

### 3.2.1 Diesel Construction Equipment and Vehicles

Emissions of DPM and ROG associated with construction activities at the Project were evaluated. These emissions estimates are used to estimate concentrations of DPM and TACs using air dispersion modeling techniques.

[42] BAAQMD. 2010. Table 2-5-1 Toxic Air Contaminant Trigger Levels.
Available at: http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx

Based on BAAQMD Regulation 2 Rule 5 Table 2-5-1, DPM should be used as a surrogate for all TAC emissions from diesel-fueled compression-ignition internal combustion engines. For the purposes of evaluating cancer risks and chronic noncancer impacts associated with diesel exhaust, it was conservatively assumed that 100% of the exhaust PM would be DPM. The DPM emissions calculation is discussed in the criteria pollutant section and Table 2.11. The calculated maximum annual DPM emissions are presented in Table 3.2.

ROG emissions were speciated into component TACs to evaluate acute health impacts from construction related diesel exhaust. ROG was speciated based on the speciation profile used in developing the BAAQMD construction screening document[43] (Appendix D). The calculated hourly TAC emissions from the construction equipment are shown in Table 3.3.

Maximum hourly TAC emissions from construction and maximum annual TAC emissions from construction were compared to the thresholds defined in BAAQMD Regulation 2 Rule 5 Table 2-5-1 Toxic Air Contaminant Trigger Levels. The chronic DPM (annual) emissions from on-site off-road construction equipment are above the BAAQMD trigger levels,[44] which suggests that additional health risk assessment is required under the 2010 CEQA Guidelines. This assessment is detailed in Section 3.3 of this technical report. The hourly emissions of each individual TAC are below the BAAQMD acute trigger thresholds. Additional health risk assessment was conducted to evaluate the cumulative acute impact of all of the TACs combined. The analysis is discussed in Section 3.3.

### 3.2.2 Helicopter TAC Emissions

As the Project proposes to use a helipad for one day to erect the gondola during Phase II of the Project, the increased TAC emissions associated with the helicopter operation were estimated.

Speciated hydrocarbon (HC) emissions for helicopters used at the Project were estimated using the EDMS developed by the FAA.[45] The most recent version of the software, EDMS 5.1, released in November 2009, is capable of calculating the speciated HC emission including 44 hazardous air pollutants (HAPs) and 351 non-toxic compounds. The TAC emissions were estimated using the same methodology as the criteria pollutant emissions calculation and are summarized in Table 3.4.

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[43] Provided via email from BAAQMD to ENVIRON on July 13, 2010.

[44] BAAQMD Regulation 2, Rule 5 specifies that all permit applications for new and modified sources must be screened for emissions of TACs. If the emissions from a project are less than the listed trigger-levels, it is assumed that the project does not pose a significant risk to the public and a health risk screening analysis is not required.

[45] Emissions and Dispersion Modeling System (EDMS) was developed by the Federal Aviation Administration as a model designed to assess the air quality impacts of proposed airport development projects (http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model/)

The chronic (annual) and acute (hourly) incremental emissions of TACs emissions from helicopter summarized in Table 3.4 are below the BAAQMD trigger levels.[46] Therefore, further assessment of the helipad emissions is not required under the 2010 CEQA Guidelines as resulting health risks from emissions at this level are "not expected to cause, or contribute significantly to, adverse health effects."[47] Details of the emission analysis and the electronic files of EDMS inputs and outputs are attached in Appendix B4.

## 3.3 Analysis of Health Risks Associated with Potential Exposure to Diesel Particulate Matter Emissions from Construction Activities

For screening purpose, the potential exposures to DPM and other chemicals from proposed Project construction activities at the Point of Maximum Impact (PMI) were evaluated. The health impact to all potential exposed populations (discussed in Section 3.3.2.1) including adult and child resident, on-site and off-site workers, and a nearby school child at the PMI are estimated and discussed in Section 3.3.8. This approach is conservative because the PMI is located inside the Project fence line and away from the actual residential property, commercial property, and schools.

Based on the results of the exposure evaluation and air dispersion modeling, quantitative estimates of excess lifetime cancer risks and noncancer hazard quotients (HQs) associated with potential exposure to Project construction related emissions were estimated. The estimated cancer risks and noncancer hazards are then compared to the thresholds for significance identified in the CEQA Guidelines.

### 3.3.1 Identification of Chemicals of Potential Concern

Diesel exhaust, both as DPM and speciated into its component TACs, are the chemicals identified for inclusion in this risk assessment. Specifically, DPM emissions and ROG emissions from heavy equipment exhaust during construction activities are the focus of this section. This includes exhaust from both on-site construction equipment and on-road diesel trucks that serve the construction site (bringing materials to the site and removing debris and soils), as well as workers' personal vehicles.

Diesel exhaust is a complex mixture that includes hundreds of individual constituents.[48] Diesel exhaust, as a mixture, is identified by the State of California as a known human carcinogen.[49,50]

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[46] BAAQMD Regulation 2, Rule 5 specifies that all permit applications for new and modified sources must be screened for emissions of TACs. If the emissions from a project are less than the listed trigger-levels, it is assumed that the project does not pose a significant risk to the public and a health risk screening analysis is not required.

[47] Ibid

[48] Air Resources Board (ARB). 1998. Initial Statement of Reasons for Rulemaking. Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. June.

[49] Cal/EPA. 2009. Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment. May.

[50] California Environmental Protection Agency (Cal/EPA). 1998. Findings of the Scientific Review Panel on The Report on Diesel Exhaust, as adopted at the Panel's April 22, 1998, meeting. Office of Environmental Health

Under California regulatory guidelines, DPM is used as a surrogate measure of exposure for the mixture of chemicals that make up diesel exhaust as a whole. Cal/EPA and other proponents of using the surrogate approach to quantifying cancer risks associated with the diesel mixture indicate that this method is preferable to the use of a component-based approach. A component-based approach involves estimating risks for each of the individual components of a mixture. Critics of the component-based approach believe it will underestimate the risks associated with diesel as a whole mixture because the identity of all chemicals in the mixture may not be known and/or exposure and health effects information for all chemicals identified within the mixture may not be available. Further, Cal/EPA[51] has concluded that "potential cancer risk from inhalation exposure to whole diesel exhaust will outweigh the multipathway cancer risk from the speciated components."

However, BAAQMD Guidance and construction screening risk methods suggest that acute non-cancer impacts from components of diesel exhaust be evaluated. Specifically, the BAAQMD Construction Screening Tables base the screening of acute impacts on analysis of acrolein concentrations. Accordingly, in addition to evaluating chronic cancer risks and noncancer HQs using DPM as a surrogate, this section evaluate acute HQs from speciates ROG emissions due to diesel combustion.

### 3.3.2 Exposure Assessment

The USEPA[52] defines exposure as "contact of an organism with a chemical or physical agent" and defines the magnitude of exposure as "the amount of the agent available at the exchange boundaries of the organism (e.g., skin, lungs, gut) and available for absorption." Exposure assessments are designed to determine the degree of contact a person has with a chemical. The components of the exposure assessment include the identification of potentially exposed populations, the identification of exposure pathways, estimation of DPM exposure concentrations, and the selection of exposure assumptions to quantify chemical intakes.

#### 3.3.2.1 Potentially Exposed Populations

To evaluate the potential human health effects posed by a site or project, it is necessary to identify the populations that may be exposed to the chemicals present and to determine the pathways by which exposures may occur. Identification of potentially exposed populations requires evaluating the human activity and land-use patterns at and in the vicinity of the Project. The populations considered in this report are off-site receptors in areas surrounding the Project.

Land use in the area surrounding the construction site (Figure 2) is zoned for a variety of residential uses surrounding small areas of mixed use, neighborhood business, or institutional

Hazard Assessment. Available electronically at http://www.arb.a.gov

51 Cal/EPA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August

52 USEPA. 1989a. Risk Assessment Guidance for Superfund: Volume 1- Human Health Evaluation Manual (Part A). Interim Final. Washington, D.C. December.

areas.[53] Consequently, off-site residents (child and adult residents) and workers (outside of the construction area[54]) were evaluated in this report. Potential off-site sensitive populations were also identified for evaluation in this report based on guidance from the District[55] and Cal/EPA[56]. Off-site sensitive receptors identified for the report included one K-12 school within 1000 feet of the Project boundary.[57] The off-site sensitive receptor locations identified for the Project are also shown on Figure 3.

On-site construction workers are not evaluated, as it is understood that on-site workers are protected by the California Occupational Safety and Health Administration (Cal/OSHA) in accordance with State health and safety requirements (8 CCR § 5194).

### 3.3.2.2 Exposure Pathways

Once potentially exposed populations are identified, the complete exposure pathways by which individuals in each of these populations may be exposed are determined. An exposure pathway is defined as "the course a chemical or physical agent takes from a source to an exposed organism."[58] A complete exposure pathway requires the following four key elements:

- Chemical source,
- Migration route (i.e., environmental transport),
- An exposure point for contact (e.g., air), and
- Human exposure route (e.g., inhalation).

An exposure pathway is not complete unless all four elements are present.

Selection of additional pathways for a multipathway analysis is specific to the chemical and land use designations in the area potentially impacted by the Project. Cal/EPA[59] has identified chemicals that must be evaluated in a multipathway analysis and DPM is not listed by Cal/EPA as a multipathway chemical. Thus, for this report, only inhalation exposures were evaluated.

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[53] Zoning information was obtained from the City of Oakland General Plan and Zoning Map, available online: http://www.oaklandnet.com/government/ceda/revised/planningzoning/ZoningSection/General%20Plan%20and%20Zoning%20Map_20100506_Addendum_Asof20100506.pdf

[54] The off-site workers include workers in the existing Zoo as well as workers at commercial sites within the area of influence (within a 1000 foot radius of the Project Boundary).

[55] BAAQMD. 2010. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. January

[56] Cal/EPA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August

[57] Marshall School is located to the south of the Project site, approximately 300 meters from the nearest construction area (the Veterinary Medical Hospital site).

[58] USEPA. 1989a. Risk Assessment Guidance for Superfund: Volume 1- Human Health Evaluation Manual (Part A). Interim Final. Washington, D.C. December.

[59] Cal/EPA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August

#### 3.3.2.3 Exposure Assumptions

Population specific exposure assumptions were obtained using site-specific information and risk assessment guidelines from BAAQMD, Cal/EPA, and USEPA, with the exception of Project-specific exposure durations. Project construction is anticipated to occur over a five year period beginning in 2011 and ending in 2015, with activities in the construction phases spanning various periods during this interval. The exposure duration assumed for each population was limited to the planned construction period for the Project. The population-specific exposure parameters and their derivation are summarized in Table 3.5.

### 3.3.3 Estimated DPM Air Concentrations

The DPM annual average air concentrations at the PMI are presented in Table 3.6.

The exposure point concentrations were calculated from the annual average concentration ($\mu g/m^3$) and the modeling-adjustment factor (AF). The adjustment factor was applied to the exposure point concentration to account for the difference in the assumed continuous construction schedule (i.e., 24 hours per day seven days per week) in the ISC-Prime modeling and the actual construction period planned for the Project (i.e., eight hours per day, five days per week). The population-specific adjustment factor and the resulting conservative ambient air concentrations (i.e. at PMI) estimated for workers, off-site resident (adult and child), and off-site sensitive receptor are shown in Table 3.6.

### 3.3.4 Calculation of Intake

The dose estimated for the exposure pathway is a function of the concentration of a chemical and the intake of that chemical. The calculation of the intake factor for inhalation, $IF_{inh}$, is presented in Table 3.5. The chemical intake or dose is estimated by multiplying the inhalation intake factor, $IF_{inh}$, by the chemical concentration in air, $C_i$. When coupled with the chemical concentration, this calculation is mathematically equivalent to the dose algorithm given in the Office of Environmental Health Hazard Assessment (OEHHA) Hot Spots guidance.[60]

### 3.3.5 Toxicity Assessment

The toxicity assessment characterizes the relationship between the magnitude of exposure and the nature and magnitude of adverse health effects that may result from such exposure. For purposes of calculating the exposure criteria to be used in risk assessments, adverse health effects are classified into two broad categories – cancer and noncancer endpoints. Toxicity values used to estimate the likelihood of adverse effects occurring in humans at different exposure levels are identified as part of the toxicity assessment component of a risk assessment.

Consistent with Cal/EPA risk assessment guidance, ENVIRON used the Cal/EPA cancer potency factor (CPF) for DPM to estimate cancer risks associated with exposure to diesel

[60] Cal/EPA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August.

emissions resulting from the Project (Cal/EPA 2009b). As discussed in Section 3.3.1, DPM is used as a surrogate measure of exposure for the mixture of chemicals that make up diesel exhaust. The chronic reference exposure level (REL) for DPM, presented in Table 3.7, represents the average daily exposure concentrations at (or below) which no adverse health effects are anticipated.[61]

### 3.3.6 Excess Lifetime Cancer Risk and Chronic Noncancer Hazards Characterization Methods

The results of this report are presented as estimated cancer risks, and noncancer hazards which are then compared to the applicable Thresholds of Significance in the CEQA Guidelines. The methodology used to estimate excess lifetime cancer risks and chronic noncancer hazards is detailed in Tables 3.8 and 3.9.

### 3.3.7 Implementation of OEHHA TSD for Cancer Potency Factors in Estimation of Cancer Risk

The CEQA Guidelines recommends estimation of cancer risk using methods from the OEHHA recently released *Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustment to Allow for Early Life Stage Exposures.*[62] The OEHHA Technical Support Document (TSD) for Cancer Potency Factors[63] represents one of the TSDs in the five-part OEHHA Air Toxic Hot Spots Program guidance series. OEHHA is currently in the process of revising the TSD guidelines to reflect scientific information and approaches developed since the previous guidelines were prepared and to address the mandates of the Children's Environmental Health Protection Act.[64] OEHHA has not yet published a revised exposure assessment TSD (Part IV of the OEHHA guidelines) or a revised guidance manual for preparation of risk assessments. Thus, comprehensive statewide procedures for implementing these policies have not been finalized.

The OEHHA TSD guidance series is not complete and the ARB and other local air districts have not formally implemented the methodology. However, BAAQMD has elected to implement the OEHHA TSD in its update to their Air Toxics NSR Program HRSA guidance[65] and CEQA Guidelines.

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[61] CalEPA. 2008. OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary. Office of Environmental Health Hazard Assessment. December 18

[62] Office of Environmental Health Hazard Assessment (OEHHA). *Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustment to Allow for Early Life Stage Exposures.* 2009. Available online: http://www.oehha.ca.gov/air/hot_spots/2009/TSDCancerPotency.pdf

[63] Ibid.

[64] Senate Bill 25, Escutia, Chapter 731, Statutes of 1999, Health and Safety Code Sections 39669.5 et seq

[65] BAAQMD. 2010. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. January

The OEHHA[66] TSD describes revisions to the approach that OEHHA uses to derive toxicity values and describes new procedures for estimating cancer risks, including ways to address the increase susceptibility of infants and children, as compared to adults. Further, the document proposes the use of age-specific sensitivity factors (ASFs) to account for an "anticipated sensitivity to carcinogens" of infants and children to carcinogens. Under the revised approach, cancer risk estimates are weighted by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age and by a factor of 3 for exposures that occur from 2 years through 15 years of age. No weighting factor (i.e., an ASF of 1, which is equivalent to no adjustment) is applied to ages 16 to 70 years. These factors are summarized below.

| Age Bin | ASF |
|---|---|
| Third trimester to age 2 years | 10 |
| 2 to 16 years | 3 |
| 16 to 70 years | 1 |

In its HRSA guidance, BAAQMD recommends the use of an ASF of 1.7 to estimate cancer risks for lifetime residential exposures (70-year resident receptors) and a factor of 3 for estimation of cancer risks for children at schools. BAAQMD has indicated that cancer risk estimates for worker populations would not be affected as the ASF for a worker is 1. BAAQMD does not explicitly identify the ASF values recommended for the evaluation of each population in the CEQA Guidelines. However, as recommended in the CEQA Guidelines, cancer risks are adjusted using the ASF approach described in the OEHHA TSD and implemented by BAAQMD in the HRSA guidelines.

### 3.3.8 Estimation of Acute Noncancer Hazard Quotients/Indices

The potential for acute effects was evaluated by comparing the annual one-hour maximum concentration with the acute REL. The equation used to calculate acute HQs is as follows:

$$HQ_i = C_i / aREL_i$$

Where:

$HQ_i$ = Hazard Quotient for $Chemical_i$

$C_i$ = Average Daily Air Concentration for $Chemical_i$ ($\mu g/m^3$)

$aREL_i$ = Acute Noncancer Reference Exposure Level for $Chemical_i$ ($\mu g/m^3$)

The methodology used to estimate the acute hazard quotients is detailed in Table 3.10.

[66] Office of Environmental Health Hazard Assessment (OEHHA). *Technical Support Document for Cancer Potency Factors: Methodologies for Derivation, Listing of Available Values, and Adjustment to Allow for Early Life Stage Exposures.* 2009. Available online: http://www.oehha.ca.gov/air/hot_spots/2009/TSDCancerPotency.pdf

### 3.3.9 Risk Characterization Results

This section compares the estimated excess lifetime cancer risks and noncancer HQs for each population in relation to significance thresholds under CEQA. The cancer risks are summarized in Table 3.8, the noncancer HQs in Table 3.9, and the acute HIs in Table 3.10. The results are summarized in Table 3.11, which shows that the Project would be below BAAQMD thresholds.

#### 3.3.9.1 Off-site Residents

The estimated excess lifetime cancer risks over the construction period for both adult and child resident at the PMI are well below the BAAQMD significance threshold of 10 in a million.

As summarized in Table 3.8, the estimated excess lifetime cancer risk for the adult resident at the PMI is 0.2 in a million ($2 \times 10^{-7}$). The estimated excess lifetime cancer risk for the child resident is 2 in a million ($2 \times 10^{-6}$).

#### 3.3.9.2 Off-site Workers

The estimated excess lifetime cancer risks over the construction period for workers at the PMI are well below the BAAQMD significance threshold of 10 in a million.

As shown in Table 3.8, the estimated excess lifetime cancer risk for the worker at the PMI is 0.3 in a million ($3 \times 10^{-7}$). The PMI in this case is the point of maximum impact outside of any construction area. Consequently the estimated risk and HQ for workers at the PMI represents the maximum impact to employees of the Zoo as well as all other workers in the vicinity of the Project.

#### 3.3.9.3 Off-site Sensitive Receptors

The estimated excess lifetime cancer risks over the construction period for off-site sensitive receptors at the PMI are well below the BAAQMD significance threshold of 10 in a million.

As shown in Table 3.8, the estimated excess lifetime cancer risks for the sensitive receptor, the school child, at the PMI is 1 in a million ($1 \times 10^{-6}$).

#### 3.3.9.4 Chronic Noncancer Hazard Quotients

As shown on Table 3.9, the estimated maximum noncancer chronic HQ at the PMI over the five year of construction period is 0.003; well below the significance threshold of one.

#### 3.3.9.5 Acute Noncancer Hazard Index

As shown on Table 3.10, the estimated maximum noncancer acute HI at the PMI over the five year of construction period is 0.32; well below the significance threshold of one.

### 3.4 Cumulative Health Impacts

The BAAQMD recommends that a Lead Agency identify all TAC and $PM_{2.5}$ sources located within a 1,000 foot radius of the Project site. The 1,000 foot buffer encompasses the existing Oakland Zoo, portions of Knowland Park, and approximately 50 acres of residential land use.

The buffer does not include any freeways, major roads, gasoline dispensing facilities, or industrial areas. As shown in Section 3.1.1, the operational TAC emissions from the Project do not exceed any acute or chronic trigger levels. It is not expected that the Project will contribute to any significant cumulative impacts.

# Tables

**Table 2.1**
**Summary of Project Criteria Air Pollutant Emissions**
**Oakland Zoo**
**Oakland, CA**

| Operational Source | Construction | | | | | | | Operational | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average Daily Emissions (lb/day) | | | | | | | Maximum Annual Emissions (tons/yr) | | | | | | Average Daily Emissions (lb/day) | | | | | | |
| | ROG | NOx | PM 10 (exhaust) | PM 2.5 (exhaust) | PM (fugitive) | SOx | CO | ROG | NOx | PM 10 (exhaust) | PM 2.5 (exhaust) | SOx | CO | ROG | NOx | PM 10 (exhaust) | PM 2.5 (exhaust) | SOx | CO |
| Construction | 2 | 4 | 0.02 | 0.02 | 3 | 0.01 | 3 | | | | | | | | | | | | |
| Diesel Generators | | | | | | | | 1.5E-02 | 5.2E-02 | 1.5E-04 | 1.5E-04 | 1.7E-02 | 5.5E-02 | 8.4E-01 | 2.1E-01 | 6.3E-03 | 6.3E-03 | 1.0E-02 | 1.2E+00 |
| Building Energy Use | | | | | | | | 8.9E-03 | 3.1E-01 | 1.2E-02 | 1.2E-02 | 9.7E-04 | 1.4E-01 | 4.9E-02 | 1.7E+00 | 6.8E-02 | 6.8E-02 | 5.3E-03 | 7.5E-01 |
| Mobile | | | | | | | | 9.6E-01 | 1.4E+00 | 2.8E+00 | 5.4E-01 | 2.0E-02 | 1.2E+01 | 5.3E+00 | 7.5E+00 | 1.6E+01 | 3.0E+00 | 1.5E-02 | 6.8E+01 |
| Animal Waste Composting | | | | | | | | 5.0E-03 | | | | | | 2.7E-02 | | | | | |
| **TOTAL** | **2** | **4** | **0.02** | **0.02** | **3** | **0.01** | **3** | **1.0** | **1.7** | **2.85** | **0.55** | **0.04** | **13** | **6** | **9** | **15.6** | **3.0** | **0.03** | **70** |
| **BAAQMD CEQA Threshold of Significance** | **54** | **54** | **82** | **54** | **N/A** | **N/A** | **N/A** | **10** | **10** | **15** | **10** | **N/A** | **N/A** | **54** | **54** | **82** | **54** | **N/A** | **N/A** |
| **Exceeds Threshold?** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** | **No** |

**Abbreviations:**
BAAQMD - Bay Area Air Quality Management District.
CEQA - California Environmental Quality Act.
CO - carbon monoxide
lb - pounds
N/A = not applicable
NOx - oxides of nitrogen
PM - particulate matter
ROG - reactive organic compounds
SOx - sulfur oxides
yr - year

**Table 2.2**
**Criteria Pollutant Emissions from Standby Diesel Generators**
**Oakland Zoo**
**Oakland, CA**

| Generators | Size[1] | Annual Operating Hours | Emission Factor[2] | | | | | Daily Emissions[3] | | | | | | Annual Emissions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ROG | $PM_{10}$ | NOx | CO | SOx | ROG | $PM_{10}$ | $PM_{2.5}$[4] | NOx | CO | SOx | ROG | $PM_{10}$ | $PM_{2.5}$ | NOx | CO | SOx |
| | hp | | (g/hp-hr) | | | | | (lb/day) | | | | | | (ton/yr) | | | | | |
| Fire Service Pump | 125 | 35 | 1.0 | 0.01 | 3.5 | 3.7 | 1.1 | 0.28 | 2.1E-03 | 2.1E-03 | 0.06 | 0.3 | 2.5E-03 | 4.8E-03 | 4.8E-05 | 4.8E-05 | 1.7E-02 | 1.8E-02 | 5.5E-03 |
| Veterinary Hospital Backup Generator | 40 | 35 | 1.0 | 0.01 | 5.6 | 4.1 | 1.1 | 0.09 | 6.6E-04 | 6.6E-04 | 0.03 | 0.3 | 2.5E-03 | 1.5E-03 | 1.5E-05 | 1.5E-05 | 8.6E-03 | 6.3E-03 | 1.8E-03 |
| Gondola Auxiliary Engine | 150 | 35 | 1.0 | 0.01 | 3.0 | 3.7 | 1.1 | 0.33 | 2.5E-03 | 2.5E-03 | 0.07 | 0.3 | 2.5E-03 | 5.8E-03 | 5.8E-05 | 5.8E-05 | 1.7E-02 | 2.1E-02 | 6.6E-03 |
| Gondola Evacuation Unit | 67 | 35 | 1.0 | 0.01 | 3.5 | 3.7 | 1.1 | 0.15 | 1.1E-03 | 1.1E-03 | 0.04 | 0.3 | 2.5E-03 | 2.6E-03 | 2.6E-05 | 2.6E-05 | 9.0E-03 | 9.6E-03 | 2.9E-03 |
| **Total** | | | | | | | | **0.8** | **6.3E-03** | **6.3E-03** | **0.2** | **1.2** | **0.01** | **1.5E-02** | **1.5E-04** | **1.5E-04** | **5.2E-02** | **5.5E-02** | **1.7E-02** |
| BAAQMD Threshold of Significance | | | | | | | | 54 | 82 | 54 | 54 | | | 10 | 15 | 10 | 10 | | |
| Exceed the Threshold? | | | | | | | | **No** | **No** | **No** | **No** | | | **No** | **No** | **No** | **No** | | |

**Notes:**
1. Provided by Oakland Zoo on 12/28/2009 and 01/13/2010.
2. Based on the Project build out date (Q1 2016), ENVIRON made the following assumption for the emission factors:
   ROG: ENVIRON conservatively used ROG emission factor of Tier 1 because that of Tier 3 is presented as the combined emission factor of NMHC and NOx.
   $PM_{10}$: ENVIRON assumed that the newly purchased diesel standby engines would meet ARB's new diesel engine PM emission standard of 0.01g/hp-hr.[b]
   NOx and CO: ENVIRON used USEPA Tier 3 emission standards.[c]
   SOx: ENVIRON used the emission factor from USEPA AP-42.[d]
3. Assume the generators will be tested for maximum one hour a day.
4. The emissions of $PM_{2.5}$ were assumed to be same as those of $PM_{10}$.

**Abbreviations:**
ARB: Air Resources Board
BAAQMD: Bay Area Air Quality Management District
CO: Carbon Monoxide
g: grams
hp: horsepower
hr: hour
lb: pound
NMHC: non-methane hydrocarbon
NOx: nitrogen oxides
PM: particulate matter
ROG: reactive organic gas
SOx: sulfur oxides
USEPA: United States Environemtnal Protection Agency
yr: year

**Reference:**

[a] California Climate Action Registry (CCAR). 2009. General Reporting Protocol. Version 3.1
Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf
[b] California Air Resource Board (ARB). 2007. Amendments To the Airborne Toxic Control Measure For Stationary Compression Ignition Engines
Available at: http://www.arb.ca.gov/diesel/ag/documents/finalreg101807.pdf
[c] ARB and USEPA OFF-Road Compression-Ignition (Diesel) Engine Standards.
Available at: http://www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls
[d] US Environmental Protection Agency (USEPA). 1996. AP 42, Fifth Edition, Volume I Chapter 3: Stationary Internal Combustion Sources.
Available at: http://www.epa.gov/ttn/chief/ap42/ch03/final/c03s03.pdf

**Table 2.3**
**Modeled Source Parameters for Standby Diesel Generators**
**Oakland Zoo**
**Oakland, CA**

| Generators | Size[1] | Stack Height[2] | Volumetric Flow Rate[3] | Stack Diameter[4] | Temperature[3] |
|---|---|---|---|---|---|
| | (hp) | (m) | ($m^3$/min) | (m) | (K) |
| Fire Service Pump | 125 | 0 | 18.7 | 0.15 | 795.2 |
| Veterinary Hospital Backup Generator | 40 | 0 | 2.5 | 0.15 | 773.2 |
| Gondola Auxiliary Engine | 150 | 0 | 29.7 | 0.15 | 710.2 |
| Gondola Evacuation Unit | 67 | 0 | 13.7 | 0.15 | 844.2 |

**Notes:**
1. Provided by Oakland Zoo on 12/28/2009 and 01/13/2010.
2. The purpose of the screening model was to identify the worst possible concentration at each receptor location. ENVIRON conservatively assumed the emission height to be same as the breath height (i.e. receptor height) setting both to be zero on a flat terrain.
3. Used the volumetric flow rate and exhaust temperature of the Caterpillar engines of similar sizes. The engine specification sheets are attached in Appendix C1.
4. The stack diameters were estimated based on the Caterpillar engines of similar sizes.

**Abbreviations:**
hp: horsepower
m: meter
$m^3$: cubic meter
min: minute
K: Kelvin

**Table 2.4**
**Criteria Pollutant Emissions from Non-Residential Energy Use**
**Oakland Zoo**
**Oakland, CA**

| Building Type | Building Square Footage | Project Energy Use[1a] (Natural Gas) | Natural Gas Average Heating Value[b] | Annual Fuel Usage | Emission Factor[b] | | | | | | Average Daily Emissions | | | | | | Annual Emissions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $NOx^2$ | CO | $PM^3$ | Pb | $SO_2^4$ | VOC | NOx | CO | PM | Pb | $SO_2$ | VOC | NOx | CO | PM | Pb | $SO_2$ | VOC |
| | (SF) | (kBTU/SF/yr) | ($BTU/ft^3$) | ($ft^3$/yr) | ($lb/10^6 ft^3$) | | | | | | (lb/day) | | | | | | (lb/yr) | | | | | |
| Restaurant | 7,315 | 170 | 1,020 | 1,219,289 | 190 | 84 | 7.6 | 5.0E-04 | 0.6 | 5.5 | 0.6 | 0.3 | 0.03 | 1.7E-06 | 2.0E-03 | 1.8E-02 | 232 | 102 | 9.3 | 6.1E-04 | 0.7 | 6.7 |
| Veterinary Hospital | 17,000 | 101 | | 1,685,458 | | | | | | | 0.9 | 0.4 | 0.04 | 2.3E-06 | 2.8E-03 | 2.5E-02 | 320 | 142 | 13 | 8.4E-04 | 1.0 | 9.3 |
| Visitor Center - Education | 13,428 | 17 | | 227,245 | | | | | | | 0.1 | 0.05 | 4.7E-03 | 3.1E-07 | 3.7E-04 | 3.4E-03 | 43 | 19 | 1.7 | 1.1E-04 | 0.14 | 1.2 |
| Visitor Center - Office | 4,718 | 25 | | 114,817 | | | | | | | 0.06 | 0.03 | 2.4E-03 | 1.6E-07 | 1.9E-04 | 1.7E-03 | 22 | 9.6 | 0.9 | 5.7E-05 | 0.07 | 0.6 |
| **Total** | | | | **3,246,809** | | | | | | | **1.7** | **0.7** | **0.07** | **4.4E-06** | **5.3E-03** | **0.05** | **617** | **273** | **25** | **1.6E-03** | **1.9** | **18** |

**Notes:**
1. Baseline usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). Energy usage rates are based on 2002 consumption data. ENVIRON used data for Pacific Gas and Electric (PG&E), Zone 5, which is the sector in which Oakland Zoo would be located.
2. Conservatively used the emission factor of an uncontrolled (post-NSPS) combuster presented in Table 1.4-1 of USEPA AP-42.
3. Total PM including condensible and filterable PM.
4. Used the emission factor associated with AP-42 assumed sulfur content of 2000 grains/$10^6$ SF.

**Abbreviations:**
CEC - California Energy Comission
CEUS - California Commercial End-Use Survey
CO - carbon monoxide
$ft^3$ - cubic feet
kBTU - kilo (1000) British thermal units
lb - pound
NOx - nitrogen oxides
NSPS - Source Performance Standard as defined in 40 CFR 60 Subparts D and Db
Pb - lead
PG&E - Pacific Gas and Electric
PM - particulate matter
SF - square feet
$SO_2$ - sulfur dioxide
USEPA - United States Environmental Protection Agency
VOC - volatile organic compound
yr - year

**References:**
[a] California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at:
http://www.energy.ca.gov/ceus/
[b] US Environmental Protection Agency (USEPA). 1998. AP-42, Fifth Edition, Volume I Chapter 1: External Combustion Sources. Available at:

**Table 2.5**
**Vehicle Trip Generation due to Project**
**Oakland Zoo**
**Oakland, CA**

| Commuter Type | URBEMIS Trip Type[2] | % Trip Type[2] | Annual One-Way Trips[1,3,4] | Daily One-Way Trips[1,3,4] |
|---|---|---|---|---|
| Employee[1] | Commercial-based Commute | 18.8% | 21,900 | 60 |
| Visitor and Other | Commercial-based Non-Work | 9.4% | 10,950 | 30 |
| | Commercial-based Customer | 71.7% | 83,332 | 1080 |
| **Total Trips** | **--** | **100%** | **116,182** | **1170** |

**Notes:**

1. Number of new employees (30) due to the project was provided by Oakland Zoo. ENVIRON assumed that each employee makes 2 one-way trips each day for a total of 365 days per year and calculated the number of annual and daily trips associated with employee trips.

2. URBEMIS trip types for commercial land uses are commercial-based commute, commercial-based work, and commercial-based customer. ENVIRON assumed that employee trips are represented by the commercial-based commute trip type. Therefore, commercial-based commute trips represent (21,900/80,000) = 18.8% of all trips. This value was entered in URBEMIS for % Worker Commute. URBEMIS then calculates the percentage of trips attributed to commercial-based non-work and commercial-based customer trips based on the following methodology: if the commercial-based commute trip value is less than 50 percent, as is the case for Oakland Zoo, then the commercial-based non commute trip percentage equals one half of the commercial-based commute trip value, and the commercial-based customer trip percentage is the remainder.

3. The number of annual one-way trips and daily one-way trips for the commercial-based non-work trip type was calculated based on the % Trip Type.

4. Hausrath Economics Group, October 19, 2010. Annual trips were determined for the year experiencing the peak increase in visitors. Daily trips were conservatively determined using the increase projected for a summer weekend day. ENVIRON assumed that each vehicle makes 2 one-way trips and calculated the commercial-based customer trip type accordingly.

**Table 2.6**
**Criteria Pollutant Emissions from Vehicles**
**Oakland Zoo**
**Oakland, CA**

| Emissions Type | Number of One-Way Trips | VMT[1] | Criteria Pollutant Emissions[2] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Unit | ROG | NOx | CO | SO2 | PM 10 | PM 2.5 |
| **Average Daily** | 1,170 | 9,072 | lbs/day | 5.26 | 7.51 | 68.27 | 0.02 | 15.56 | 2.96 |
| **Maximum Annual** | 116,182 | 3,311,430 | tons/yr | 0.96 | 1.37 | 12.46 | 0.02 | 2.84 | 0.54 |

**Notes:**

1. Daily VMT was calculated in URBEMIS based on the number of trips and urban trip lengths for BAAQMD. Annual VMT was calculated by multiplying the daily VMT by 365.

2. Annual emissions were calculated in URBEMIS based on 2015 emission factors. ENVIRON assumed that the vehicle fleet would be consistent with the default 2015 EMFAC fleet mix. Average daily emissions were calculated by dividing the annual emissions by 365 and converting from tons to pounds

**Abbreviations:**
BAAQMD - Bay Area Air Quality Management District
CO - carbon monoxide
lb - pound
LDA - Light duty automobiles
LDT1 - Light duty trucks (weight class is 0-3,750 lbs)
LDT2 - Light duty trucks (weight class is 3,751-5,750 lbs)
MDV - Medium duty vehicles (5,751-8,500 lbs)
NOx - oxides of nitrogen
PM - particulate matter
ROG - reactive organic compounds
$SO_2$ - sulfur dioxide
URBEMIS - Urban Emissions Model
VMT - Vehicle Miles Traveled

**Table 2.7**

**Criteria Air Pollutant Emissions from Manure Handling for California! Exhibit**

**Oakland Zoo**

**Oakland, CA**

| Herbivore Animal[1] | Number of Animals[2] | VOC Emission factor[3] | Manure Produced | | Scaled VOC Emission Factor[4] | Uncontrolled VOC Emissions | Control Efficiency[6] | Controlled VOC Emissions | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Milking Cow | Bison | | | | Annual | Average Daily |
| | | lb/milking cow/yr | lb/day | lb/day | lb/bison/yr | lb/yr | | ton/yr | lb/day |
| Bison | 5 | 4.8 | 23 | 20 | 4.2 | 20.9 | 0.475 | 5.0E-03 | 2.7E-02 |

1. Only manure from bison is composted on-site. Manure from the other animals in the exhibit is sent off-site for treatment.
2. The size of the bison herd will be increased by five head as part of the California! Project.
3. This emissions factor is derived from a SJVAPCD report and is accepted for use in SJVAPCD. SJVAPCD 2005. The BAAQMD does not have guidance on calculating VOC emissions from manure at this time.
4. Emission factors for buffalo were calculated by scaling the emission factors for cows by the relative volume of manure produced by buffalo. $EF_{bison} = EF_{milking\ cow} * (Daily\ manure_{bison} / Daily\ manure_{milking\ cow})$
6. Control efficiency was based on the value for enclosed composting from Table 2 of SCAQMD 2004.

**Abbreviations:**
lb - pound
SCAQMD - South Coast Air Quality Management District
SJVAPCD - San Joaquin Valley Air Pollution Control District
VOC - volatile organic compound
yr - year

**Sources**

San Joaquin Valley Air Pollution Control District. 2005. Dairy VOC and NH3 emissions factors.
South Coast Air Quality Management District. 2004. Staff Report on Rule 1127 Emission Reductions from Livestock Waste

**Table 2.8**
**Emission Sources associated with Construction Activities**
**Oakland Zoo**
**Oakland, CA**

| Source | Emission Category | Pollutants | | | | | |
|---|---|---|---|---|---|---|---|
| | | ROG | NOx | CO | SOx | $PM_{10}$ | $PM_{2.5}$[5] |
| On-site Equipment[1] | Exhaust | x | x | x | x | x | x |
| Mobile Sources[2] | Exhaust - Running | x | x | x | x | x | x |
| | Exhaust - Starting | x | x | x | x | x | x |
| | Exhaust - Idling | x | x | x | x | x | x |
| | Hot Soak | x | | | | | |
| | Diurnal | x | | | | | |
| | Evaporative | x | | | | | |
| Architectural Coating[3] | Off-gas | x | | | | | |
| Asphalt Paving[4] | Off-gas | x | | | | | |

**Notes:**
1. Exhaust emissions from on-site off-road construction equipment operation through diesel fuel combustion.

2. The explanation of the following emission category are directly cited from EMFAC2007 User's Guide:[a]
**Running exhaust**: Emissions that come out of the vehicle tailpipe while it is traveling on the road.
**Starting exhaust**: Tailpipe emissions that occurs as a result of starting a vehicle. The magnitude of these emissions is dependent on how long the vehicle has been sitting prior to starting. Based on EMFAC2007, starting emissions are only estimated for gasoline fueled vehicles.
**Idle exhaust**: Emissions that come out of the vehicle tailpipe while it is operating but not traveling any significant distance. Based on EMFAC2007, idling emissions are calculated for heavy-duty trucks.
**Hot soak**: Evaporative HC emissions that occur immediately after a trip end due to fuel heating and the fact that engine remains hot for a short time after being switched off.
**Diurnal**: HC emissions that occur when rising ambient temperatures cause fuel evaporation from vehicle sitting throughout the day. These losses are from leaks in the fuel system, fuel hoses, connectors, and as a result of breakthrough of vapors from the carbon canister. If a vehicle is sitting for a period of time, emissions from the first 35 minutes are counted as hot soak and emissions from the remaining period are counted as diurnal emissions, provided that the ambient temperature is increasing during the remaining period of time.
**Evaporative running losses**: Evaporative HC emissions that occur when hot fuel vapors escape from the fuel system or overwhelm the carbon canister while the vehicle is operating.

3. ROG off-gas emissions resulting from the evaporation of solvents contained in paints, varnishes, primers, and other surface coatings.[b]

4. ROG off-gas emissions associated with asphalt paving.  The construction equipment exhaust emissions associated with asphalt paving are explained in the On-site Equipment section of this table.

**Abbreviations:**
CO: carbon monoxide
EMFAC: EMission FACtor Model
HC: hydrocarbon
NOx: nitrogen oxides
PM: particulate matter
ROG: reactive organic gases
SOx: sulfur oxides

**References:**
[a] EMFAC v2.3 User's Guide. 2006.
http://www.arb.ca.gov/msei/onroad/downloads/docs/user_guide_emfac2007.pdf
[b] URBEMIS Users Manual (Appendices).
http://www.urbemis.com/software/URBEMIS9%20Users%20Manual%20Appendices.pdf

**Table 2.9**
**Methodology of Emissions Calculation associated with Construction Activities**
**Oakland Zoo**
**Oakland, CA**

| Source | Emission Category | Methodology and Formula | Reference |
|---|---|---|---|
| On-site Equipment[1] | Exhaust | Off-road equipment: $Ec = \Sigma(EFc * HP * LF * Hr * C)$[2]<br>Helicopter: EDMS model | OFFROAD2007<br>EDMS v5.1.2 |
| Mobile Sources[3] | Exhaust - Running | $E_R = \Sigma(EF_R * VMT * C)$[4], where<br>VMT = Trip Length * Trip Number | EMFAC2007 |
| | Exhaust - Starting | $E_S = \Sigma(EF_S * \text{Number of Vehicle Starts} * C)$[5] | EMFAC2007 |
| | Exhaust - Idling | $E_I = \Sigma(EF_I * \text{Idling Time})$[6] | EMFAC2007 |
| | Hot Soak | $E_H = \Sigma(EF_H * \text{Trip Number} * C)$[7] | EMFAC2007 |
| | Diurnal | $E_D = \Sigma(EF_D * \text{Wait Time})$[8] | EMFAC2007 |
| | Evaporative | $E_E = \Sigma(EF_E * \text{Driving Time} * \text{Trip Number} * C)$[9] | EMFAC2007 |
| Architectural Coating[3] | Off-gas | $E_{AC} = \Sigma(E_{AC} * \text{Area Painted} * C)$[10], where<br>Area to Paint = Building Square Footage * 2 | URBEMIS 9.4.2 |
| Asphalt Paving | Off-gas | $EAP = \Sigma(EAP * \text{Area Paved})$[11] | URBEMIS 9.4.2 |

**Notes:**

1. Including the exhaust emissions from onsite off-road equipment and helicopter. The helicopter emissions are presented and discussed separately in Table 2.14.

2. $E_c$: on-site equipment exhaust emissions (lb). See Table 2.8f or explanation.
$EF_c$ (PM): emission factor (g/hp-hr). ENVIRON used USEPA Tier 4 Interim emission standard.[a]
EFc (other criteria pollutants): emission factor (g/hp-hr). The emission factors were back calculated from OFFROAD 2007 modeled emission rates using the following formula. The back calculated emissions factors have taken into account the equipment age distribution and engine deterioration factor.
$EF_c$ (other criteria pollutants) = OFFROAD Emissions (ton/day) / Activities / AveHP / LF / 3600 seconds per hour
Where,
Activities and AveHP are both presented in the OFFROAD output files along with the emission rates.
Activities are total daily equipment hours and AveHP is the average equipment horsepower used by OFFROAD.
The effective emissions factors by year for on-site equipment are presented in Appendix B2.
HP: equipment horsepower. ENVIRON used URBEMIS 2007 default equipment horsepower.
LF: equipment load factor. ENVIRON used URBEMIS 2007/OFFROAD 2007 default equipment load factor.
Hr: equipment hours. Provided by Oakland Zoo. The detailed equipment hours by construction phase are presented in Appendix B1.
C: unit conversion factor.

3. Mobile sources Include material transporting trucks, soil hauling trucks, and workers' private vehicles. See Appendix B.1 for the detailed equipment list. Emissions associated with mobile sources were calculated using the following formulas.

4. $E_R$: running exhaust emissions (lb). See Table 2.8for explanation.
$EF_R$: running emission factor (g/mile). From EMFAC2007. The EMFAC modeled emission factors are presented in Appendix B3.
For material transporting and soil hauling trucks:
$EF_R = EF_{MHDt}$;
For worker commuting trips:
$EF_R = 0.5 * EF_{LDA} + 0.25 * EF_{LDT1} + 0.25 * EF_{LDT2}$
Where,
$EF_{MHDT}$: emission factor of medium-heavy duty trucks (g/mile). From EMFAC2007. The EMFAC modeled emission factors are presented in Appendix B3.
$EF_{LDA}$: emission factor of light duty autos (g/mile). From EMFAC2007.
$EF_{LDT1}$: emission factor of light duty trucks: up to 6000 GVW
$EF_{LDT2}$: emission factor of light duty trucks: up to 8500 GVW
VMT: vehicle miles traveled
C: unit conversion factor.
The calculation involves the following assumptions:
a. All material transporting and soil hauling trucks are medium-heavy duty trucks.
b. URBEMIS defaults assume that half of the workers commute with light duty trucks (LDTs) and half commute in light duty autos (LDAs).
c. Half of the LDTs were assumed to be type 1 and the other half type 2.
d. The emission factor depends upon the speed of the vehicle. The local speed limit of 25 miles per hour was used.
Trip Length: The one-way trip length of 2.8 miles was provided by Oakland Zoo via email on 12/03/2009 to represent the local travel distance between highway I-880 and the Project.
Trip Number: for material transporting and soil hauling trucks the trip number was calculated dividing the equipment hours by the estimated round trip duration of 1 hour per trip. The equipment hours were provided by Oakland Zoo and are presented in Appendix B1. For workers' vehicle the round trip number was estimated based on the maximum daily number of workers assuming one round trip per worker per day. The daily number of workers by construction phase were provided by Oakland Zoo and are presented in Appendix B.1.

5. $E_S$: vehicle starting emissions (lb). See Table 2.8for explanation.
$EF_S$: starting emission factor (g/mile). From EMFAC2007. The EMFAC modeled emission factors are presented in Appendix B3. ENVIRON conservatively assumed the vehicle sitting time prior to the on-site starting to be eight hours.
Number of Vehicle Starts: ENVIRON assumed that one start per round trip. See note 4 for the trip number estimation methodology.
The starting emissions.
C: unit conversion factor.

6. $E_I$: vehicle idling emissions (lb). See Table 2.8 for explanation.
EFI: vehicle idling emission factor (g/min). From EMFAC2007. The EMFAC modeled emission factors are presented in Appendix B3.
Idling Time: ENVIRON assumed the maximum idling time was 10 minutes per round trip for trucks (five minutes after arrival, and five before departure) based on CARB's regulation under Heavy-Duty Vehicle Idling Emission Reduction Program.[b] ENVIRON assumed that worker's personal vehicle would not idle on-site.
C: unit conversion factor.

7. $E_H$: hot soak emissions (lb). See Table 2.8 for explanation.
$EF_H$: hot soak emission factor (g/trip). From EMFAC2007. The EMFAC modeled emission factors are presented in Appendix B3. ENVIRON conservatively used the highest emissions factor from EMFAC2007 assuming the vehicles would travel for at least 40 minutes before arrival.
Trip Number: see note 4 for trip number estimation methodology.
C: unit conversion factor.

8. $E_D$: diurnal loss emissions (lb). See Table 2.8 for explanation.
$EF_D$: partial day diurnal loss emissions factor (g/hour). From EMFAC2007. The EMFAC modeled emissions factors are presented in Appendix B..
Wait Time: ENVIRON assumed the on-site waiting time to be eight hours per day for all vehicles.
C: unit conversion factor.

9. $E_E$: evaporative running loss emissions (lb). See Table 2.8f or explanation.
$EF_E$: evaporative running loss emissions factor (g/min). From EMFAC2007. The EMFAC modeled emissions factors are presented in Appendix B3. ENVIRON conservatively used the worst case emissions factor given by EMFAC2007.
Driving Time: ENVIRON estimated the local one-way driving time on the local routes between I-880 and the Project to be 15 minutes.
Trip Number: see note 4 for trip number estimation methodology.
C: unit conversion factor.

10. $E_{AC}$: off-gas emissions from architectural coating (lb).
$EF_{AC}$: architectural coating off-gas emission factor (lb/sqft). The off-gas emission factor is based on the ROG content of the paint. ENVIRON used URBEMIS assumption of 250 grams ROG per liter of paint.[c]
Area Painted: The building square footage were provided by Oakland Zoo. Based on the conversation with Oakland Zoo, animal holdings would not be painted.
C: unit conversion factor.

11. $E_{AP}$: off-gas emissions from asphalt paving (lb).
$EF_{AP}$: asphalt paving off-gas emission factor (lb/sqft). ENVIRON used URBEMIS default of 2.5 lbs ROG per acre of paved area.
Area Painted: The total paved area of the Project (3.25 acres) were provided by Oakland Zoo through phone conversation on Feb 10, 2010.

**Abbreviations:**
CO: Carbon Monoxide
EF: Emission Factor
EMFAC: EMission FACtor Model
g: gram
HP: Horsepower
lb: pound
LDA: Light Duty Auto
LDT: Light Duty Truck
LF: Load Factor
MHDT: Medium-Heavy Duty Truck
min: minute
NOx: Nitrogen Oxides
PM: Particulate Matter
ROG: Reactive Organic Gases
SOx: Sulfur Oxides
sqft: square feet
URBEMIS: URBem EMISsions Model

**References:**

[a] ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards.
Available at: http://www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls
[b] ARB. 2005. Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling.
http://www.arb.ca.gov/msprog/truck-idling/2485.pdf
[c] URBEMIS Users Manual (Appendices).

**Table 2.10**
**Total Emissions of Criteria Pollutants associated with the Construction Activities**
**Oakland Zoo**
**Oakland, CA**

| Source | Emission Category | Total Emissions (lb) | | | | | |
|---|---|---|---|---|---|---|---|
| | | ROG | NOx | CO | SOx | $PM_{10}$ | $PM_{2.5}$ |
| On-site Equipment[1] | Exhaust | 422 | 3,411 | 1,976 | 7.9 | 13 | 13 |
| Mobile Sources[2] | Exhaust - Running | 28 | 138 | 772 | 1.4 | 6.9 | 6.9 |
| | Exhaust - Starting | 33 | 23 | 407 | 0.10 | 0.8 | 0.8 |
| | Exhaust - Idling | 1.5 | 34 | 12 | 0.02 | 0.4 | 0.4 |
| | Hot Soak | 12 | | | | | |
| | Diurnal | 22 | | | | | |
| | Evaporative | 360 | | | | | |
| Architectural Coating | Off-gas | 1,090 | | | | | |
| Asphalt Paving | Off-gas | 8.5 | | | | | |

**Notes:**
1. Includes exhaust emissions from on-site off-road construction equipment and helicopter.
2. Includes exhaust and evaporative mobile emissions from material transporting, soil hauling, vendor trips, and worker commuting. See Table 2.8 for explanation of emission categories and Table 2.9 for detailed emissions calculation methodology.

**Abbreviations:**
CO: carbon monoxide
lb: pound
NOx: nitrogen oxides
PM: particulate matter
ROG: reactive organic gases
SOx: sulfur oxides

**Table 2.11**
**Criteria Pollutant Emissions from Use of Helicopter[1,2]**
**Oakland Zoo**
**Oakland, CA**

| Pollutant | Total Emissions (lb) |
|---|---|
| ROG | 0.5 |
| CO | 2.7 |
| NOx | 17.4 |
| SOx | 4.0 |

**Notes:**
1. Based on the information provided by Oakland Zoo on 03/29/2010, a helicopter will be used for one day to erect the gondola tower.
2. ENVIRON modeled the emissions per minute for all operating modes (i.e. taxi out, takeoff, climb out, approach, and taxi in) using the Emissions and Dispersion Modeling System (EDMS) developed Federal Aviation Administration (FAA). ENVIRON then calculated the helicopter emissions multiplying the emissions per minute of the worst case mode with 480 minutes (one day of operation). The EDMS input and output files are attached in Appendix B4.

**Abbreviations:**
CO: carbon monoxide
lb: pound
NOx: nitrogen oxides
ROG: reactive organic gases

**Table 2.12**
**Average Daily Emissions of Criteria Pollutants associated with the Construction Activities**
**Oakland Zoo**
**Oakland, CA**

| Pollutants | Total Project Emissions[1,2] | | | Project | Annual Average | Total Project | Average Daily | CEQA Threshold of | Significant? (Y/N) |
|---|---|---|---|---|---|---|---|---|---|
| | California Project | Veterinary Hospital | Total | California | Veterinary Hospital | Total | Total | Significance[a] | |
| | (lb) | | | (yr) | (lb/yr) | (day) | (lb/day) | (lb/day) | |
| ROG | 1,430 | 546 | 1,976 | 5.0 | 395 | 956 | 2.1 | 54 | N |
| NOx | 3,182 | 424 | 3,606 | | 721 | | 3.8 | 54 | N |
| CO | 2,657 | 511 | 3,167 | | 633 | | 3.3 | -- | -- |
| SOx | 9 | 1 | 9 | | 1.9 | | 0.01 | -- | -- |
| $PM_{10}$ (Exhaust) | 18 | 3 | 21 | | 4 | | 0.02 | 82 | N |
| $PM_{2.5}$[3] (Exhaust) | 18 | 3 | 21 | | 4 | | 0.02 | 54 | N |

**Notes:**
1. Includes criteria pollutant emissions associated with on-site equipment, mobile sources, architectural coating, and asphalt paving from the California Project and Veterinary Hospital as presented in Table 2.10.
2. Detailed emissions calculations and assumptions made for each emission category are presented in Table 2.9.
3. The total number of working days within the project duration (2011-2015).

**Abbreviations:**
CEQA: California Environmental Quality Act
CO: carbon monoxide
lb: pound
NOx: nitrogen oxides
PM: particulate matter
ROG: reactive organic gases
SOx: sulfur oxides
yr: year

**Reference:**
[a] Bay Area Air Quality Management District (BAAQMD). 2009. California Environmental Quality Act Guidlines Update - Proposed Thresholds of Significance.
http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/Proposed%20Thresholds%20of%20Significance%20Dec%207%2009.ashx

**Table 2.13**
**Summary of Modeled Construction Sources**
**Oakland Zoo**
**Oakland, CA**

| Phase | Source Group[1] | Construction Phase |
|---|---|---|
| 1 | P1A | Veterinary Hospital |
| | P1B | Perimeter Fence |
| | P1C | Service Road |
| 2 | P2A | Gondola |
| | P2B | Grizzly Exibition, Active Zone, Overnight Campsite, and Bison/Elk Extension |
| | | Site Utilities & Pathways |
| 3 | P3 | Wolf Exhibit, Eagle Aviary, Black Bear Exhibit, Mountain Lion Exhibit, and Interpretive Kiosk |
| | | Site Utilities |
| 4 | P4A | Visitor Center |
| | P4B | Jaguar Exhibit and Condor Interpretive Station |
| 5 | P5 | Amphitheater, Beaver Exhibit, and Water Fowl Exhibit |

**Notes:**
1. The modeled source groups were setup based on the construction phasing schedule provided by Oakland Zoo on Mar 26, 2010.  Figure 2 presents the construction source locations.

**Table 2.14**
**Summary of $PM_{2.5}$ Emissions associated with the Modeled Construction Sources**
**Oakland Zoo**
**Oakland, CA**

| Year | Modeled Source Group[1] | Annual Emissions by Source Group[2] | |
|---|---|---|---|
| | | (lb/yr) | (g/s) |
| 2011 | P1A | 2.3 | 3.2E-05 |
| | P1B | 0.8 | 1.1E-05 |
| | P1C | 0.7 | 1.0E-05 |
| 2012 | P1A | 1.2 | 1.7E-05 |
| | P2A | 1.0 | 1.4E-05 |
| | P2B | 0.6 | 9.0E-06 |
| 2013 | P2A | 3.7 | 5.3E-05 |
| | P2B | 1.5 | 2.1E-05 |
| | P3 | 3.6 | 5.2E-05 |
| 2014 | P3 | 1.6 | 2.3E-05 |
| | P4A | 1.3 | 1.8E-05 |
| | P4B | 2.6 | 3.8E-05 |
| 2015 | P5 | 2.5 | 3.6E-05 |

**Notes:**
1. Source groups are explained in Table 2.13.
2. The annual emission rate swere calculated for each modeled source group based on the equipment list and associated hours of operation provided by Oakland Zoo on Mar. 26, 2010. The Oakland Zoo proposes to use diesel construction equipment that achieves the equivalent of USEPA Tier 4 PM emission standards. Emission factors were chosen accordingly.[b]

**Abbreviations:**
PM: particulate matter
g: gram
lb: pound
s: second
yr: year
USEPA - United States Environmental Protection Agency

**Reference:**
[a] Bay Area Air Quality Management District (BAAQMD). 2010. Table 2-5-1: Toxic Air Contaminant Trigger Levels. Available at:
http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx
[b] ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards.

**Table 2.15**
**$PM_{2.5}$ Concentrations at Point of Maximum Impact**
**Oakland Zoo**
**Oakland, CA**

| Location of PMI[1] | | Year | Modeled Concentration, Annual Average | BAAQMD Threshold of Signifiance[a] | Exceeding the Threshold? |
|---|---|---|---|---|---|
| UTMx (m) | UTMy (m) | | (µg/m3) | (µg/m3) | (Y/N) |
| 575,980 | 4,178,600 | 2011 | 0.004 | 0.3 | N |
| | | 2012 | 0.006 | | N |
| | | 2013 | 0.008 | | N |
| | | 2014 | 0.01 | | N |
| | | 2015 | 0.01 | | N |
| | | **Max** | **0.01** | | **N** |

**Notes:**
1. The PMI is the offsite receptor location with the maximum annual average $PM_{2.5}$ concentration.  The modeled receptor grid is presented in Figure 3.

**Abbreviations:**
BAAQMD: Bay Area Air Quality Management District
m: meter
PM: particulate matter
PMI: Point of Maximum Impact
ug/m$^{3:}$ microgram per cubic meter
UTM: Universal Transverse Mercator

**Reference:**
a Bay Area Air Quality Management District. 2010. California Environmental Quality Act Air Quality Guidelines, May. Available at:
http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/Draft_BAAQMD_CEQA_Guidelines_May_2010_Final.ashx

**Table 2.16**
**Standby Diesel Generator Criteria Pollutant Emissions for Screening Air Dispersion Modeling**
**Oakland Zoo**
**Oakland, California**

| Generators | Size[1] | Maximum Daily Operating Hours[2] | Annual Operating Hours | Emission Factor[3] | $PM_{2.5}$ Emissions[4] |
|---|---|---|---|---|---|
| | hp | | | (g/hp-hr) | (g/s) |
| Fire Service Pump | 125 | 1 | 35 | 0.01 | 1.4E-06 |
| Veterinary Hospital Backup Generator | 40 | 1 | 35 | 0.01 | 4.4E-07 |
| Gondola Auxiliary Engine | 150 | 1 | 35 | 0.01 | 1.7E-06 |
| Gondola Evacuation Unit | 67 | 1 | 35 | 0.01 | 7.4E-07 |

**Notes:**
1. Provided by Oakland Zoo on 12/28/2009 and 01/13/2010.
2. ENVIRON assumed that the generators will be tested for maximum one hour a day.
3. Based on the Project build out date (the end of 2015), ENVIRON assumed that the newly purchased diesel standby engines would meet ARB's new diesel engine PM emission standard of 0.01g/hp-hr.[a] In addition, ENVIRON conservatively the $PM_{2.5}$ emissions to be same as total PM emissions.
4. The $PM_{2.5}$ annual average emissions were calculated using the following formula:
$Emissions_{PM2.5}$ (g/s) = Emission $Factor_{PM2.5}$ (g/hp-hr) * Horsepower * Annual Operating Hours / 8760 (hours/year) / 3600 (seconds/hour)

**Abbreviations:**
hp: horsepower
hr: hour
g: gram
PM: particulate matter
s: second

**Reference**:
[a] California Air Resource Board (ARB). 2007. Amendments To the Airborne Toxic Control Measure For Stationary Compression Ignition Engines http://www.arb.ca.gov/diesel/ag/documents/finalreg101807.pdf

**Table 2.17**

**Modeled $PM_{2.5}$ Concentrations - Standby Diesel Engines[1,2]**

**Oakland Zoo**
**Oakland, CA**

| Sources | | $PM_{2.5}$ Annual Average Modeled Concentration ($\mu g/m^3$) | $PM_{2.5}$ Annual Average Threshold of Significance[a] ($\mu g/m^3$) | $PM_{2.5}$ Annual Average Exceeding the Threshold? (Y/N) |
|---|---|---|---|---|
| Standby Diesel Generators | Fire Service Pump | 1.4E-03 | 0.3 | No |
| | Veterinary Hospital | 4.8E-04 | | No |
| | Gondola Auxiliary Engine | 1.6E-03 | | No |
| | Gondola Evacuation Unit | 7.8E-04 | | No |
| | **Total** | **4.3E-03** | | **No** |

**Notes:**
1. The concentrations PM2.5 were modeled using USEPA SCREEN3 model. The SCREEN3 modeling results are presented in Appendix C2.
2. Since the exact locations of the standby diesel engines were not provided, ENVIRON conservatively assumed all four diesel generators were co-located. In addition, the worst case modeled concentrations were used to represent the maximum impact to the offsite individuals.

**Abbreviations:**
µg: microgram
$m^3$: cubic meter
PM: particulate matter

**Reference:**
[a] Bay Area Air Quality Management District. 2010. California Environmental Quality Act Air Quality Guidelines, May. Available at:
http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/Draft_BAAQMD_CEQA_Guidelines_May_2010_Final.ashx

**Table 3.1**
**Annual DPM Emissions from Standby Diesel Generators**
**Oakland Zoo**
**Oakland, CA**

| Generators | Size[1] | Annual Emissions[2] | | BAAQMD Trigger Level[a] | Triggered? |
|---|---|---|---|---|---|
| | hp | (ton/yr) | (lb/yr) | (lb/yr) | (Y/N) |
| Fire Service Pump | 125 | 4.8E-05 | 0.10 | 0.34 | N |
| Veterinary Hospital Backup Generator | 40 | 1.5E-05 | 0.031 | | N |
| Gondola Auxiliary Engine | 150 | 5.8E-05 | 0.12 | | N |
| Gondola Evacuation Unit | 67 | 2.6E-05 | 0.052 | | N |
| **Total** | | 1.5E-04 | 0.29 | | N |

**Notes:**
1. Provided by Oakland Zoo on 12/28/2009 and 01/13/2010.
2. ENVIRON conservatively assumed the annual emissions of DPM to be same as those of PM10 and PM2.5 presented in Table 2.2.

**Abbreviations:**
BAAQMD: Bay Area Air Quality Management District
DPM: Diesel Particulate Matter
hp: horsepower
lb: pound
PM: Particulate Matter
yr: year

**Reference:**
[a] Bay Area Air Quality Management District (BAAQMD). 2010. Table 2-5-1: Toxic Air Contaminant Trigger Levels. http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx

**Table 3.2**

**Summary of DPM Emissions associated with the Modeled Construction Sources[1]**

**Oakland Zoo**

**Oakland, CA**

<table>
<tr><th rowspan="2">Year</th><th rowspan="2">Modeled Source Group[2]</th><th colspan="2">Annual Emissions by Source Group[3]</th><th>Annual Total Emissions</th><th>BAAQMD Trigger Level[a]</th><th>Triggered?</th></tr>
<tr><th>(lb/yr)</th><th>(g/s)</th><th>(lb/yr)</th><th>(lb/yr)</th><th>(Y/N)</th></tr>
<tr><td rowspan="3">2011</td><td>P1A</td><td>2.3</td><td>3.2E-05</td><td rowspan="3">3.7</td><td rowspan="13">0.34</td><td rowspan="3">Y</td></tr>
<tr><td>P1B</td><td>0.8</td><td>1.1E-05</td></tr>
<tr><td>P1C</td><td>0.7</td><td>1.0E-05</td></tr>
<tr><td rowspan="3">2012</td><td>P1A</td><td>1.2</td><td>1.7E-05</td><td rowspan="3">2.8</td><td rowspan="3">Y</td></tr>
<tr><td>P2A</td><td>1.0</td><td>1.4E-05</td></tr>
<tr><td>P2B</td><td>0.6</td><td>9.0E-06</td></tr>
<tr><td rowspan="3">2013</td><td>P2A</td><td>3.7</td><td>5.3E-05</td><td rowspan="3">8.7</td><td rowspan="3">Y</td></tr>
<tr><td>P2B</td><td>1.5</td><td>2.1E-05</td></tr>
<tr><td>P3</td><td>3.6</td><td>5.2E-05</td></tr>
<tr><td rowspan="3">2014</td><td>P3</td><td>1.6</td><td>2.3E-05</td><td rowspan="3">5.5</td><td rowspan="3">Y</td></tr>
<tr><td>P4A</td><td>1.3</td><td>1.8E-05</td></tr>
<tr><td>P4B</td><td>2.6</td><td>3.8E-05</td></tr>
<tr><td>2015</td><td>P5</td><td>2.5</td><td>3.6E-05</td><td>2.5</td><td>Y</td></tr>
<tr><td colspan="2">Total (lb)</td><td>23.3</td><td></td><td>23.3</td><td></td><td></td></tr>
</table>

**Notes:**

1. ENVIRON conservatively assumed that the DPM emissions to be same as the $PM_{10}$ and $PM_{2.5}$ emissions in Table 2.12.
2. Source groups are explained in Table 2.13.
3. The annual emission rate were calculated for each modeled source group based on the equipment list and associated hours of operation provided by Oakland Zoo on Mar. 26, 2010. As suggested by Oakland Zoo, the construction diesel equipment were assumed to meet USEPA Tier 4 standard.[b]

**Abbreviations:**

ARB: Air Resources Board
DPM: Diesel Particulate Matter
g: gram
lb: pound
s: second
USEPA: United States Environmental Protection Agency
yr: year

**Reference:**

[a] Bay Area Air Quality Management District (BAAQMD). 2010. Table 2-5-1: Toxic Air Contaminant Trigger Levels.
Available at: http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx

[b] ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards.
Available at: http://www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls

**Table 3.3**
**Maximum Hourly TAC Emissions from Diesel Construction Activity**
**Oakland Zoo**
**Oakland, CA**

| Year | Quarter | Chemical | Emissions (lb/hr) | Acute (1-hr. max.) Trigger Level (lb/hr) | Triggered? (Y/N) |
|---|---|---|---|---|---|
| 2011 | 2 | acrolein | 2.1E-03 | 0.0055 | N |
| | | formaldehyde | 2.4E-02 | 0.12 | N |
| | | acetaldehyde | 1.2E-02 | 1 | N |
| | | benzene | 3.3E-03 | 2.9 | N |
| | | methyl ethyl ketone (mek) (2-butanone) | 2.4E-03 | 29 | N |
| | | toluene | 2.4E-03 | 82 | N |
| | | m-xylene | 1.0E-03 | 49 | N |
| | | o-xylene | 5.5E-04 | 49 | N |

**Abbreviations:**
hr: hour
lb: pound
TAC: Toxic Air Contaminant

**References:**
Bay Area Air Quality Management District (BAAQMD), Table 2-5-1: Toxic Air Conatminant Trigger Levels.

**Table 3.4**

**Toxic Air Contaminant Emissions Associated with Use of Helicopter[1]**

**Oakland Zoo**

**Oakland, CA**

| Pollutants[2] | CAS | Total Emissions | Chronic Trigger Level[a] | Triggered? | Maximum Hourly Emissions | Acute (1-hr. max.) Trigger Level[a] | Triggered? |
|---|---|---|---|---|---|---|---|
| | | (lb/yr) | (lb/yr) | (Y/N) | (lb/hr) | (lb/hr) | (Y/N) |
| Formaldehyde | 50-00-0 | 5.6E-02 | 18 | N | 7.1E-03 | 1.2E-01 | N |
| Methyl alcohol | 67-56-1 | 8.3E-03 | 150000 | N | 1.0E-03 | 6.2E+01 | N |
| Benzene | 71-43-2 | 7.7E-03 | 3.8 | N | 9.6E-04 | 2.9E+00 | N |
| Acetaldehyde | 75-07-0 | 2.0E-02 | 38 | N | 2.5E-03 | 1.0E+00 | N |
| Naphthalene | 91-20-3 | 2.5E-03 | 3.2 | N | 3.1E-04 | | N |
| O-xylene | 95-47-6 | 7.8E-04 | 27000 | N | 9.7E-05 | 4.9E+01 | N |
| Ethylbenzene | 100-41-4 | 7.8E-04 | 43 | N | 9.7E-05 | | N |
| Styrene | 100-42-5 | 1.4E-03 | 35000 | N | 1.7E-04 | 4.6E+01 | N |
| 1,3-butadiene | 106-99-0 | 7.7E-03 | 0.63 | N | 9.7E-04 | | N |
| Acrolein | 107-02-8 | 1.1E-02 | 14 | N | 1.4E-03 | 5.5E-03 | N |
| Toluene | 108-88-3 | 3.0E-03 | 12000 | N | 3.7E-04 | 8.2E+01 | N |
| Phenol (carbolic acid) | 108-95-2 | 3.3E-03 | 7700 | N | 4.2E-04 | 1.3E+01 | N |
| M & P-xylene | 1330-20-7 | 1.3E-03 | 27000 | N | 1.6E-04 | 4.9E+01 | N |
| Propylene | 115-07-1 | 2.1E-02 | 120000 | N | 2.6E-03 | | N |

**Notes:**

1. Calculated using Emissions Dispersion Modeling System (EDMS) version 5.1 developped by Federal Aviation Administration (FAA).
2. Only present the pollutants that are listed in BAAQMD's Table 2-5-1. The full model ouput is presented in Appendix B4.

**Abbreviations:**

hr: hour

lb: pound

yr: year

**References:**

[a] Bay Area Air Quality Management District (BAAQMD). 2010. Table 2-5-1 Toxic Air Contaminant Trigger Levels. Available at: http://www.baaqmd.gov/~/media/Files/Engineering/Air%20Toxics%20Programs/table_2-5-1.ashx

**Table 3.5**
**Exposure Parameters for Construction Scenario [1]**
**Oakland Zoo**
**Oakland, CA**

| Exposure Parameter | Units | Resident Adult[2] | Resident Child[2] | Worker[2] | School Child[3] |
|---|---|---|---|---|---|
| Breathing Rate (BR) | [L/kg-day] | 302 | 581 | 149 | 581 |
| Exposure Time (ET) | [hours/day] | 24 | 24 | 8 | 10 |
| Exposure Frequency (EF) | [days/year] | 350 | 350 | 245 | 180 |
| Exposure Duration (ED) | [years] | 1 | 1 | 1 | 1 |
| Conversion Factor (CF) | [$m^3$/L] | 0.001 | 0.001 | 0.001 | 0.001 |
| Averaging Time (AT) | [days] | 25550 | 25550 | 25550 | 25550 |
| Intake Factor, Inhalation ($IF_{inh}$) | [$m^3$/kg-day] | 0.0041 | 0.0080 | 0.0014 | 0.0017 |

**Notes:**
1. With the exception of the exposure duration (ED), the exposure parameters are based on OEHHA (2003) and BAAQMD (2010). The exposure duration was set to one year to estimate year-by-year cancer risk over the five year of construction duration.
2. For this EIR and as a conservative (i.e., health-protective) approach, it was assumed that residents are present at their residence for 24 hours per day, 350 days per year (USEPA 1989a, 1991; Cal/EPA 2003). However, adults spend only 68 to 73% of their total daily time at home (USEPA 1997), rather than the 100% assumed in this EIR. Accordingly, the actual risks to residents in the vicinity of the Project are likely to be significantly lower than those estimated in this EIR.
3. Workers are assumed to be exposed for eight hours per day for 245 days per year (BAAQMD 2010, Cal/EPA 2003). A breathing rate of 149 L/kg-day was assumed for is the worker population (Cal/EPA 2003).
4. Potential offsite sensitive populations were identified for evaluation in this EIR based on guidance from the District (BAAQMD 2010) and Cal/EPA (2003). As discussed in Section 3.3.2.3, offsite sensitive receptors identified for the Project include K-12 schools within a one kilometer radius surrounding the Project. For this reason, a school child was identified as the sensitive receptor for evaluation in this EIR.
As recommended by the BAAQMD, the exposure time for a school child is assumed to be 10 hours per day and is representative of a school day (BAAQMD 2010). School children are assumed to be exposed to construction emissions for 180 days per year (BAAQMD 2010) for the entire construction period of five years. The high-end breathing rate of 581 L/kg-day recommended for a child population was used (BAAQMD 2010, Cal/EPA 2003).

**Calculation:**
$IF_{inh}$ = (Breathing Rate*Exposure Time*Exposure Frequency*Exposure Duration*CF)/(24 Hours * Averaging time)

**Abbreviations:**
BAAQMD = Bay Area Air Quality Management District
OEHHA = Office of Environmental Health Hazard Assessment
L = liter
kg = kilogram
m3 = cubic meter

**References:**
Bay Area Air Quality Management District (BAAQMD). 2010. Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines. January.
OEHHA. 2003. Air Toxics Hot Spots Program Risk Assessment Guidelines, the Air Toxics Hot Spots Program Guidance Manual

**Table 3.6**
**DPM Concentrations at Point of Maximum Impact from Construction Activity**
**Oakland Zoo**
**Oakland, CA**

| Location of PMI[1] | | Year | Modeled Concentration, Annual Average ($\mu g/m^3$) | Exposure Point DPM Concentration - Ci[2] | | | |
|---|---|---|---|---|---|---|---|
| UTMx (m) | UTMy (m) | | | Resident Adult AF = 1 | Resident Child AF = 1 | Worker AF = 4.2 | School Child AF=4.2 |
| 575,980 | 4,178,600 | 2011 | 0.004 | 0.004 | 0.004 | 0.02 | 0.02 |
| | | 2012 | 0.006 | 0.006 | 0.006 | 0.02 | 0.02 |
| | | 2013 | 0.008 | 0.008 | 0.008 | 0.03 | 0.03 |
| | | 2014 | 0.015 | 0.015 | 0.015 | 0.06 | 0.06 |
| | | 2015 | 0.011 | 0.011 | 0.011 | 0.05 | 0.05 |

**Notes:**

1. The PMI is the off-site receptor location with the maximum cumulative cancer risk presented in Table 3.11. The modeled receptor grid is presented in Figure 3.
2. Cal/EPA recommends that "annual average concentrations for the worker inhalation pathway will need to be adjusted" to assure that the exposure point concentration is representative of the "average concentration that a worker breathes over his or her working day" (Cal/EPA 2003). In essence, the adjustment factor compresses emissions that could potentially occur over a 24-hour period, 365 days per year into an 8-hour period, 245 days per year. This method is consistent with the Air Toxics Hot Spots Risk Assessment Guidelines recommendations for applying an adjustment factor only when the operating schedule of a facility and off-site worker exposures occur at the same time (Cal/EPA 2003). The modeling adjustment factors for off-site residents, off-site workers, and off-site sensitive receptors are discussed below.

Off-site residents are assumed to be present at their residence 24 hours per day, seven days per week. This assumption is consistent with the modeled annual average air concentration (24-hours, seven days per week). Thus, the annual average concentration does not require an adjustment factor.

As recommended by Air Toxics Hot Spots Risk Assessment Guidelines, an adjustment factor of 4.2 was applied to the annual average concentration prediction (based on 24 hours per day) for the evaluation of offsite workers and sensitive receptors to account for a construction schedule of approximately eight hours per day and five days per week ([24/8] * [7/5] = 4.2). This concentration represents the theoretical maximum 8-hour concentration over the five day operating period to which the offsite workers and sensitive receptors might be exposed.

**Calculation:**

Exposure Point Concentration (Ci) = Modeled Concentration, Annual Average * AF

**Abbreviations:**

AF: Model Adjustment Factor
DPM: Diesel Particulate Matter
m: meter
PMI: Point of Maximum Impact
$ug/m^{3:}$ microgram per cubic meter
UTM: Universal Transverse Mercator

**Table 3.7**
**Carcinogenic and Chronic Noncarcinogenic Toxicity Values**
**Oakland Zoo**
**Oakland, CA**

| **Chemical** | **Cancer Potency Factor[a]** | **Chronic Reference Exposure Level[b]** |
|---|---|---|
| | **($[mg/kg\text{-}day]^{-1}$)** | **($\mu g/m^3$)** |
| Diesel PM | 1.1 | 5.0 |

**Abbreviations:**
$\mu g/m^3$: micrograms per cubic meter
$[mg/kg\text{-}day]^{-1}$: per milligram per kilogram-day

**References:**
[a]. California Environmental Protection Agency (Cal EPA). 2009. Toxicity Criteria Database. July 21.
[b]. California Environmental Protection Agency (CalEPA). 2008. OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary. Office of Environmental Health Hazard Assessment. December 18.

**Table 3.8**
**Estimated Excess Lifetime Cancer Risk at Point of Maximum Impact from Diesel Construction Activity**
**Oakland Zoo**
**Oakland, CA**

| Location of PMI[1] | | Year | Cumulative Cancer Risk[1] (in one million) | | | |
|---|---|---|---|---|---|---|
| **UTMx (m)** | **UTMy (m)** | | **Resident Adult** | **Resident Child** | **Worker** | **School Child** |
| 575,980 | 4,178,600 | 2011 | 0.02 | 0.00 | 0.03 | 0.10 |
| | | 2012 | 0.03 | 0.00 | 0.04 | 0.13 |
| | | 2013 | 0.04 | 0.71 | 0.05 | 0.19 |
| | | 2014 | 0.07 | 1.31 | 0.10 | 0.35 |
| | | 2015 | 0.05 | 0.47 | 0.07 | 0.27 |
| | | **Total** | **0.2** | **2** | **0.3** | **1** |

**Notes:**
1. The cancer risks are estimated as the upper-bound incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens. The estimated risk is expressed as a unitless probability. The cancer risk attributed to a chemical is calculated by multiplying the chemical intake or dose at the human exchange boundaries (e.g., lungs) by the chemical-specific Cancer Potency Factor (CPF).
The cancer risks attribute to the DPM emissions associated with the Project were calculated based on the exposure point DPM concentration (Ci) presented in Table 3.6, the intake factor presented in Table 3.5, and the CPF presented in Table 3.7.
Cancer risks shown take into account the Age Sensitivity Factor (ASF). ENVIRON derived ASF based on recommendations by the Office of Environmental Health Hazard Assessment OEHHA (2009) and BAAQMD (2010). See Section 3.3.7 of the Report.

**Calculation:**
$Risk_{inh} = C_i \times CF \times IF_{inh} \times CPF \times ASF$
Where:
$Risk_{inh}$ = Cancer Risk; the incremental probability of an individual developing cancer as a result of inhalation exposure to a particular potential carcinogen (unitless)
Ci = Exposure point concentration in air for chemical i (µg/m3)
CF = Conversion Factor (mg/µg)
$IF_{inh}$ = Intake Factor for Inhalation (m3/kg-day)
CPF = Cancer Potency Factor (mg chemical/kg body weight-day)
ASF = Age Sensitivity Factor

**Abbreviations:**
ASF: Age Sensitivity Factor
DPM: Diesel Particulate Matter
m: meter
PMI: Point of Maximum Impact

**Table 3.9**
**Estimated Chronic Hazard Quotients at Point of Maximum Impact from Diesel Construction Activity**
**Oakland Zoo**
**Oakland, CA**

| Location of PMI | | Year | Hazard Quotients[1] |
|---|---|---|---|
| **UTMx (m)** | **UTMy (m)** | | |
| 575,980 | 4,178,600 | 2011 | 0.001 |
| | | 2012 | 0.001 |
| | | 2013 | 0.002 |
| | | 2014 | 0.003 |
| | | 2015 | 0.002 |
| | | **Max** | **0.003** |

**Notes:**
1. The potential for exposure to result in chronic noncancer effects is evaluated by comparing the estimated annual average air concentration (which is equivalent to the average daily air concentration) to the chemical-specific noncancer chronic RELs. When calculated for a single chemical, the comparison yields a ratio termed a hazard quotient.
The hazard quotions were calculated based on the modeled annual average DPM concentrations presented in Table 3.6, and the chronic REL presented in Table 3.7.

**Calculation:**
HQi = Ci / RELi
Where:
HQi = Hazard Quotient for Chemicali
Ci = Average Daily Air Concentration for Chemicali (μg/m3)
RELi = Noncancer Reference Exposure Level for Chemicali (μg/m3)

**Abbreviations:**
AF: Model Ajustment Factor
DPM: Diesel Particulate Matter
PMI: Point of Maximum Impact
REL: Reference Exposure level
ug/m$^{3:}$ microgram per cubic meter

**Table 3.10**
**Estimated Acute Hazard Quotients at Point of Maximum Impact from Diesel Construction Activity**
**Oakland Zoo**
**Oakland, CA**

| Year | Quarter | Location of PMI | | Chemical | 1 Hour Concentration | Acute REL | Acute HQ |
|---|---|---|---|---|---|---|---|
| | | UTMx | UTMy | | | | |
| 2011 | 2 | 575,460 | 4,178,460 | acrolein | 0.51 | 2.5 | 0.20 |
| | | | | formaldehyde | 5.77 | 55 | 0.10 |
| | | | | acetaldehyde | 2.89 | 470 | 6.1E-03 |
| | | | | benzene | 0.79 | 1300 | 6.0E-04 |
| | | | | methyl ethyl ketone (mek) (2-butanone) | 0.58 | 13000 | 4.5E-05 |
| | | | | toluene | 0.58 | 37000 | 1.6E-05 |
| | | | | m-xylene | 0.24 | 22000 | 1.1E-05 |
| | | | | o-xylene | 0.13 | 22000 | 6.0E-06 |
| | | | | Total | | | 0.32 |

**Notes:**
1. The potential for exposure to result in acute noncancer effects is evaluated by comparing the estimated maximum hourly air concentration to the chemical-specific noncancer acute RELs. When calculated for a single chemical, the comparison yields a ratio termed a hazard quotient.

**Calculation:**
Acute HQi = Ci / RELi
Where:
Acute HQi = Acute Hazard Quotient for Chemicali
Ci = Average Daily Air Concentration for Chemicali (µg/m3)
RELi = Noncancer Reference Exposure Level for Chemicali (µg/m3)

**Abbreviations:**
REL: Reference Exposure level
TAC: Toxic Air Contaminant

**Table 3.11**
**Summary Comparison of Estimated Impacts from Diesel Construction Activity to Thresholds**
**Oakland Zoo**
**Oakland, CA**

| | Estimated Impact | BAAQMD Threshold[a] | Units | Exceeds Threshold? |
|---|---|---|---|---|
| Excess lifetime cancer risk (Child Resident)[1] | 2.5 | 10 | in one million | N |
| Chronic non-cancer hazard index | 0.003 | 1 | | N |
| Acute non-cancer hazard index[2] | 0.3 | 1 | | N |
| Annual average $PM_{2.5}$ concentration[3] | 0.01 | 0.3 | $\mu g/m^3$ | N |

**Notes:**
1. The maximum estimated excess lifetime cancer risk was for the resident child, as shown in Table 3.8
2. The value shown represents the total acute HI from the speciated diesel exhaust emissions from construction activities, as shown in Table 3.10
3. The value shown is the maximum incremental increase in annual average PM2.5 concentration during project construction, as shown in Table 3.6.

**Abbreviations:**
µg: microgram
$m^3$: cubic meter
PM: particulate matter

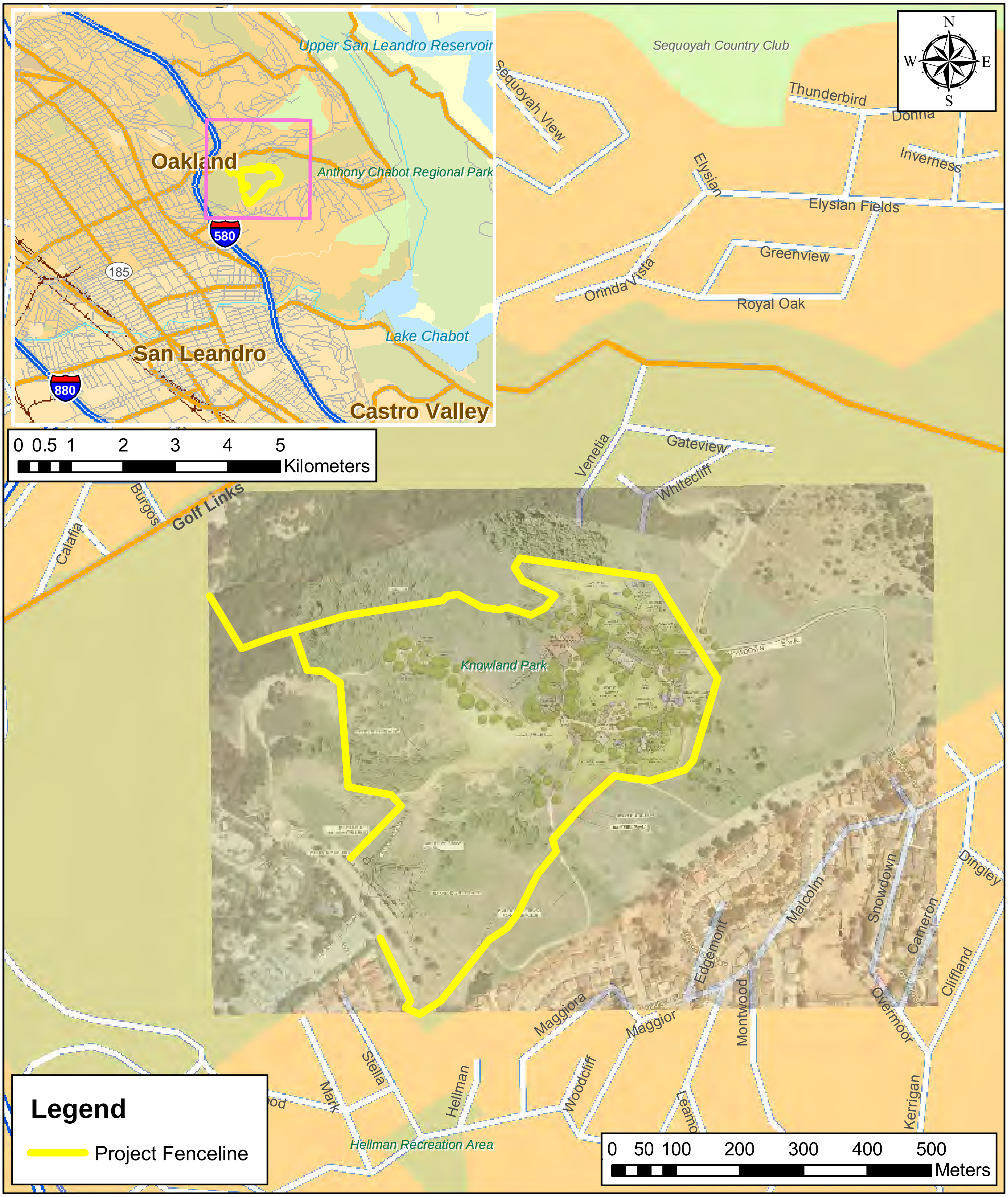
**Reference:**

[a] Bay Area Air Quality Management District. 2010. California Environmental Quality Act Air Quality Guidelines, June. Available at:
http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_June%202010.ashx

**D R A F T**

# Figures

Draft

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**Location of the Project**
**Oakland Zoo**
**Oakland, CA**

Figure
1

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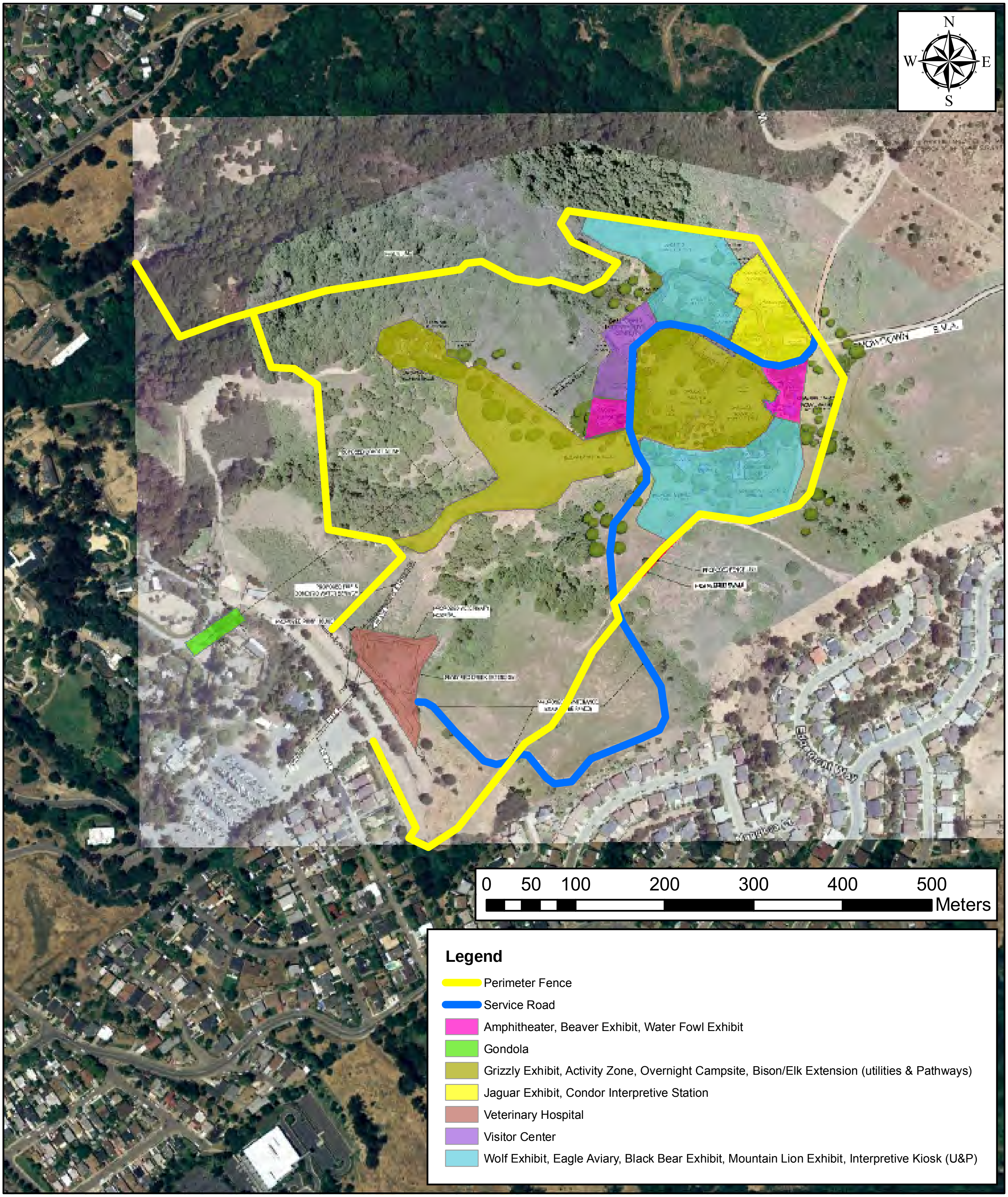
**Draft**




ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

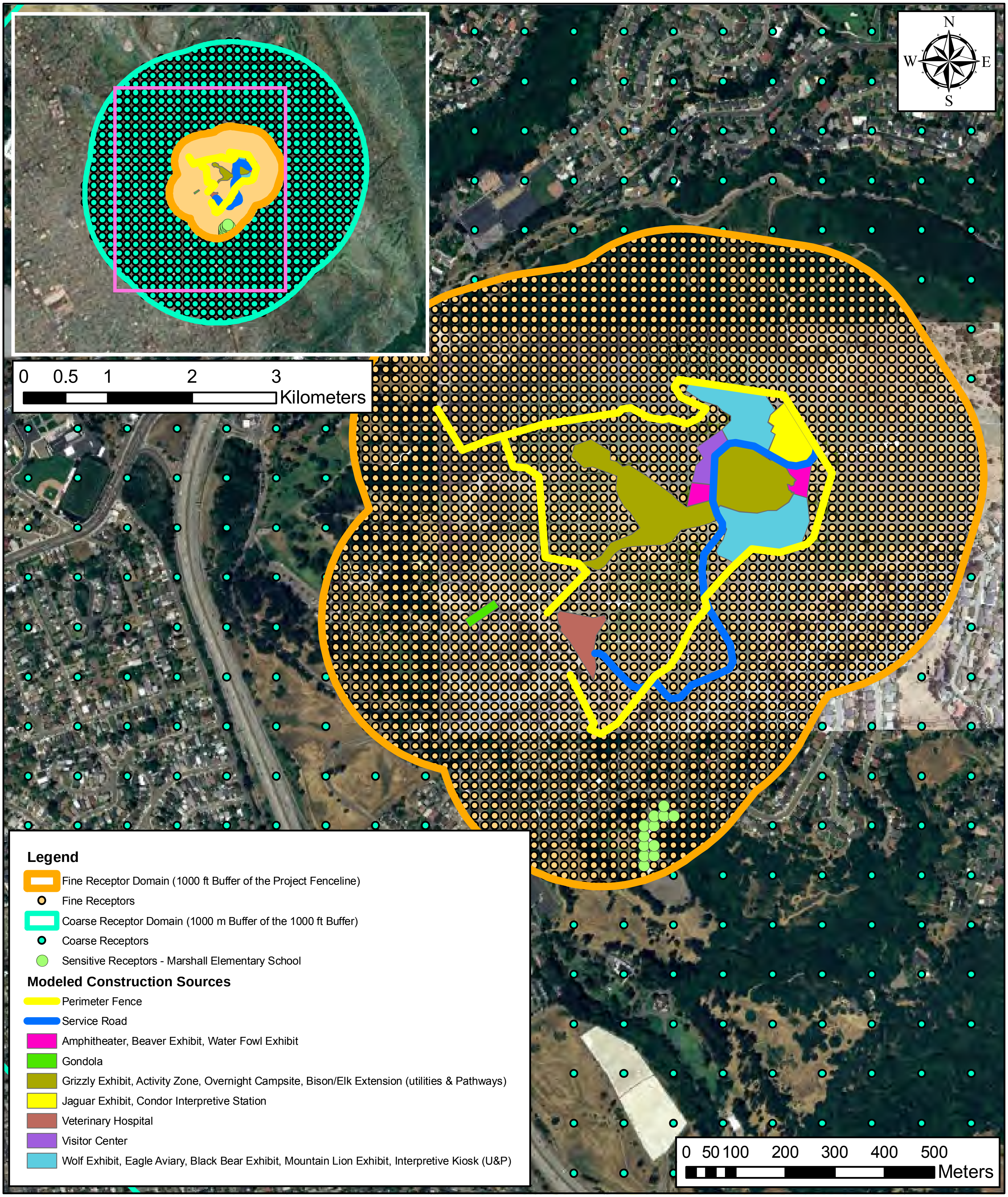
**Location of Modeled Construction Sources**
**Oakland Zoo**
**Oakland, CA**

Figure

2

Drafter: KZ Date: 5/11/2010 Contract Number: 03-23540A

Draft




ENVIRON

6001 Shellmound St., Suite 700, Emeryville, CA 94608

**Location of Modeled Receptors**
**Oakland Zoo**
**Oakland, CA**

Figure 3

Drafter: KZ Date: 5/11/2010 Contract Number: 03-23540A

# Appendix A

# Mobile Source URBEMIS Run

**6/15/2010 1:40:58 PM**

Urbemis 2007 Version 9.2.4

Detail Report for Annual Operational Unmitigated Emissions (Tons/Year)

File Name: U:\Oakland Zoo\Calculations\Mobile\Oakland Zoo_UPDATED.urb924

Project Name: Oakland Zoo

Project Location: Bay Area Air District

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

OPERATIONAL EMISSION ESTIMATES (Annual Tons Per Year, Unmitigated)

| Source | ROG | NOX | CO | SO2 | PM10 | PM25 | CO2 |
|---|---|---|---|---|---|---|---|
| Zoo | 0.18 | 0.26 | 2.40 | 0.00 | 0.55 | 0.10 | 293.41 |
| TOTALS (tons/year, unmitigated) | 0.18 | 0.26 | 2.40 | 0.00 | 0.55 | 0.10 | 293.41 |

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2015 Season: Annual

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

| Land Use Type | Acreage | Trip Rate | Unit Type | No. Units | Total Trips | Total VMT |
|---|---|---|---|---|---|---|
| Zoo | | 219.18 | unknown | 1.00 | 219.18 | 1,740.09 |
| | | | | | 219.18 | 1,740.09 |

Vehicle Fleet Mix

| Vehicle Type | Percent Type | Non-Catalyst | Catalyst | Diesel |
|---|---|---|---|---|
| Light Auto | 53.8 | 0.2 | 99.6 | 0.2 |

**6/15/2010 1:40:58 PM**

Vehicle Fleet Mix

| Vehicle Type | Percent Type | Non-Catalyst | Catalyst | Diesel |
|---|---|---|---|---|
| Light Truck < 3750 lbs | 12.7 | 0.8 | 96.8 | 2.4 |
| Light Truck 3751-5750 lbs | 19.9 | 0.0 | 100.0 | 0.0 |
| Med Truck 5751-8500 lbs | 6.6 | 0.0 | 100.0 | 0.0 |
| Lite-Heavy Truck 8501-10,000 lbs | 0.9 | 0.0 | 77.8 | 22.2 |
| Lite-Heavy Truck 10,001-14,000 lbs | 0.6 | 0.0 | 50.0 | 50.0 |
| Med-Heavy Truck 14,001-33,000 lbs | 1.0 | 0.0 | 20.0 | 80.0 |
| Heavy-Heavy Truck 33,001-60,000 lbs | 0.4 | 0.0 | 0.0 | 100.0 |
| Other Bus | 0.1 | 0.0 | 0.0 | 100.0 |
| Urban Bus | 0.1 | 0.0 | 0.0 | 100.0 |
| Motorcycle | 3.2 | 50.0 | 50.0 | 0.0 |
| School Bus | 0.1 | 0.0 | 0.0 | 100.0 |
| Motor Home | 0.6 | 0.0 | 83.3 | 16.7 |

Travel Conditions

| | Residential | | | Commercial | | |
|---|---|---|---|---|---|---|
| | Home-Work | Home-Shop | Home-Other | Commute | Non-Work | Customer |
| Urban Trip Length (miles) | 10.8 | 7.3 | 7.5 | 9.5 | 7.4 | 7.4 |
| Rural Trip Length (miles) | 16.8 | 7.1 | 7.9 | 14.7 | 6.6 | 6.6 |
| Trip speeds (mph) | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 |
| % of Trips - Residential | 32.9 | 18.0 | 49.1 | | | |

% of Trips - Commercial (by land use)

**6/15/2010 1:40:58 PM**

Travel Conditions

| | Residential | | | Commercial | | |
|---|---|---|---|---|---|---|
| | Home-Work | Home-Shop | Home-Other | Commute | Non-Work | Customer |
| Zoo | | | | 27.4 | 13.7 | 58.9 |

Operational Changes to Defaults

# Appendix B1

# Construction Phasing schedule

# PHASE I - April 2011 - March 2012

| Oakland Zoo - California Exhibit | | Hours of Operation | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fence, Service Road | | Approximate Quarter of Use | | | | | | |
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2011 | | | 2012 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Perimeter Fence | | | | | | | | |
| | Drill Rig | 16 | | | | | | |
| | Flatbed | 4 | | | | | | |
| | Bobcat | 40 | | | | | | |
| | | | | | | | | |
| Service Road | | | | | | | | |
| | Bulldozer | 90 | | | | | | |
| | Compactor | 24 | | | | | | |
| | Front-end Loader | 30 | | | | | | |
| | Paver | 16 | | | | | | |
| | Material Trucking | 8 | | | | | | |
| | Dump Truck | 10 | | | | | | |
| | Water Truck | 40 | | | | | | |

| Oakland Zoo - Veterinary Medical Hospital | | Hours of Operation | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | Approximate Month of Use | | | | | | |
| | | 2011 | | | 2012 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Dumpster - Pick-up | | 2 | 4 | 2 | 4 | 0 | | |
| Boom Lift | | 0 | 6 | 6 | 6 | 0 | | |
| Forklift | | 6 | 6 | 6 | 0 | 0 | | |
| Bulldozer | | 16 | 0 | 0 | 0 | 0 | | |
| Excavator | | 64 | 0 | 0 | 0 | 0 | | |
| Compact Excavator | | 0 | 0 | 0 | 16 | 0 | | |
| Compactor | | 32 | 0 | 0 | 16 | 0 | | |
| Backhoe | | 40 | 0 | 0 | 24 | 0 | | |
| Front-end Loader | | 64 | 0 | 0 | 16 | 0 | | |
| Paver | | 0 | 0 | 0 | 16 | 0 | | |
| Material Trucking | | 16 | 0 | 0 | 0 | 0 | | |
| Dump Truck | | 4 | 0 | 0 | 0 | 0 | | |
| Ready Mix Trucks | | 15 | 0 | 0 | 10 | 0 | | |
| Small-Med Flatbed | | 15 | 6 | 0 | 0 | 0 | | |
| Flatbed Semi Trucks | | 0 | 4 | 0 | 0 | 0 | | |
| Full Flatbed Semi Trucks (All) | | 0 | 16 | 18 | 12 | 0 | | |

# PHASE II - April 2012 - March 2013

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Gondola, Grissly Exhibit, Campsite, Bison, Activity Zone, Site Utilities & Pathways | | Hours of Operation Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2012 | | | 2013 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Gondola | | | | | | | | |
| | Tracked Excavator | 24 | 60 | | | | | |
| | Ready Mix Trucks | 37 | 20 | | | | | |
| | Small-Med Flatbed | 6 | 24 | | | | | |
| | Bobcat | 8 | 24 | | | | | |
| | 75 Ton Crane | 24 | 0 | | | | | |
| | Helicopter | 8 | 0 | | | | | |
| Grizzly Exhibit | | | | | | | | |
| Activity Zone | | | | | | | | |
| Overnight Campsite | | | | | | | | |
| Bison/Elk Extension | | | | | | | | |
| | Dumpster - Pick-up | 8 | 8 | 8 | 8 | | | |
| | Forklift | 2 | 8 | 8 | 8 | | | |
| | Portalbe Toilets - Servicing | 10 | 10 | 10 | 10 | | | |
| | Excavator | 80 | | 24 | | | | |
| | Bulldozer | 90 | 8 | | | | | |
| | Compactor | 16 | 8 | 8 | | | | |
| | Front-end Loader | 16 | 24 | 24 | 40 | | | |
| | Bobcat | 16 | 12 | 12 | 60 | | | |
| | Dump Truck | 10 | 6 | 6 | 16 | | | |
| | Ready Mix Trucks | | 10 | 10 | 10 | | | |
| | Med Flatbed | 8 | 8 | 8 | 8 | | | |
| | Small-Med Flatbed | 16 | 16 | 24 | 24 | | | |
| Main Site Utilities | | | | | | | | |
| | Excavator | 60 | | | | | | |
| | Backhoe | 60 | | 40 | 40 | | | |
| | Backfill Compactor | 40 | | 10 | | | | |
| | Dump Truck | 7 | 20 | 8 | 10 | | | |
| | Small-Med Flatbed | 10 | 8 | 8 | 8 | | | |
| | Ready Mix Trucks | 2 | 2 | | 10 | | | |
| | Paver | | | | 16 | | | |

# PHASE III - April 2013 - March 2014

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Wolf Exhibit, Eagle Aviary, Black Bear, Mountain Lion, Interpretive Kiosk, Site Utilities | | Hours of Operation Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2013 | | | 2014 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Wolf Exhibit | | | | | | | | |
| Eagle Aviary | | | | | | | | |
| Black Bear Exhibit | | | | | | | | |
| Mountain Lion Exhibit | | | | | | | | |
| Interpretive Kiosk | | | | | | | | |
| | Dumpster - Pick-up | 12 | 12 | 12 | 12 | | | |
| | Forklift | 8 | 16 | 8 | 8 | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | 6 | | | |
| | Bulldozer | 120 | 20 | 20 | 80 | | | |
| | Compactor | 16 | | | 24 | | | |
| | Front-end Loader | 120 | 60 | 60 | 80 | | | |
| | Dump Truck | 100 | 20 | 20 | 80 | | | |
| | Ready Mix Trucks | | 24 | 24 | 6 | | | |
| | Med Flatbed | | 10 | 10 | 8 | | | |
| | Drill Rig | | 8 | 8 | | | | |

# PHASE IV - April 2014 - March 2015

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Visitor Center, Jaguar Exhibit<br>Condor Interpretive Station | | Hours of Operation<br>Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2014 | | | | | | |
| | | Q2 | Q3 | Q4 | | | | |
| Visitor Center | | | | | | | | |
| | Dumpster - Pick-up | 8 | 10 | 10 | | | | |
| | Truck Cranes | | | 4 | | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | | | | |
| | Small-Med Flatbed | 30 | 30 | 30 | | | | |
| Jaguar Exhibit | | | | | | | | |
| Condor Interpretive Station | | | | | | | | |
| | Boom Lift | | 24 | 32 | | | | |
| | Forklift | 20 | 20 | 20 | | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | | | | |
| | Bulldozer | 16 | | 32 | | | | |
| | Compactor | 16 | | 32 | | | | |
| | Front-end Loader | 24 | 8 | 60 | | | | |
| | Material Trucking | 8 | 16 | 16 | | | | |
| | Dump Truck | 16 | | 8 | | | | |
| | Ready Mix Trucks | 10 | | 6 | | | | |
| | Small-Med Flatbed | 6 | 6 | 8 | | | | |
| | Drill Rig | | 16 | 8 | | | | |

# PHASE V - March 2015 - April 2016

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Amphitheater<br>Beaver Exhibit, Water Fowl Exhibit | | Hours of Operation<br>Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2015 | | | 2016 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Amphitheater | | | | | | | | |
| Beaver Exhibit | | | | | | | | |
| Water Fowl Exhibit | | | | | | | | |
| | Dumpster - Pick-up | 8 | 8 | 8 | | | | |
| | Boom Lift | | 12 | 16 | | | | |
| | Forklift | 10 | 10 | 10 | | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | | | | |
| | Excavator | 60 | 40 | | | | | |
| | Bulldozer | 20 | | 20 | | | | |
| | Compactor | 10 | | 16 | | | | |
| | Front-end Loader | 16 | 24 | 24 | | | | |
| | Material Trucking | 4 | 8 | 8 | | | | |
| | Dump Truck | 20 | 10 | 20 | | | | |
| | Ready Mix Trucks | | 20 | 10 | | | | |
| | Small-Med Flatbed | | 8 | 8 | | | | |

**PROPOSED MASTER PLAN AMENDMENT: CONSTRUCTION PHASING AND NUMBER OF CONSTRUCTION WORKERS**

| Phase | Duration | Construction Workers (peak daily number) |
|---|---|---|
| ***Phase 1*** | ***12 months*** | ***32 workers*** |
| Veterinary Medical Hospital | 12 months | 18 |
| Perimeter Fence | 3 months | 6 |
| Service Road | 2-3 months | 8 |
| ***Phase 2*** | ***8 months*** | ***43 workers*** |
| Gondola People-Moving System (including portion of California Interpretive Center building) | 8 months | 11 |
| Overnight Camping Area | 3 months | 3 |
| Grizzly Bear Exhibit | 8 months | 8 |
| Bison/Tule Elk Feeding Station | 1 month | 4 |
| Small Exhibit Activity Zone | 4 months | 5 |
| Main Site Utilities | 3 months | 12 |
| | | |
| ***Phase 3*** | ***6 months*** | ***31 workers*** |
| Wolf Exhibit | 6 months | 6 |
| Eagle Exhibit and Viewing Structures | 6 months | 14 |
| Black Bear and Mountain Lion Exhibits | 4 months | 3 |
| Interpretive Kiosk | 6 months | 8 |
| | | |
| ***Phase 4*** | ***8 months*** | ***34 workers*** |
| California Interpretive Center | 8 months | 18 |
| Jaguar Exhibit | 6 months | 8 |
| Condor Exhibit | 3 months | 8 |
| | | |
| ***Phase 5*** | ***8 months*** | ***20 workers*** |
| Amphitheater | 4 months | 10 |
| Beaver/Water Fowl Aviary | 6-8 months | 10 |

Source: Oakland Zoo, 2010.

# Appendix B2

# Construction OFFROAD Emission factors

| CY | Project Equipment | OFFROAD Equipment | Horsepower | Load Factor | Emission Factor | Units | Pollutant |
|---|---|---|---|---|---|---|---|
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.18 | g/hp-hr | NOX |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.20 | g/hp-hr | PM10 |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.16 | g/hp-hr | CH4 |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.58 | g/hp-hr | CO |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.49 | g/hp-hr | NOX |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.75 | g/hp-hr | ROG |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.09 | g/hp-hr | CH4 |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.72 | g/hp-hr | CO |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 6.68 | g/hp-hr | NOX |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 1.04 | g/hp-hr | ROG |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.09 | g/hp-hr | CH4 |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.98 | g/hp-hr | CO |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 6.22 | g/hp-hr | NOX |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 1.00 | g/hp-hr | ROG |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.07 | g/hp-hr | CH4 |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 5.64 | g/hp-hr | NOX |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.74 | g/hp-hr | ROG |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.07 | g/hp-hr | CH4 |
| 2010 | Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2010 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2010 | Excavator | Excavators | 168 | 0.57 | 5.64 | g/hp-hr | NOX |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.74 | g/hp-hr | ROG |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.07 | g/hp-hr | CH4 |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 5.59 | g/hp-hr | NOX |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.74 | g/hp-hr | ROG |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.07 | g/hp-hr | CH4 |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.38 | g/hp-hr | CO |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 6.15 | g/hp-hr | NOX |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.79 | g/hp-hr | ROG |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.12 | g/hp-hr | CH4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2010 | Paver | Pavers | 100 | 0.62 | 4.29 | g/hp-hr | CO |
| 2010 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2010 | Paver | Pavers | 100 | 0.62 | 7.96 | g/hp-hr | NOX |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2010 | Paver | Pavers | 100 | 0.62 | 1.35 | g/hp-hr | ROG |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.07 | g/hp-hr | CH4 |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 5.64 | g/hp-hr | NOX |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.74 | g/hp-hr | ROG |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.02 | g/hp-hr | CO |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 3.11 | g/hp-hr | NOX |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.27 | g/hp-hr | ROG |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.06 | g/hp-hr | CH4 |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.67 | g/hp-hr | CO |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 6.28 | g/hp-hr | NOX |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.64 | g/hp-hr | ROG |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 2.09 | g/hp-hr | CO |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 5.59 | g/hp-hr | NOX |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.57 | g/hp-hr | ROG |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.07 | g/hp-hr | CH4 |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.74 | g/hp-hr | CO |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 6.88 | g/hp-hr | NOX |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.78 | g/hp-hr | ROG |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 2.00 | g/hp-hr | CO |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 5.27 | g/hp-hr | NOX |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.48 | g/hp-hr | ROG |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 2.09 | g/hp-hr | CO |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 5.59 | g/hp-hr | NOX |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.57 | g/hp-hr | ROG |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |

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|---|---|---|---|---|---|---|---|
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.15 | g/hp-hr | NOX |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.17 | g/hp-hr | PM10 |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.14 | g/hp-hr | CH4 |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.37 | g/hp-hr | CO |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.41 | g/hp-hr | NOX |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.52 | g/hp-hr | ROG |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.09 | g/hp-hr | CH4 |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.69 | g/hp-hr | CO |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 6.31 | g/hp-hr | NOX |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.96 | g/hp-hr | ROG |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.08 | g/hp-hr | CH4 |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.94 | g/hp-hr | CO |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 5.81 | g/hp-hr | NOX |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.91 | g/hp-hr | ROG |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 5.25 | g/hp-hr | NOX |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.70 | g/hp-hr | ROG |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2011 | Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2011 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2011 | Excavator | Excavators | 168 | 0.57 | 5.25 | g/hp-hr | NOX |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.70 | g/hp-hr | ROG |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.06 | g/hp-hr | CH4 |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 5.13 | g/hp-hr | NOX |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.68 | g/hp-hr | ROG |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.07 | g/hp-hr | CH4 |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.37 | g/hp-hr | CO |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 5.78 | g/hp-hr | NOX |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.74 | g/hp-hr | ROG |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2011 | Paver | Pavers | 100 | 0.62 | 0.11 | g/hp-hr | CH4 |
| 2011 | Paver | Pavers | 100 | 0.62 | 4.24 | g/hp-hr | CO |
| 2011 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2011 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2011 | Paver | Pavers | 100 | 0.62 | 7.59 | g/hp-hr | NOX |

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|---|---|---|---|---|---|---|---|
| 2011 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2011 | Paver | Pavers | 100 | 0.62 | 1.27 | g/hp-hr | ROG |
| 2011 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 5.25 | g/hp-hr | NOX |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.70 | g/hp-hr | ROG |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 2.72 | g/hp-hr | NOX |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.26 | g/hp-hr | ROG |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.60 | g/hp-hr | CO |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 5.75 | g/hp-hr | NOX |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.60 | g/hp-hr | ROG |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.94 | g/hp-hr | CO |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 5.20 | g/hp-hr | NOX |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.54 | g/hp-hr | ROG |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.07 | g/hp-hr | CH4 |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.49 | g/hp-hr | CO |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 6.52 | g/hp-hr | NOX |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.75 | g/hp-hr | ROG |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.87 | g/hp-hr | CO |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 4.91 | g/hp-hr | NOX |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.45 | g/hp-hr | ROG |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 1.94 | g/hp-hr | CO |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 5.20 | g/hp-hr | NOX |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.54 | g/hp-hr | ROG |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.17 | g/hp-hr | PM10 |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |

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|---|---|---|---|---|---|---|---|
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.12 | g/hp-hr | CH4 |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.19 | g/hp-hr | CO |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.35 | g/hp-hr | NOX |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.33 | g/hp-hr | ROG |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.08 | g/hp-hr | CH4 |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.65 | g/hp-hr | CO |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 5.93 | g/hp-hr | NOX |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.89 | g/hp-hr | ROG |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.08 | g/hp-hr | CH4 |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.91 | g/hp-hr | CO |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 5.39 | g/hp-hr | NOX |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.84 | g/hp-hr | ROG |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 4.87 | g/hp-hr | NOX |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.65 | g/hp-hr | ROG |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2012 | Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2012 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2012 | Excavator | Excavators | 168 | 0.57 | 4.87 | g/hp-hr | NOX |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.65 | g/hp-hr | ROG |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.06 | g/hp-hr | CH4 |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 4.69 | g/hp-hr | NOX |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.63 | g/hp-hr | ROG |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.06 | g/hp-hr | CH4 |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.36 | g/hp-hr | CO |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 5.42 | g/hp-hr | NOX |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.70 | g/hp-hr | ROG |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.11 | g/hp-hr | CH4 |
| 2012 | Paver | Pavers | 100 | 0.62 | 4.19 | g/hp-hr | CO |
| 2012 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2012 | Paver | Pavers | 100 | 0.62 | 7.22 | g/hp-hr | NOX |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2012 | Paver | Pavers | 100 | 0.62 | 1.21 | g/hp-hr | ROG |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |

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|---|---|---|---|---|---|---|---|
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 4.87 | g/hp-hr | NOX |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.65 | g/hp-hr | ROG |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 2.40 | g/hp-hr | NOX |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.25 | g/hp-hr | ROG |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.53 | g/hp-hr | CO |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 5.26 | g/hp-hr | NOX |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.57 | g/hp-hr | ROG |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.80 | g/hp-hr | CO |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 4.84 | g/hp-hr | NOX |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.52 | g/hp-hr | ROG |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.27 | g/hp-hr | CO |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 6.18 | g/hp-hr | NOX |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.72 | g/hp-hr | ROG |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.75 | g/hp-hr | CO |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 4.58 | g/hp-hr | NOX |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.42 | g/hp-hr | ROG |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 1.80 | g/hp-hr | CO |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 4.84 | g/hp-hr | NOX |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.52 | g/hp-hr | ROG |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.16 | g/hp-hr | PM10 |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.10 | g/hp-hr | CH4 |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.04 | g/hp-hr | CO |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |

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|---|---|---|---|---|---|---|---|
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.07 | g/hp-hr | NOX |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.15 | g/hp-hr | ROG |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.07 | g/hp-hr | CH4 |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.61 | g/hp-hr | CO |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 5.55 | g/hp-hr | NOX |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.82 | g/hp-hr | ROG |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.07 | g/hp-hr | CH4 |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.88 | g/hp-hr | CO |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 5.02 | g/hp-hr | NOX |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.76 | g/hp-hr | ROG |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 4.52 | g/hp-hr | NOX |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.61 | g/hp-hr | ROG |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2013 | Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2013 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2013 | Excavator | Excavators | 168 | 0.57 | 4.52 | g/hp-hr | NOX |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.61 | g/hp-hr | ROG |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.05 | g/hp-hr | CH4 |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 4.29 | g/hp-hr | NOX |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.57 | g/hp-hr | ROG |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.06 | g/hp-hr | CH4 |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.35 | g/hp-hr | CO |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 5.08 | g/hp-hr | NOX |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.66 | g/hp-hr | ROG |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.10 | g/hp-hr | CH4 |
| 2013 | Paver | Pavers | 100 | 0.62 | 4.15 | g/hp-hr | CO |
| 2013 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2013 | Paver | Pavers | 100 | 0.62 | 6.86 | g/hp-hr | NOX |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2013 | Paver | Pavers | 100 | 0.62 | 1.14 | g/hp-hr | ROG |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 4.52 | g/hp-hr | NOX |

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|---|---|---|---|---|---|---|---|
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.61 | g/hp-hr | ROG |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 2.14 | g/hp-hr | NOX |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.24 | g/hp-hr | ROG |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.49 | g/hp-hr | CO |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 4.81 | g/hp-hr | NOX |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.54 | g/hp-hr | ROG |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.67 | g/hp-hr | CO |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 4.49 | g/hp-hr | NOX |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.49 | g/hp-hr | ROG |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.05 | g/hp-hr | CO |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 5.86 | g/hp-hr | NOX |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.69 | g/hp-hr | ROG |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.65 | g/hp-hr | CO |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 4.26 | g/hp-hr | NOX |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.39 | g/hp-hr | ROG |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 1.67 | g/hp-hr | CO |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 4.49 | g/hp-hr | NOX |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.49 | g/hp-hr | ROG |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.16 | g/hp-hr | PM10 |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.09 | g/hp-hr | CH4 |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.89 | g/hp-hr | CO |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.81 | g/hp-hr | NOX |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.99 | g/hp-hr | ROG |

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|---|---|---|---|---|---|---|---|
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.07 | g/hp-hr | CH4 |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.57 | g/hp-hr | CO |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 5.21 | g/hp-hr | NOX |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.74 | g/hp-hr | ROG |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.06 | g/hp-hr | CH4 |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.85 | g/hp-hr | CO |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 4.67 | g/hp-hr | NOX |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.70 | g/hp-hr | ROG |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 4.22 | g/hp-hr | NOX |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.57 | g/hp-hr | ROG |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2014 | Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2014 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2014 | Excavator | Excavators | 168 | 0.57 | 4.22 | g/hp-hr | NOX |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.57 | g/hp-hr | ROG |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.05 | g/hp-hr | CH4 |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 3.91 | g/hp-hr | NOX |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.53 | g/hp-hr | ROG |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.06 | g/hp-hr | CH4 |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.35 | g/hp-hr | CO |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 4.77 | g/hp-hr | NOX |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.62 | g/hp-hr | ROG |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.10 | g/hp-hr | CH4 |
| 2014 | Paver | Pavers | 100 | 0.62 | 4.12 | g/hp-hr | CO |
| 2014 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2014 | Paver | Pavers | 100 | 0.62 | 6.53 | g/hp-hr | NOX |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2014 | Paver | Pavers | 100 | 0.62 | 1.08 | g/hp-hr | ROG |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 4.22 | g/hp-hr | NOX |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.57 | g/hp-hr | ROG |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.74 | g/hp-hr | NOX |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.22 | g/hp-hr | ROG |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.46 | g/hp-hr | CO |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 4.30 | g/hp-hr | NOX |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.52 | g/hp-hr | ROG |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.56 | g/hp-hr | CO |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 4.10 | g/hp-hr | NOX |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.46 | g/hp-hr | ROG |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 2.85 | g/hp-hr | CO |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 5.49 | g/hp-hr | NOX |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.66 | g/hp-hr | ROG |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.03 | g/hp-hr | CH4 |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.56 | g/hp-hr | CO |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 3.89 | g/hp-hr | NOX |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.37 | g/hp-hr | ROG |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 1.56 | g/hp-hr | CO |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 4.10 | g/hp-hr | NOX |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.46 | g/hp-hr | ROG |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.16 | g/hp-hr | PM10 |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.08 | g/hp-hr | CH4 |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.76 | g/hp-hr | CO |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.57 | g/hp-hr | NOX |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.84 | g/hp-hr | ROG |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.06 | g/hp-hr | CH4 |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.54 | g/hp-hr | CO |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 4.83 | g/hp-hr | NOX |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.67 | g/hp-hr | ROG |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.06 | g/hp-hr | CH4 |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.82 | g/hp-hr | CO |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 4.25 | g/hp-hr | NOX |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.63 | g/hp-hr | ROG |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 3.75 | g/hp-hr | NOX |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.53 | g/hp-hr | ROG |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2015 | Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2015 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2015 | Excavator | Excavators | 168 | 0.57 | 3.75 | g/hp-hr | NOX |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.53 | g/hp-hr | ROG |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.04 | g/hp-hr | CH4 |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 3.36 | g/hp-hr | CO |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 3.46 | g/hp-hr | NOX |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.49 | g/hp-hr | ROG |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.05 | g/hp-hr | CH4 |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.34 | g/hp-hr | CO |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 4.32 | g/hp-hr | NOX |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.58 | g/hp-hr | ROG |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.09 | g/hp-hr | CH4 |
| 2015 | Paver | Pavers | 100 | 0.62 | 4.08 | g/hp-hr | CO |
| 2015 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2015 | Paver | Pavers | 100 | 0.62 | 6.14 | g/hp-hr | NOX |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2015 | Paver | Pavers | 100 | 0.62 | 1.01 | g/hp-hr | ROG |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 3.75 | g/hp-hr | NOX |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.53 | g/hp-hr | ROG |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.40 | g/hp-hr | NOX |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.20 | g/hp-hr | ROG |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.04 | g/hp-hr | CH4 |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.44 | g/hp-hr | CO |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 3.82 | g/hp-hr | NOX |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.49 | g/hp-hr | ROG |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.47 | g/hp-hr | CO |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 3.73 | g/hp-hr | NOX |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.44 | g/hp-hr | ROG |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 2.67 | g/hp-hr | CO |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 5.14 | g/hp-hr | NOX |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.63 | g/hp-hr | ROG |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.03 | g/hp-hr | CH4 |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.48 | g/hp-hr | CO |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 3.55 | g/hp-hr | NOX |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.34 | g/hp-hr | ROG |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 1.47 | g/hp-hr | CO |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 3.73 | g/hp-hr | NOX |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.44 | g/hp-hr | ROG |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |

# Appendix B3

## Construction Mobile EMFAC Output

**Modeled Mobile Sources**

| Project Vehicle | EMFAC Vehicle Class | Fuel |
|---|---|---|
| Dump Truck | MHDT | Diesel |
| Dumpster - Pick-up | MHDT | Diesel |
| Flatbed | MHDT | Diesel |
| Flatbed Semi Trucks | MHDT | Diesel |
| Full Flatbed Semi Trucks (All) | MHDT | Diesel |
| Material Trucking | MHDT | Diesel |
| Med Flatbed | MHDT | Diesel |
| Ready Mix Trucks | MHDT | Diesel |
| Small-Med Flatbed | MHDT | Diesel |

| Employee Vehicle | EFMAC Vehicle Class | Fuel |
|---|---|---|
| Passenger Car | LDA | All |
| Light-Duty Truck (GVW <3,750 lb) | LDT1 | All |
| Light-Duty Truck (GVW >3,750 lb) | LDT2 | All |

**<u>Abbreviations</u>**
GVW: Gross Vehicle Weight
LDA: Light-Duty Auto
LDT: Light-Duty Truck
MHDT: Medium Heavy-Duty Truck

**EMFAC Running Log (Oakland Zoo.inp)**

```
Emfac2007-Header
   Version 2 30 3 501
   Scenario-Count 1
End-Header
Begin-Scenario 1
   Title Oakland Zoo
   Program-Mode Emfac
   Area-Method One-County
   Area-Type County
   Area-Number 1 [Alameda County]
   HC-Mode ROG
   PM-Mode PM10
   CYr 2010 2011 2012 2013 2014
   MYr All
   Vehicles LDA LDT1 LDT2 MHD
   Season Annual
   Emfac-Reports RTL
   Emfac-Speed 0 5. 10. 15. 20. 25. 30. 35. 40. 45. 50. 55. 60. 65.
   Emfac-RH 75.
   Emfac-Temp 59.
End-Scenario
```

**Emission Factors by Vehicle Type by Year**

| Year | Vehicle Class | nission Fact | Units | Pollutants | Emission Type |
|---|---|---|---|---|---|
| 2010 | MHDT | 0.242 | g/mile | ROG | Running |
| 2011 | MHDT | 0.233 | g/mile | ROG | Running |
| 2012 | MHDT | 0.224 | g/mile | ROG | Running |
| 2013 | MHDT | 0.214 | g/mile | ROG | Running |
| 2014 | MHDT | 0.204 | g/mile | ROG | Running |
| 2015 | MHDT | 0.194 | g/mile | ROG | Running |
| 2010 | MHDT | 2.061 | g/mile | CO | Running |
| 2011 | MHDT | 2.016 | g/mile | CO | Running |
| 2012 | MHDT | 1.965 | g/mile | CO | Running |
| 2013 | MHDT | 1.91 | g/mile | CO | Running |
| 2014 | MHDT | 1.854 | g/mile | CO | Running |
| 2015 | MHDT | 1.798 | g/mile | CO | Running |
| 2010 | MHDT | 7.102 | g/mile | NOx | Running |
| 2011 | MHDT | 6.511 | g/mile | NOx | Running |
| 2012 | MHDT | 5.937 | g/mile | NOx | Running |
| 2013 | MHDT | 5.384 | g/mile | NOx | Running |
| 2014 | MHDT | 4.866 | g/mile | NOx | Running |
| 2015 | MHDT | 4.38 | g/mile | NOx | Running |
| 2010 | MHDT | 1505 | g/mile | CO2 | Running |
| 2011 | MHDT | 1505 | g/mile | CO2 | Running |
| 2012 | MHDT | 1505 | g/mile | CO2 | Running |
| 2013 | MHDT | 1505 | g/mile | CO2 | Running |
| 2014 | MHDT | 1505 | g/mile | CO2 | Running |
| 2015 | MHDT | 1505 | g/mile | CO2 | Running |
| 2010 | MHDT | 0.014 | g/mile | SOx | Running |
| 2011 | MHDT | 0.014 | g/mile | SOx | Running |
| 2012 | MHDT | 0.014 | g/mile | SOx | Running |
| 2013 | MHDT | 0.014 | g/mile | SOx | Running |
| 2014 | MHDT | 0.014 | g/mile | SOx | Running |
| 2015 | MHDT | 0.014 | g/mile | SOx | Running |
| 2010 | MHDT | 0.295 | g/mile | PM10 | Running |
| 2011 | MHDT | 0.282 | g/mile | PM10 | Running |
| 2012 | MHDT | 0.268 | g/mile | PM10 | Running |
| 2013 | MHDT | 0.255 | g/mile | PM10 | Running |
| 2014 | MHDT | 0.241 | g/mile | PM10 | Running |
| 2015 | MHDT | 0.229 | g/mile | PM10 | Running |
| 2010 | LDA | 0.11 | g/mile | ROG | Running |
| 2011 | LDA | 0.092 | g/mile | ROG | Running |
| 2012 | LDA | 0.077 | g/mile | ROG | Running |
| 2013 | LDA | 0.065 | g/mile | ROG | Running |
| 2014 | LDA | 0.055 | g/mile | ROG | Running |
| 2015 | LDA | 0.047 | g/mile | ROG | Running |
| 2010 | LDA | 2.869 | g/mile | CO | Running |
| 2011 | LDA | 2.56 | g/mile | CO | Running |
| 2012 | LDA | 2.29 | g/mile | CO | Running |
| 2013 | LDA | 2.059 | g/mile | CO | Running |
| 2014 | LDA | 1.853 | g/mile | CO | Running |
| 2015 | LDA | 1.678 | g/mile | CO | Running |
| 2010 | LDA | 0.25 | g/mile | NOx | Running |
| 2011 | LDA | 0.221 | g/mile | NOx | Running |
| 2012 | LDA | 0.196 | g/mile | NOx | Running |
| 2013 | LDA | 0.175 | g/mile | NOx | Running |

| | | | | | |
|---|---|---|---|---|---|
| 2014 | LDA | 0.156 | g/mile | NOx | Running |
| 2015 | LDA | 0.14 | g/mile | NOx | Running |
| 2010 | LDA | 389.562 | g/mile | CO2 | Running |
| 2011 | LDA | 388.335 | g/mile | CO2 | Running |
| 2012 | LDA | 387.131 | g/mile | CO2 | Running |
| 2013 | LDA | 386.107 | g/mile | CO2 | Running |
| 2014 | LDA | 385.222 | g/mile | CO2 | Running |
| 2015 | LDA | 384.281 | g/mile | CO2 | Running |
| 2010 | LDA | 0.004 | g/mile | SOx | Running |
| 2011 | LDA | 0.004 | g/mile | SOx | Running |
| 2012 | LDA | 0.004 | g/mile | SOx | Running |
| 2013 | LDA | 0.004 | g/mile | SOx | Running |
| 2014 | LDA | 0.004 | g/mile | SOx | Running |
| 2015 | LDA | 0.004 | g/mile | SOx | Running |
| 2010 | LDA | 0.013 | g/mile | PM10 | Running |
| 2011 | LDA | 0.013 | g/mile | PM10 | Running |
| 2012 | LDA | 0.013 | g/mile | PM10 | Running |
| 2013 | LDA | 0.013 | g/mile | PM10 | Running |
| 2014 | LDA | 0.013 | g/mile | PM10 | Running |
| 2015 | LDA | 0.013 | g/mile | PM10 | Running |
| 2010 | LDT1 | 0.201 | g/mile | ROG | Running |
| 2011 | LDT1 | 0.175 | g/mile | ROG | Running |
| 2012 | LDT1 | 0.152 | g/mile | ROG | Running |
| 2013 | LDT1 | 0.131 | g/mile | ROG | Running |
| 2014 | LDT1 | 0.112 | g/mile | ROG | Running |
| 2015 | LDT1 | 0.096 | g/mile | ROG | Running |
| 2010 | LDT1 | 5.022 | g/mile | CO | Running |
| 2011 | LDT1 | 4.554 | g/mile | CO | Running |
| 2012 | LDT1 | 4.116 | g/mile | CO | Running |
| 2013 | LDT1 | 3.707 | g/mile | CO | Running |
| 2014 | LDT1 | 3.341 | g/mile | CO | Running |
| 2015 | LDT1 | 3.015 | g/mile | CO | Running |
| 2010 | LDT1 | 0.456 | g/mile | NOx | Running |
| 2011 | LDT1 | 0.412 | g/mile | NOx | Running |
| 2012 | LDT1 | 0.371 | g/mile | NOx | Running |
| 2013 | LDT1 | 0.334 | g/mile | NOx | Running |
| 2014 | LDT1 | 0.301 | g/mile | NOx | Running |
| 2015 | LDT1 | 0.271 | g/mile | NOx | Running |
| 2010 | LDT1 | 479.718 | g/mile | CO2 | Running |
| 2011 | LDT1 | 479.817 | g/mile | CO2 | Running |
| 2012 | LDT1 | 479.717 | g/mile | CO2 | Running |
| 2013 | LDT1 | 479.608 | g/mile | CO2 | Running |
| 2014 | LDT1 | 479.498 | g/mile | CO2 | Running |
| 2015 | LDT1 | 479.156 | g/mile | CO2 | Running |
| 2010 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2011 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2012 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2013 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2014 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2015 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2010 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2011 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2012 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2013 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2014 | LDT1 | 0.017 | g/mile | PM10 | Running |

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|---|---|---|---|---|---|
| 2015 | LDT1 | 0.016 | g/mile | PM10 | Running |
| 2010 | LDT2 | 0.115 | g/mile | ROG | Running |
| 2011 | LDT2 | 0.104 | g/mile | ROG | Running |
| 2012 | LDT2 | 0.094 | g/mile | ROG | Running |
| 2013 | LDT2 | 0.084 | g/mile | ROG | Running |
| 2014 | LDT2 | 0.075 | g/mile | ROG | Running |
| 2015 | LDT2 | 0.067 | g/mile | ROG | Running |
| 2010 | LDT2 | 3.55 | g/mile | CO | Running |
| 2011 | LDT2 | 3.342 | g/mile | CO | Running |
| 2012 | LDT2 | 3.139 | g/mile | CO | Running |
| 2013 | LDT2 | 2.939 | g/mile | CO | Running |
| 2014 | LDT2 | 2.744 | g/mile | CO | Running |
| 2015 | LDT2 | 2.561 | g/mile | CO | Running |
| 2010 | LDT2 | 0.44 | g/mile | NOx | Running |
| 2011 | LDT2 | 0.407 | g/mile | NOx | Running |
| 2012 | LDT2 | 0.377 | g/mile | NOx | Running |
| 2013 | LDT2 | 0.347 | g/mile | NOx | Running |
| 2014 | LDT2 | 0.319 | g/mile | NOx | Running |
| 2015 | LDT2 | 0.293 | g/mile | NOx | Running |
| 2010 | LDT2 | 484.079 | g/mile | CO2 | Running |
| 2011 | LDT2 | 484.2 | g/mile | CO2 | Running |
| 2012 | LDT2 | 484.307 | g/mile | CO2 | Running |
| 2013 | LDT2 | 484.402 | g/mile | CO2 | Running |
| 2014 | LDT2 | 484.486 | g/mile | CO2 | Running |
| 2015 | LDT2 | 484.559 | g/mile | CO2 | Running |
| 2010 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2011 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2012 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2013 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2014 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2015 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2010 | LDT2 | 0.029 | g/mile | PM10 | Running |
| 2011 | LDT2 | 0.029 | g/mile | PM10 | Running |
| 2012 | LDT2 | 0.03 | g/mile | PM10 | Running |
| 2013 | LDT2 | 0.031 | g/mile | PM10 | Running |
| 2014 | LDT2 | 0.031 | g/mile | PM10 | Running |
| 2015 | LDT2 | 0.032 | g/mile | PM10 | Running |
| 2010 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2011 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2012 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2013 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2014 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2015 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2010 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2011 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2012 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2013 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2014 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2015 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2010 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2011 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2012 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2013 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2014 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2015 | MHDT | 75.051 | g/idle-hour | NOx | Idling |

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|---|---|---|---|---|---|
| 2010 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2011 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2012 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2013 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2014 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2015 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2010 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2011 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2012 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2013 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2014 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2015 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2010 | MHDT | 0.917 | g/idle-hour | PM10 | Idling |
| 2011 | MHDT | 0.903 | g/idle-hour | PM10 | Idling |
| 2012 | MHDT | 0.891 | g/idle-hour | PM10 | Idling |
| 2013 | MHDT | 0.879 | g/idle-hour | PM10 | Idling |
| 2014 | MHDT | 0.869 | g/idle-hour | PM10 | Idling |
| 2015 | MHDT | 0.861 | g/idle-hour | PM10 | Idling |
| 2010 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2011 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2012 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2013 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2014 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2015 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2010 | LDA | 0 | g/idle-hour | CO | Idling |
| 2011 | LDA | 0 | g/idle-hour | CO | Idling |
| 2012 | LDA | 0 | g/idle-hour | CO | Idling |
| 2013 | LDA | 0 | g/idle-hour | CO | Idling |
| 2014 | LDA | 0 | g/idle-hour | CO | Idling |
| 2015 | LDA | 0 | g/idle-hour | CO | Idling |
| 2010 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2011 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2012 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2013 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2014 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2015 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2010 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2011 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2012 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2013 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2014 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2015 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2010 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2011 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2012 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2013 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2014 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2015 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2010 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2011 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2012 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2013 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2014 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2015 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | ROG | Idling |

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|---|---|---|---|---|---|
| 2011 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | CO2 | Idling |

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|---|---|---|---|---|---|
| 2012 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2010 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2011 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2012 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2013 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2014 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2015 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2010 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2011 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2012 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2013 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2014 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2015 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2010 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2011 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2012 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2013 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2014 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2015 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2010 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2011 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2012 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2013 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2014 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2015 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2010 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2011 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2012 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2013 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2014 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2015 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2010 | MHDT | 0.917 | g/idle-hour | PM10 | Startup |
| 2011 | MHDT | 0.903 | g/idle-hour | PM10 | Startup |
| 2012 | MHDT | 0.891 | g/idle-hour | PM10 | Startup |
| 2013 | MHDT | 0.879 | g/idle-hour | PM10 | Startup |
| 2014 | MHDT | 0.869 | g/idle-hour | PM10 | Startup |
| 2015 | MHDT | 0.861 | g/idle-hour | PM10 | Startup |
| 2010 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2011 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2012 | LDA | 0 | g/idle-hour | ROG | Startup |

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|---|---|---|---|---|---|
| 2013 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2014 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2015 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2010 | LDA | 0 | g/idle-hour | CO | Startup |
| 2011 | LDA | 0 | g/idle-hour | CO | Startup |
| 2012 | LDA | 0 | g/idle-hour | CO | Startup |
| 2013 | LDA | 0 | g/idle-hour | CO | Startup |
| 2014 | LDA | 0 | g/idle-hour | CO | Startup |
| 2015 | LDA | 0 | g/idle-hour | CO | Startup |
| 2010 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2011 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2012 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2013 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2014 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2015 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2010 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2011 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2012 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2013 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2014 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2015 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2010 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2011 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2012 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2013 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2014 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2015 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2010 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2011 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2012 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2013 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2014 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2015 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | CO2 | Startup |

| | | | | | |
|---|---|---|---|---|---|
| 2014 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2010 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2011 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2012 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2013 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2014 | MHDT | 0 | g/trip | ROG | Hot Soak |

| | | | | | |
|---|---|---|---|---|---|
| 2015 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2010 | LDA | 0.256 | g/trip | ROG | Hot Soak |
| 2011 | LDA | 0.247 | g/trip | ROG | Hot Soak |
| 2012 | LDA | 0.238 | g/trip | ROG | Hot Soak |
| 2013 | LDA | 0.23 | g/trip | ROG | Hot Soak |
| 2014 | LDA | 0.222 | g/trip | ROG | Hot Soak |
| 2015 | LDA | 0.214 | g/trip | ROG | Hot Soak |
| 2010 | LDT1 | 0.331 | g/trip | ROG | Hot Soak |
| 2011 | LDT1 | 0.325 | g/trip | ROG | Hot Soak |
| 2012 | LDT1 | 0.317 | g/trip | ROG | Hot Soak |
| 2013 | LDT1 | 0.309 | g/trip | ROG | Hot Soak |
| 2014 | LDT1 | 0.3 | g/trip | ROG | Hot Soak |
| 2015 | LDT1 | 0.291 | g/trip | ROG | Hot Soak |
| 2010 | LDT2 | 0.212 | g/trip | ROG | Hot Soak |
| 2011 | LDT2 | 0.217 | g/trip | ROG | Hot Soak |
| 2012 | LDT2 | 0.221 | g/trip | ROG | Hot Soak |
| 2013 | LDT2 | 0.225 | g/trip | ROG | Hot Soak |
| 2014 | LDT2 | 0.227 | g/trip | ROG | Hot Soak |
| 2015 | LDT2 | 0.228 | g/trip | ROG | Hot Soak |
| 2010 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2011 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2012 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2013 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2014 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2015 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2010 | LDA | 0.06 | g/hour | ROG | Diurnal |
| 2011 | LDA | 0.056 | g/hour | ROG | Diurnal |
| 2012 | LDA | 0.053 | g/hour | ROG | Diurnal |
| 2013 | LDA | 0.05 | g/hour | ROG | Diurnal |
| 2014 | LDA | 0.047 | g/hour | ROG | Diurnal |
| 2015 | LDA | 0.045 | g/hour | ROG | Diurnal |
| 2010 | LDT1 | 0.08 | g/hour | ROG | Diurnal |
| 2011 | LDT1 | 0.078 | g/hour | ROG | Diurnal |
| 2012 | LDT1 | 0.075 | g/hour | ROG | Diurnal |
| 2013 | LDT1 | 0.072 | g/hour | ROG | Diurnal |
| 2014 | LDT1 | 0.069 | g/hour | ROG | Diurnal |
| 2015 | LDT1 | 0.067 | g/hour | ROG | Diurnal |
| 2010 | LDT2 | 0.051 | g/hour | ROG | Diurnal |
| 2011 | LDT2 | 0.05 | g/hour | ROG | Diurnal |
| 2012 | LDT2 | 0.05 | g/hour | ROG | Diurnal |
| 2013 | LDT2 | 0.05 | g/hour | ROG | Diurnal |
| 2014 | LDT2 | 0.049 | g/hour | ROG | Diurnal |
| 2015 | LDT2 | 0.049 | g/hour | ROG | Diurnal |
| 2010 | MHDT | 0 | g/min | ROG | Evaporative |
| 2011 | MHDT | 0 | g/min | ROG | Evaporative |
| 2012 | MHDT | 0 | g/min | ROG | Evaporative |
| 2013 | MHDT | 0 | g/min | ROG | Evaporative |
| 2014 | MHDT | 0 | g/min | ROG | Evaporative |
| 2015 | MHDT | 0 | g/min | ROG | Evaporative |
| 2010 | LDA | 0.026 | g/min | ROG | Evaporative |
| 2011 | LDA | 0.023 | g/min | ROG | Evaporative |
| 2012 | LDA | 0.02 | g/min | ROG | Evaporative |
| 2013 | LDA | 0.019 | g/min | ROG | Evaporative |
| 2014 | LDA | 0.017 | g/min | ROG | Evaporative |
| 2015 | LDA | 0.015 | g/min | ROG | Evaporative |

| | | | | | |
|---|---|---|---|---|---|
| 2010 | LDT1 | 0.605 | g/min | ROG | Evaporative |
| 2011 | LDT1 | 0.602 | g/min | ROG | Evaporative |
| 2012 | LDT1 | 0.591 | g/min | ROG | Evaporative |
| 2013 | LDT1 | 0.576 | g/min | ROG | Evaporative |
| 2014 | LDT1 | 0.558 | g/min | ROG | Evaporative |
| 2015 | LDT1 | 0.538 | g/min | ROG | Evaporative |
| 2010 | LDT2 | 0.379 | g/min | ROG | Evaporative |
| 2011 | LDT2 | 0.384 | g/min | ROG | Evaporative |
| 2012 | LDT2 | 0.385 | g/min | ROG | Evaporative |
| 2013 | LDT2 | 0.384 | g/min | ROG | Evaporative |
| 2014 | LDT2 | 0.381 | g/min | ROG | Evaporative |
| 2015 | LDT2 | 0.376 | g/min | ROG | Evaporative |

**D R A F T**

# Appendix B4

# Construction Helicopter EDMS Output

# EDMS 5.1.2 Emissions Inventory Report
# Aircraft Emissions by Mode
# Study: Oakland Zoo 2
# Scenario - Airport: Baseline - Metropolitan Oakland Intl
# Year: 2011
# Units: Grams per Year
# Generated: 01/12/10 11:23:59

| # Type | Engine | ID | Euro. Grou | Mode | CO2 | CO | THC | NMHC | VOC |
|---|---|---|---|---|---|---|---|---|---|
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Startup | N/A | N/A | N/A | N/A | N/A |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Taxi Out | 173839.8 | 48.182 | 7.118 | 8.23 | 8.187 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Takeoff | 20014.29 | 5.547 | 0.819 | 0.948 | 0.943 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Climb Out | 40059.05 | 11.103 | 1.64 | 1.896 | 1.887 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Approach | 42944.6 | 11.903 | 1.758 | 2.033 | 2.022 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Taxi In | 64046.24 | 17.751 | 2.622 | 3.032 | 3.016 |

| **Mode** | **Mode Duration (min)** | |
|---|---|---|
| | **Model Default** | **Assumption For Emissions Calculation** |
| Taxi Out | 19 | 480 |
| Takeoff | 2.27 | 480 |
| Climbout | 4.53 | 480 |
| Approach | 6.8 | 480 |
| Landing Roll | 0 | 480 |
| Taxi in | 7 | 480 |

| TOG | NOx | SOx | PM-10 | PM-2.5 | Fuel Cons | Formaldeh | Methyl alc | Benzene ( | Acetaldehy | Naphthale | O-xylene ( | Isopropylb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 8.23 | 312.078 | 71.189 | N/A | N/A | 55099.77 | 1.013 | 0.149 | 0.138 | 0.352 | 0.045 | 0.014 | 0 |
| 0.948 | 35.93 | 8.196 | N/A | N/A | 6343.674 | 0.117 | 0.017 | 0.016 | 0.04 | 0.005 | 0.002 | 0 |
| 1.896 | 71.914 | 16.405 | N/A | N/A | 12697.01 | 0.233 | 0.034 | 0.032 | 0.081 | 0.01 | 0.003 | 0 |
| 2.033 | 77.094 | 17.586 | N/A | N/A | 13611.6 | 0.25 | 0.037 | 0.034 | 0.087 | 0.011 | 0.003 | 0 |
| 3.032 | 114.976 | 26.227 | N/A | N/A | 20299.92 | 0.373 | 0.055 | 0.051 | 0.13 | 0.016 | 0.005 | 0 |

| Ethylbenz | Styrene (I | 1,3-butadi | Acrolein (I | Toluene (I | Phenol (ca | M & P-xyle | Propionalc | Acetone (I | 2-methylna | Benzaldeh | N-heptane | Ethane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.014 | 0.025 | 0.139 | 0.202 | 0.053 | 0.06 | 0.023 | 0.06 | 0.03 | 0.017 | 0.039 | 0.005 | 0.043 |
| 0.002 | 0.003 | 0.016 | 0.023 | 0.006 | 0.007 | 0.003 | 0.007 | 0.003 | 0.002 | 0.004 | 0.001 | 0.005 |
| 0.003 | 0.006 | 0.032 | 0.046 | 0.012 | 0.014 | 0.005 | 0.014 | 0.007 | 0.004 | 0.009 | 0.001 | 0.01 |
| 0.004 | 0.006 | 0.034 | 0.05 | 0.013 | 0.015 | 0.006 | 0.015 | 0.008 | 0.004 | 0.01 | 0.001 | 0.011 |
| 0.005 | 0.009 | 0.051 | 0.074 | 0.019 | 0.022 | 0.009 | 0.022 | 0.011 | 0.006 | 0.014 | 0.002 | 0.016 |

| Ethylene | Acetylene | Propane | 2-methyl-2 | Methylglyc | 1-Methylna | 1,2,4-trime | N-propylbe | p-Toluald | 1-butene | Glyoxal | 2-methylp | 1,3,5-trime |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1.272 | 0.324 | 0.006 | 0.035 | 0.124 | 0.02 | 0.029 | 0.004 | 0.004 | 0.144 | 0.149 | 0.034 | 0.004 |
| 0.146 | 0.037 | 0.001 | 0.004 | 0.014 | 0.002 | 0.003 | 0.001 | 0 | 0.017 | 0.017 | 0.004 | 0.001 |
| 0.293 | 0.075 | 0.001 | 0.008 | 0.029 | 0.005 | 0.007 | 0.001 | 0.001 | 0.033 | 0.034 | 0.008 | 0.001 |
| 0.314 | 0.08 | 0.002 | 0.009 | 0.031 | 0.005 | 0.007 | 0.001 | 0.001 | 0.036 | 0.037 | 0.008 | 0.001 |
| 0.469 | 0.119 | 0.002 | 0.013 | 0.046 | 0.007 | 0.011 | 0.002 | 0.001 | 0.053 | 0.055 | 0.012 | 0.002 |

| N-pentane | 1-pentene | Valeraldeh | N-octane | 1-octene | N-nonane | N-dodecan | Propylene | Butyraldeh | 1-nonene | N-decane | 2-methyl-2 | 1,2,3-trime |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.016 | 0.064 | 0.02 | 0.005 | 0.023 | 0.005 | 0.038 | 0.373 | 0.01 | 0.02 | 0.026 | 0.015 | 0.009 |
| 0.002 | 0.007 | 0.002 | 0.001 | 0.003 | 0.001 | 0.004 | 0.043 | 0.001 | 0.002 | 0.003 | 0.002 | 0.001 |
| 0.004 | 0.015 | 0.005 | 0.001 | 0.005 | 0.001 | 0.009 | 0.086 | 0.002 | 0.005 | 0.006 | 0.004 | 0.002 |
| 0.004 | 0.016 | 0.005 | 0.001 | 0.006 | 0.001 | 0.009 | 0.092 | 0.002 | 0.005 | 0.007 | 0.004 | 0.002 |
| 0.006 | 0.024 | 0.007 | 0.002 | 0.008 | 0.002 | 0.014 | 0.137 | 0.004 | 0.007 | 0.01 | 0.006 | 0.003 |

| o-Tolualde | N-Hexade | 3-methyl-1 | 2-methyl-1 | Cis-2-bute | Isovaleralc | 1-hexene | 1-Methyl-2 | 1-Methyl-3 | Tolualdehy | 1-Methyl-4 | Cis-2-pent | N-tridecan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.019 | 0.004 | 0.009 | 0.012 | 0.017 | 0.003 | 0.061 | 0.005 | 0.013 | 0.023 | 0.005 | 0.023 | 0.044 |
| 0.002 | 0 | 0.001 | 0.001 | 0.002 | 0 | 0.007 | 0.001 | 0.001 | 0.003 | 0.001 | 0.003 | 0.005 |
| 0.004 | 0.001 | 0.002 | 0.003 | 0.004 | 0.001 | 0.014 | 0.001 | 0.003 | 0.005 | 0.001 | 0.005 | 0.01 |
| 0.005 | 0.001 | 0.002 | 0.003 | 0.004 | 0.001 | 0.015 | 0.001 | 0.003 | 0.006 | 0.001 | 0.006 | 0.011 |
| 0.007 | 0.001 | 0.003 | 0.004 | 0.006 | 0.001 | 0.022 | 0.002 | 0.005 | 0.008 | 0.002 | 0.008 | 0.016 |

| N-Tetrade | N-Pentade | N-heptade | Trans-2-pe | 4-methyl-1 | 2-methyl-1 | 1-decene | N-undecar | Trans-2-he | Crotonalde | Heptene | Dimethyl r | C-10 Olefi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.034 | 0.014 | 0.001 | 0.03 | 0.006 | 0.003 | 0.015 | 0.037 | 0.002 | 0.085 | 0.036 | 0.007 | 0.481 |
| 0.004 | 0.002 | 0 | 0.003 | 0.001 | 0 | 0.002 | 0.004 | 0 | 0.01 | 0.004 | 0.001 | 0.055 |
| 0.008 | 0.003 | 0 | 0.007 | 0.001 | 0.001 | 0.004 | 0.008 | 0.001 | 0.02 | 0.008 | 0.002 | 0.111 |
| 0.008 | 0.004 | 0 | 0.007 | 0.001 | 0.001 | 0.004 | 0.009 | 0.001 | 0.021 | 0.009 | 0.002 | 0.119 |
| 0.013 | 0.005 | 0 | 0.011 | 0.002 | 0.001 | 0.006 | 0.013 | 0.001 | 0.031 | 0.013 | 0.003 | 0.177 |

| C-10 Para | C-14 Alkai | C-15 Alkai | C-16 Alkai | C-18 Alkai | C-4 Benze | C-5 Benze | Decanol | Dodecano |
|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1.202 | 0.015 | 0.015 | 0.012 | 0 | 0.054 | 0.027 | 0.481 | 0.24 |
| 0.138 | 0.002 | 0.002 | 0.001 | 0 | 0.006 | 0.003 | 0.055 | 0.028 |
| 0.277 | 0.004 | 0.003 | 0.003 | 0 | 0.012 | 0.006 | 0.111 | 0.055 |
| 0.297 | 0.004 | 0.004 | 0.003 | 0 | 0.013 | 0.007 | 0.119 | 0.059 |
| 0.443 | 0.006 | 0.005 | 0.004 | 0 | 0.02 | 0.01 | 0.177 | 0.089 |

# Appendix C1

# CAT Engine Specification Sheets

# DIESEL GENERATOR SET

CATERPILLAR®

## STANDBY 80-100 kW
## PRIME 72-90 kW

### 60 Hz

| Model | Standby kW (kVA) | Prime kW (kVA) |
|---|---|---|
| D80-6 | 80 (100) | 72 (90) |
| D80-2S | 80 (80) | 72 (72) |
| D100-6 | 100 (125) | 90 (112.5) |
| D100-6S | 100 (100) | 90 (90) |

Tier 3 EPA Approved, Emissions Certified

## FEATURES

### GENERATOR SET
- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### ENGINE
- Governor, electronic
- Electrical system, 12 VDC
- Cartridge type filters
- Battery rack and cables
- Coolant and lube drains piped to edge of base

### GENERATOR
- Insulation system, class H
- Drip proof generator air intake (NEMA 2, IP23)
- Electrical design in accordance with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33

### CONTROL SYSTEM
- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

### MOUNTING ARRANGEMENT
- Heavy-duty fabricated steel base with lifting points
- Anti-vibration pads to ensure vibration isolation
- Complete OSHA guarding
- Stub-up pipe ready for connection to silencer pipework
- Flexible fuel lines to base with NPT connections

### COOLING SYSTEM
- Radiator and cooling fan complete with protective guards
- Standard ambient temperatures up to 50° C (122° F)

### CIRCUIT BREAKER
- UL/CSA listed
- 3-pole with solid neutral
- NEMA 1 steel enclosure, vibration isolated
- Electrical stub-up area directly below circuit breaker

### AUTOMATIC VOLTAGE REGULATOR
- Voltage within ± 0.5% 3-phase and ± 1.0% single phase at steady state from no load to full load
- Provides fast recovery from transient load changes

### EQUIPMENT FINISH
- All electroplated hardware
- Anticorrosive paint protection
- High gloss polyurethane paint for durability and scuff resistance

### QUALITY STANDARDS
- BS4999, BS5000, BS5514, EN61000-6, IEC60034, NEMA MG-1.33, NFPA 110 (with optional equipment)

### DOCUMENTATION
- Operation and maintenance manuals provided
- Wiring diagrams included

### WARRANTY
- All equipment carries full manufacturer's warranty.

CATERPILLAR®

## OPTIONAL EQUIPMENT*

### ENCLOSURE
- B Series weather protective enclosure (includes internal silencer system)
  – Single point lift
  – Panel viewing window
  – External emergency stop pushbutton
- Sound attenuated enclosure (includes internal silencer system)

### SILENCER SYSTEM – OPEN UNIT
- Level 1 silencer
- Level 2 silencer
- Level 3 silencer
- Mounting kit
- Through-wall installation kits

### ENGINE
- Battery heater
- Lube oil drain pump
- High lube oil temperature shutdown
- Lube oil sump heater

### CIRCUIT BREAKER
- Auxiliary voltfree contacts
- Shunt trip (100+ amp breakers)

### GENERATOR
- Anti-condensation heater
- Permanent magnet generator
- AREP excitation system (3-Phase only)
- Generator upgrade 1 size (3-Phase only)

### CONTROL SYSTEM
- No control system
- EMCP 3.2 digital control panel

### MOUNTING ACCESSORIES
- Seismic (Zone 4) vibration isolators

### FUEL SYSTEM
- UL listed closed top-diked skid-mounted fuel tank base (12/24-hour capacity) with fuel alarm (low level/leak detected)
- Critical high fuel alarm
- Critical low fuel level shutdown

### COOLING SYSTEM
- Coolant heater
- Low coolant temperature alarm
- Low coolant level shutdown
- Radiator transition flange

### REMOTE ANNUNCIATORS
- 16-channel remote annunciator panel (supplied loose)

### MISCELLANEOUS ACCESSORIES
- Toolkit
- Additional operator's manual pack
- Special enclosure color
- UL listing
- CSA certification
- French or Spanish language labels

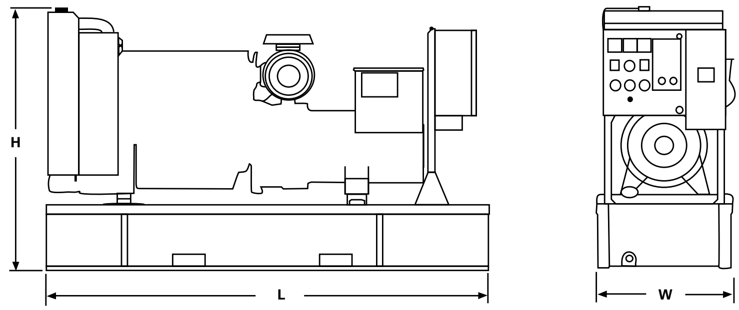
### EXTENDED SERVICE CONTRACTS
- Extended Service Coverage available

### TESTING
- Factory test and report at both 1.0 pf and 0.8 pf

* Some options may not be available on all models.
Not all options are listed.

CATERPILLAR®

## GENERATOR SET DIMENSIONS AND WEIGHTS




| Model | Length mm (in) | Width mm (in) | Height mm (in) | Weight kg (lb)* |
|---|---|---|---|---|
| **D80-6** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 960 (2,116) |
| **D80-2S** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 934 (2,059) |
| **D100-6** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 1389 (3,062) |
| **D100-6S** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 1066 (2,350) |

**NOTE:** General configuration not to be used for installation. See specific dimensional drawings for detail.

*Includes oil and coolant

CATERPILLAR®

# SPECIFICATIONS

## GENERATOR

Voltage regulation ........ ± 0.5% 3-phase and ± 1.0% single phase at steady state from no load to full load
Frequency ..... ± 0.25% for constant load, no load to full load
Waveform distortion ................. THD < 4%, at no load
Radio interference .............. Compliance with EN61000-6
Telephone interference.................. TIF < 50, THF < 2%
Overspeed limit .................................. 2250 rpm
Insulation.......................................... Class H
Temperature rise ...................... Within Class H limits
Available voltages ....... 1-phase – 120/240, 115/230, 110/220
3-phase – 277/480, 266/460, 120/240, 127/220, 120/208, 347/600
Deration ............... Consult factory for available outputs
Ratings ............... At 30° C (86° F), 152.4 m (500 ft), 60% humidity, 1.0 pf (1-phase), 0.8 pf (3-phase)

## ENGINE

Manufacturer .................................... Caterpillar
Type ............................................... 4-cycle
Bore – mm (in) ................................ 105.0 (4.13)
Stroke – mm (in)............................... 127.0 (5.00)
Governor Type ................................. Electronic
Class................................................... G2
Piston speed – m/sec (ft/sec)..................... 7.62 (25.0)
Engine speed – rpm ................................. 1800
Air cleaner type ..................... Dry, replaceable paper element type with restriction indicator

**D80-6, D80-2S – C4.4**

Aspiration.................................. Turbocharged
Cylinder configuration............................. In-line 4
Displacement – L (cu in)........................... 4.4 (269)
Compression ratio .................................. 19.2:1
Max power at rated rpm – kW (hp)
Standby......................................... 97 (130)
Prime ........................................... 88 (118)
BMEP – kPa (psi)
Standby ..................................... 1476 (213)
Prime......................................... 1335 (194)
Regenerative power – kW (hp) ................... 13.8 (18.5)

**D100-6, D100-6S – C4.4**

Aspiration.................................. Turbocharged
Cylinder configuration............................. In-line 4
Displacement – L (cu in)........................... 4.4 (269)
Compression ratio .................................. 19.2:1
Max power at rated rpm – kW (hp)
Standby..................................... 117 (156.9)
Prime ....................................... 106 (142.1)
BMEP – kPa (psi)
Standby ..................................... 1612 (233)
Prime......................................... 1771 (257)
Regenerative power – kW (hp) ................... 13.8 (18.5)

## CONTROL PANEL

- Heavy duty sheet steel enclosure with lockable hinged door
- Vibration isolated from generating set
- LCD display
- AC metering
- DC metering
- Fail to start shutdown
- Low oil pressure shutdown
- High engine temperature
- Low/high battery voltage
- Underspeed/overspeed
- Loss of engine speed detection
- 2 spare fault channels
- 20 event fault log
- 2 LED status indicators
- Lockdown emergency stop push button

# RATING DEFINITIONS AND CONDITIONS

**Standby** – Applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings. The generator is peak rated (as defined in ISO8528-3).

**Prime** – Applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. There is no limitation to the annual hours of operation and the generator set can supply 10 percent overload power for 1 hour in 12 hours.

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## D80-6 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 80 | 100 | 72 | 90 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8 | 2.1 | 8 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 24.7 | 6.5 | 22.7 | 6 |
| 75% load | L/hr | gal/hr | 19.7 | 5.2 | 18.2 | 4.8 |
| 50% load | L/hr | gal/hr | 14.6 | 3.9 | 13.5 | 3.6 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 53.6 | 3,051 | 50.2 | 2,857 |
| Total heat radiated to room at rated power | kW | Btu/min | 15.9 | 905 | 9.3 | 529 |
| Radiator fan load | kW | hp | 4.8 | 6.4 | 4.8 | 6.4 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 7.6 | 268 | 7.7 | 272 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 18.77 | 663 | 16 | 572 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 522 | 972 | 524 | 975 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 97 | | 97 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V 120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** (30% voltage dip) | (kVA) | | | | | |
| | Self excited | 239 | 223 | 207 | 188 | 239 |
| | PM excited** | 311 | 291 | 270 | 247 | 311 |
| | AREP excited | 311 | 291 | 270 | 247 | 311 |
| **Full Load Efficiencies:** | Standby | 91.7 | 91.6 | 91.4 | 90.9 | 91.7 |
| | Prime | 91.9 | 91.8 | 91.7 | 91.3 | 91.8 |
| **Reactances (per unit):** | $X_d$ | 2.69 | 2.93 | 3.21 | 3.58 | 2.69 |
| | $X'_d$ | 0.09 | 0.10 | 0.11 | 0.12 | 0.09 |
| Reactances shown are applicable to the standby rating. | $X''_d$ | 0.045 | 0.049 | 0.053 | 0.060 | 0.045 |
| | $X_q$ | 1.62 | 1.76 | 1.92 | 2.15 | 1.62 |
| | $X''_q$ | 0.056 | 0.061 | 0.066 | 0.074 | 0.056 |
| | $X_2$ | 0.051 | 0.056 | 0.061 | 0.068 | 0.051 |
| | $X_0$ | 0.005 | 0.005 | 0.006 | 0.007 | 0.005 |

| | | | | |
|---|---|---|---|---|
| **Time Constants:** | $t'_d$ 50 ms | $t''_d$ 5 ms | $t'_{do}$ 1480 ms | $t_a$ 8 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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## D80-2S (1-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** (at 240V) | kW | kVA | 80 | 80 | 72 | 72 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8 | 2.1 | 8 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 24.7 | 6.5 | 22.7 | 6.0 |
| 75% load | L/hr | gal/hr | 19.7 | 5.2 | 18.2 | 4.8 |
| 50% load | L/hr | gal/hr | 14.6 | 3.9 | 13.5 | 3.6 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 53.6 | 3,051 | 50.2 | 2,857 |
| Total heat radiated to room at rated power | kW | Btu/min | 15.9 | 905 | 9.3 | 529 |
| Radiator fan load | kW | hp | 4.8 | 6.4 | 4.8 | 6.4 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 7.6 | 268 | 7.7 | 271 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 18.7 | 663 | 16 | 572 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 522 | 972 | 524 | 975 |
| **Generator Set Noise Rating*** (without attenuation) at 1 m (3 ft) | dB(A) | | 97 | | 97 | |

| Generator Technical Data | | 120/240V | 115/230V | 110/220V |
|---|---|---|---|---|
| **Motor Starting Capability:** (30% voltage dip) | (kVA) | | | |
| | Self excited | 150 | 160 | 170 |
| | PM excited** | 150 | 160 | 170 |
| **Full Load Efficiencies:** | Standby | 87.9 | 88.5 | 89.1 |
| | Prime | 88.4 | 89.0 | 89.5 |
| **Reactances (per unit):** | $X_d$ | 2.14 | 2.33 | 2.54 |
| Reactances shown are applicable to the standby rating. | $X'_d$ | 0.16 | 0.17 | 0.19 |
| | $X''_d$ | 0.082 | 0.089 | 0.096 |
| | $X_q$ | 1.28 | 1.40 | 1.53 |
| | $X''_q$ | 0.101 | 0.109 | 0.120 |

| Time Constants: | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 80 ms | 7 ms | 1431 ms | 12 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

CATERPILLAR®

## D100-6 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 100 | 125.0 | 90 | 112.5 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8.0 | 2.1 | 8.0 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 29.8 | 7.9 | 26.8 | 7.1 |
| 75% load | L/hr | gal/hr | 23.7 | 6.3 | 21.9 | 5.8 |
| 50% load | L/hr | gal/hr | 17.5 | 4.6 | 16.3 | 4.3 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | Ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 65.6 | 3,731 | 59.7 | 3,396 |
| Total heat radiated to room at rated power | kW | Btu/min | 20.7 | 1,177 | 18.3 | 1,041 |
| Radiator fan load | kW | hp | 5.0 | 6.7 | 5.0 | 6.7 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 8.4 | 297 | 8.5 | 300 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 17.5 | 618 | 16 | 572 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 522 | 972 | 524 | 975 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 98 | | 97 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V 120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** (30% voltage dip) | (kVA) | | | | | |
| | Self excited | 206 | 191 | 177 | 160 | 191 |
| | PM excited** | 271 | 252 | 233 | 211 | 252 |
| | AREP excited | 271 | 252 | 233 | 211 | 252 |
| **Full Load Efficiencies:** | Standby | 91.1 | 90.9 | 90.6 | 90.1 | 91.0 |
| | Prime | 91.5 | 91.3 | 91.0 | 90.6 | 91.4 |
| **Reactances (per unit):** | $X_d$ | 3.58 | 3.90 | 4.26 | 4.77 | 3.90 |
| Reactances shown are applicable to the standby rating. | $X'_d$ | 0.14 | 0.15 | 0.17 | 0.19 | 0.15 |
| | $X''_d$ | 0.083 | 0.091 | 0.099 | 0.111 | 0.091 |
| | $X_q$ | 2.15 | 2.34 | 2.56 | 2.86 | 2.34 |
| | $X''_q$ | 0.104 | 0.113 | 0.123 | 0.138 | 0.113 |
| | $X_2$ | 0.094 | 0.102 | 0.112 | 0.125 | 0.102 |
| | $X_0$ | 0.005 | 0.005 | 0.006 | 0.006 | 0.005 |
| **Time Constants:** | | $t'_d$ 100 ms | $t''_d$ 10 ms | $t'_{do}$ 2555 ms | $t_a$ 15 ms | |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

# STANDBY 80-100 kW
# PRIME 72-90 kW
# 60 Hz

CATERPILLAR®

## D100-6S (1-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** (at 240V) | kW | kVA | 100 | 100 | 90 | 90 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8 | 2.1 | 8 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 29.7 | 7.8 | 27.3 | 7.2 |
| 75% load | L/hr | gal/hr | 23.7 | 6.3 | 21.9 | 5.8 |
| 50% load | L/hr | gal/hr | 17.6 | 4.6 | 16.3 | 3 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 61.0 | 3,472 | 57.0 | 3,244 |
| Total heat radiated to room at rated power | kW | Btu/min | 18.0 | 1,025 | 15.0 | 854 |
| Radiator fan load | kW | hp | 4.8 | 6.4 | 4.8 | 6.4 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3/min$ | cfm | 8.4 | 297 | 8.5 | 300 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3/min$ | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3/min$ | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3/min$ | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3/min$ | cfm | 22.5 | 794 | 20.0 | 705 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 580 | 1,076 | 540 | 1,004 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 98 | | 97 | |

| Generator Technical Data | | 120/240V | 115/230V | 110/220V |
|---|---|---|---|---|
| **Motor Starting Capability:** | (kVA) | | | |
| (30% voltage dip) | Self excited | 187 | 175 | 162 |
| | PM excited** | 187 | 175 | 162 |
| **Full Load Efficiencies:** | Standby | 90.5 | 90.0 | 89.4 |
| | Prime | 90.9 | 90.4 | 89.4 |
| **Reactances (per unit):** | $X_d$ | 2.67 | 2.91 | 3.18 |
| Reactances shown | $X'_d$ | 0.21 | 0.23 | 0.25 |
| are applicable to | $X''_d$ | 0.127 | 0.138 | 0.151 |
| the standby rating. | $X_q$ | 1.60 | 1.74 | 1.90 |
| | $X''_q$ | 0.151 | 0.164 | 0.180 |

| **Time Constants:** | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 165 ms | 13 ms | 2734 ms | 20 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12



LEHE7189-05 (01-09)

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# DIESEL GENERATOR SET

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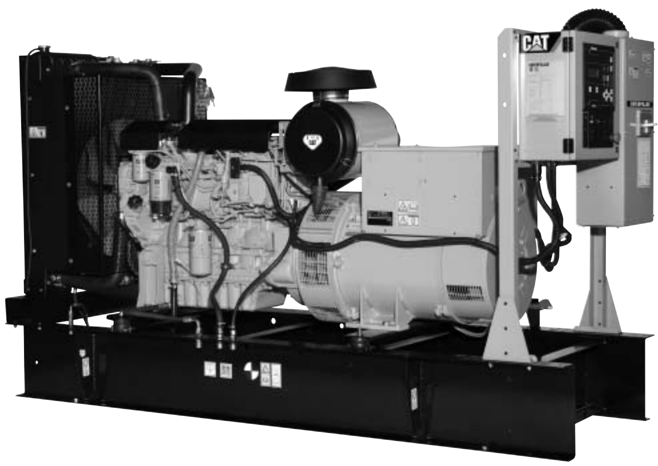


Picture shown may not reflect actual package

## STANDBY 125-150 kW
## PRIME 114-135 kW
### 60 Hz

| Model | Standby kW (kVA) | Prime kW (kVA) |
|---|---|---|
| D125-6 | 125 (156.3) | 114 (142.5) |
| D150-8 | 150 (187.5) | 135 (168.8) |

Tier 3 EPA Approved, Emissions Certified

## FEATURES

### GENERATOR SET
- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### ENGINE
- Governor, electronic
- Electrical system, 12 VDC
- Cartridge type filters
- Battery rack and cables
- Coolant and lube drains piped to edge of base

### GENERATOR
- Insulation system, class H
- Drip proof generator air intake (NEMA 2, IP23)
- Electrical design in accordance with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33

### CONTROL SYSTEM
- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

### MOUNTING ARRANGEMENT
- Heavy-duty fabricated steel base with lifting points
- Anti-vibration pads to ensure vibration isolation
- Complete OSHA guarding
- Stub-up pipe ready for connection to silencer pipework
- Flexible fuel lines to base with NPT connections

### COOLING SYSTEM
- Radiator and cooling fan complete with protective guards
- Standard ambient temperatures up to 50° C (122° F)

### CIRCUIT BREAKER
- UL/CSA listed
- 3-pole with solid neutral
- NEMA 1 steel enclosure, vibration isolated
- Electrical stub-up area directly below circuit breaker

### AUTOMATIC VOLTAGE REGULATOR
- Voltage within ± 0.5% 3-phase at steady state from no load to full load
- Provides fast recovery from transient load changes

### EQUIPMENT FINISH
- All electroplated hardware
- Anticorrosive paint protection
- High gloss polyurethane paint for durability and scuff resistance

### QUALITY STANDARDS
- BS4999, BS5000, BS5514, EN61000-6, IEC60034, NEMA MG-1.33, NFPA 110 (with optional equipment)

### DOCUMENTATION
- Operation and maintenance manuals provided
- Wiring diagrams included

### WARRANTY
- All equipment carries full manufacturer's warranty.

## OPTIONAL EQUIPMENT*

### ENCLOSURE
- B Series weather protective enclosure (includes internal silencer system)
- Sound attenuated enclosure (includes internal silencer system)
  - Single point lift
  - Panel viewing window
  - External emergency stop pushbutton

### SILENCER SYSTEM – OPEN UNIT
- Level 1 silencer
- Level 2 silencer
- Level 3 silencer
- Mounting kit
- Through-wall installation kits

### ENGINE
- Battery heater
- Lube oil drain pump
- High lube oil temperature shutdown
- Lube oil sump heater

### CIRCUIT BREAKER
- Auxiliary voltfree contacts
- Shunt trip

### GENERATOR
- Anti-condensation heater
- Permanent magnet generator
- AREP excitation system
- Generator upgrade 1 size

### CONTROL SYSTEM
- No control system
- EMCP 3.2 digital control panel

### MOUNTING ACCESSORIES
- Seismic (Zone 4) vibration isolators

### FUEL SYSTEM
- UL listed closed top-diked skid-mounted fuel tank base (12/24-hour capacity) with fuel alarm (low level/leak detected)
- Critical high fuel alarm
- Critical low fuel level shutdown

### COOLING SYSTEM
- Coolant heater
- Low coolant temperature alarm
- Low coolant level shutdown
- Radiator transition flange

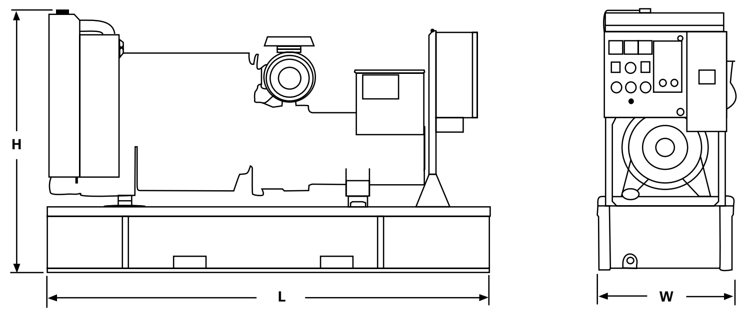
### REMOTE ANNUNCIATORS
- 16-channel remote annunciator panel (supplied loose)

### MISCELLANEOUS ACCESSORIES
- Toolkit
- Additional operator's manual pack
- Special enclosure color
- UL listing
- CSA certification
- French or Spanish language labels

### EXTENDED SERVICE CONTRACTS
- Extended Service Coverage available

* Some options may not be available on all models. Not all options are listed.

## GENERATOR SET DIMENSIONS AND WEIGHTS




| Model | Length mm (in) | Width mm (in) | Height mm (in) | Weight kg (lb)* |
|---|---|---|---|---|
| **D125-6** | 2780 (109.4) | 900 (35.4) | 1543 (60.7) | 1347 (2,970) |
| **D150-8** | 2780 (109.4) | 900 (35.4) | 1543 (60.7) | 1407 (3,102) |

**NOTE:** General configuration not to be used for installation. See specific dimensional drawings for detail.

*Includes oil and coolant

## SPECIFICATIONS

### GENERATOR

Voltage regulation ................ ± 0.5% 3-phase at steady state from no load to full load
Frequency ..... ± 0.25% for constant load, no load to full load
Waveform distortion ................. THD < 4%, at no load
Radio interference ............. Compliance with EN61000-6
Telephone interference.................. TIF < 50, THF < 2%
Overspeed limit ................................ 2250 rpm
Insulation......................................... Class H
Temperature rise ...................... Within Class H limits
Available voltages ....................... 277/480, 266/460, 120/240, 127/220, 120/208, 347/600
Deration ............... Consult factory for available outputs
Ratings .................... At 30° C (86° F), 152.4 m (500 ft), 60% humidity, 0.8 pf

### ENGINE

Manufacturer ................................... Caterpillar
Type ............................................ 4-cycle
Bore – mm (in) ............................... 105.0 (4.13)
Stroke – mm (in).............................. 127.0 (5.00)
Governor Type ................................ Electronic
Class................................................ G2
Piston speed – m/sec (ft/sec).................... 7.62 (25.0)
Engine speed – rpm ................................ 1800
Air cleaner type .................... Dry, replaceable paper element type with restriction indicator

**D125-6 – C6.6 ACERT**

Aspiration ........................................ ATAAC
Cylinder configuration............................ In-line 6
Displacement – L (cu in)........................... 6.6 (404)
Compression ratio ................................. 16.3:1
Max power at rated rpm – kW (hp)
Standby ..................................... 161.6 (217)
Prime ....................................... 144.6 (194)
BMEP – kPa (psi)
Standby ..................................... 1633 (237)
Prime........................................ 1461 (212)
Regenerative power – kW (hp)...................... 14.9 (20)

**D150-8 – C6.6 ACERT**

Aspiration ........................................ ATAAC
Cylinder configuration............................ In-line 6
Displacement – L (cu in)........................... 6.6 (404)
Compression ratio ................................. 16.3:1
Max power at rated rpm – kW (hp)
Standby ..................................... 171.3 (230)
Prime ....................................... 154.4 (207)
BMEP – kPa (psi)
Standby ..................................... 1731 (251)
Prime........................................ 1560 (226)
Regenerative power – kW (hp)...................... 14.9 (20)

### CONTROL PANEL

- Heavy duty sheet steel enclosure with lockable hinged door
- Vibration isolated from generating set
- LCD display
- AC metering
- DC metering
- Fail to start shutdown
- Low oil pressure shutdown
- High engine temperature
- Low/high battery voltage
- Underspeed/overspeed
- Loss of engine speed detection
- 2 spare fault channels
- 20 event fault log
- 2 LED status indicators
- Lockdown emergency stop push button

## RATING DEFINITIONS AND CONDITIONS

**Standby** – Applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings. The generator is peak rated (as defined in ISO8528-3).

**Prime** – Applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. There is no limitation to the annual hours of operation and the generator set can supply 10 percent overload power for 1 hour in 12 hours.

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## D125-6 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 125 | 156.3 | 114 | 142.5 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4/CI4 | | | | | | |
| Total oil capacity | L | U.S. gal | 16.5 | 4.4 | 16.5 | 4.4 |
| Oil pan | L | U.S. gal | 15.5 | 4.1 | 15.5 | 4.1 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 40.6 | 10.7 | 36.0 | 9.5 |
| 75% load | L/hr | gal/hr | 31.6 | 8.3 | 30.0 | 7.9 |
| 50% load | L/hr | gal/hr | 24.5 | 6.5 | 23.2 | 6.1 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 100 | | 100 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 21.0 | 5.5 | 21.0 | 5.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 8.0 | 26.0 | 8.0 | 26.0 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 200 | 2,693 | 10 200 | 2,693 |
| Minimum temperature to engine | °C | °F | 85 | 185 | 85 | 185 |
| Temperature rise across engine | °C | °F | 7.9 | 14.2 | 7.9 | 14.2 |
| Heat rejected to coolant at rated power | kW | Btu/min | 74.9 | 4,262 | 69.8 | 3,971 |
| Total heat radiated to room at rated power | kW | Btu/min | 13.0 | 740 | 12.1 | 688 |
| Radiator fan load | kW | hp | 8.0 | 10.7 | 8.0 | 10.7 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 12.6 | 445 | 12.3 | 434 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 5 | 20 | 5 | 20 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 327 | 11,548 | 327 | 11,548 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 923 | 26.4 | 923 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.12 | 0.50 | 0.12 | 0.50 |
| Cooling air flow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 317 | 11,195 | 317 | 11,195 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in Hg | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 29.7 | 1,049 | 28.6 | 1,010 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 437 | 819 | 427 | 801 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 97 | | 97 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V 120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** (30% voltage dip) | (kVA) | | | | | |
| | Self excited | 360 | 335 | 311 | 283 | N/A |
| | PM excited** | 469 | 437 | 406 | 370 | 437 |
| | AREP excited | 469 | 437 | 406 | 370 | 437 |
| **Full Load Efficiencies:** | Standby | 92.7 | 92.6 | 92.5 | 92.3 | 92.6 |
| | Prime | 92.8 | 92.8 | 92.7 | 92.5 | 92.8 |
| **Reactances (per unit):** | $X_d$ | 2.74 | 2.99 | 3.27 | 3.65 | 2.99 |
| Reactances shown are applicable to the standby rating. | $X'_d$ | 0.10 | 0.10 | 0.11 | 0.13 | 0.10 |
| | $X''_d$ | 0.057 | 0.062 | 0.068 | 0.076 | 0.062 |
| | $X_q$ | 1.65 | 1.79 | 1.96 | 2.19 | 1.79 |
| | $X''_q$ | 0.068 | 0.074 | 0.080 | 0.090 | 0.074 |
| | $X_2$ | 0.063 | 0.068 | 0.075 | 0.083 | 0.068 |
| | $X_0$ | 0.004 | 0.005 | 0.005 | 0.006 | 0.005 |
| **Time Constants:** | | $t'_d$ 100 ms | $t''_d$ 10 ms | $t'_{do}$ 2865 ms | $t_a$ 15 ms | |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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## D150-8 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 150 | 187.5 | 135 | 168.8 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4/CI4 | | | | | | |
| Total oil capacity | L | U.S. gal | 16.5 | 4.4 | 16.5 | 4.4 |
| Oil pan | L | U.S. gal | 15.5 | 4.1 | 15.5 | 4.1 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 44.7 | 11.8 | 41.5 | 11.0 |
| 75% load | L/hr | gal/hr | 36.8 | 9.7 | 34.3 | 9.1 |
| 50% load | L/hr | gal/hr | 28.4 | 7.5 | 26.6 | 7.0 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 100 | | 100 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 21.0 | 5.5 | 21.0 | 5.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 8.0 | 26.0 | 8.0 | 26.0 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 200 | 2,693 | 10 200 | 2,693 |
| Minimum temperature to engine | °C | °F | 85 | 185 | 85 | 185 |
| Temperature rise across engine | °C | °F | 7.9 | 14.2 | 7.9 | 14.2 |
| Heat rejected to coolant at rated power | kW | Btu/min | 78.4 | 4,461 | 73.5 | 4,182 |
| Total heat radiated to room at rated power | kW | Btu/min | 13.6 | 774 | 12.7 | 723 |
| Radiator fan load | kW | hp | 8.0 | 10.7 | 8.0 | 10.7 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 12.9 | 456 | 12.6 | 445 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 5 | 20 | 5 | 20 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 327 | 11,548 | 327 | 11,548 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 923 | 26.4 | 923 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.12 | 0.50 | 0.12 | 0.50 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 317 | 11,195 | 317 | 11,195 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in Hg | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 31.5 | 1,112 | 30.5 | 1,077 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 625 | 1,157 | 610 | 1,130 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 97.3 | | 97.3 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V 120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** | (kVA) | | | | | |
| (30% voltage dip) | Self excited | 420 | 391 | 363 | 330 | N/A |
| | PM excited** | 548 | 511 | 476 | 433 | 511 |
| | AREP excited | 548 | 511 | 476 | 433 | 511 |
| **Full Load Efficiencies:** | Standby | 92.9 | 92.9 | 92.9 | 92.5 | 92.9 |
| | Prime | 93.1 | 93.1 | 93.1 | 92.8 | 93.1 |
| **Reactances (per unit):** | $X_d$ | 2.90 | 3.16 | 3.45 | 3.86 | 3.16 |
| | $X'_d$ | 0.10 | 0.11 | 0.12 | 0.13 | 0.11 |
| Reactances shown are applicable to the standby rating. | $X''_d$ | 0.058 | 0.063 | 0.069 | 0.078 | 0.063 |
| | $X_q$ | 1.74 | 1.89 | 2.07 | 2.32 | 1.89 |
| | $X''_q$ | 0.069 | 0.075 | 0.082 | 0.092 | 0.075 |
| | $X_2$ | 0.063 | 0.069 | 0.075 | 0.084 | 0.069 |
| | $X_0$ | 0.005 | 0.005 | 0.006 | 0.007 | 0.005 |

| Time Constants: | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 100 ms | 10 ms | 2966 ms | 15 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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LEHE5521-01 (04-07)

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DIESEL GENERATOR SET

CATERPILLAR®

Image shown may not reflect actual package.

# STANDBY
## 30 ekW 37 kVA
## 60 Hz 1800 rpm 480 Volts

**Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.**

## FEATURES

**Caterpillar Model D30-10 3 phase**

### FUEL/EMISSIONS STRATEGY
- EPA Tier 4 interim

### DESIGN CRITERIA
- The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

### FULL RANGE OF ATTACHMENTS
- Wide range of bolt-on system expansion attachments, factory designed and tested
- Flexible packaging options for easy and cost effective installation

### SINGLE-SOURCE SUPPLIER
- Fully prototype tested with certified torsional vibration analysis available

### WORLDWIDE PRODUCT SUPPORT
- Caterpillar® dealers provide extensive post sale support including maintenance and repair agreements
- Caterpillar dealers have over 1,600 dealer branch stores operating in 200 countries
- The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

### CAT® C2.2 DIESEL ENGINE
- Reliable, rugged, durable design
- Field-proven in thousands of applications worldwide
- Four-stroke diesel engine combines consistent performance and excellent fuel economy with minimum weight
- Electronic engine control

### GENERATOR SET
- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### CONTROL SYSTEM
- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

# FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

| System | Standard | Optional |
|---|---|---|
| Air Inlet | • Dry replaceable paper element type with restriction indicator | |
| Cooling | • Radiator and cooling fan complete with protective guards<br>• Standard ambient temperatures up to 40 degrees C (104 degrees F) | • Coolant heater<br>• Low coolant temperature alarm<br>• Low coolant level shutdown<br>• Radiator transition flange |
| Engine | • Governor, mechanical<br>• Electrical system, 12 VDC<br>• Cartridge type filters<br>• Battery rack and cables<br>• Coolant and lube drains piped to edge of base | • Governor, electronic<br>• Battery heater<br>• Lube oil drain pump<br>• High lube oil temperature shutdown<br>• Lube oil sump heater |
| Generator | • Class H insulation<br>• Drip proof generator air intake (NEMA 2,IP23)<br>• Electrical design in accordance with with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33<br>• IP23 Protection | • Anti-condensation space heater |
| Circuit Breaker | • UL/CSA listed<br>• 3-pole with solid neutral<br>• NEMA 1 steel enclosure, vibration isolated<br>• Electrical stub-up area directly below circuit breaker | • Auxilary voltfree contacts |
| Control Panels | • EMCP 3.1 digital control panel<br>• Vibration isolated NEMA 1 enclosure with lockable hinged door<br>• DC and AC Wiring harnesses | • EMCP 3.2 digital control panel |
| Mounting | • Heavy-duty fabricated steel base with lifting points<br>• Anti-vibration pads<br>• Complete OSHA guarding<br>• Stub-up pipe ready for connection to silencer pipework<br>• Flexible fuel lines to base with NPT connections | • Seismic (Zone 4) vibration isolators |
| General | • High gloss polyurethane paint, Caterpillar yellow except rails and radiators gloss black<br>• Anticorrosive paint protection<br>• All electroplated hardware | • Toolkit<br>• Additional operator's manual pack<br>• Special enclosure color<br>• UL Listing, CSA Certification<br>• French or Spanish language labels |

CATERPILLAR®

## SPECIFICATIONS

### CAT GENERATOR

Frame Size....................LC1014S
Excitation....................Self Excited
Pitch....................0.6667
Number of Poles....................4
Number of bearings....................Single Bearing
Number of Leads....................012
IP Rating....................IP23
Overspeed capability....................125
Wave form deviation (Line Wave Form to Line).......002.00
Paralleling kit droop transformer....................Standard
Voltage regulator.3 Phase sensing with selectible volts/Hz
Telephone Influence Factor....................Less than 50

### CAT ENGINE

C2.2 In-line 4, 4-cycle diesel
Bore - mm....................84.00 mm (3.31 in)
Stroke - mm....................100.00 mm (3.94 in)
Displacement-L.................... 2.20 L (134.25 $in^3$)
Compression ratio....................23.5:1
Aspiration....................TA

### Control Panel

Heavy duty sheet steel enclosure with lockable hinged door
Vibration isolated from generating set
LCD display
AC metering
DC metering
Fail to start shutdown
Low oil pressure shutdown
High engine temperature
Low / high battery voltage
Underspeed/overspeed
Loss of engine speed detection
2 spare fault channels
20 event fault log
2 LED status indicators
Lockdown emergency stop push button

CATERPILLAR®

## TECHNICAL DATA

| Open Generator Set - - 1800 rpm/60 Hz/480 Volts | P3524A | |
|---|---|---|
| **EPA Tier 4 interim** | | |
| **Generator Set Package Performance** | | |
| Genset Power rating @ 0.8 pf | 37.5 kVA | |
| Genset Power rating with fan | 30 ekW | |
| **Fuel Consumption** | | |
| 100% load with fan | 10.7 L/hr | 2.8 Gal/hr |
| **Cooling System** [1] | | |
| Air flow restriction (system) | 0.12 kPa | 0.48 in. water |
| Air flow (max @ rated speed for radiator arrangement) | 75 $m^3$/min | 2649 cfm |
| Engine coolant capacity | 3.6 L | 1.0 gal |
| **Exhaust System** | | |
| Exhaust gas flow rate | 2.5 $m^3$/min | 88.3 cfm |
| Exhaust flange size (internal diameter) | 6.4 mm | 0.3 in |
| **Heat Rejection** | | |
| Heat rejection to exhaust (total) | 33 kW | 1877 Btu/min |
| Heat rejection to atmosphere from generator | 3.3 kW | 187.7 Btu/min |
| **Alternator**[2] | | |
| Motor starting capability @ 30% voltage dip | 70 skVA | |
| Frame | LC1014S | |
| Temperature Rise | 130 ° C | 234 ° F |
| **Emissions (Nominal)** | | |
| NOx g/hp-hr | 5.43 g/hp-hr | |
| CO g/hp-hr | .78 g/hp-hr | |
| HC g/hp-hr | .09 g/hp-hr | |
| PM g/hp-hr | .323 g/hp-hr | |

[1] For ambient and altitude capabilities consult your Caterpillar dealer. Airflow restriction (system) is added to existing restriction from factory.
[2] Generator temperature rise is based on a 40 C (104 F) ambient per NEMA MG1-32.

## RATING DEFINITIONS AND CONDITIONS

**Meets or Exceeds International Specifications:** AS1359, CSA, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, UL508A, 72/23/EEC, 98/37/EC, 2004/108/EC

**Standby** - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year. Standby power in accordance with ISO8528. Fuel stop power in accordance with ISO3046. Standby ambients shown indicate ambient temperature at 100% load which results in a coolant top tank temperature just below the shutdown temperature.

**Ratings** are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

**Fuel rates** are based on fuel oil of 35° API [16° C (60° F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Caterpillar representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Caterpillar dealer.

# Standby 30 ekW 37 kVA

**60 Hz 1800 rpm 480 Volts**

CATERPILLAR®

## DIMENSIONS

| Package Dimensions | | |
|---|---|---|
| **Length** | **1893.1 mm** | **74.5 in** |
| **Width** | **714.0 mm** | **28.1 in** |
| **Height** | **1406.3 mm** | **55.4 in** |
| **Weight** | **487 kg** | **1074.1 lb** |

NOTE: For reference only - do not use for installation design. Please contact your local dealer for exact weight and dimensions.

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Performance No.:P3524A

Feature Code: NAC098P

Gen. Arr. Number: 3215082

Sourced: U.S. Sourced

LEHE0078-00 12/09

# DIESEL GENERATOR SET

CATERPILLAR®


Image shown may not reflect actual package.

## STANDBY
## 50 ekW 62 kVA
## 60 Hz 1800 rpm 480 Volts

**Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.**

## FEATURES

**Caterpillar Model D50-6 3 phase**

### FUEL/EMISSIONS STRATEGY
- EPA Tier 3

### DESIGN CRITERIA
- The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

### FULL RANGE OF ATTACHMENTS
- Wide range of bolt-on system expansion attachments, factory designed and tested
- Flexible packaging options for easy and cost effective installation

### SINGLE-SOURCE SUPPLIER
- Fully prototype tested with certified torsional vibration analysis available

### WORLDWIDE PRODUCT SUPPORT
- Caterpillar® dealers provide extensive post sale support including maintenance and repair agreements
- Caterpillar dealers have over 1,600 dealer branch stores operating in 200 countries
- The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

### CAT® C4.4 DIESEL ENGINE
- Reliable, rugged, durable design
- Field-proven in thousands of applications worldwide
- Four-stroke diesel engine combines consistent performance and excellent fuel economy with minimum weight
- Electronic engine control

### GENERATOR SET
- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### CONTROL SYSTEM
- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

## FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

| System | Standard | Optional |
|---|---|---|
| Air Inlet | • Dry replaceable paper element type with restriction indicator | |
| Cooling | • Radiator and cooling fan complete with protective guards<br>• Standard ambient temperatures up to 50 degrees C (122 degrees F) | • Coolant heater<br>• Low coolant temperature alarm<br>• Low coolant level shutdown<br>• Radiator transition flange |
| Engine | • Governor, mechanical<br>• Electrical system, 12 VDC<br>• Cartridge type filters<br>• Battery rack and cables<br>• Coolant and lube drains piped to edge of base | • Governor, electronic<br>• Battery heater<br>• Lube oil drain pump<br>• High lube oil temperature shutdown<br>• Lube oil sump heater |
| Generator | • Class H insulation<br>• Drip proof generator air intake (NEMA 2,IP23)<br>• Electrical design in accordance with with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33<br>• IP23 Protection | • Anti-condensation space heater<br>• Permanent magnet excitation<br>• Internal Excitation<br>• Generator upgrade 1 size |
| Circuit Breaker | • UL/CSA listed<br>• 3-pole with solid neutral<br>• NEMA 1 steel enclosure, vibration isolated<br>• Electrical stub-up area directly below circuit breaker | • Auxiliary voltfree contacts<br>• Shunt trip |
| Control Panels | • EMCP 3.1 digital control panel<br>• Vibration isolated NEMA 1 enclosure with lockable hinged door<br>• DC and AC Wiring harnesses | • No control system<br>• EMCP 3.2 digital control panel |
| Mounting | • Heavy-duty fabricated steel base with lifting points<br>• Anti-vibration pads to ensure vibration isolation<br>• Complete OSHA guarding<br>• Stub-up pipe ready for connection to silencer pipework<br>• Flexible fuel lines to base with NPT connections | • Seismic (Zone 4) vibration isolators |
| General | • High gloss polyurethane paint, Caterpillar yellow except rails and radiators gloss black<br>• Anticorrosive paint protection<br>• All electroplated hardware | • Toolkit<br>• Additional operator's manual pack<br>• Special enclosure color<br>• UL Listing, CSA Certification<br>• French or Spanish language labels |

# SPECIFICATIONS

### CAT GENERATOR

Frame Size....................LC2014D
Excitation....................Self Excited
Pitch....................0.6667
Number of Poles....................4
Number of bearings....................Single Bearing
Number of Leads....................012
IP Rating....................IP23
Overspeed capability....................125
Wave form deviation (Line Wave Form to Line).......002.00
Paralleling kit droop transformer....................Standard
Voltage regulator.3 Phase sensing with selectible volts/Hz
Telephone Influence Factor....................Less than 50

### CAT ENGINE

C4.4 In-line 4, 4-cycle diesel
Bore - mm....................105.00 mm (4.13 in)
Stroke - mm....................127.00 mm (5.0 in)
Displacement-L.................... 4.40 L (268.5 $in^3$)
Aspiration....................T
Fuel system....................Common Rail
Governor type....................Mechanical

### Emissions

Nox g/hp-hr....................5.90
CO g/hp-hr....................1.34
HC g/hp-hr....................0.27
PM g/hp-hr....................0.40

### Control Panel

Heavy duty sheet steel enclosure with lockable hinged door
Vibration isolated from generating set
LCD display
AC metering
DC metering
Fail to start shutdown
Low oil pressure shutdown
High engine temperature
Low / high battery voltage
Underspeed/overspeed
Loss of engine speed detection
2 spare fault channels
20 event fault log
2 LED status indicators
Lockdown emergency stop push button

# STANDBY 50 ekW 62 kVA

**60 Hz 1800 rpm 480 Volts**

CATERPILLAR®

## TECHNICAL DATA

| Open Generator Set - - 1800 rpm/60 Hz/480 Volts | P3454A | |
|---|---|---|
| **Tier 3** | | |
| **Generator Set Package Performance** | | |
| Genset Power rating @ 0.8 pf | 62.5 kVA | |
| Genset Power rating with fan | 50 ekW | |
| **Fuel Consumption** | | |
| 100% load with fan | 19.2 L/hr | 5.1 Gal/hr |
| **Cooling System** [1] | | |
| Ambient air temperature | 61 ° C | 142 ° F |
| Air flow restriction (system) | 0.12 kPa | 0.48 in. water |
| Air flow (max @ rated speed for radiator arrangement) | 134 $m^3$/min | 4732 cfm |
| Engine Coolant capacity with radiator/exp. tank | 6.7 L | 1.8 gal |
| Engine coolant capacity | .7 L | 0.2 gal |
| Radiator coolant capacity | 6.0 L | 1.6 gal |
| **Inlet Air** | | |
| Combustion air inlet flow rate | 5.3 $m^3$/min | 187.2 cfm |
| **Exhaust System** | | |
| Exhaust stack gas temperature | 571.0 ° C | 1059.8 ° F |
| Exhaust gas flow rate | 13.7 $m^3$/min | 483.8 cfm |
| Exhaust flange size (internal diameter) | 6.4 mm | 0.3 in |
| **Heat Rejection** | | |
| Heat rejection to exhaust (total) | 67 kW | 3810 Btu/min |
| Heat rejection to atmosphere from generator | 6.2 kW | 352.6 Btu/min |
| **Alternator**[2] | | |
| Motor starting capability @ 30% voltage dip | 115 skVA | |
| Frame | LC2014D | |
| Temperature Rise | 130 ° C | 234 ° F |
| **Lube System** | | |
| Sump refill with filter | 6.0 L | 1.6 gal |

[1] For ambient and altitude capabilities consult your Caterpillar dealer. Airflow restriction (system) is added to existing restriction from factory.
[2] Generator temperature rise is based on a 40 C (104 F) ambient per NEMA MG1-32.

## RATING DEFINITIONS AND CONDITIONS

**Meets or Exceeds International Specifications:** AS1359, CSA, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, UL508A, 72/23/EEC, 98/37/EC, 2004/108/EC

**Standby** - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year. Standby power in accordance with ISO8528. Fuel stop power in accordance with ISO3046. Standby ambients shown indicate ambient temperature at 100% load which results in a coolant top tank temperature just below the shutdown temperature.

**Ratings** are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

**Fuel rates** are based on fuel oil of 35° API [16° C (60° F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Caterpillar representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Caterpillar dealer.

## DIMENSIONS

| Package Dimensions | | |
|---|---|---|
| Length | 2208.0 mm | 86.93 in |
| Width | 1000.0 mm | 39.37 in |
| Height | 1265.9 mm | 49.84 in |
| Weight | 306 kg | 675 lb |

NOTE: For reference only - do not use for installation design. Please contact your local dealer for exact weight and dimensions. (General Dimension Drawing #3301887).

Performance No.: P3454A

Feature Code: NAC088P

Gen. Arr. Number: 2652660

Source: U.S. Sourced

LEHE0092 02/09

14172650

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# Appendix C2

# SCREEN3 Model for Diesel Engine

**SCREEN3 Output and Calculation of Annual PM2.5 Concentrations for Diesel Engines**

| Distance | Maximum Hourly Dispersion Factor | | | | Annual Average Dispersion Factor | | | | | Average Annual Concentration | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fire Service Pump | Veterinary Hospital | Gondola Auxiliary Engine | Gondola Evacuation Unit | Fire Service Pump | Veterinary Hospital | Gondola Auxiliary Engine | Gondola Evacuation Unit | Total | Fire Service Pump | Veterinary Hospital | Gondola Auxiliary Engine | Gondola Evacuation Unit | Total |
| | ($\mu g/m^3$)/(g/s) | | | | ($\mu g/m^3$)/(g/s) | | | | | ($\mu g/m^3$) | | | | |
| 1 | 0 | 0 | 0 | 0 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| 33 | 1.02E+04 | 1.07E+04 | 9687 | 1.05E+04 | 1.0E+03 | 1.1E+03 | 9.7E+02 | 1.0E+03 | 4.1E+03 | 1.4E-03 | 4.8E-04 | 1.6E-03 | 7.8E-04 | 4.3E-03 |
| 50 | 6849 | 7218 | 5702 | 7089 | 6.8E+02 | 7.2E+02 | 5.7E+02 | 7.1E+02 | 2.7E+03 | 9.5E-04 | 3.2E-04 | 9.5E-04 | 5.3E-04 | 2.7E-03 |
| 100 | 3046 | 3132 | 2766 | 3102 | 3.0E+02 | 3.1E+02 | 2.8E+02 | 3.1E+02 | 1.2E+03 | 4.2E-04 | 1.4E-04 | 4.6E-04 | 2.3E-04 | 1.3E-03 |
| 150 | 1955 | 2172 | 1788 | 2028 | 2.0E+02 | 2.2E+02 | 1.8E+02 | 2.0E+02 | 7.9E+02 | 2.7E-04 | 9.6E-05 | 3.0E-04 | 1.5E-04 | 8.2E-04 |
| 200 | 1645 | 1817 | 1513 | 1703 | 1.6E+02 | 1.8E+02 | 1.5E+02 | 1.7E+02 | 6.7E+02 | 2.3E-04 | 8.1E-05 | 2.5E-04 | 1.3E-04 | 6.9E-04 |
| 300 | 1234 | 1348 | 1145 | 1272 | 1.2E+02 | 1.3E+02 | 1.1E+02 | 1.3E+02 | 5.0E+02 | 1.7E-04 | 6.0E-05 | 1.9E-04 | 9.5E-05 | 5.2E-04 |
| 400 | 975.6 | 1056 | 912.6 | 1003 | 9.8E+01 | 1.1E+02 | 9.1E+01 | 1.0E+02 | 3.9E+02 | 1.4E-04 | 4.7E-05 | 1.5E-04 | 7.5E-05 | 4.1E-04 |
| 500 | 799.2 | 858.4 | 752.4 | 819.4 | 8.0E+01 | 8.6E+01 | 7.5E+01 | 8.2E+01 | 3.2E+02 | 1.1E-04 | 3.8E-05 | 1.3E-04 | 6.1E-05 | 3.4E-04 |
| 600 | 671.7 | 716.9 | 635.8 | 687.1 | 6.7E+01 | 7.2E+01 | 6.4E+01 | 6.9E+01 | 2.7E+02 | 9.3E-05 | 3.2E-05 | 1.1E-04 | 5.1E-05 | 2.8E-04 |
| 700 | 575.6 | 611 | 547.3 | 587.7 | 5.8E+01 | 6.1E+01 | 5.5E+01 | 5.9E+01 | 2.3E+02 | 8.0E-05 | 2.7E-05 | 9.1E-05 | 4.4E-05 | 2.4E-04 |
| 800 | 500.9 | 529.2 | 478.1 | 510.6 | 5.0E+01 | 5.3E+01 | 4.8E+01 | 5.1E+01 | 2.0E+02 | 6.9E-05 | 2.3E-05 | 8.0E-05 | 3.8E-05 | 2.1E-04 |
| 900 | 441.3 | 464.3 | 422.7 | 449.2 | 4.4E+01 | 4.6E+01 | 4.2E+01 | 4.5E+01 | 1.8E+02 | 6.1E-05 | 2.1E-05 | 7.0E-05 | 3.3E-05 | 1.9E-04 |
| 1000 | 392.8 | 411.9 | 377.4 | 399.3 | 3.9E+01 | 4.1E+01 | 3.8E+01 | 4.0E+01 | 1.6E+02 | 5.4E-05 | 1.8E-05 | 6.3E-05 | 3.0E-05 | 1.7E-04 |
| 1100 | 352.7 | 368.6 | 339.7 | 358.1 | 3.5E+01 | 3.7E+01 | 3.4E+01 | 3.6E+01 | 1.4E+02 | 4.9E-05 | 1.6E-05 | 5.7E-05 | 2.7E-05 | 1.5E-04 |
| 1200 | 329.3 | 344.3 | 317.1 | 334.4 | 3.3E+01 | 3.4E+01 | 3.2E+01 | 3.3E+01 | 1.3E+02 | 4.6E-05 | 1.5E-05 | 5.3E-05 | 2.5E-05 | 1.4E-04 |
| 1300 | 299.4 | 312.1 | 289 | 303.7 | 3.0E+01 | 3.1E+01 | 2.9E+01 | 3.0E+01 | 1.2E+02 | 4.2E-05 | 1.4E-05 | 4.8E-05 | 2.3E-05 | 1.3E-04 |
| 1400 | 274.8 | 285.9 | 265.7 | 278.6 | 2.7E+01 | 2.9E+01 | 2.7E+01 | 2.8E+01 | 1.1E+02 | 3.8E-05 | 1.3E-05 | 4.4E-05 | 2.1E-05 | 1.2E-04 |
| 1500 | 253.5 | 263.2 | 245.5 | 256.8 | 2.5E+01 | 2.6E+01 | 2.5E+01 | 2.6E+01 | 1.0E+02 | 3.5E-05 | 1.2E-05 | 4.1E-05 | 1.9E-05 | 1.1E-04 |
| 1600 | 234.8 | 243.4 | 227.8 | 237.8 | 2.3E+01 | 2.4E+01 | 2.3E+01 | 2.4E+01 | 9.4E+01 | 3.3E-05 | 1.1E-05 | 3.8E-05 | 1.8E-05 | 9.9E-05 |
| 1700 | 218.4 | 226 | 212.2 | 221.1 | 2.2E+01 | 2.3E+01 | 2.1E+01 | 2.2E+01 | 8.8E+01 | 3.0E-05 | 1.0E-05 | 3.5E-05 | 1.6E-05 | 9.2E-05 |
| 1800 | 203.9 | 210.7 | 198.3 | 206.2 | 2.0E+01 | 2.1E+01 | 2.0E+01 | 2.1E+01 | 8.2E+01 | 2.8E-05 | 9.4E-06 | 3.3E-05 | 1.5E-05 | 8.6E-05 |
| 1900 | 190.9 | 197 | 185.9 | 193 | 1.9E+01 | 2.0E+01 | 1.9E+01 | 1.9E+01 | 7.7E+01 | 2.6E-05 | 8.7E-06 | 3.1E-05 | 1.4E-05 | 8.1E-05 |
| 2000 | 179.3 | 184.8 | 174.8 | 181.2 | 1.8E+01 | 1.8E+01 | 1.7E+01 | 1.8E+01 | 7.2E+01 | 2.5E-05 | 8.2E-06 | 2.9E-05 | 1.3E-05 | 7.6E-05 |
| 2100 | 168.9 | 173.8 | 164.8 | 170.6 | 1.7E+01 | 1.7E+01 | 1.6E+01 | 1.7E+01 | 6.8E+01 | 2.3E-05 | 7.7E-06 | 2.7E-05 | 1.3E-05 | 7.1E-05 |
| 2200 | 159.4 | 163.9 | 155.7 | 160.9 | 1.6E+01 | 1.6E+01 | 1.6E+01 | 1.6E+01 | 6.4E+01 | 2.2E-05 | 7.3E-06 | 2.6E-05 | 1.2E-05 | 6.7E-05 |
| 2300 | 150.8 | 154.9 | 147.4 | 152.2 | 1.5E+01 | 1.5E+01 | 1.5E+01 | 1.5E+01 | 6.1E+01 | 2.1E-05 | 6.9E-06 | 2.5E-05 | 1.1E-05 | 6.4E-05 |
| 2400 | 147 | 151.1 | 143.7 | 148.4 | 1.5E+01 | 1.5E+01 | 1.4E+01 | 1.5E+01 | 5.9E+01 | 2.0E-05 | 6.7E-06 | 2.4E-05 | 1.1E-05 | 6.2E-05 |
| 2500 | 139.7 | 143.4 | 136.6 | 141 | 1.4E+01 | 1.4E+01 | 1.4E+01 | 1.4E+01 | 5.6E+01 | 1.9E-05 | 6.4E-06 | 2.3E-05 | 1.0E-05 | 5.9E-05 |
| 2600 | 133.1 | 136.6 | 130.3 | 134.3 | 1.3E+01 | 1.4E+01 | 1.3E+01 | 1.3E+01 | 5.3E+01 | 1.8E-05 | 6.1E-06 | 2.2E-05 | 1.0E-05 | 5.6E-05 |
| 2700 | 127.1 | 130.3 | 124.4 | 128.2 | 1.3E+01 | 1.3E+01 | 1.2E+01 | 1.3E+01 | 5.1E+01 | 1.8E-05 | 5.8E-06 | 2.1E-05 | 9.5E-06 | 5.4E-05 |
| 2800 | 121.5 | 124.5 | 119.1 | 122.6 | 1.2E+01 | 1.2E+01 | 1.2E+01 | 1.2E+01 | 4.9E+01 | 1.7E-05 | 5.5E-06 | 2.0E-05 | 9.1E-06 | 5.1E-05 |
| 2900 | 116.4 | 119.2 | 114.1 | 117.3 | 1.2E+01 | 1.2E+01 | 1.1E+01 | 1.2E+01 | 4.7E+01 | 1.6E-05 | 5.3E-06 | 1.9E-05 | 8.7E-06 | 4.9E-05 |
| 3000 | 111.6 | 114.2 | 109.4 | 112.5 | 1.1E+01 | 1.1E+01 | 1.1E+01 | 1.1E+01 | 4.5E+01 | 1.5E-05 | 5.1E-06 | 1.8E-05 | 8.4E-06 | 4.7E-05 |
| 3500 | 92.07 | 93.97 | 90.51 | 92.73 | 9.2E+00 | 9.4E+00 | 9.1E+00 | 9.3E+00 | 3.7E+01 | 1.3E-05 | 4.2E-06 | 1.5E-05 | 6.9E-06 | 3.9E-05 |
| 4000 | 77.81 | 79.25 | 76.62 | 78.31 | 7.8E+00 | 7.9E+00 | 7.7E+00 | 7.8E+00 | 3.1E+01 | 1.1E-05 | 3.5E-06 | 1.3E-05 | 5.8E-06 | 3.3E-05 |
| 4500 | 67 | 68.12 | 66.07 | 67.39 | 6.7E+00 | 6.8E+00 | 6.6E+00 | 6.7E+00 | 2.7E+01 | 9.3E-06 | 3.0E-06 | 1.1E-05 | 5.0E-06 | 2.8E-05 |
| 5000 | 58.56 | 59.45 | 57.81 | 58.87 | 5.9E+00 | 5.9E+00 | 5.8E+00 | 5.9E+00 | 2.3E+01 | 8.1E-06 | 2.6E-06 | 9.6E-06 | 4.4E-06 | 2.5E-05 |
| 5500 | 51.81 | 52.54 | 51.2 | 52.06 | 5.2E+00 | 5.3E+00 | 5.1E+00 | 5.2E+00 | 2.1E+01 | 7.2E-06 | 2.3E-06 | 8.5E-06 | 3.9E-06 | 2.2E-05 |
| 6000 | 46.31 | 46.92 | 45.81 | 46.52 | 4.6E+00 | 4.7E+00 | 4.6E+00 | 4.7E+00 | 1.9E+01 | 6.4E-06 | 2.1E-06 | 7.6E-06 | 3.5E-06 | 2.0E-05 |
| 6500 | 42.19 | 42.72 | 41.75 | 42.38 | 4.2E+00 | 4.3E+00 | 4.2E+00 | 4.2E+00 | 1.7E+01 | 5.9E-06 | 1.9E-06 | 7.0E-06 | 3.2E-06 | 1.8E-05 |
| 7000 | 38.39 | 38.84 | 38.02 | 38.55 | 3.8E+00 | 3.9E+00 | 3.8E+00 | 3.9E+00 | 1.5E+01 | 5.3E-06 | 1.7E-06 | 6.3E-06 | 2.9E-06 | 1.6E-05 |
| 7500 | 35.19 | 35.58 | 34.86 | 35.32 | 3.5E+00 | 3.6E+00 | 3.5E+00 | 3.5E+00 | 1.4E+01 | 4.9E-06 | 1.6E-06 | 5.8E-06 | 2.6E-06 | 1.5E-05 |
| 8000 | 32.43 | 32.77 | 32.14 | 32.55 | 3.2E+00 | 3.3E+00 | 3.2E+00 | 3.3E+00 | 1.3E+01 | 4.5E-06 | 1.5E-06 | 5.4E-06 | 2.4E-06 | 1.4E-05 |
| 8500 | 30.03 | 30.33 | 29.78 | 30.13 | 3.0E+00 | 3.0E+00 | 3.0E+00 | 3.0E+00 | 1.2E+01 | 4.2E-06 | 1.3E-06 | 5.0E-06 | 2.2E-06 | 1.3E-05 |
| 9000 | 27.93 | 28.2 | 27.7 | 28.02 | 2.8E+00 | 2.8E+00 | 2.8E+00 | 2.8E+00 | 1.1E+01 | 3.9E-06 | 1.3E-06 | 4.6E-06 | 2.1E-06 | 1.2E-05 |
| 9500 | 26.07 | 26.31 | 25.87 | 26.16 | 2.6E+00 | 2.6E+00 | 2.6E+00 | 2.6E+00 | 1.0E+01 | 3.6E-06 | 1.2E-06 | 4.3E-06 | 1.9E-06 | 1.1E-05 |
| 10000 | 24.43 | 24.64 | 24.25 | 24.5 | 2.4E+00 | 2.5E+00 | 2.4E+00 | 2.5E+00 | 9.8E+00 | 3.4E-06 | 1.1E-06 | 4.0E-06 | 1.8E-06 | 1.0E-05 |

**D R A F T**

# Appendix D

# Diesel Exhaust Speciation Profile

[redacted] [redacted]

Table 2. Speciation Factors, Non-Cancer, and Cancer Risk Factors for Selected TACs

| TAC Name | Speciation Factor | Non Cancer | | | Cancer | |
|---|---|---|---|---|---|---|
| | | Acute Inhalation (µg/m3) | 8-Hour Inhalation (µg/m3) | Chronic Inhalation (µg/m3) | Inhalation Unit Risk (µg/m3)-1 | Inhalation Cancer Potency Factor (mg/kg-d)-1 |
| DPM | NA | - | - | 5.00E+00 | 3.00E-04 | 1.10E+00 |
| PM2.5 | NA | - | - | - | - | - |
| acetaldehyde | 0.07353 | 4.70E+02 | 3.00E+02 | 1.40E+02 | 2.70E-06 | 1.00E-02 |
| acrolein | 0.01297 | 2.50E+00 | 7.00E+01 | 3.50E+01 | - | - |
| benzaldehyde | 0.00699 | - | | - | - | - |
| benzene | 0.02001 | 1.30E+03 | | 6.00E+01 | 2.90E-05 | 1.00E-01 |
| ethanol | 0.00009 | - | | - | - | - |
| ethylbenzene | 0.00305 | - | | 2.00E+03 | 2.50E-06 | 8.70E-03 |
| ethylene | 0.14377 | - | | | - | - |
| ethylene dibromide (1,2-dibromoethane) | Uk | - | | 8.00E-01 | 7.10E-05 | 2.50E-01 |
| ethylene dichloride (1,2-dichloroethane) | Uk | - | | 4.00E+02 | 2.10E-05 | 7.20E-02 |
| ethylene glycol | Uk | - | | 4.00E+02 | - | - |
| ethylene oxide (1,2-epoxyethane) | Uk | - | | 3.00E+01 | 8.80E-05 | 3.10E-01 |
| ethylene thiourea | Uk | - | | - | 1.30E-05 | 4.50E-02 |
| ethylene glycol butyl ether | Uk | 1.40E+04 | | - | - | - |
| ethylene glycol ethyl ether | Uk | 3.70E+02 | | 7.00E+01 | - | - |
| ethylene glycol ethyl ether acetate | Uk | 1.40E+02 | | 3.00E+02 | - | - |
| ethylene glycol methyl ether | Uk | 9.30E+01 | | 6.00E+01 | - | - |
| ethylene glycol methyl ether acetate | Uk | | | 9.00E+01 | - | - |
| formaldehyde | 0.14714 | 5.50E+01 | 9.00E+00 | 9.00E+00 | 6.00E-06 | 2.10E-02 |
| isobutane | 0.01222 | - | | - | - | - |
| isopentane | 0.00602 | - | | - | - | - |
| methane | 0.04084 | - | | - | - | - |
| methyl ethyl ketone (mek) (2-butanone) | 0.01477 | 1.30E+04 | | - | - | - |
| methylcyclopentane | 0.00149 | | | - | - | - |
| m-xylene | 0.00611 | 2.20E+04 | | 7.00E+02 | - | - |
| n-butane | 0.00104 | - | | - | - | - |
| n-hexane | 0.00157 | - | | 7.00E+03 | - | - |
| n-pentane | 0.00175 | - | | - | - | - |
| o-xylene | 0.00335 | 2.20E+04 | | 7.00E+02 | - | - |
| propionaldehyde | 0.0097 | - | | - | - | - |
| propylene | 0.02597 | - | | 3.00E+03 | - | - |
| propylene glycol monomethyl ether | uk | - | | 7.00E+03 | - | - |
| propylene oxide | uk | 3.10E+03 | | 3.00E+01 | 3.70E-06 | 1.30E-02 |
| toluene | 0.01473 | 3.70E+04 | | - | - | - |

uk = unknown.

APPENDIX G

# BIOLOGICAL RESOURCES

# APPENDIX G-1

## Status of the Alameda Whipsnake in Knowland Park for the Proposed Expansion of the Oakland Zoo (Swaim Biological, Inc., 2011)

**Status of the Alameda Whipsnake (*Masticophis lateralis euryxanthus*) in Knowland Park for the Proposed Expansion of the Oakland Zoo City of Oakland, Alameda County, California**

*Prepared for*

Mr. Nik Haas-Dehejia
Director, Strategic Initiatives
East Bay Zoological Society
P.O. Box 5238
Oakland, CA 94605

*Prepared by*

Swaim Biological, Inc
4435 First Street, PMB 312
Livermore, CA 94551
(925) 455-8770

January 3, 2011

**TABLE OF CONTENTS**



**LIST OF FIGURES**



**LIST OF TABLES**

# 1.0 INTRODUCTION

The purpose of this report is to present the results of live trapping surveys conducted for the Alameda whipsnake (*Masticophis lateralis euryxanthus*) in Knowland Park, City of Oakland, Alameda County, California and to discuss the impacts associated with the proposed expansion of the Oakland Zoo and a proposal for a mitigation plan. The Oakland Zoo is located at the western edge of Knowland Park and has an approved Master Plan that allows the zoo to expand to the east of the existing zoo. The project site (i.e. the expansion area) is located just east of the existing Oakland Zoo and lies within Knowland Park, just east of Interstate 580 at the Golf Links Road intersection. The Oakland Zoo is proposing to expand the Zoo to include a new 17,000 square foot Veterinary Medical Hospital and a new California Exhibit which will exhibit native California species from the past and present and provide education on conservation of native California species. The California Exhibit is located to the east of the existing zoo and will only be accessed by the public via a gondola. An existing dirt road would be paved to provide emergency and maintenance access to the new California Exhibit.

The Alameda whipsnake (AWS) is listed as a state and federally threatened species. None of the project site is within the current Critical Habitat for the Alameda whipsnake (U. S. Fish and Wildlife Service, 2006), but is within the former critical habitat for the Alameda whipsnake (U.S. Fish and Wildlife Service 2000). The undeveloped portion of Knowland Park east of the existing zoo, is within the Oakland-Las Trampas Recovery Unit established by the U.S. Fish and Wildlife Service (2002) Draft Recovery Plan for Chaparral and Scrub Community Species East of San Francisco Bay, California.

Two separate surveys have been conducted for the Alameda whipsnake on the project site. The first was conducted in 1998 and 1999 due to the presence of potential whipsnake habitat in the project area. The second was conducted in fall 2009/spring 2010 due to the amount of time that had lapsed and changes to the survey protocol for determining the status of the species.

The surveys were conducted under the authority of a federal recovery permit (TE-815537) issued by the U.S. Fish and Wildlife Service (USFWS) and a Memorandum of Understanding from the California Department of Fish and Game (CDFG).

# 2.0 Ecology of the Alameda Whipsnake

## *2.1 Description*

The Alameda whipsnake is a slender, fast moving, diurnal snake with a narrow neck and relatively broad head (Stebbins 2003). The dorsal color is sooty-black with wide yellow-orange dorso-lateral stripes (Riemer 1954). The anterior portion of the stripes and ventral surface of the snake are heavily pigmented with orange-rufous coloration. The Alameda whipsnake and the chaparral whipsnake (*Masticophis lateralis lateralis*) make up the two subspecies of the California whipsnake (*Masticophis lateralis*) (U.S. Department of Interior, 2000). Adults can reach up to five feet in length (Swaim 1994).

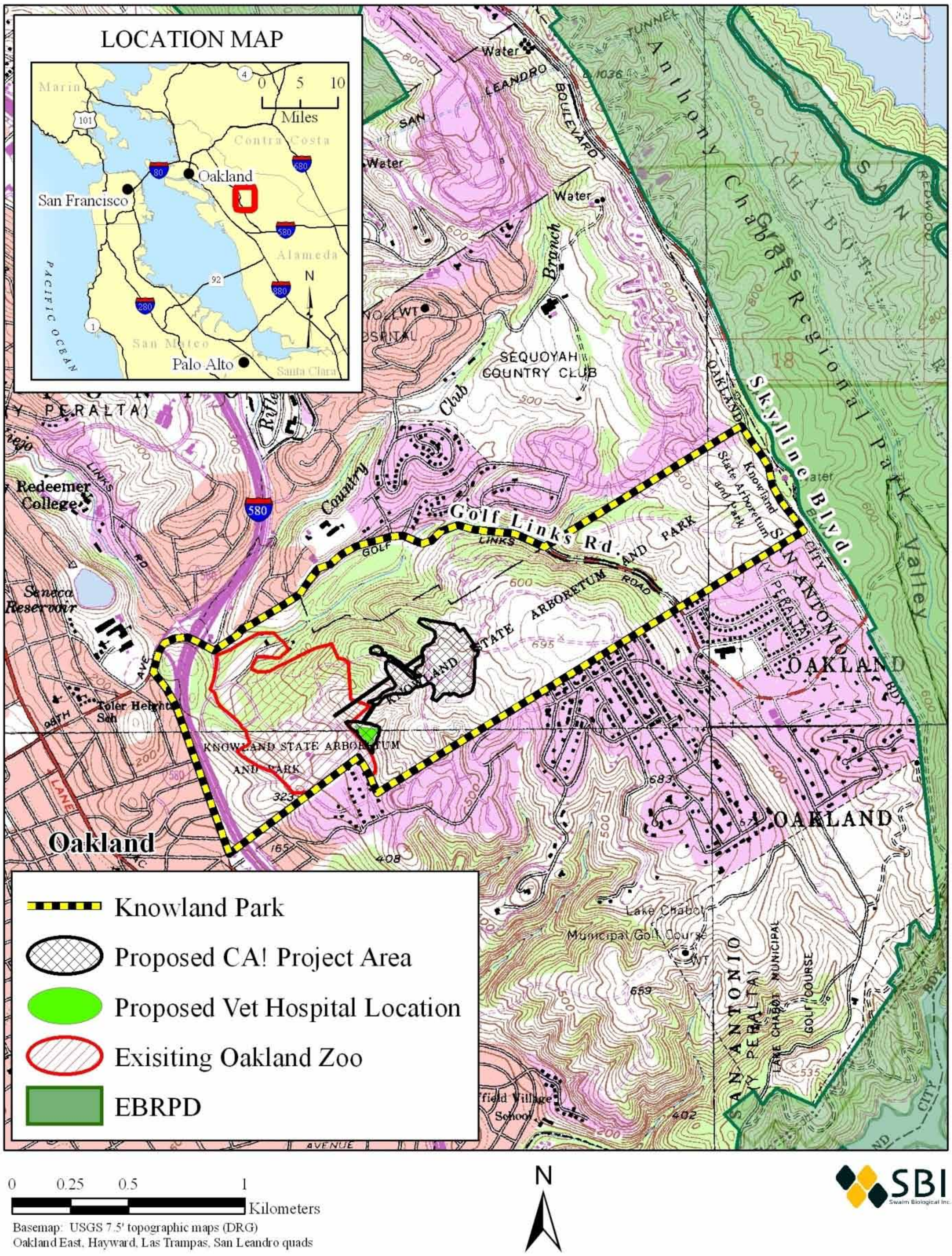


**Figure 1. Regional Location Map**

## 2.2 Habitat Use and Spatial Ecology

The Alameda whipsnake uses the mosaic of habitats found in the East Bay, with the highest frequency of use in and near scrub and chaparral habitats including chamise chaparral, Diablan sage scrub, northern coyote brush scrub, and riparian scrub (Swaim 1994). Swaim (1994) also found that there was extensive use of grassland and oak woodland/savanna adjacent to chaparral and scrub communities by Alameda whipsnakes equipped with radio transmitters. The home ranges of six radio-equipped whipsnakes were centered on scrub communities. Core areas (areas of concentrated use) were on east, south, southeast, southwest-facing slopes with open or partially open canopy scrub or chaparral communities. Protection and conservation of core type habitats and the communities/undeveloped areas that connect them is critical to avoiding significant impacts to Alameda whipsnake populations.

Chamise chaparral and Diablan sage scrub communities have a measurably higher carrying capacity for AWS populations than coyote brush scrub. AWS are typically the dominant snake species in chamise chaparral. This is likely due in part to the higher carrying capacity for most lizard prey species in these communities and a tendency for slow (or no) succession or conversion to less suitable habitat.

Whipsnakes monitored with telemetry ranged into the surrounding grassland for distances of greater than 500 feet (Swaim 1994). Whipsnakes remained in the grassland for periods ranging from a few hours to several weeks at a time (Swaim 1994). Grassland habitats were used by male whipsnakes most extensively during the mating season in spring (Swaim 1994). Female whipsnakes used grassland areas most extensively after mating, possibly in their search for suitable egg-laying sites (Swaim 1994). Anecdotal information also indicates Alameda whipsnakes can be found even greater distances from scrub and chaparral habitats (up to approximately four miles) in grassland and oak savannah (Swaim 2000a, 2000b, 2000c, 2003a, 2003b).

Rock outcrops can enhance the habitat for Alameda whipsnake because they provide cover and promote abundant lizard populations. However, rock outcrops are not present at all study areas where whipsnakes have been documented. We did not map the distribution of rock outcrops in the study area for this reason.

## 2.3 Distribution in the Project Vicinity

The closest records of the Alameda whipsnake in the project vicinity include recent observations (2006) from Chabot Regional Park approximately 1.62 miles northeast of the site and 1.75 miles east of the site (Table 1). Several other observations are known from within three miles of the site and are outlined below with a general location, distance and direction from the site, year of observation and source of the data record. Habitat with significant areas of core habitat remains in pockets to the north and south of Knowland Park, but have not been surveyed for AWS (e.g. Leona Quarry, open space west of the Chabot Municipal Golf Course).

**Table 1. Alameda whipsnake records in the project vicinity.**

| Location | Distance (miles) and direction from Site | Year of Observation | Source |
|---|---|---|---|
| Chabot Regional Park | 1.62 /NE | 2006 | CNDDB |
| Chabot Regional Park | 1.75/ E | 2006 | CNDDB |
| USLRW | 2.35/NE | 2008 | CNDDB |
| USLRW | 2.44/NE | 2008 | CNDDB |
| Merit College Area | 2.8/NW | 1940s | MVZ |
| Leona Heights Park | 3.0 /N | 1953 | CNDDB |

CNDDB= California Natural Diversity Data Base.
MVZ= Museum of Vertebrate Zoology (Berkeley Collections).
USLRW= Upper San Leandro Reservoir Watershed.

The historic distribution of the Alameda whipsnake and potential habitat in the region suggests that the area was contiguous with occupied habitat to the north and south prior to large scale development in the area. The study area has physically suitable habitat and appears to have an adequate lizard prey base. Chamise chaparral is typically a habitat type where AWS is the dominant snake species. However, development in the project vicinity has likely significantly reduced connectivity of the site to other occupied areas of habitat. The site is a relatively narrow island of habitat (between 0.3 and 0.5 miles wide) that has been virtually isolated for several decades by the residential development to the north and south and the existing Oakland Zoo to the west. To the east, a major road (Golf Links Road) bisects Knowland Park into two areas. This road does not function as a complete barrier to movement, but likely is a significant deterrent. The potential for whipsnakes moving into the site from the closest known occupied habitat to the east is limited by the need to cross both Golf Links Road and Skyline Boulevard further to the east. The potential for AWS to come to the site via other routes has not been specifically analyzed.

# 3.0 MATERIALS AND METHODS

## *3.1 Vegetation Community Mapping*

SBI biologists mapped vegetation using GIS and aerial photography from several years to capture the dynamic changes in distribution and reemergence of one community (French broom scrub) over time. Naming of vegetation communities generally follows Holland (1986). Vegetative communities present in the study area include grassland (non-native and native needle grass grassland), Diablan sage scrub, French broom scrub, northern coyote brush scrub, chamise chaparral, coast-live oak woodland, barren and disturbed (roads/turn outs), and ornamental (*Eucalyptus* sp. and non-native pine).

## *3.2 Alameda Whipsnake Habitat Modeling*

We created and overlaid an aspect layer onto the vegetation layer to identify the location of core type habitats of the AWS. This allowed us to meaningfully evaluate the potential impacts to Alameda whipsnake associated with the proposed project.

## *3.3 Field Trapping Surveys*

**1998-1999 Survey Periods**

Trapping surveys in 1998-1999 were conducted from April 16, 1998 through July 17, 1998 and May 21 through June 21, 1999. Although 90 days of trapping were conducted during 1998, as required by the survey protocol at that time, a total of 25 to 30 days during the survey period were lost due to rainy and/or cold foggy weather the San Francisco Bay Area experienced during the spring of 1998. The period of trapping during 1999 was conducted to make up for the days of trapping lost during 1998. A total of 21 traplines were placed in the areas with the highest quality potential whipsnake habitat in the California 1820 (now called the California Exhibit) study area as planned at that time (Figure 2). These areas included open and partially open canopy stands of chamise chaparral, coyote brush scrub, Diablan sage scrub, rock outcrops and the ecotone of scrub and grassland communities (Figure 2). Trapline placement was slightly different in 1998 versus 1999 (Figure 2).

**2009-2010 Surveys**

In 2009-2010 a second status survey was conducted due to time elapsed since the first survey and changes to the status survey protocol, which added a 45-day fall trapping component to the survey methods. In addition several project features had changed or been eliminated. A total of 35 traplines were distributed in areas of optimal habitat in Knowland Park for this survey and the placement of traplines differed slightly from the 1998-99 survey (Figure 2). Trapping periods for this survey included a fall component from September 5, 2009 –October 27, 2009. We completed 45 active trapping days in this period. For eight of the days in this time period, the traps were deactivated due to extreme heat or rain events. The spring component was conducted from April 13, 2010 through July 23, 2010 and a total of 90 trap days were completed during that period.

**General Trapping Methods for all Surveys**

A trapline consists of an approximately 50-foot length of drift fence with a double-funneled trap at each end. Drift fences were constructed with 1/8 inch thick hardboard and were a minimum of 14 inches high (above the surface) with approximately two inches buried in the ground **(Figure 3)**. Where slopes were particularly steep drift fences were 20-22 inches in height. Traps consisted of a wooden frame with large panels of 1/8 inch wire mesh during the 1998 survey. During the 1998 survey period, the traps used measured 12 inches wide, 12 inches high, and 16 inches long (Figure 3). During the 1999 survey, minnow traps constructed of 1/4 inch hardware cloth supported by a metal frame were used. Written permission from the California Department of Fish and Game and the U.S. Fish and Wildlife Service to use the 1/4 inch wire mesh is on file at Swaim Biological Consulting. The traps used in 1999 measured 8 inches high and wide and 16 inches long. A piece of wire mesh was attached to the outside edge of each trap so that the total width of the entrance funnel measured 12 inches (Figure 3). Traplines were checked at least every other day during the study period. Each time the traps were monitored vertebrate species captured and the location of capture were recorded. Most snake species were measured and marked for individual recognition by clipping a certain ventral scale. Traps were checked daily in 2009-2010, regardless of weather conditions.


Figure 2. Trapline Locations 1998-1999 and 2009-2010 with an outline of the current project component configuration

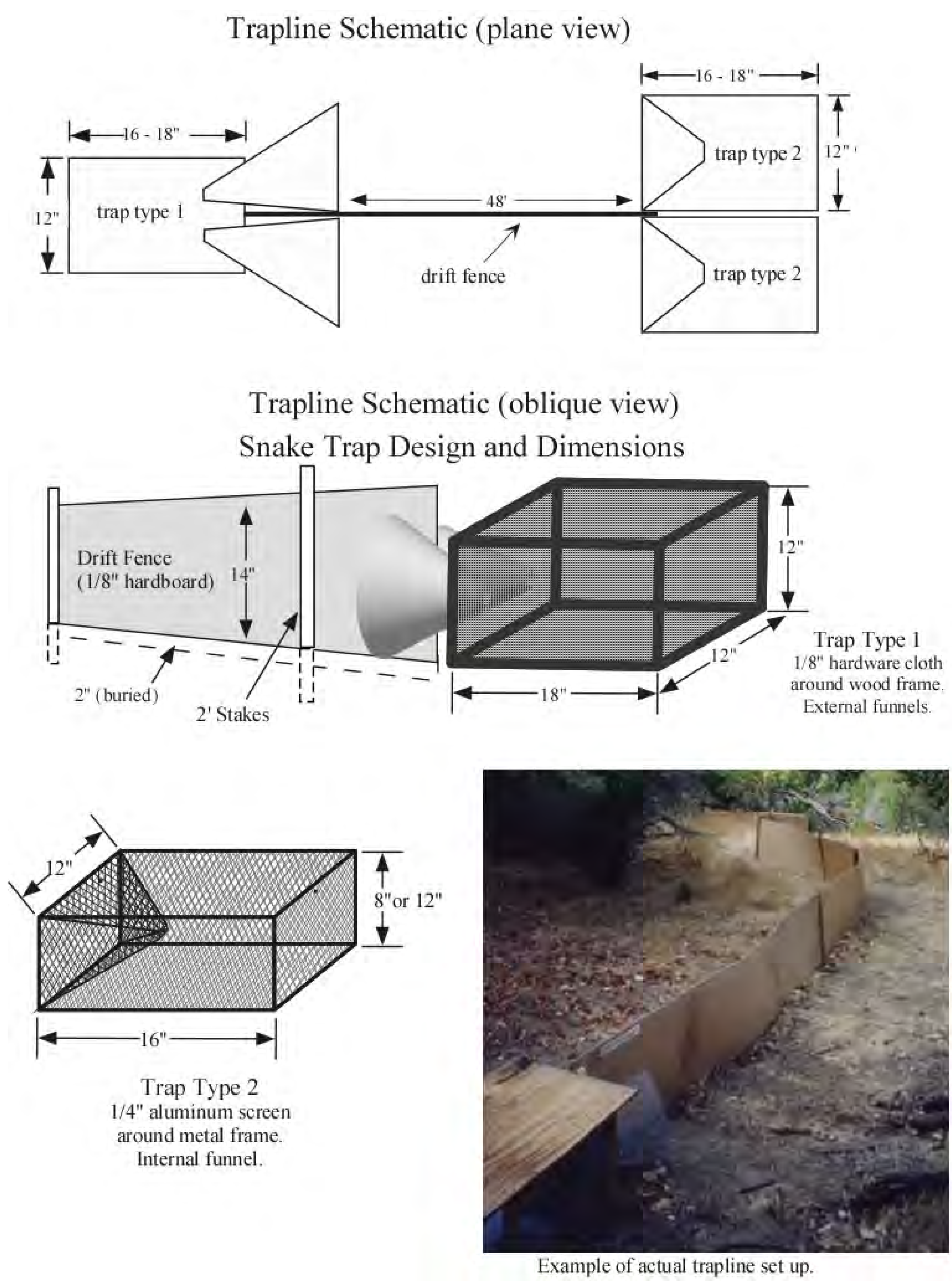


**Figure 3. Trapline Schematic and Trap Designs- Metal traps were only used in 1998-1999.**

# 4.0 RESULTS

## *4.1 Vegetation Community Mapping*

### 4.1.1 Vegetation Community Distribution

The distribution of the vegetation communities mapped is shown in **Figure 4**. A brief description of the community types mapped and brief evaluation of the habitat value/frequency of use by AWS for each community are provided below. Knowland Park is a valuable example of how, under existing conditions in the East Bay, Alameda whipsnake habitat is being lost through natural succession combined with the lack of natural periodic disturbance (e.g. fire).

**Grassland (Non-Native and Native)**

This grassy vegetation type is dominated by introduced annual grasses and herbs. This natural community is being rapidly replaced by non-native French broom scrub in the project area and in other parts of Knowland Park. Needle grass grassland, a natural community, is still a visible component embedded within the non-native grasslands in the project area. No mapping distinction could be made to distinguish these grassland communities.

**Northern Coyote Brush Scrub**

This natural community is dominated by a single species, coyote brush (*Baccharis pilularis*), although several other shrubby species are present, such as poison-oak (*Toxicodendron diversilobum*), bush monkeyflower (*Mimulus aurantiacus*), coffeeberry (*Rhamnus californica)*, elderberry (*Sambucus mexicana*), and coastal sagebrush (*Artemisia californica*). Northern coyote brush scrub encroaches into grasslands in the absence of fire or browsing by large herbivores. Knowland Park has not had significant fires or large scale grazing in decades. During the trapping survey in fall of 2009 a small fire (1 – 2 acres) burned some brush/grassland habitat north of the project area.

Natural succession tends to result in coast live oaks (*Quercus agrifolia*) and California bay (*Umbellularia californica*) invading coyote brush scrub in moister sites, deeper soils, and in the absence of other disturbance such as fire. Northern coyote brush scrub is on many parts of the upper elevations of the site and Knowland Park.

**Diablan Sage Scrub**

Diablan sage scrub is dominated by coastal sagebrush, poison-oak, bush monkeyflower, and occasional coyote brush. Coastal sage scrub is typically confined to relatively steep, rocky, often south-facing slopes, as it is in the study area. There is much intergradation of Diablan sage scrub and northern coyote brush scrub, since the predominant of one natural community is almost always found in the other, though in lesser amounts. Intermediate or transitional vegetation was mapped as Diablan sage scrub because it is generally a higher quality of habitat for the Alameda whipsnake and is important for other wildlife species in general.

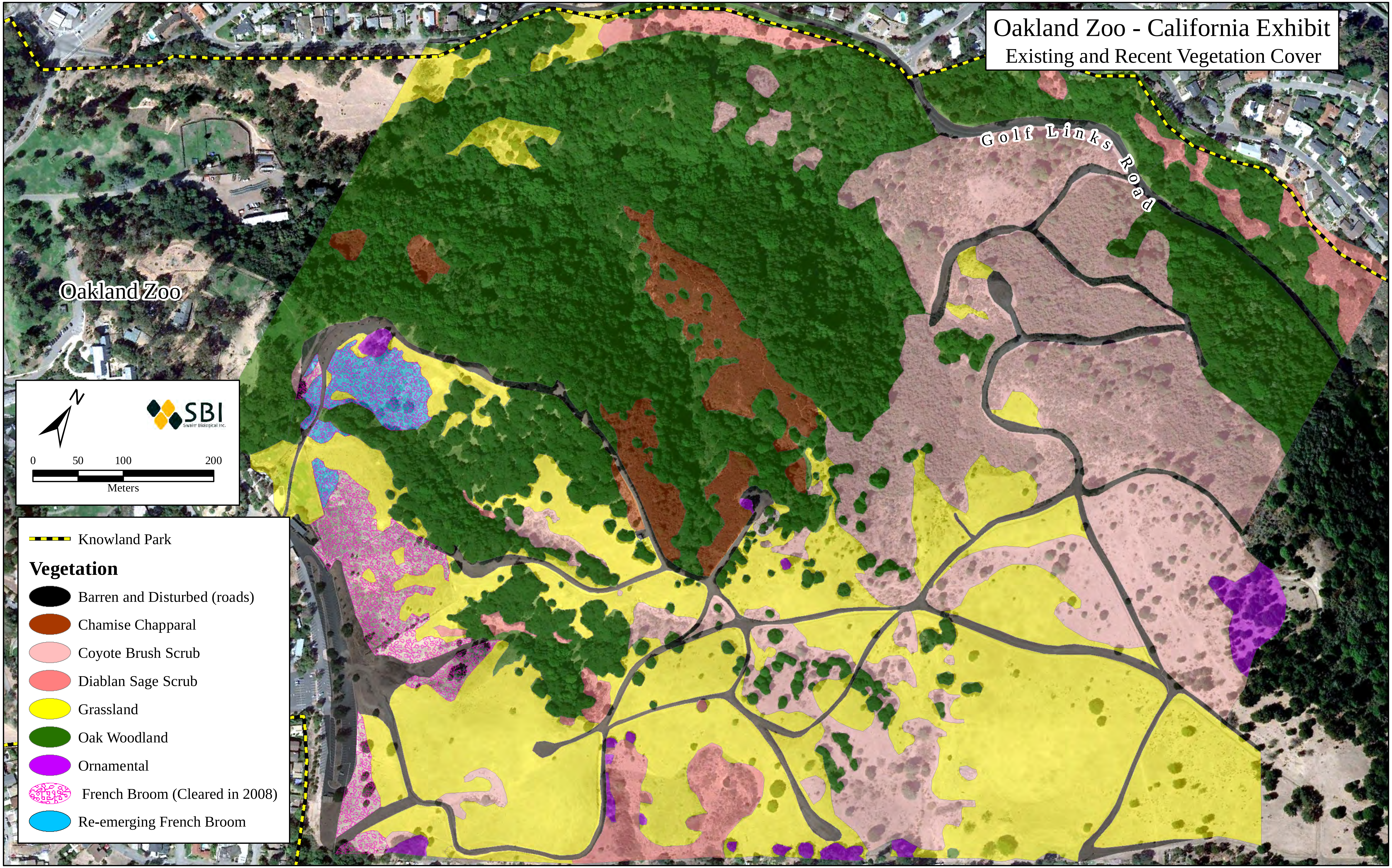


Figure 4. Vegetative Cover Map for Oakland Zoo Expansion Area.

**Chamise Chaparral**

This natural community is dominated by chamise (*Adenostoma fasciculatum*), growing in tall (up to 10 feet or more), dense stands. In the study area, several other woody species were found in chamise chaparral: on the more shaded slopes with deeper soil, silktassel (*Garrya elliptica*), brittle manzanita (*Arctostaphylos tomentosa* ssp. *crustacea*), coyote brush, poison-oak and coast live oak occur. On more exposed slopes, often in particularly rocky places, small patches or isolated individuals of coastal sagebrush and bush monkeyflower are found. There is little understory in this natural community within the study area. Chamise chaparral is a natural community adapted to repeated fires (Holland 1986) due to its ability to stump sprout. In the study area, however, the stands do not appear to have experienced fire in many decades. Despite the shrubs being tall, they still provide high quality habitat for the Alameda whipsnake. Chamise chaparral is found on the slopes of the upper part of the study area. French broom is invading areas of chamise on the site.

**French Broom Scrub**

This vegetation type is not described by Holland (1986), although it occupies extensive and increasing acreage in the coastal regions of California. It is dominated by a non-native shrub, French broom (*Genista monspessulana*) which forms a nearly pure stand. French broom invades grassland, coyote brush scrub and open oak savanna, out competing much of the understory. Soil disturbance greatly encourages the spread of French broom. French broom is distributed in many large stands throughout the East Bay Hills and it is present in every natural community within the study area. Over the course of the survey work for AWS at Knowland Park, the distribution of French broom has been dynamic, due to natural and human related actions. Large areas of broom that were present in 1998-1999 within existing animal exhibits and areas adjacent to the existing zoo were removed from the project area by contractors (Appendix A, 2007 and 2009 Google Earth Photos). Subsequently new areas have been invaded by broom and it is spreading in nearly all of the native communities in Knowland Park. The spread of broom and conversion of native habitats to stands of broom, poses a significant threat to the quality of the site for AWS. Efforts are being made to reduce the spread and eliminate it from areas of high quality AWS habitat on lands owned and managed by the East Bay Regional Park District.

**Coast Live-oak Woodland**

This natural community varies from an open savanna with herbaceous or shrubby understory to a closed-canopy woodland. It is dominated by coast live oak. The second most frequently occurring tree is California bay. Other species that occur occasionally in the study area are California buckeye (*Aesculus californica*) and elderberry. The understory of this community varies. When the oaks have an open canopy, the understory is much the same as the adjacent needlegrass grassland or open Northern coyote brush scrub. When coast live oak woodland exists as a closed-canopy woodland, the understory is more diverse with herbs and shrubs, including poison-oak, hazelnut (*Corylus cornuta* var. *californica*), gooseberry (*Ribes* spp.), snowberry (*Symphoricarpos albus* var. *laevigatus*), and blackberry (*Rubus* spp.). Coast live oak woodland occurs throughout the study area on shaded slopes, primarily with a, north-or east-facing aspect. Coast live oak woodland habitats with a more open canopy and on aspects facing southerly and easterly, are generally used more frequently by AWS.

**Barren/Disturbed**

This category is primarily the existing fire roads, turn around areas where fire roads terminated and the barren portion of the compost pile area where the veterinary hospital is proposed.

**Ornamental**

Eucalyptus and pine trees are the two mapped ornamental tree species. Eucalyptus is not prevalent in the study area and occurs in only small isolated patches with a few large trees. These stands may slightly reduce the habitat value, but are not large enough to present any kind of barrier or deterrent of movement between better habitat areas. In some areas of the Oakland- Berkeley Hills, Eucalyptus stands are a major factor in habitat loss. Pine trees occur in a small clump near the upper end of the study area.

## *4.2 Alameda Whipsnake Habitat Modeling*

Habitat modeling was used to generally define the core areas on the site where the frequency of use for any AWS on the site would be highest and contain essential habitat features such as most egg laying sites, winter retreats, and high quality foraging areas. They contain the majority of components that are essential for supporting viable resident populations of AWS and are used at a very high frequency although habitat use is not limited to core areas. **Figure 5** shows the aspect for all scrub and chaparral habitat types in the project area. In addition we included two zones of habitat regularly used by AWS when adjacent to scrub and/or chaparral based on telemetry data, trapping data, and opportunistic observations of free ranging AWS. This graphic indicates that there is a mosaic of core habitats that are spaced at close enough distances that any AWS on site would use/incorporate several of these core habitats within their home range and that if an AWS population were present, it would use most if not virtually all of the study area to varying degrees.

## *4.3 Field Trapping Surveys*

A single Alameda whipsnake was captured during the entire study period. A small adult male AWS was captured on June 3, 4, and 27 in three different traplines (**Figure 5 and Figure 6**). The exact location of AWS captures is not shown. No other AWS were captured or observed during the study.

A total of at least twenty-five vertebrate species were captured including six amphibian species, three lizard species, six snake species, eight small mammal species, two bird species identified and at least one unidentified species of bird. The common and scientific name and number of captures for each species during each trapping session is summarized in Table 1. The most commonly captured snake species was the western yellow-bellied racer (*Coluber constrictor mormon*). Like the Alameda whipsnake, this species is more visually oriented and generally prefers higher ambient temperatures than the other snake species captured on the site.

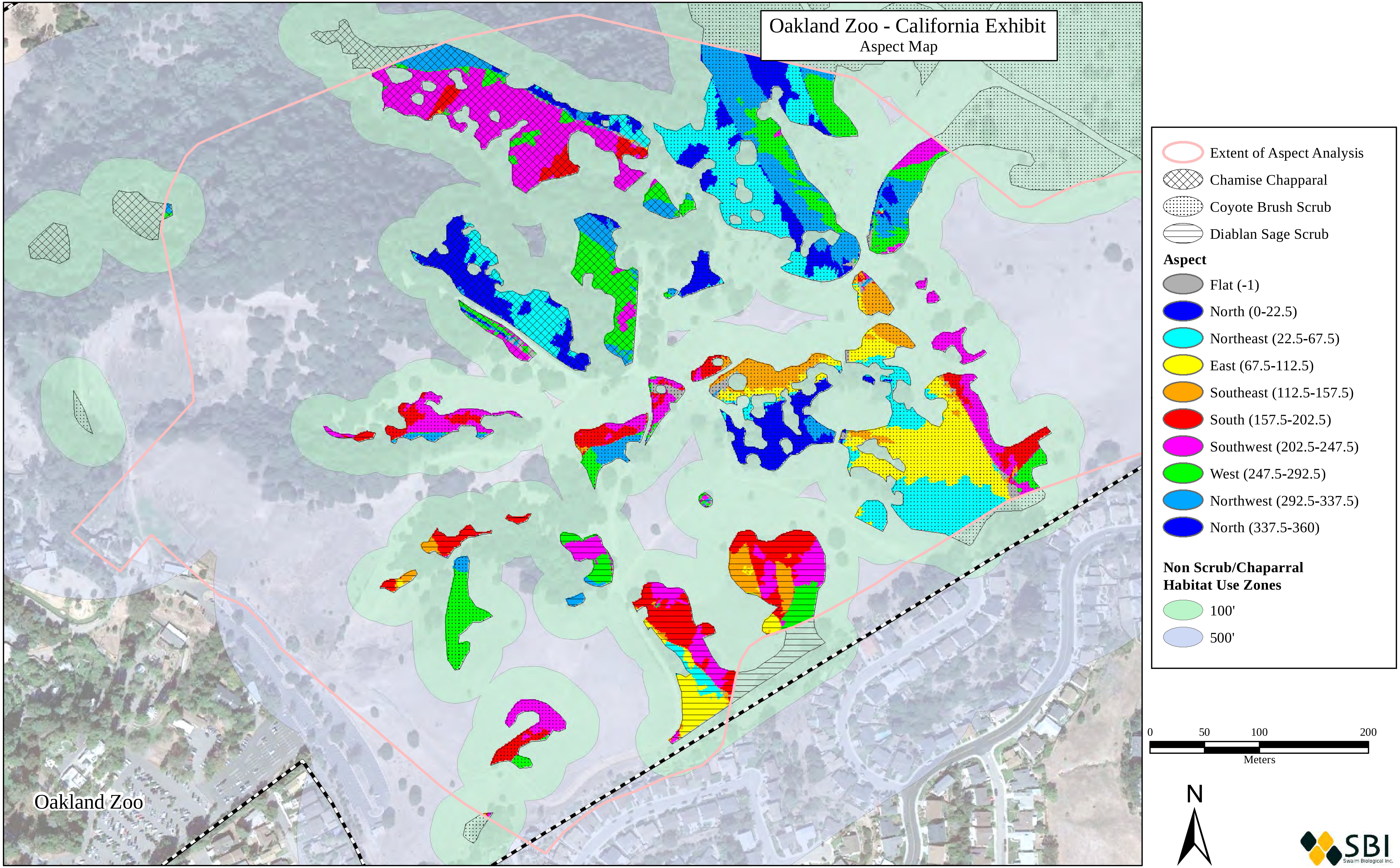


Figure 5. Aspect of scrub and chaparral habitats in the project area.

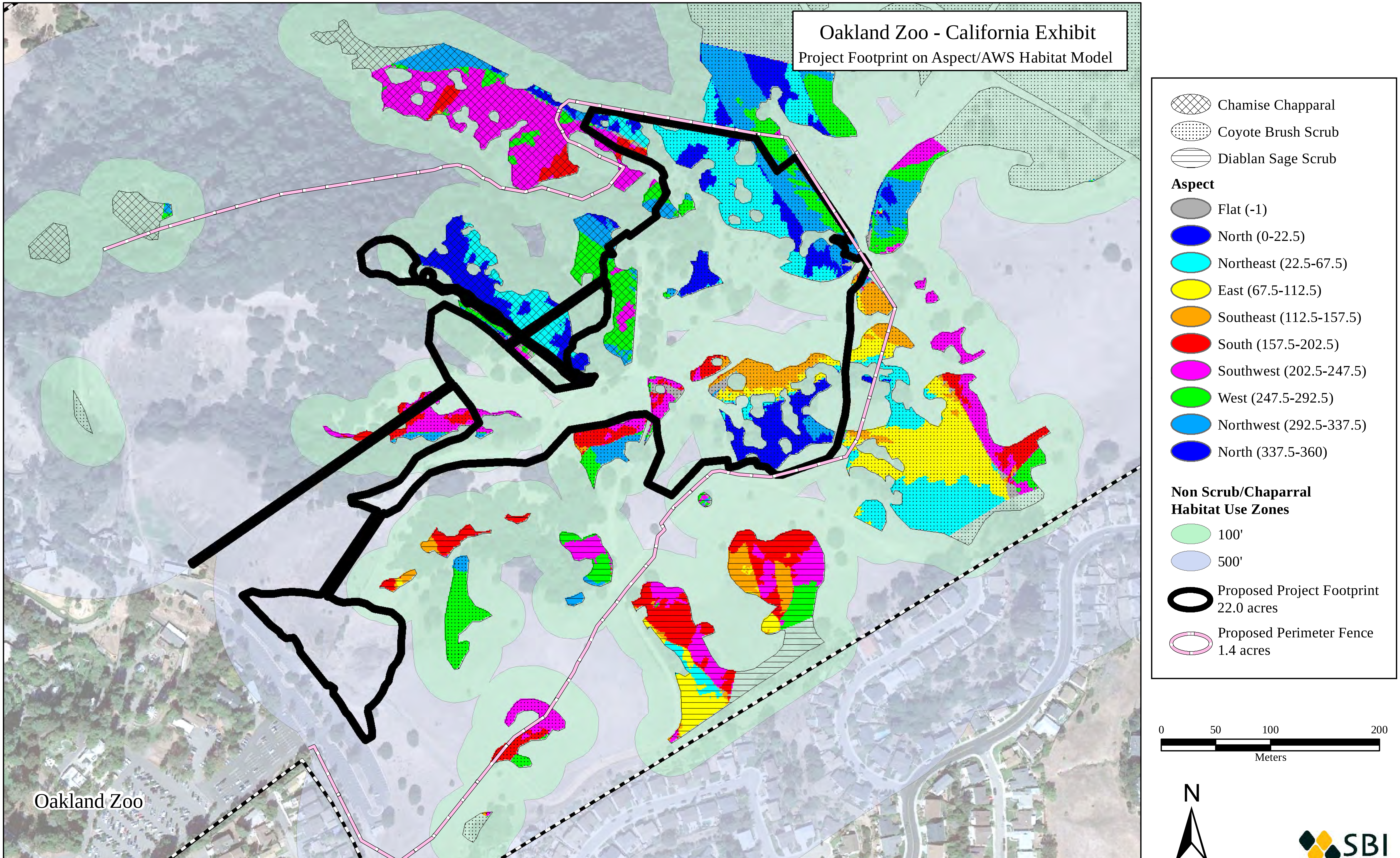


Figure 6. Project Footprint on AWS Habitat Model.

**Table 2. Vertebrate Species Captured in Knowland Park.**

| **Common Name** | **Scientific Name** | **Total Captures (Includes Recaptures)** | | | |
|---|---|---|---|---|---|
| | | **Spring 1998** | **Spring 1999** | **Fall 2009** | **Spring 2010** |
| Arboreal Salamander | *Aneides lugubris* | 8 | 1 | 20 | 20 |
| California Slender Salamander | *Batrachoseps attenuatus* | 42 | 0 | 145 | 223 |
| Yellow-eyed Salamander | *Ensatina eschscholtzii xanthoptica* | ? | ? | 55 | 26 |
| Coast Range Newt | *Taricha torosa torosa* | 45 | 8 | 19 | 406 |
| Rough-skinned Newt | *Taricha granulosa* | ? | ? | 19 | 2 |
| Pacific Chorus Frog | *Pseudacris regilla* | 2 | 1 | 1 | 0 |
| California Alligator Lizard | *Elgaria multicarinata multicarinata* | 205 | 48 | 24 | 143 |
| Skilton Skink | *Eumeces skiltonianus skiltonianus* | 160 | 6 | 31 | 101 |
| Western Fence Lizard | *Sceloporus occidentalis* | 725 | 195 | 316 | 544 |
| Western Yellow-bellied Racer | *Coluber constrictor mormon* | 44 | 11 | 2 | 28 |
| **Alameda Whipsnake** | ***Masticophis lateralis euryxanthus*** | **0** | **0** | **0** | **3** |
| Sharp-tailed Snake | *Contia tenuis* | 10 | 0 | 8 | 12 |
| Pacific Gopher Snake | *Pituophis catenifer catenifer* | 18 | 11 | 26 | 40 |
| Ring-necked Snake | *Diadophis punctatus* | 9 | 0 | 9 | 34 |
| California Kingsnake | *Lampropeltis getula* | 4 | 2 | ? | ? |
| Broad-handed Mole | *Scapanus latimanus* | ? | ? | 0 | 1 |
| Shrew | *Sorex* sp. | ? | ? | 1 | 2 |
| Audubon's Cottontail | *Sylvilagus audubonii* | 0 | 0 | 0 | 1 |
| Western Harvest Mouse | *Reithrodontomys megalotis* | 75 | 6 | 23 | 57 |
| Black Rat | *Rattus rattus* | 1 | 0 | 0 | 0 |
| California Meadow Vole | *Microtus californicus* | 78 | 30 | 2 | 18 |
| Deer Mouse | *Peromyscus* spp. | 45 | 12 | 42 | 125 |
| Botta's Pocket Gopher | *Thomomys bottae* | 1 | 0 | 27 | 8 |
| Dark-eyed Junco | *Junco hyemalis* | 0 | 0 | 0 | 1 |
| Bewick's Wren | *Thyromanes bewickii* | 0 | 0 | 1 | 4 |
| Unknown Bird | | 0 | 0 | 3 | 2 |

# 5.0 DISCUSSION

## *5.1 California Exhibit*

Based on the survey findings, the site must be considered occupied by the Alameda whipsnake. The proposed project will have a significant impact on the core AWS habitat and possibly the species. It would result in direct loss of core type habitat areas, fragmentation of core areas and other habitat (Figure 7), potential for invasion of French broom into previously undisturbed areas, and potentially direct take of individual AWS.

Prior to listing by USFWS, CDFG mitigation requirements were as follows:

- **5:1 for scrub/chaparral impacts**
- **5:1 for habitat within 100 feet of chaparral and scrub habitat.**
- **1:1 for the habitat zone between 100 through 500 feet from scrub/chaparral.**

When the snake was listed under the Federal ESA mitigation took on a more stringent requirement in the sense that it was recognized in the data that habitat use extended beyond 500 feet from scrub/chaparral. The general rule of 3:1 has been applied to most projects SBI has been directly involved with in consultations, but USFWS has recommended higher ratios in some instances recently. The 3:1 ratio applied to blocks of habitat and application to non-scrub/chaparral habitats greater than 500 feet is optimal for conservation in some cases. However, it is not as optimal for the conservation of the small population (viable or not) in Knowland Park, because it does not provide incentive for the zoo to avoid the core habitat.

Based on current findings, it is unclear whether the project area or Knowland Park does or could support a viable long term population. The project area includes large areas of physically suitable core type habitat, but two years of trapping only resulted in a single capture of an adult male. When high quality core habitat is present and Alameda whipsnakes are detected they are usually relatively abundant and the dominant snake species. During the same time period using the same methodology in the 1998-1999 studies, six captures of Alameda whipsnakes were made during a survey conducted by Swaim Biological, Inc. at a site on the Walpert Ridge in the Hayward Hills (Swaim Biological 2000). Five of the whipsnake captures at the Hayward site were from scrub habitat and one was from grassland habitat. The Oakland Zoo survey actually had more traplines in the scrub than the Hayward Hills survey (21 traplines at Oakland versus 15 at the Hayward site). Trapping comparisons for the spring 2010 work at the zoo include surveys Swaim Biological conducted on East Bay Municipal Utility District Property north of Orinda, where three AWS were captured in the first three days of trapping at the site. AWS are not difficult to detect in core type habitat when a resident breeding population is present. They also do not appear to be "trap-shy" as evidenced by the recapture of the same AWS three times on the site in three different traplines.

The population viability in the project area may also be limited by the poor level of connectivity to other occupied or potentially occupied habitat. In 2003 and 2004, live trapping surveys were conducted for the Alameda whipsnake at Anthony Chabot Regional Park for the EBRPD. These surveys produced negative results (Swaim Biological, Inc. 2003b, 2004). This survey was part of a larger research project investigating the effects of vegetation management practices on Alameda whipsnake. The study area was on the western edge of the park, the urban – wildland interface, adjacent to Skyline Blvd . The Chabot surveys were split into two seasonal trapping efforts to coincide with spring and fall peaks of Alameda whipsnake activity. The 2003 spring season ran from May 19$^{th}$ to August 1$^{st}$, and the fall season spanned September 10$^{th}$ to October 11$^{th}$. The 2004 spring season ran from May 12$^{th}$ to July 16$^{th}$, and the fall season spanned September 10$^{th}$ to October 11$^{th}$. Traps were active for 96 day (64 fin the spring and 32 in the fall) in 2003 and 91 days (60 days in the spring and 31 days in the fall) in 2004. A total of 27 vertebrate species were captured. Like the project site, the most commonly captured snake species was the western yellow-bellied racer. As described above, the high capture rate of this species (197 in 2003 and 52 in 2004) indicate that the traplines were functioning well. Chabot Regional Park appears to be the most contiguous undeveloped area adjacent to Knowland Park.

## *5.2 Veterinary Medical Hospital*

The chances of an AWS encountering the construction area footprint of the Veterinary Medical Hospital is low and not expected because of the low number of AWS likely to inhabit the site. Several factors indicated the Veterinary Medical Hospital can be constructed without significantly impacting AWS habitat or taking of an individual AWS with implementation of avoidance and minimization measures. These include the small size of the grading limit and hospital footprint, the bare and/or highly disturbed nature of much of the Veterinary Medical Hospital project area, its location immediately adjacent to the zoo parking lot away from core type habitat, and the results of the trapping surveys which indicate an extremely low number of AWS in the entire project area.

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

1. The capture of the Alameda whipsnake dictates that the project area is considered occupied by the Alameda whipsnake. We recommend that measures be included in the project to avoid, minimize, and mitigate for potential significant impacts to AWS and its habitat

2. Project modifications can reduce impacts to core habitat and potential habitat fragmentation. Following are suggested modifications:

   (a) Amphitheater: Remove from the project;

   (b) Interpretative Center: Moved 10 feet to the east and limit grading to within 10 feet of the edge of the building.

   (c) Bison/Tule Elk Extension Exhibit: Limit number of animals housed in the exhibit to 20 bison and 20 Tule elk. Irrigate the pasture area and enhance the grassland through placement of rock outcrops, fallen logs or a combination of the two (existing and proposed areas);

   (d) Perimeter Fence: Install a perimeter fence that is permeable to allow the passage of any AWS on the project site.

3. Potential impacts to AWS during construction shall be minimized by the clearing of construction areas prior to ground disturbing activities, the installation of exclusionary fencing around all construction areas, and the presence of a biological monitor on site during all work which could impact AWS habitat. Construction workers will be trained regarding the potential presence of AWS and how to respond to any wildlife encountered.

4. The project should mitigate at a final ratio or package through consultation with the USFWS and CDFG.

5. The project should set aside in a USFWS and CDFG approved permanent conservation easement an acreage approved by CDFG and USFWS in either an on –site area surrounding the project or off-site as determined in consultation with the Agencies.

6. The project should mitigate impacts to AWS habitat by conducting habitat enhancement in the Upper Knowland Park. The habitat enhancement should be focused on controlling and where feasible, eradicating highly invasive non-native species which continue to spread in the area and severely compromise existing habitat values. Target invasive species include: French broom, sweet fennel, blue gum eucalyptus, acacias, and other exotic plants. The enhancement efforts will include implementation of an effective Integrated Pest Management Plan (IPM) program. The IPM will include measures to remove the target species and to prevent resprouting or reestablishment of these species. Management measures may include hand pulling, cutting followed by topical application of appropriate herbicide, use of livestock and removal and burning of cut plant materials. Annual monitoring will be conducted. The enhancement efforts will also include the planting of native grassland, riparian and woodland species where native

cover types have been displaced by non-native species. The recommended area of enhancement is the area below Golf Links Road. This will ensure a contiguous block with Golf Links providing some level of a barrier to introduction of target species from the area above Golf Links back into the enhancement area.

7. Construction of the Veterinary Medical Hospital could be accomplished with no take of AWS or their habitat. Avoidance measures would include placement of exclusion fencing around the construction area prior to ground disturbance, removal of vegetation with a mower and monitoring during construction.

8. Incorporate specific educational exhibits/public education regarding conservation of California native wildlife, including the Alameda whipsnake and into the project. Exhibits could educate visitors on conservation ethics, such as decreasing the spread of non-native flora and fauna and using in-fill areas for development to keep open space in large blocks with the smallest urban edge possible to maintain species diversity and connectivity between native habitat areas.

If the above referenced mitigation measures are incorporated, the proposed project will not result in any significant impacts to AWS.

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## APPENDIX A – WHIPSNAKE AND SITE PHOTOS

Photo montage of Alameda whipsnake #1
First capture date: 3 June 2010, Trapline 13

Dorsal view of entire snake.

Close up view of chin showing degree of black spotting.

Close up view of right side of head and neck.

Close up view of dorsolateral stripe.

Photo montage of capture locations of Alameda whipsnake #1

Chamise habitat near trapline 13 - Location of first capture: 3 June 2010


Trapline 12 - Location of second capture: 4 June 2010

Trapline 21 - Location of third capture: 27 June 2010

2007 Google Earth Image showing the distribution of large French broom stands

2009 Google Earth Image showing the results of removal efforts by the Oakland Zoo

## APPENDIX G-2

### Habitat Enhancement Plan at the Oakland Zoo California Exhibit and Upper Knowland Park (Environmental Collaborative, 2010b)

# HABITAT ENHANCEMENT PLAN
for
# KNOWLAND PARK
# OAKLAND, CALIFORNIA


Prepared by

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## TABLE OF CONTENTS



## LIST OF TABLES



## LIST OF FIGURES

# INTRODUCTION AND SUMMARY

This Habitat Enhancement Plan (HEP) has been prepared by Environmental Collaborative for the East Bay Zoological Society. The HEP implements certain mitigation measures and conditions of approval for the Oakland Zoo in Knowland Park Master Plan (Master Plan), adopted by the City of Oakland in 1998, and updated mitigation measures from the 2011 Subsequent Mitigated Negative Declaration / Addendum prepared for the amendment to the Master Plan. Habitat enhancement provided under the HEP would be achieved through the control and eradication of the target invasive species and through revegetation with native grassland, riparian, and woodland species where the native cover types have been displaced by non-native species. This HEP provides background information on the status of the Master Plan, a brief description of habitat conditions in the HEP treatment area of Knowland Park, identifies performance standards regarding invasive species control and native revegetation in treatment areas, summarizes phasing of implementation based on construction of the California Exhibit project and resulting on-going monitoring and maintenance as part of required mitigation, and defines goals and implementing actions related to the invasive species removal, native revegetation, and sensitive resource protections.

# BACKGROUND

In 1997, the Oakland Zoo submitted an application to the City of Oakland for a major conditional use permit for the Master Plan intended to allow development of certain improvements and programs at the zoo over a period of 20 years (Zoning Case No. CM97-25). On April 16, 1997, the Oakland City Planning Commission adopted a Mitigated Negative Declaration (MND) for the Master Plan and approved part of the Master Plan. On June 4, 1997, the City Planning Commission approved the remainder of the Master Plan. On December 15, 1998, the City Council adopted Resolution No. 74736 C.M.S. upholding the City Planning Commission's adoption of the 1998 MND and decision approving the California 1820 exhibit portion of the major conditional use permit, subject to certain conditions of approval and mitigation measures.

The Oakland Zoo has applied for approval of an amendment to the approved Master Plan that would refine and make certain changes to the site plan for the approved California 1820 exhibit, now identified as the California Exhibit, and provide for a new relocated Veterinary Medical Hospital. A Subsequent Mitigated Negative Declaration/ Addendum, prepared pursuant to CEQA Guidelines Section 15164, updates the information contained in the 1998 MND in light of the proposed Master Plan amendment, changed circumstances, and new information.

One of the mitigation measures from the adopted 1998 MND, Mitigation Measure 13a, calls for preparation and implementation of a HEP for the California Exhibit area and Upper Knowland Park. The HEP addresses impacts of the project on native vegetation and wildlife habitat by removing infestations of highly invasive non-native plant species and revegetating degraded areas with native plantings. These highly invasive plant species tend to outcompete and eventually replace native cover, eliminating native groundcover vegetation, and reducing the habitat values for native wildlife. Below is a copy of Mitigation Measure 13a.

13a) *The proposed Master Plan would include implementation of a Habitat Enhancement Plan that would enhance oak woodlands, native grasslands, coastal scrub and riparian woodland, and remove eucalyptus, French broom and other exotic plants from the California 1820 Exhibit area and Upper Knowland Park. The Habitat Enhancement Plan should include the following:*

- *An annual assessment of the species and distribution of invasive nonnative weeds (examples of invasive species would include artichoke thistle, French broom, giant reed, German ivy, pampas grass, Algerian ivy, acacia and eucalyptus). The assessment would include a map and estimate of abundance of weeds.*
- *A management element for the control of each weedy species. Methods used for each species should be based on current accepted best available practices, including hand-pulling, cutting followed by topical application of suitable herbicide, use of livestock, removal or burning of cut plant materials, and so on. The justification for the control methods used should be explained, and a tracking system maintained to document areas treated, methods used, and effectiveness of the results.*
- *A revegetation element for areas where heavy infestations of weeds comprise a significant portion of the existing vegetation. The riparian zone of lower Arroyo Viejo Creek, for example, is so dominated by nonnative species that planting of indigenous tree and shrub species following the removal of weeds is needed to speed up the restoration process. This element would include a tracking system for areas treated, a record of the source and species of plant materials used, methods of installation and maintenance, and an assessment of the success of each effort.*

## LOCATION AND DESCRIPTION OF EXISTING HABITAT CONDITIONS

The Oakland Zoo in Knowland Park is located in south Oakland, east of Interstate 580 and adjacent to Anthony Chabot Regional Park (see **Figure 1**). Knowland Park contains a total of approximately 490 acres, of which approximately 93 acres comprise the arboretum, zoo, and related support facilities and approximately 62 acres were approved by the City Council for development of the Oakland Zoo's California 1820 exhibit. The remaining 335 acres contain upper and lower Knowland Park. Upper Knowland Park contains approximately 278 acres of open space, vegetation, public trails, and fire roads, and is bisected by Golf Links Road. Lower Knowland Park contains approximately 57 acres of open space, vegetation, zoo entrance area, and roads. The Ecological Recovery Zone encompasses that portion of the area within the proposed perimeter fence, but outside the existing zoo and California Exhibit area (see **Figure 1**). **Table 1** presents a breakdown of acreage by use area.

**FIGURE 1 KNOWLAND PARK AND CALIFORNIA EXHIBIT AREA BOUNDARY**

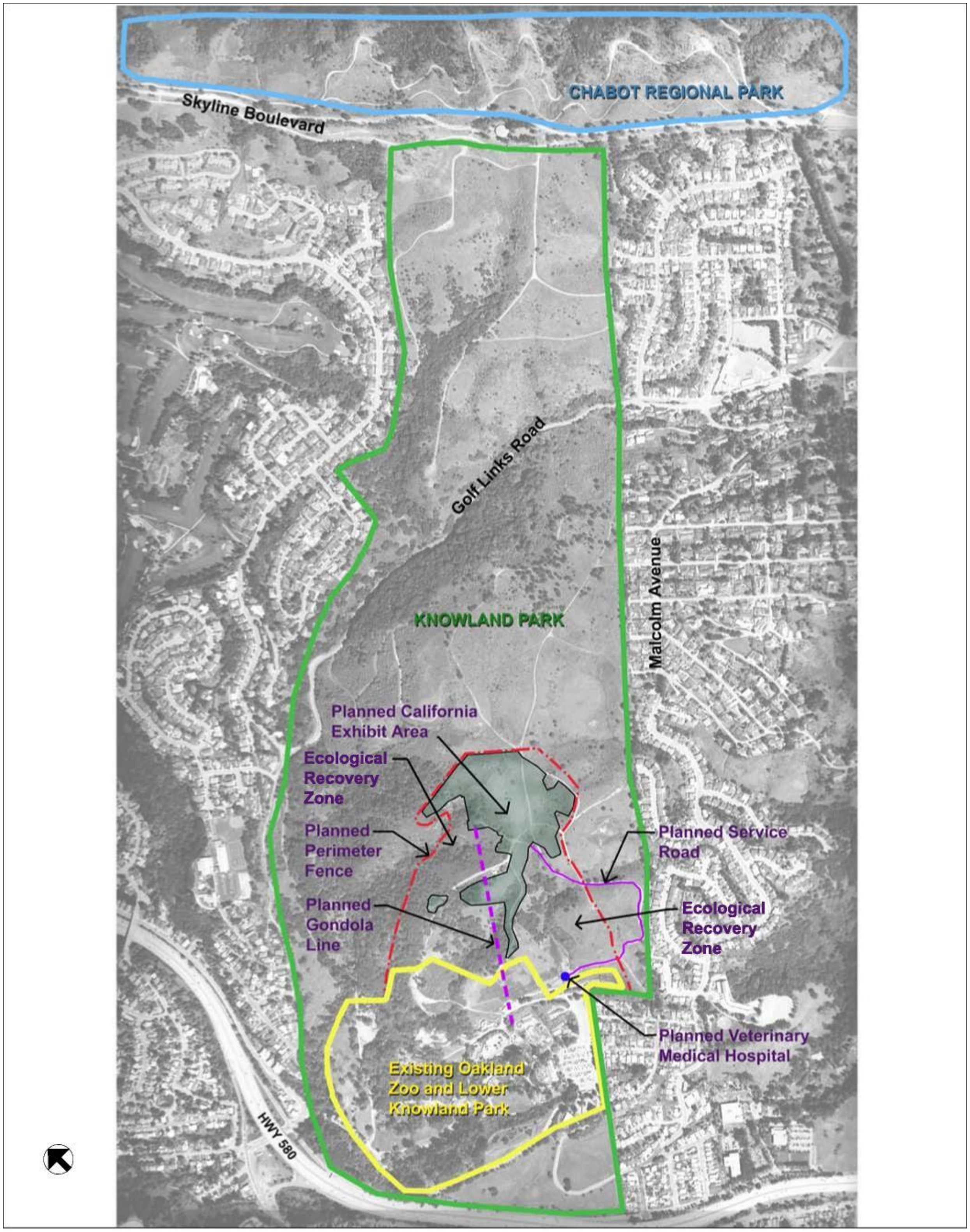

**TABLE 1 KNOWLAND PARK ACREAGE BY AREA**

| Area | Number of Acres | Zoning |
|---|---|---|
| Upper Knowland Park | 278[a] | Open Space (Resource Conservation Area) |
| Approved California 1820 Exhibit | 62[b] | Open Space (Special Use) |
| Arboretum, Zoo, and Related Support Facilities | 93[c] | Open Space (Special Use) |
| Lower Knowland Park | 57[d] | Open Space (Resource Conservation Area) |
| Total | 490 | |

[a] Zoo-City Management Agreement, May 2005. This agreement identifies 340 acres in the upper area of Knowland Park. Subtracting the 62 acres for the approved California 1820 exhibit leaves a balance of 278 acres.
[b] The project conditions of approval did not identify a total acreage for the California 1820 exhibit. This figure was calculated based on the Final Revised Plan approved by the City Council on December 15, 1998.
[c] Oakland Zoo In Knowland Park Master Plan Mitigated Negative Declaration/Initial Study, 1998.
[d] Zoo-City Management Agreement, May 2005. This agreement identifies 150 acres in the lower area of Knowland Park. Subtracting the 93 acres for the arboretum, zoo, and related support facilities leaves a balance of 57 acres.
Source: Placemakers, 2011 Subsequent Mitigated Negative Declaration / Addendum, Oakland Zoo Master Plan.

Vegetation in the California Exhibit and Upper Knowland Park area consists of a mosaic of grassland, woodland, scrub, and chaparral vegetation as indicated in aerial photographs of the vicinity (see **Figure 1**). The developed exhibit area of the existing zoo forms the southwestern edge of the Master Plan area and contains large paved parking lots, ornamental landscaping, structures, and animal enclosures. Arroyo Viejo Creek is a perennial creek that flows approximately 600 feet north of the proposed California Exhibit area, at its closest location, and supports a dense cover of riparian trees and shrubs. The creek continues as an open channel through Upper Knowland Park, passing through a culvert under Golf Links Road. A major habitat restoration effort of the lower reach of Arroyo Viejo Creek was undertaken in 2007 as a joint effort of the City of Oakland, Oakland Zoo, California Coastal Conservancy, the California Department of Parks and Recreation, and Alameda County Flood Control and Water Conservation District. Highly invasive species were removed and native enhancement plantings installed along approximately 1,000 feet of the creek corridor as part of this habitat restoration project.

Knowland Park supports a wide range of animal species, including a variety of birds, mammals, amphibians, reptiles, and invertebrates. The mosaic of vegetation types, protective cover, and available surface water provides important habitat resources to resident and migratory species that use the largely undeveloped parklands. Golf Links Road bisects the parklands, and Skyline Boulevard separates Knowland Park from the nearby Anthony Chabot Regional Park to the east. These roadways disrupt movement opportunities between natural areas for some terrestrial wildlife species but do not form complete barriers to wildlife movement. Existing residential development to the north and south, and Highway 580 and the urbanized area to the west limit opportunities for movement and dispersal of terrestrial wildlife beyond these boundaries of Knowland Park.

A number of highly invasive plant species have become particularly problematic around the perimeter of the existing zoo, along the middle reach of Arroyo Viejo Creek upstream of the 2007 restoration area, and in parts of the California Exhibit area and Upper Knowland Park. In some locations, the invasive species have largely replaced native plants, eliminating most of the associated wildlife habitat functions and values. Of greatest concern are infestations of French broom (*Genista monspessulana*) which forms dense thickets in some locations and is spreading throughout the remaining natural areas of Knowland Park, replacing grassland habitat and invading the understory of the woodlands, scrub, and chaparral. The Oakland Zoo and City of Oakland have taken several steps to control this problematic species given how it compromises native habitat, interferes with use of some of the existing animal enclosures, and contributes to fire fuel loading. Stands of invasive blue gum eucalyptus (*Eucalyptus globulus*), green wattle (*Acacia decurrens*), and blackwood acacia (*Acacia melanoxylon*) occur in a number of locations in Knowland Park, and heavy infestations of German ivy (*Senecia mikanioides*), Algerian ivy (*Hedera helix* ssp. *canariensis*), periwinkle (*Vinca major*), and Himalayan blackberry (*Rubus discolor*) occur along Arroyo Viejo, all of which compromise existing natural habitat and will continue to spread if not controlled. Other problematic invasive species reported from grassland, riparian and woodland habitats in Knowland Park include: artichoke thistle (*Cynara cardunculus*), pampas grass (*Cortaderia selloana*), sweet fennel (*Foeniculum vulgare*), and giant reed (*Arundo donax*). And planted stands of Monterey pine (*Pinus radiata*) also compromise the native cover, particularly grasslands, although trees of this species on public lands such as Knowland Park are to be protected and any removal must comply with the City's Tree Protection Ordinance (Oakland Municipal Code Chapter 12.36).

## COMPONENTS OF THE HEP

The HEP has been prepared in compliance with the 1998 Master Plan approval and the Master Plan Amendment. The HEP serves to mitigate project-related impacts on natural habitat and native trees, and will be coordinated with measures implemented to address potential impacts on suitable habitat for the State- and federally-threatened Alameda whipsnake (*Masticophis lateralis*). The HEP expands upon the broad requirements of Mitigation Measure 13a, specifying replacement ratios and implementing actions for replacement of affected habitat or specific resource, defining performance standards and success criteria to be achieved upon full implementation, and identifying on-going assessment and reporting requirements.

The 1998 MND identified a number of mitigation measures related to avoidance of potential impacts on Alameda whipsnake, particularly during construction and operation of the California Exhibit. An individual male Alameda whipsnake was live trapped from the vicinity of the California Exhibit area in the summer of 2010 during protocol surveys to confirm presence or absence of this species. Given the confirmed presence of this species, appropriate authorizations for possible loss of individual snakes and essential habitat resulting from implementation of the California Exhibit project will be required from the U.S. Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG) pursuant to the requirements of the federal Endangered Species Act and the California Endangered Species Act, respectively. This will most likely include some type of compensatory mitigation that could consist of habitat enhancement measures consistent with the general goals of the HEP for invasive species removal and native habitat restoration. Mitigation Measure 14c from the 1998 MND has been revised in the 2011 Subsequent Mitigated Negative Declaration / Addendum to specify that a minimum 1:1 ratio of compensatory mitigation (at least one acre of mitigation to every acre of impact) will be required. Compensatory mitigation ratios may be refined as part of the consultation process with the USFWS and CDFG in securing incidental take authorizations for potential impacts on suitable habitat for the Alameda whipsnake. The assumptions regarding the limits of invasive species treatment and native replanting specified in this HEP may have to be adjusted based on future input from the USFWS and CDFG, but it appears there is more than sufficient land area in Upper Knowland Park in need of improved habitat management to meet compensatory mitigation requirements for Alameda whipsnake.

The HEP provides a coordinated approach to protecting and enhancing natural habitat, and meeting mitigation requirements for the Master Plan and the California Exhibit. The HEP contains six basic elements, consisting of: an Invasive Species Control Element; Grassland Protection and Enhancement Element; Native Revegetation Element; Native Tree Protection and Replacement Element; Special-Status Species Protection Element, and Implementation Element. The HEP provides for input from the City of Oakland, and encourages participation from organizations such as the California Native Plant Society, and interested public. Where necessary, the HEP will incorporate refinements that are necessary based on the mitigation plans prepared as part of the incidental take authorizations for Alameda whipsnake required by the USFWS and CDFG.

The initial focus of the invasive species control provided under the HEP will be directed towards achieving the mitigation for Alameda whipsnake and grasslands habitat lost or modified as a result of implementing the California Exhibit project. Treatment areas will be prioritized based on proximity to the California Exhibit site and need to meet specific habitat enhancement objectives specified in the 1998 MND and 2011 Subsequent Mitigated Negative Declaration / Addendum. French broom and other invasive species are spreading into the essential chaparral and scrub habitat within the Ecological Recovery Zone adjacent to the California Exhibit where the single Alameda whipsnake was encountered. The Ecological Recovery Zone encompasses that portion of the remaining natural areas outside of the existing zoo and future California Exhibit enclosures, but within the perimeter fence (see **Figure 1**). Preventing further degradation of the remaining natural areas within the California Exhibit and in the Ecological Recovery Zone will be crucial in protecting the important habitat it provides for Alameda whipsnake in Knowland Park. A preliminary analysis indicates that the compensatory mitigation requirements for Alameda whipsnake and loss of grassland habitat could be achieved through treatment and management of lands in Upper Knowland Park west of Golf Links Road. As described further in the Implementation Element, once the compensatory mitigation ratios are met and required habitat enhancement is achieved, then the invasive species treatment under the HEP will be expanded into the remaining areas of Knowland Park east of Golf Links Road. On-going monitoring and management will be required in perpetuity to control possible re-establishment of the target invasive species due to the continued spread of seed from adjacent private properties and surrounding open space where management is less rigorous.

The six elements contained in the HEP are listed below, together with identified goals, performance standards and success criteria, and specific implementing actions. A description of the process for implementing the HEP is provided in the Implementation Element, together with details regarding on-going management and annual reporting requirements, as described below.

### INVASIVE SPECIES CONTROL ELEMENT

**Goal 1: *Control and, where feasible, eradicate highly invasive non-native species which continue to spread in Knowland Park and severely compromise existing habitat values.***

The HEP will focus on controlling and where feasible, eradicating highly invasive non-native species in Knowland Park. The initial treatment areas addressed under the HEP will include the Ecological Recovery Zone, the remaining natural areas of the California Exhibit, and the adjacent lands of Knowland Park west of Golf Links Road to address the threat these invasive species pose to the important habitat for Alameda whipsnake, and to protect and enhance the remaining grasslands in close proximity to the California Exhibit. Target invasive species include: French broom (*Genista monspessulana*), blue gum eucalyptus (*Eucalyptus globulus*), green wattle (*Acacia decurrens*), blackwood acacia (*Acacia melanoxylon*) artichoke thistle (*Cynara cardunculus*), sweet fennel (*Foeniculum vulgare*), yellow star thistle (*Centaurea solstitialis*), German ivy (*Senecia mikanioides*), Algerian ivy (*Hedera helix* ssp. *canariensis*), periwinkle (*Vinca major*), Himalayan blackberry (*Rubus discolor*) pampas grass (*Cortaderia selloana*), and giant reed (*Arundo donax*). Effective control of these target species requires an effective Integrated Pest Management (IPM) program. The IPM must be flexible in its implementation to address possible resprouting or re-establishment of the target species in treatment areas, adaptive to site conditions and successful treatment methods, and use of best available practices, including hand pulling, cutting followed by topical application of appropriate herbicide, use of livestock, and removal and burning of cut plant materials.

Successive treatment will be performed until the target species have been effectively controlled from the treatment area and comprise less than five percent of the absolute cover.[1] Ideally, target invasive species would be completely eradicated (eliminated) from treatment areas, but these are highly aggressive species which could be reintroduced from the untreated areas on Upper Knowland Park and surrounding private properties, making complete eradication highly challenging.

The following Implementing Actions serve to implement the basic goal for the Invasive Species Control Element of the HEP.

***Implementing Action 1-1:*** *Develop and implement IPM program for treatment areas in Knowland Park to address target invasive plant species including: French broom (Genista monspessulana), blue gum eucalyptus (Eucalyptus globulus), green wattle (Acacia decurrens), blackwood acacia (Acacia melanoxylon) artichoke thistle (Cynara cardunculus), sweet fennel (Foeniculum vulgare), yellow star thistle (Centaurea solstitialis), German ivy (Senecia mikanioides), Algerian ivy (Hedera helix ssp. canariensis), periwinkle (Vinca major), Himalayan blackberry (Rubus discolor) pampas grass (Cortaderia selloana), and giant reed (Arundo donax). The list of target species shall be adjusted as additional invasive species may become*

[1] Absolute Cover is a method of describing vegetative cover where the percentages of each component plant species are determined over a defined area, and where barren ground is also factored into the total cover.

*established and problematic in Knowland Park, but generally shall include any species listed as having a "high" and "moderate" rating for "Invasive Non-Native Plants that Threaten Wildlands in California" according to the electronic Inventory of the California Invasive Species Council (Cal IPC).*

***Implementing Action 1-2****: The IPM shall be flexible in its implementation to address possible resprouting or re-establishment of target species, shall be adaptive to site conditions and successful treatment methods, and shall use best available practices, including hand pulling, cutting followed by topical application of appropriate herbicide, livestock grazing, and removal and burning of cut plant materials, as appropriate.*

***Implementing Action 1-3****: Target species shall be mapped for future treatment, with estimates of absolute cover class identified for the target species, other vegetative cover, and any native species component as part of baseline data collection. Initial mapping shall encompass the Ecological Recovery Zone, California Exhibit Area, and Upper Knowland Park west of Golf Links Road, consistent with the phasing described in the Implementation Element.*

***Implementation Action 1-4****: Successive treatment shall be performed until the target species have been effectively controlled from the treatment area and comprise less than five percent of the absolute cover. Additional treatment for invasives shall be applied to the treatment area whenever the target species collectively comprise more than five percent of the absolute cover during annual monitoring.*

***Implementation Action 1-5****: Any herbicide application shall comply with City of Oakland regulations and shall be carefully controlled consistent with City of Oakland ordinance, and overseen by a certified pest applicator to protect desired native vegetation and sensitive resources, avoid enhancement plantings, and protect the aquatic habitat of the Arrojo Viejo and other receiving waters.*

***Implementation Action 1-6****: All activities associated with implementation of the HEP shall comply with any applicable Standard Conditions of Approval of the City of Oakland related to tree protection, creek protection, and other sensitive resource protections.*

## GRASSLAND PROTECTION AND ENHANCEMENT ELEMENT

**Goal 2:** ***Provide for the protection and enhancement of grassland habitat in Knowland Park through invasive species control and revegetation with native grassland species, and achieve adequate mitigation for the loss and modification of an estimated 8.6 acres of grassland habitat as a result of implementing the California Exhibit by protecting and enhancing a minimum of 17.2 acres of grasslands in Knowland Park.***

The spread of invasive shrub and tree species, particularly French broom, is one of the greatest threats to the remaining grassland habitat in Knowland Park. French broom tends to become established at the interface between grasslands and the adjacent woodland, scrub, and chaparral habitats. Once established at the interface, thickets of French broom begin to shade out the dense grassland cover, creating a barren or sparse groundcover and conditions more suitable for successful establishment of this invasive species. Over time, French broom can completely replace areas of grassland habitat, forming monotypic stands with little plant and animal diversity and low wildlife habitat values. Effective control of invasive species is critical to protecting and enhancing the grassland habitat in Knowland Park.

A grassland enhancement and replacement program will be implemented as part of the HEP to ensure that adequate mitigation is provided for the estimated 8.6 acres of native and non-native grassland habitat possibly lost or modified within the footprint of proposed improvements or within animal enclosures of the California Exhibit. The grassland program will identify historic grasslands in Knowland Park currently dominated or under threat by invasion of French broom and other non-native species. Some limited removal of dead or senescent planted Monterey pines may be appropriate as a management technique in meeting the grassland mitigation and enhancement goals of the HEP. Through invasive species removal, and native revegetation where required, the grassland protection and enhancement goal of the HEP will be met. The following Implementing Actions serve to implement the basic goal for the Grassland Protection and Enhancement Element of the HEP. The grassland protection and enhancement mitigation ratios identified below in Implementation Action 2-1 are required to mitigate impacts of the California Exhibit.[2]

**Implementing Action 2-1:** *A minimum of 17.2 acres of grassland habitat outside of animal exhibits but in as close proximity to the California Exhibit as possible based on the mapped extent of target invasive species shall be treated, protected and managed as part of the Invasive Species Control and Native Revegetation Elements of the HEP, as defined under Implementation Actions 2-2 through 2-4, thereby providing a 2:1 mitigation ratio for grasslands lost or compromised as a result of improvements in the California Exhibit area.*

**Implementing Action 2-2:** *To accomplish the grassland protection and enhancement, the invasive species removal and control shall focus on locations which historically supported grasslands and where native grassland species comprise a discernable component of the existing cover, generally over ten percent native grassland species.*

**Implementing Action 2-3:** *Grasslands shall be re-established and enhanced as described in the Native Revegetation Element where invasive species have displaced vegetation and removal of the invasives would leave bare ground over ten percent or more of the treatment area with an absolute cover for the remaining vegetation of less than 90 percent.*

**Implementation Action 2-4**. *Consider limited removal of planted stands of Monterey pine where trees are dead or senescent, the trees compromise the native grassland cover, and no disruption of views or privacy of adjacent private property owners would result. Any removal of Monterey pine trees shall comply with the City's Tree Protection Ordinance (Oakland Municipal Code Chapter 12.36).*

[2] The HEP identifies those measures that are required because of the impacts associated with implementation of the California Exhibit. If the California Exhibit is not constructed, these specific provisions of the HEP would not be required, although other provisions of the HEP would remain operative.

**Implementation Action 2-5**. *The remaining grassland habitat within the developed California Exhibit shall also be managed as grassland habitat where preservation and enhancement is feasible, although these would not qualify as treatment areas in meeting the required mitigation ratios called for in Implementing Action 2-1. In areas outside of improvements (i.e. structures, pathways, animal enclosures and required landscape plantings), the remaining grasslands shall be managed as natural habitat with appropriate invasive species controls and native species enhancement plantings. Within animal enclosures where grazing and trampling may prevent long-term establishment and retention of native grasses and forbs, native and non-native grassland cover will be retained through adaptive management practices that may include use of artificial irrigation, reseeding and replanting with non-invasive species, excluding exhibit animals from portions of their enclosure to control disturbance during critical periods of establishment by subdividing the enclosure areas and rotating access accordingly, and other appropriate techniques.*

## NATIVE REVEGETATION ELEMENT

**Goal 3: *Successfully revegetate areas where heavy infestations of invasive species have displaced grasslands and other natural cover types.***

The HEP includes a Native Revegetation Element for areas where heavy infestations of invasive species comprise a significant portion of the existing vegetation, and removal of the invasive vegetation would leave the treatment area with an absolute cover of less than 90 percent for the vegetative component. Implementation of this element includes a tracking system for areas treated, a record of the source and species of plant materials used in revegetation, methods of installation and maintenance, and an assessment of the success of each treatment effort. The focus of the Native Revegetation Element will be on grasslands that have been replaced by invasive species removed as part of the Invasive Species Control and the Grassland Protection and Enhancement Elements of the HEP. Any areas receiving revegetation will be monitored annually as part of an overall Annual Assessment program of the HEP, and maintained as necessary to ensure successful establishment.

The following Implementing Actions serve to implement the basic goal for the Native Revegetation Element of the HEP.

***Implementing Action 3-1:*** *The Native Revegetation Element shall focus on grasslands that have been replaced by invasive species removed as part of the Invasive Species Control and the Grassland Protection and Enhancement Elements of the HEP, as identified in the baseline data mapping program described in Implementing Action 1-3.* ***Table 2*** *provides a list of native grassland species suitable for seeding and/or planting installation as part of grassland revegetation, and defines general methods that shall be used during revegetation efforts.*

***Implementing Action 3-2:*** *Grassland revegetation efforts shall emphasize seeding of treatment areas with an appropriate mix of native grasses and forbs indigenous to Knowland Park. The seed mix and rates of application shall be adjusted based on location-specific conditions, including absolute cover values of the remaining native and non-native grassland species, slope*

## TABLE 2 NATIVE PLANT SPECIES SUITABLE FOR SEEDING/PLANTING KNOWLAND PARK HABITAT ENHANCEMENT PLAN

<table>
<tr><th>Grassland Species</th><th>General Treatment Methods</th></tr>
<tr><td>Grasses</td><td rowspan="17"><ul>
<li>Seed shall be applied before onset of fall rains, generally prior to November 1. Seed source shall be as local as possible, supplied on a basis of Pure Live Seed (PLS), and not contain an excess of one percent (1%) of weed seed.</li>
<li>Plantings shall be installed during wet period between November 15 and January 15.</li>
<li>Appropriate browse protection shall be used where necessary during initial establishment, including protection from livestock grazing used for fire fuel management.</li>
<li>Revegetation treatment shall occur for areas where removal of the invasive vegetation would leave an average absolute cover of less than 90 percent for the remaining plant cover in treatment areas.</li>
<li>Seed mix and rate of application shall be adjusted based on location-specific conditions, including absolute cover values of the remaining native and non-native grassland species, slope and exposure, successional trends to other cover types such as scrub and woodland, and other factors.</li>
<li>Plug and container plantings of native grasses and forbs shall be used to supplement seeding in treatment areas where average absolute cover values for grassland species is less than 40 percent in treatment areas due to competitive shading from invasive species.</li>
<li>Annual monitoring and maintenance of treatment areas shall be provided to ensure the following performance standards are met on average for the treatment area: 1) achieve a minimum survival rate of 80 percent for all plantings; 2) demonstrate that invasive species comprise less than 5 percent of the absolute cover; and 3) that bare ground comprises no more than the percentage of bare ground before invasive species are initially removed.</li>
</ul></td></tr>
<tr><td>California brome<br>(Bromus carinatus)</td></tr>
<tr><td>Creeping wildrye<br>(Elymus glaucus ssp. glaucus)*</td></tr>
<tr><td>California oatgrass<br>(Danthonia californica var. californica)*</td></tr>
<tr><td>Foothill needlegrass<br>(Nassella lepida)*</td></tr>
<tr><td>Meadow barley<br>(Hordeum brachyantherum)</td></tr>
<tr><td>Leafy bentgrass<br>(Agrostis pallens)</td></tr>
<tr><td>Pacific vulpia<br>(Vulpia microstachys var. pauciflora)</td></tr>
<tr><td>Purple needle-grass<br>(Nassella pulchra)*</td></tr>
<tr><td>Torrey's melic<br>(Melica torreyana)</td></tr>
<tr><td>Forbs</td></tr>
<tr><td>Blue-eyed grass<br>(Sisyrinchium bellum)*</td></tr>
<tr><td>California poppy<br>(Eschscholzia californica)</td></tr>
<tr><td>Coast buckwheat<br>(Eriogonum nudum var. auriculatum)*</td></tr>
<tr><td>Dove lupine<br>(Lupinus bicolor)</td></tr>
<tr><td>Sticky cinquefoil<br>(Potentilla glandulosa)*</td></tr>
<tr><td>Yarrow<br>(Achillea millefolium)*</td></tr>
</table>

* Species suitable for both seeding and container/plug plantings.

*and exposure, successional trends to other cover types such as scrub and woodland, and other factors.*

***Implementing Action 3-3:*** *Plug and container plantings of native grasses and forbs shall be used to supplement seeding in treatment areas where the average absolute cover values for grassland species is less than 40 percent in the treatment area due to competitive shading from invasive species.*

***Implementing Action 3-4:*** *Additional revegetation efforts may be required along the Arroyo Viejo riparian corridor, which would utilize a mixture of native riparian groundcovers, shrubs, and tree plantings in addition to seeding with a short-term grassland ground cover following invasive species removal in treatment areas. Where additional revegetation of the Arroyo Viejo riparian corridor is to be implemented, an appropriate revegetation and maintenance plan utilizing riparian species shall be developed and appropriate authorizations secured, where required. Plantings used in the revegetation plan shall be restricted to the use of native tree, shrub, and groundcover species.*

***Implementing Action 3-5:*** *Any areas receiving revegetation shall be monitored annually as part of an overall Annual Assessment program of the HEP, and maintained as necessary to ensure successful establishment. Performance and success criteria may be refined for each treatment area, but shall provide for a minimum survival rate of 80 percent for all plantings, demonstrate that invasive species comprise less than five percent of the absolute cover, and that bare ground comprises no more than the percentage of bare ground before invasive species are initially removed. Maintenance shall include follow-up invasive species removal, possible replacement replanting, and successive reseeding if plant survival and absolute cover rates for revegetation are not achieved.*

## NATIVE TREE PROTECTION AND REPLACEMENT ELEMENT

**Goal 4:** ***Protect native trees in Knowland Park that qualify as a "protected tree" under the City of Oakland Tree Protection Ordinance, and provide for replacement of any "protected tree" removed during construction of the California Exhibit.***

An estimated 51 trees meeting the definition of a "protected tree" under the City of Oakland Tree Protection Ordinance would be removed during construction of the California Exhibit. The Preliminary Landscape Plan for the project includes schematic plans for planting of replacement native deciduous and broadleaf evergreen trees along the eastern boundary and at other locations in the California Exhibit. An estimated 185 native trees would be planted as part of replacement and enhancement plantings within the California Exhibit area, providing a minimum 3:1 replacement ratio. Other land area is available within the perimeter fence, either within the footprint of the California Exhibit or the Ecological Recovery Zone, if additional tree replacement plantings are considered necessary to achieve mitigation and enhancement objectives. Given the available land area within the perimeter fence, no additional native tree replacement planting is considered necessary in the Upper Knowland Park area as part of the HEP.

Mitigation Measure 13b from the 1998 MND calls for preparation of a Tree Protection and Revegetation Plan to protect, replace, and preserve trees within the California Exhibit area. This mitigation also calls for protection of oaks in Upper Knowland Park outside of the California Exhibit area as part of the HEP. Encouraging the maximum natural extent of oak woodland was suggested as a possible management program in Mitigation Measure 13b given the limited fire risks associated with this cover type, but this would conflict with the grassland preservation objectives of the HEP. Because of fire suppression, native oaks and bay trees are now spreading into areas formerly dominated by chaparral, scrub, and in some places grasslands, reducing the extent of important habitat for Alameda whipsnake and other wildlife dependent on non-woodland habitat types. While retaining and enhancing existing habitat values of oak woodlands are desirable objectives, this can be achieved through control of target invasive species and monitoring canopy and understory regeneration. Maximizing the extent of oak woodlands is no longer considered a desirable management program for Upper Knowland Park where grasslands and other natural habitat types would be replaced. Mitigation Measure 13b was revised in the 2011 Subsequent Mitigated Negative Declaration / Addendum to reflect this important consideration.

The following Implementing Actions serve to implement the basic goal for the Native Tree Protection and Replacement Element of the HEP.

**Implementing Action 4-1:** *Tree protection measures shall be implemented for all trees to be preserved, consistent with the City's Standard Conditions of Approval related to tree preservation SCA #46 and #47).*

**Implementing Action 4-2:** *Any protected tree removed during construction of the California Exhibit or implementation of the HEP shall be replaced at a minimum 3:1 replacement ratio.*

## SPECIES PROTECTION ELEMENT

### Goal 5. *Protect and enhance habitat for notable species in treatment areas of Knowland Park.*

Notable species known from or suspected to occur in Upper Knowland Park include Alameda whipsnake, two species of plants and possibly other plant species as well, and a number of bird species, including raptors. Below is a discussion of the respective protection measures developed as implementing actions of the HEP with regard to these species.

***Plant Species***. Systematic surveys have been conducted for special-status plant species for areas encompassing improvements associated with the California Exhibit. As discussed in the 2011 Subsequent Mitigated Negative Declaration / Addendum, the occurrences of robust monardella (*Monardella villosa* ssp. *globosa*) described in the 1998 MND were not found during extensive surveys conducted in 2009 and 2010, and are believed to be extirpated from the vicinity of the California Exhibit. Measures have been developed to protect the two occurrences of notable plant species subsequently found in the vicinity of the California Exhibit - Oakland star tulip (*Calochortus umbellatus*) and bristly leptosiphon (*Leptosiphon acicularis*).Neither of these species is listed under the State and/or federal Endangered Species Acts, and both are maintained on List 4.2 (limited distribution) of the California Native Plant Society (CNPS) *Inventory of Rare and Endangered Plant Species (Inventory).* The Technical Appendices (Volume 1, Chapter 3) of the Oakland General Plan OSCAR Element provides information on the definition of special-status species used by the City of Oakland and identifies 31 plant species considered to be "Rare, Threatened, and Endangered Vascular Plants Potentially Present in Oakland",[3] which includes

[3] See **Table 3-13: Rare, Threatened, and Endangered Vascular Plants Potentially Present in Oakland** on page 3-50 of Volume 1 – Chapter 3 of Oakland General Plan, OSCAR Element Technical Appendices.

Oakland star tulip but not bristly leptosiphon. As such, Oakland star tulip does qualify as a special-status species. No direct impacts to this population of Oakland star tulip are anticipated as part of implementing the California Exhibit project because the occurrence is more than 500 feet from the perimeter fence, but measures to monitor and protect this occurrence have nevertheless been provided as part of the HEP given that it contributes to the diversity of Knowland Park.

The occurrence of bristly leptosiphon would be located within the wolf exhibit area that is part of the California Exhibit. Although it appears that direct disturbance to this occurrence would be avoided, the occurrence could be affected by trampling, den digging, and other activities of wolves within the wolf enclosure area. As noted above, bristly leptosiphon has no legal protective status under the State and/or federal Endangered Species Acts, is maintained on List 4.2 of the CNPS *Inventory*, and is not included on the list of 31 “Rare, Threatened, and Endangered Vascular Plants Potentially Present in Oakland” according to the Technical Appendices (Volume 1, Chapter 3) of the Oakland General Plan OSCAR Element. It is also not included on the list of “Unusual or Significant Plants in Oakland” contained in Appendix 3-A of the OSCAR Element. The City has no specific policies or practices in place about protecting CNPS List 4 species. As such, bristly leptosiphon does not meet the criteria as a special-status species requiring avoidance or compensatory mitigation. However, the presence of this species does contribute to the biological diversity of Knowland Park, and as such measures have been developed to monitor and protect this occurrence.

The general occurrences of Oakland start tulip and bristly leptosiphon are shown in the Preliminary Landscape Plan for the California Exhibit Project, and will be shown on the Final Landscape Plan, Grading Plan, and Site Plan. Systematic surveys have not been conducted for other areas in Upper Knowland Park outside the California Exhibit area. There remains a possibility that additional populations of the three notable plant species encountered in the vicinity of the California Exhibit, or possibly other species, could be present and would require additional protective measures if encountered during future systematic surveys of Knowland Park. Implementation actions have been developed as part of the HEP to provide for appropriate protections for occurrences of special-status plant species within Knowland Park.

***Nesting Birds***. There remains a possibility that one or more species of bird protected under the Migratory Bird Treaty Act could be nesting within or in the vicinity of areas to be treated under the HEP. The City of Oakland’s Standard Conditions of Approval includes provisions regarding protection of possible nesting habitat and the requirement that a preconstruction survey be conducted if vegetation removal and construction is to be initiated during the breeding/nesting season (from March 15 through August 15). Human activity associated with intensive vegetation removal could result in nest abandonment, and should either occur during the non-nesting season (August 16 to March 14) or should be preceded by a preconstruction survey as part of implementing the HEP. If surveys indicate the presence of nesting birds, disturbance within a specified buffer zone shall be restricted as necessary to prevent possible abandonment of any active nest.

***Alameda Whipsnake***. Specific habitat enhancement measures developed as part of the detailed mitigation program for Alameda whipsnake must be incorporated into the HEP where relevant to invasive species control and habitat management. These measures are specifically related to construction of the California Exhibit and include achieving a minimum 1:1 mitigation ratio, as called for in Mitigation Measure 14c from the 1998 MND, as revised in the 2011 Subsequent Mitigated Negative Declaration / Addendum. These additional measures will be developed as part of the consultation process with USFWS and CDFG as part of the incidental take authorization for the California Exhibit, and could include developing and implementing an interpretive program with appropriate signage, restrictions on access to certain areas of the park, and enforcement of existing leash laws, among other controls. Other measures related to implementing the HEP could also be required as part of the mitigation program for Alameda whipsnake, including restrictions on timing and methods used for invasive species removal, controls on herbicide application, worker training programs, and possible need for preconstruction avoidance surveys, among others.

The following Implementing Actions serve to implement the basic goal for the Special-Status Species Protection Element of the HEP. The species protection measures called for in Implementation Action 5-2 and 5-5 are required to mitigate impacts of the California Exhibit.[4]

***Implementing Action 5-1:*** *The population of Oakland star tulip is located over 500 feet from the perimeter fence at its closest point and no direct impacts are anticipated as part of the California Exhibit project. The occurrence of Oakland star tulip shall be avoided and protected during project construction and vegetation management activities. Any future vegetation management activities undertaken as part of the HEP shall be designed to avoid direct disturbance and retain suitable habitat conditions for this species. Any invasive species removal within 20 feet of this occurrence shall be accomplished by hand pulling, under the supervision of a qualified botanist, and all herbicide use shall be prohibited within this zone. All workers shall be informed of the presence of this occurrence, its sensitivity and need to minimize trampling and other disturbance in the vicinity.*

***Implementing Action 5-2:*** *The population of bristly leptosiphon is located within the "Wolf Expansion" area of the California Exhibit project, and shall be avoided and protected during construction and future management activities. No direct impacts to this occurrence are anticipated, but appropriate controls over construction operation shall be implemented and the population monitored to determine whether indirect impacts from wolf activities are adversely affecting the occurrence. The location of the population shall be indicated on project plans, and temporary construction restriction fencing installed around the entire occurrence and a minimum 25-foot buffer. The temporary construction restriction fencing shall be installed under the supervision of a qualified botanist or biologist, shall remain in place for the duration of construction, and all workers informed of the need to avoid entering the area. Any future vegetation management activities shall be designed to minimize disturbance and retain suitable habitat conditions for this species as prescribed in this Implementing Action.*

*Annual monitoring shall be provided for a minimum of five years once wolves begin using the "Wolf Expansion" area to determine whether trampling, digging, and other possible*

[4] The HEP identifies those measures that are required because of the impacts associated with implementation of the California Exhibit. If the California Exhibit is not constructed, these specific provisions of the HEP would not be required, although other provisions of the HEP would remain operative.

*disturbances could result in the extirpation of this population. The monitoring shall be conducted by a qualified botanist or biologist, with annual reports on the condition of the occurrence, reproductive success, and need for any changes in access or management. Annual monitoring reports shall be submitted to the City of Oakland by October 15 of each year of monitoring. If it is clear that the occurrence becomes threatened by wolf activities, permanent protective fencing shall be installed providing a 25-foot buffer around the population. Annual monitoring shall be provided a minimum of three years beyond installation of any permanent protective fencing to ensure that the population is adequately protected and monitor changes in population size and distribution within and outside of the protective fence boundary.*

***Implementing Action 5-3:*** *Prior to implementing any invasive species removal or other management activities associated with the HEP, systematic surveys shall be conducted by a qualified botanist to confirm presence or absence of any additional populations of special-status species. This will provide baseline data on any other occurrences that need to be considered during vegetation management. Systematic surveys have not been conducted for other areas in Upper Knowland Park, and additional populations of the three species encountered in the vicinity of the California Exhibit, or possibly other special-status plant species, could be present. If any additional populations are encountered, appropriate protective measures shall be implemented as part of the HEP. Species receiving appropriate protection shall include any species that is formally listed under the State and/or federal Endangered Species Acts, is maintained on Lists 1, 2 and 3 of the CNPS Inventory, is included on the list of 31 "Rare, Threatened, and Endangered Vascular Plants Potentially Present in Oakland" according to the Technical Appendices (Volume 1, Chapter 3) of the Oakland General Plan OSCAR Element, and/or is included on the list of "Unusual or Significant Plants in Oakland" contained in Appendix 3-A of the OSCAR Element. Any invasive species removal within 20 feet of this occurrence shall be accomplished by hand pulling, under the supervision of a qualified botanist, and all herbicide use shall be prohibited within this zone. All workers shall be informed of the presence of this occurrence, its sensitivity and need to minimize trampling and other disturbance in the vicinity.*

***Implementing Action 5-4:*** *The City of Oakland's Standard Conditions of Approval shall be followed with regard to protection of possible bird nesting habitat. A preconstruction survey shall be conducted if vegetation removal and construction is to be initiated during the breeding/nesting season (from March 15 through August 15). Human activity associated with intensive vegetation removal could result in nest abandonment, and shall either occur during the non-nesting season (August 16 to March 14) or shall be preceded by a preconstruction survey as part of implementing the HEP. If the survey indicates the potential presences of nesting raptors or other birds, the biologist shall determine an appropriately sized buffer around the nest in which no work will be allowed until the young have successfully fledged. The size of the nest buffer shall be determined by the biologist in consultation with the CDFG, and shall be based to a large extent on the nesting species and its sensitivity to disturbance. In general, buffer sizes of 200 feet for raptors and 50 feet for other birds shall suffice to prevent disturbance to birds nesting in the urban environment, but these buffers may be increased or decreased, as appropriate, depending on the bird species and the level of disturbance anticipated near the nest.*

***Implementing Action 5-5:*** *In addition to the minimum 1:1 compensatory mitigation requirement called for in Mitigation 14c, specific habitat enhancement measures developed as part of the detailed mitigation program for Alameda whipsnake shall be incorporated into the HEP where relevant to invasive species control and habitat management. These additional measures may be required as part of the consultation process with USFWS and CDFG in securing the incidental take authorization for the California Exhibit project, and could include interpretive programs, access restrictions, controls on timing and methods for invasive species removal, need for worker training, and possibly preconstruction surveys prior to vegetation removal, among other measures.*

## IMPLEMENTATION ELEMENT

This HEP will be refined over time as necessary to provide a coordinated approach to invasive species control, required mitigation, and native habitat enhancement in the California Exhibit and larger treatment area in Knowland Park. Refinement and implementation of the HEP will be accomplished through the following steps.

**Initiate HEP and Identify Invasive Species Treatment Areas**. In large part, this HEP has been prepared to meet the mitigation requirements of implementing the California Exhibit project. Although the invasive species, native revegetation, and sensitive resource protections called for under this HEP meet the requirement for an HEP related to the Oakland Zoo Master Plan certain Implementing Actions are specifically related to implementation of the California Exhibit. The Veterinary Medical Hospital may proceed with construction prior to implementation of the HEP as this element of the amended Master Plan does not have the potential to result in significant impacts to sensitive biological resources and would eliminate stands of invasive French broom which currently dominant much of the vicinity.

Prior to initiating construction of any element of the California Exhibit project, baseline conditions within HEP treatment areas will be determined. The initial boundaries of the invasive species treatment addressed by the HEP will encompass the Ecological Recovery Zone, vicinity of the California Exhibit, and Upper Knowland Park west of Golf Links Road (see **Figure 1**). These boundaries may be refined based on the final authorizations from the USFWS and CDFG for Alameda whipsnake, and need to achieve the required compensatory mitigation ratios for Alameda whipsnake and grasslands habitat lost or modified as a result of implementing the California Exhibit project. Treatment areas will be prioritized based on proximity to the California Exhibit site and achieving the specific habitat enhancement objectives identified in the 1998 MND and 2011 Subsequent Mitigated Negative Declaration / Addendum. Once the compensatory mitigation ratios are met and required habitat enhancement is achieved, the invasive species treatment under the HEP will subsequently be expanded into the remaining areas of Knowland Park east of Golf Links Road. On-going monitoring and management will be required in perpetuity to prevent re-establishment of the target invasive species due to the continued spread of seed from adjacent private properties and surrounding open space where management is less rigorous. In the event that construction on the California Exhibit has not been initiated by 2015, the provisions of the HEP shall be initiated and implemented. Implementation Actions related specifically to construction of the California Exhibit would not apply until components of this element of the Master Plan are initiated.

**Confirm Baseline Conditions of HEP Treatment Areas**. Baseline data will be verified through field surveys and detailed mapping of existing vegetative cover. Stands of target invasive species will be identified and a schedule for treatment developed. Systematic surveys for special-status plant species will be conducted during the appropriate time of year for previously unsurveyed areas of Upper Knowland Park within the HEP management area prior to implementing any mechanical or chemical treatments. This mapping and systematic surveys could be phased over time, given that invasive species control and revegetation efforts will be phased, with areas west of Golf Links Road most likely completed first and east of Golf Links Road initiated at a future time. Systematic surveys are typically considered valid by resource agencies for two years, which should be factored into the timing of future detailed surveys for special-status plant species. If any additional populations of special-status species are encountered, appropriate protective measures equivalent to those set forth in Implementing Action 5-3 above will be defined and implemented as part of the HEP.

**Provide Agency Review of HEP Implementation**. Future amendments to the HEP and information about implementation of the HEP will be available for public and agency review. After initiation of the HEP management activities, the Zoo shall provide the City Planning Director with an Annual Progress Report (including the Annual Assessment described below) on the status of HEP implementation. Refinements of the HEP consistent with the provisions of the HEP are permitted. Proposals for major amendments (i.e. removal or additional of an Element or Implementing Action) of the HEP shall require approval of the Planning Director.

**Encourage Public Participation of HEP Implementation.** Public participation will be encouraged as part of HEP implementation. The Zoo's website will be expanded to include information on the HEP and any amendments, updates on implementation activities, and opportunities for public participation including volunteering for invasive species removal and native revegetation efforts. Ideally, the HEP will receive widespread support for its implementation, including volunteers participating in both the invasive species removal and native revegetation efforts. Encouraging public participation, particularly from interested conservation organizations such as the California Native Plant Society, should serve to minimize potential future conflicts with park users and attract interested volunteers.

**Implement On-going Management and Annual Assessment**. The HEP shall provide a coordinated approach for control of each target invasive species, native revegetation of highly degraded areas, and monitoring and maintenance. Methods used for treating each target invasive species shall be based on currently accepted best available practices as described in the Invasive Species Control Element. Management techniques shall be updated and adjusted to reflect best practices for invasive species control and native plant restoration, where appropriate. Phasing associated with implementation of the HEP is important to successful eradication of invasive species and establishment of native cover. The initial phase of any treatment shall involve a concerted effort to remove invasive species. The next phase involves heavy seeding of treatment areas in advance of the fall rains. Where absolute cover values for grassland species are low, enhancement plantings with native grasses and forbs can be accomplished either at the same time native grassland seeding is installed, or in subsequent years.

On-going management shall involve routine inspection and removal of any target invasive species, including possibly successive treatments using broadleaf-specific herbicides that won't affect the seeded native grasslands. Any herbicide application must be carefully controlled to protect desired native vegetation and sensitive resources, avoid enhancement plantings, and protect the aquatic habitat of the Arrojo Viejo and other receiving waters. Control of the herbicide application shall comply with City of Oakland standards, use of best management practices related to the particular product in use, and certification restrictions of the certified pest applicator responsible for any chemical treatment methods. Adaptive management allowed under the HEP where necessary to achieve performance standards and success criteria. Adaptive Management is a resource management tool that allows for adjustments in treatment methodologies for invasive species control and native revegetation as best management practices evolve and become more effective over time.

An Annual Assessment of the distribution and abundance of target invasive species shall be performed as part of the HEP, including a map showing location, treatment areas and methods, and estimates of abundance. The success of invasive treatment shall be described, together with any adjustments to management techniques. Monitoring of any native revegetation efforts shall be documented as part of the Annual Assessment. Vegetation sampling transects shall be established following the first year of any revegetation treatment, and field visits conducted in spring or summer to record plant cover and survival rates to determine whether performance standards and success criteria are met.. Photo stations shall be established at larger revegetation areas to document progression in plant establishment, and included in the Annual Assessment report until success criteria are met for that particular treatment area. Recommendations for necessary maintenance shall be included in the Annual Assessment report, and could include: follow-up invasive species removal, possible replacement replanting, and successive reseeding if plant survival and absolute cover rates for revegetation are not achieved. Copies of the Annual Assessment shall be provided to the City of Oakland for review and approval, as part of its oversight responsibilities.

Eventually any native revegetation efforts would be successfully established when plant survival and cover class goals are met, but there remains an on-going threat that target invasive species could become re-established in the HEP management area. Annual monitoring reports shall be necessary to identify locations of invasive species re-establishment and appropriate treatment methods when absolute cover for all target species exceeds five percent. It is assumed that volunteer programs overseen by the Zoo will play an important part in implementing the HEP and providing for long-term control of invasive species and native habitat enhancement.

# APPENDIX G-3

## *Alameda Whipsnake Habitat Evaluation*
## (Swaim Biological, Inc. 2009)

Swaim Biological Inc.
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July 17, 2009

Ms. Patricia Jeffrey
Placemakers
1500 Park Avenue, Loft 310
Emeryville, CA 94608

**RE: Alameda Whipsnake Habitat Evaluation Oakland Zoo Master Plan Update**

Dear Ms. Jeffrey:

Swaim Biological, Inc. was retained by Placemakers to provide an updated habitat evaluation on the potential effects of the proposed Oakland Zoo Master Plan on the State and federally-threatened Alameda whipsnake (*Masticophis lateralis euryxanthus*), comparing the impacts to potential Alameda whipsnake (AWS) habitat associated with the currently proposed project with that previously analyzed in the Mitigated Negative Declaration (MND) certified for the project in 1998. Since 1998, the original Master Plan has been revised to eliminate two new access roads and replace a shuttle road with a gondola, refine the exhibit areas in the original “California 1820” area, include a new Overnight Experience area, and construct a new Vet Hospital where the original River Exhibit was to be located. The new California! Exhibit (CA!) defines proposed exhibit areas and visitor serving uses in the vicinity of the original “California 1820” exhibit areas.

The project site includes habitat features which are suitable for the AWS. However, the AWS has not been found in the project vicinity during recent trapping efforts. In 1998-99, Swaim Biological, Inc. conducted a protocol survey for the AWS for the Oakland Zoo, and no AWS were trapped or observed. Additionally, trapping surveys conducted on the adjacent Chabot Regional Park in 2003-04 were also negative. Based on these results, it is anticipated that the project site is not likely to be occupied by AWS.

Since the surveys were completed on the project site in 1999, the level of survey effort required for the U.S. Fish and Wildlife Service (USFWS) protocols has increased. In addition, the project area has changed and some locations that may now be impacted were not specifically trapped (see Attachment A). Given the length of time that has elapsed since completion of the earlier surveys, the change in the survey protocol, and the project revisions, the Oakland Zoo will complete additional protocol level surveys for AWS in 2009-10 to re-confirm the status of the AWS on the property.

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To evaluate impacts to potential AWS habitat, Swaim Biological identified the land cover and habitat features found on the project site. Swaim Biological then compared the amount and types of vegetation impacted by the currently proposed CA Exhibit with the previously approved California 1820 Exhibit. Table 1 provides a summary of the various habitat types affected under the original California 1820 and currently proposed CA! Exhibit.

Attachment B shows a map of existing vegetative cover types on the site, and the degree of disturbance associated with the revised CA! Exhibits. This map separates those areas that would be considered permanent impacts with a high level of disturbance (i.e., structures, roadways, pathways, etc.), those areas with limited disturbance (i.e.. visitor use and day-time exhibit areas), and those with low disturbance (i.e.. non-display exhibit areas and larger animal enclosure areas), based on mapping provided by the project landscape architect, PJA. Temporary impacts would include the joint trench for utility installation.

**Vegetation Impacts**

California 1820

As summarized in the 1998 MND, California 1820 would have directly impacted 36.3 acres of potential AWS habitat in exhibit areas, plus and additional 9.0 acres of habitat associated with construction of the proposed Shuttle Road The proposed Shuttle Road that would have served California 1820 would have affected an additional 58 acres of potential AWS habitat by enclosing those habitat areas within the proposed Shuttle Road. Shuttle vehicles would have run frequently along the route during the daytime when AWS are active, and could have created an impediment to snake movement into the enclosed habitat areas, or resulted in an inadvertent take if snakes are present. The proposed Shuttle Road has been eliminated in the new CA! Exhibit and replaced with a gondola for visitors, and upgrades to the existing fire road for maintenance only access.

CA!

The CA! Exhibit has reduced the permanent impacts to 21.5 acres of potential AWS habitat, plus an estimated 9.0 acres associated with widening and paving the existing fire road to sever as the future maintenance road. An estimated 3.8 acres would also be temporarily disturbed along an existing fire road and paddock area during installation of a utility trench that would serve the CA! Exhibit area, also affecting potential AWS habitat. By eliminating the Shuttle Road and transporting visitors to the exhibit area by gondola, the CA! Exhibit

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would also lessen potential direct impacts to individual AWS through reduced or eliminated mortality on project roadways.

**Table 1.** Estimated Vegetation Impacts: Comparison Between Current Proposed Project (CA!) and original California 1820 Evaluated in 1998 MND.

| **California 1820 (1998)** | **CC** | **DSS** | **CBS** | **FBS** | **GSL** | **OW** | **Rock** | **Totals** | **BOD** | **ORN** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 0.0 | | | |
| Bison | 3.6 | 0.0 | 0.7 | 0.0 | 3.5 | 0.0 | 0.0 | **7.8** | | |
| Breeding | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.0 | **0.8** | | |
| Wolf | 0.0 | 0.4 | 1.4 | 0.2 | 1.5 | 0.2 | 0.0 | **3.7** | | |
| River (included vet hospital) | 0.0 | 0.2 | 0.3 | 5.6 | 5.0 | 0.5 | 0.0 | **11.6** | | |
| Canyon | 0.0 | 0.0 | 0.0 | 4.2 | 0.9 | 7.3 | 0.0 | **12.4** | | |
| Total Exhibit Acreage | 3.6 | 0.6 | 2.4 | 10.0 | 10.9 | 8.8 | 0.0 | **36.3** | | |
| | | | | | | | 0.0 | | | |
| Enclosed by shuttle but outside exhibits | 0.0 | 1.3 | 5.8 | 4.0 | 18.9 | 28.0 | 0.0 | **58.0** | | |
| **Totals 1998** | **3.6** | **1.9** | **8.2** | **14.0** | **29.8** | **36.8** | **0.0** | **94.3** | | |

| **California!** | **CC** | **DSS** | **CBS** | **FBS** | **GSL** | **OW** | **Rock** | **Totals** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Permanent + Limited Dist | 0.2 | 0.0 | 4.3 | 0.2 | 3.8 | 0.9 | 0.0 | **9.3** | 1.5 | 0.0 |
| Low Disturbance | 0.3 | 0.0 | 3.4 | 0.0 | 3.2 | 1.2 | 0.0 | **8.1** | 0.5 | |
| Vet Hospital | 0.0 | 0.0 | 0.0 | 2.7 | 0.3 | 0.0 | 0.0 | **3.0** | 0.9 | 0.0 |
| Maintenance Only Road | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | **0.1** | 9.0 | 0.2 |
| Creek Extension | 0.0 | 0.0 | 0.0 | 0.7 | 0.3 | 0.0 | 0.0 | **1.0** | 0.5 | 0.0 |
| **Total Project acreage** | 0.6 | 0.0 | 7.8 | 3.5 | 7.6 | 2.1 | 0.0 | **21.5** | 1.4 | |
| **Temporary Impacts** | | | | | | | | | | |
| Joint Trench | 0.0 | 0.0 | 0.1 | 0.2 | 3.4 | 0.0 | 0.0 | **3.8** | | |

CC (Chamise Chaparral)
DSS (Diablan Sage Scrub)
CBS (Coyote Brush Scrub)
FBS (French Broom Scrub)
OW (Oak Woodland)
GLS (Grassland, Native, Non-native combined)
Rock (Rock Outcrops)
BOD (Barren or Disturbed)
ORN (Ornamental)

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**Project Configuration Comparison**.

The new configuration of the CA! Exhibit is more compact and causes significantly less fragmentation of potential AWS habitat. This reduction in affected acreage, combined with the removal of the Shuttle Road, lessens the projects potential impacts on the AWS, if present on the site, as well as the natural habitat for other wildlife in Knowland Park.

Please call if you have any questions or comment regarding this AWS Habitat Evaluation for the Oakland Zoo Master Plan update.

Sincerely,

Karen E. Swaim

Karen E. Swaim
Herpetologist

Attachments: A: Revised 2009 Project with 1998-99 AWS Survey Traplines; B: Vegetation Cover and Project Disturbance Areas.

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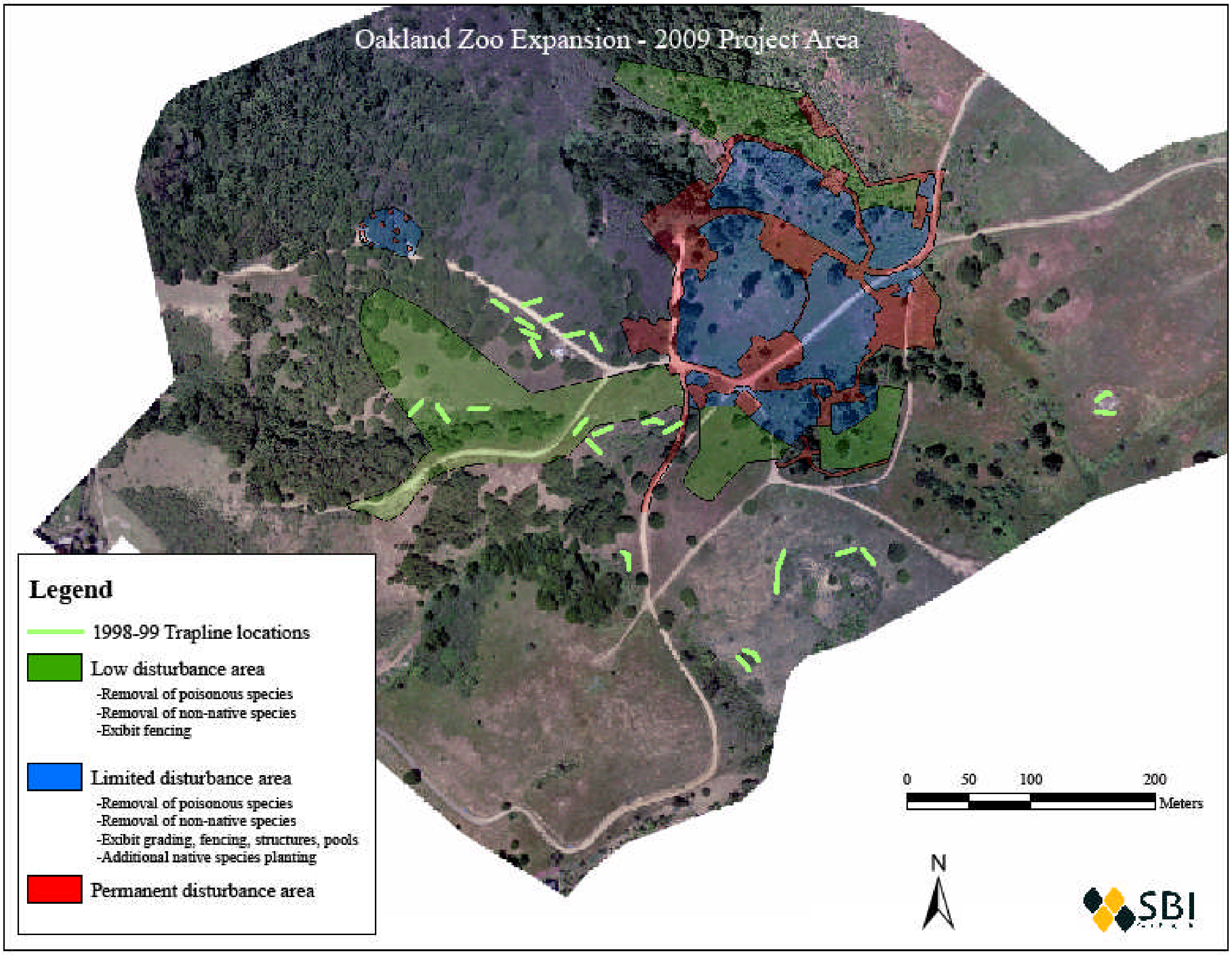
**Attachment A**: 2009 Project with 1998-1999 AWS Survey Trapline Locations



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**Attachment B:** Vegetation Cover and Project Disturbance Areas.

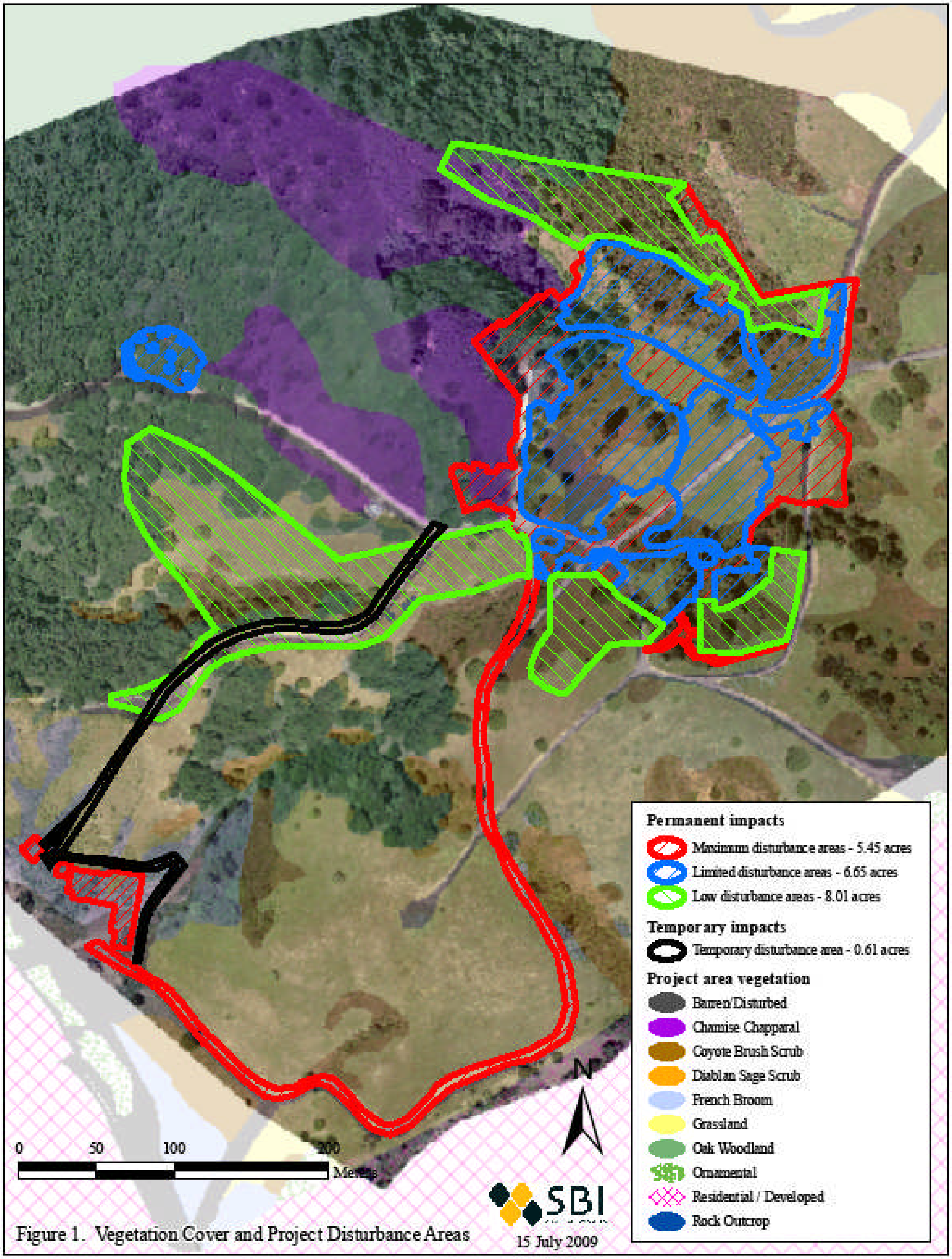

Figure 1. Vegetation Cover and Project Disturbance Areas

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November 9, 2009

Mr. Nik Haas-Dehejia
East Bay Zoological Society
P.O. Box 5238
Oakland, CA 94605

**RE: Results of the Fall 2009 Alameda Whipsnake Trapping Survey at the Oakland Zoo/Knowland Park in Oakland, Alameda County, California**

Dear Mr. Haas-Dehejia:

The purpose of this letter is to provide you with the results of the fall 2009 component of the trapping survey for Alameda whipsnake (*Masticophis lateralis euryxanthus*) at the Oakland Zoo/Knowland Park in Oakland, CA. The project site is located in the City of Oakland east of Interstate 580 (Attachment A). This survey fulfilled the fall component of the effort proposed to the U.S. Fish and Wildlife Service and California Department of Fish and Game in the 2009 Research Proposal prepared by Swaim Biological, Inc.

The trapping survey began on September 5, 2009 and continued through October 27, 2009. A total of 35 traplines were distributed in the areas of most optimal habitat in Knowland Park (Attachment B). We completed 45 active trapping days in this period. For eight of the days in this time period, the traps were deactivated due to extreme heat or rain events.

No Alameda whipsnakes were captured or observed on the site during the fall survey. Species captured during the survey included four snake species, three lizard species, six amphibian, three small mammal and one bird species (Attachment C).

On October 6, 2009, a small brush fire destroyed 5 of the traplines in an area of rock outcrops and coastal scrub, south and west of Golf Links Road. One southern alligator lizard was killed while in a trap at the time of the fire. The lines will be reconstructed and activated for the spring 2010 survey.

All traps were removed from the site at the conclusion of the fall survey. The spring survey will consist of 90 active trapping days and will fulfill the effort proposed to the U.S. Fish and Wildlife Service and California Department of Fish and Game in the 2009 Research Proposal prepared and submitted by Swaim Biological, Inc. A final survey report with analysis of the data collected at the site and conclusions regarding the status of the Alameda whipsnake at the site will be submitted upon completion of the spring 2010 effort.

Please feel free to contact me if you have any questions regarding the results of the fall survey or need additional information.

Sincerely,

Karen E. Swaim
Herpetologist

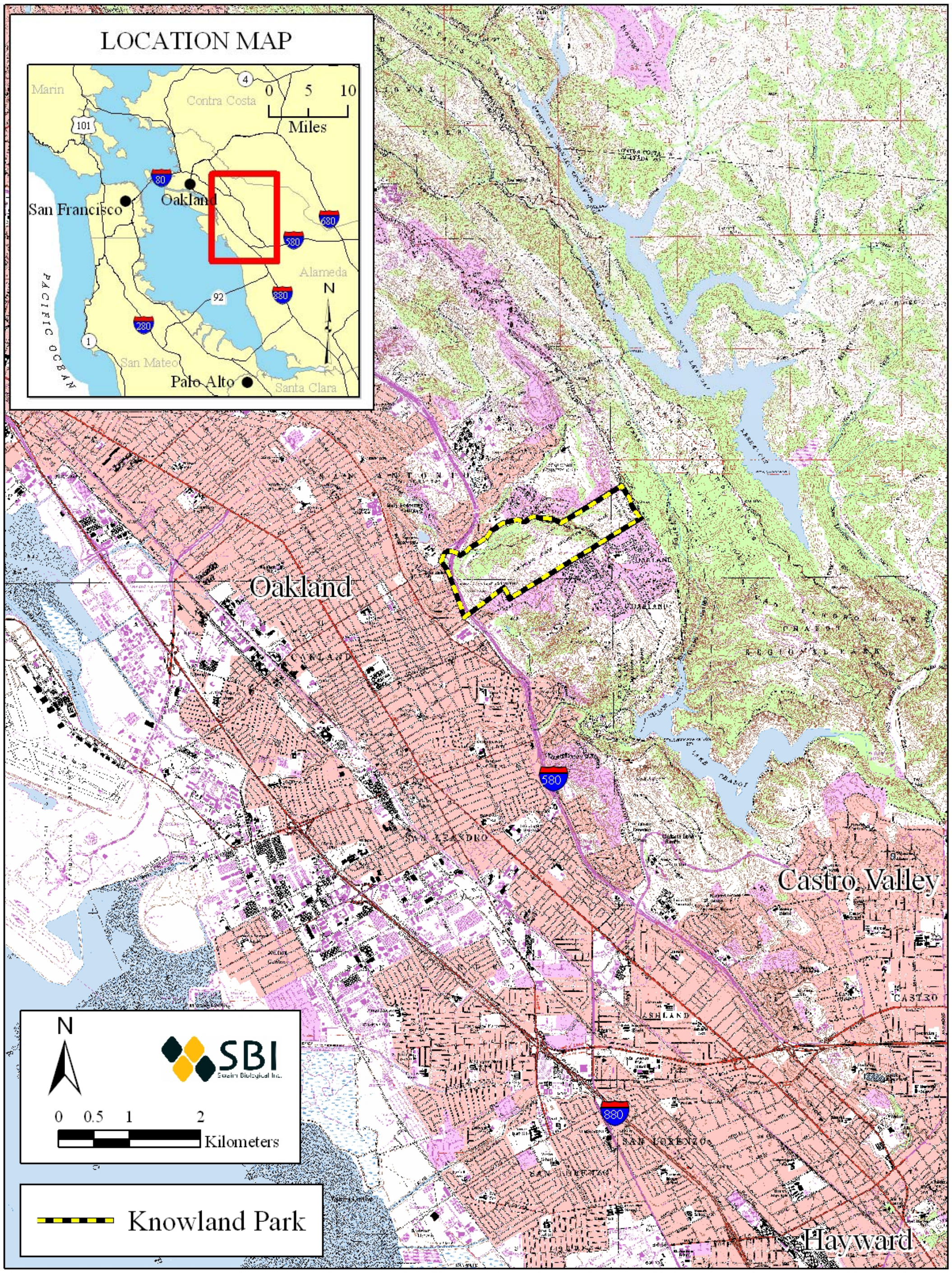
Attachments:

A: Project Site Location

B: Trapline Set Up

C: Table of Vertebrate Species Captured

Attachment A –
Regional and Project Location, Knowland Park, Oakland, CA.



Attachment B: Trapline Set Up

Photo 1. Example of an active trapline (#22) set in chaparral habitat in Knowland Park. One of the two funnel traps is visible in the foreground.

Attachment C

Vertebrates Captured During the Fall 2009 Trapping Survey at Knowland Park, Oakland, CA.

| Scientific Name | Common Name | Total Captures |
|---|---|---|
| **Snakes** | | |
| *Coluber constrictor mormon* | Western Yellow-bellied Racer | 2 |
| *Contia tenuis* | Sharp-tailed Snake | 8 |
| *Diadophis punctatus* | Ring-necked Snake | 8 |
| *Pituophis catenifer catenifer* | Pacific Gopher Snake | 26 |
| **Lizards** | | |
| *Elgaria multicarinata multicarinata* | California Alligator Lizard | 24 |
| *Sceloporus occidentalis* | Western Fence Lizard | 314 |
| *Eumeces skiltonianus skiltonianus* | Skilton Skink | 29 |
| **Amphibians** | | |
| *Aneides lugubris* | Arboreal Salamander | 20 |
| *Batrachoseps attenuatus* | California Slender Salamander | 123 |
| *Ensatina eschscholtzii xanthoptica* | Yellow-eyed Salamander | 54 |
| *Hyla regilla* | Pacific Treefrog | 1 |
| *Taricha granulosa* | Rough-skinned Newt | 18 |
| *Taricha torosa torosa* | Coast Range Newt | 27 |
| **Mammals** | | |
| *Microtus californicus* | California Meadow Vole | 2 |
| *Peromyscus* sp. | Deer Mouse | 42 |
| *Reithrodontomys megalotis* | Western Harvest Mouse | 23 |
| *Sorex* sp. | Shrew | 1 |
| **Birds** | | |
| *Thyromanes bewickii* | Bewick's Wren | 1 |
| | Unknown bird | 2 |

# APPENDIX G-4

## California Exhibit Tree Diagram and Tree Survey
## (PJA, 2010)

# Oakland Zoo - California Project - Tree Survey

## Protected Trees

| Tree Number | Type | Trunk Diameter | Remove | To Remain - 10' of Const. | Construction Phase | Sheet Location |
|---|---|---|---|---|---|---|
| 403 | BAY | 48B* | | X | 1 | 2-22A |
| 404 | OAK | 24-20 | | X | 1 | 2-22A |
| 423 | OAK | 36B | | X | 1 | 2-22A |
| 424 | BAY | 30B | | X | 1 | 2-22A |
| 426 | OAK | 18 | | X | 3 | 2-22A |
| 427 | OAK | 36B-24-24 | | X | 1 | 2-22A |
| 441 | OAK | 18 | | X | 1 | 2-22A |
| 444 | OAK | 18 | | X | 1 | 2-22A |
| 445 | OAK | 16 | | X | 1 | 2-22A |
| 449 | OAK | 6 | | X | 1 | 2-22A |
| 450 | OAK | 24 | | X | 1 | 2-22A |
| 453 | OAK | 24 | | X | 1 | 2-22A |
| 454 | OAK | 10 | | X | 1 | 2-22A |
| 457 | OAK | 12 | | X | 1 | 2-22A |
| 531 | OAK | 30 | X | | 1 | 2-22A |
| 532 | OAK | 12 | X | | 1 | 2-22A |
| 533 | OAK | 30 | X | | 1 | 2-22A |
| 533 | OAK | 30 | X | | 2 | 2-22A |
| 534 | OAK | 18 | | X | 2 | 2-22A |
| 536 | OAK | 10-12-10-8 | X | | 2 | 2-22A |
| 537 | OAK | 12-8 | X | | 2 | 2-22A |
| 538 | OAK | 10 | | X | 4 | 2-22A |
| 539 | OAK | 18 | | X | 4 | 2-22A |
| 550 | OAK | 12 | | X | 4 | 2-22A |
| 551 | OAK | 36 | X | | 4 | 2-22A |
| 552 | OAK | 12/8/2004 | X | | 3 | 2-22A |
| 553 | OAK | 6 | X | | 3 | 2-22A |
| 554 | OAK | 10 | X | | 3 | 2-22A |

# Oakland Zoo - California Project - Tree Survey

## Protected Trees

| Tree Number | Type | Trunk Diameter | Remove | To Remain - 10' of Const. | Construction Phase | Sheet Location |
|---|---|---|---|---|---|---|
| 555 | OAK | 12-6 | X | | 4 | 2-22A |
| 556 | OAK | 18 | X | | 4 | 2-22A |
| 558 | OAK | 10 | X | | 4 | 2-22A |
| 559 | OAK | 18 | X | | 4 | 2-22A |
| 560 | OAK | 24 | X | | 4 | 2-22A |
| 574 | OAK | 18 | | X | 3 | 2-22A |
| 593 | OAK | 16 | X | | 1 | 2-22A |
| 595 | OAK | 12 | | X | 3 | 2-22A |
| 702 | OAK | 16 | | X | 2 | 2-22A |
| 704 | OAK | 16 | | X | 2 | 2-22A |
| 706 | OAK | 18 | | X | 1 | 2-22A |
| 714 | OAK | 6 | | X | 1 | 2-22A |
| 716 | OAK | 8 | X | | 1 | 2-22A |
| 720 | OAK | 24 | | X | 1 | 2-22A |
| 25B | OAK | 4 | | X | 2 | 2-22A |
| 28A | OAK | 18 | | X | 3 | 2-22A |
| 29A | OAK | 18 | | X | 1 | 2-22A |
| 30A | OAK | 18 | | X | 3 | 2-22A |
| 32A | OAK | 10-10-10-8 | | X | 1 | 2-22A |
| 33A | OAK | 30 | | X | 1 | 2-22A |
| 535B | OAK | 10-8 | X | | 2 | 2-22A |
| 557B | OAK | 18 | | X | 2 | 2-22A |
| 594B | OAK | 12-12 | X | | 1 | 2-22A |
| 36 | OAK | 8 | | X | 1 | 2-22B |
| 37 | OAK | 20 | | X | 3 | 2-22B |
| 42 | OAK | 4-6 | X | | 1 | 2-22B |
| 45 | BAY | 12 | | X | 3 | 2-22B |
| 47 | OAK | 24 | | X | 3 | 2-22B |

# Oakland Zoo - California Project - Tree Survey

## Protected Trees

| Tree Number | Type | Trunk Diameter | Remove | To Remain - 10' of Const. | Construction Phase | Sheet Location |
|---|---|---|---|---|---|---|
| 61 | BAY | 12 | X | | 4 | 2-22B |
| 77 | OAK | 14 | | X | 1 | 2-22B |
| 97 | OAK | 12 | X | | 5 | 2-22B |
| 115 | OAK | 10-12 | | X | 2 | 2-22B |
| 474 | OAK | 8 | | X | 2 | 2-22B |
| 476 | OAK | 16 | | X | 2 | 2-22B |
| 483 | OAK | 12 | | X | 1 | 2-22B |
| 484 | OAK | 18 | X | | 1 | 2-22B |
| 485 | OAK | 12 | X | | 1 | 2-22B |
| 486 | OAK | 12 | | X | 1 | 2-22B |
| 492 | OAK | 16 | | X | 2 | 2-22B |
| 494 | OAK | 12 | | X | 2 | 2-22B |
| 495 | OAK | 10 | | X | 2 | 2-22B |
| 564 | OAK | 4 | X | | 3 | 2-22B |
| 565 | OAK | 4 | X | | 3 | 2-22B |
| 566 | OAK | 6 | X | | 3 | 2-22B |
| 567 | OAK | 4 | X | | 3 | 2-22B |
| 568 | OAK | 6 | X | | 3 | 2-22B |
| 581 | OAK | 4 | | X | 3 | 2-22B |
| 589 | OAK | 6-6 | X | | 3 | 2-22B |
| 591 | BAY | 12 | | X | 3 | 2-22B |
| 596 | OAK | 24 | | X | 3 | 2-22B |
| 598 | OAK | 18 | | X | 3 | 2-22B |
| 599 | OAK | 10 | | X | 3 | 2-22B |
| 600 | OAK | 36 | | X | 3 | 2-22B |
| 852 | EUC | 60 | X | | 2 | 2-22B |
| 864 | OAK | 4 | X | | 2 | 2-22B |

GENERAL NOTES:

1. PLS Surveys Inc., an Oakland-based surveying company, surveyed the trees within the Oakland Zoo's California Exhibit and Veterinary Medical Hospital Master Plan area on several occasions in 2009 and 2010. Provided with a plan of the Zoo's project, PLS Surveys tagged those trees projected for removal and within 10-feet of construction. Some trees already included a unique identifying tag resulting from prior surveys while other trees required new tags and number systems. The latest tree surveys were then reviewed by Seattle-based PJA Architects, the Oakland Zoo's principal architect for the Master Plan. PJA Architects compared and verified the PLS Surveys tree survey against the latest planned project to determine potential impact to trees.

## Oakland Zoo - California Project - Tree Survey

### Protected Trees

| Tree Number | Type | Trunk Diameter | Remove | To Remain - 10' of Const. | Construction Phase | Sheet Location |
|---|---|---|---|---|---|---|
| 865 | OAK | 4 | X | | 2 | 2-22B |
| 866 | OAK | 4 | X | | 1 | 2-22B |
| 867 | OAK | 6 | | X | 3 | 2-22B |
| 869 | OAK | 4 | | X | 2 | 2-22B |
| 876 | OAK | 10 | | X | 1 | 2-22B |
| 901 | OAK | 24 | | X | 1 | 2-22B |
| 903 | OAK | 12-18 | | X | 1 | 2-22B |
| 905 | BAY | 10 | X | | 3 | 2-22B |
| 907 | BAY | 30-30 | | X | 3 | 2-22B |
| 908 | TREE** | 12-10-10 | | X | 3 | 2-22B |
| 910 | TREE** | 30 | | X | 1 | 2-22B |
| 24A | OAK | 12 | X | | 4 | 2-22B |
| 25A | OAK | 18 | | X | 1 | 2-22B |
| 27A | OAK | 18 | | X | 1 | 2-22B |
| 35A | OAK | 30 | | X | 1 | 2-22B |
| 480A | OAK | 6 | | X | 2 | 2-22B |
| 592B | OAK | 4 | X | | 3 | 2-22B |
| N616 | OAK | 42 | | X | 1 | 2-22B |
| N620 | OAK | 18 | X | | 1 | 2-22B |
| N621 | OAK | 8 | | X | 1 | 2-22B |
| N622 | BAY | 18 | X | | 1 | 2-22B |
| 78 | OAK | 14 | | X | 1 | 2-22C |
| 80 | OAK | 12 | | X | 1 | 2-22C |
| 81 | OAK | 12 | | X | 1 | 2-22C |
| 743 | BAY | 12 | | X | 2 | 2-22C |
| 745 | OAK | 6 | | X | 2 | 2-22C |
| 751 | OAK | 12 | | X | 3 | 2-22C |
| 754 | OAK | 12 | | X | 2 | 2-22C |

## Oakland Zoo - California Project - Tree Survey

### Protected Trees

| Tree Number | Type | Trunk Diameter | Remove | To Remain - 10' of Const. | Construction Phase | Sheet Location |
|---|---|---|---|---|---|---|
| 756 | BAY | 18 | | X | 3 | 2-22C |
| 757 | BAY | 12 | | X | 3 | 2-22C |
| 758 | OAK | 16 | | X | 3 | 2-22C |
| 764 | OAK | 30 | | X | 3 | 2-22C |
| 765 | OAK | 30B | | X | 3 | 2-22C |
| 772 | BAY | 12 | | X | 3 | 2-22C |
| 776 | OAK | 12 | | X | 3 | 2-22C |
| 777 | OAK | 8 | X | | 3 | 2-22C |
| 778 | BAY | 12 | X | | 3 | 2-22C |
| 779 | OAK | 24 | | X | 3 | 2-22C |
| 780 | OAK | 24B | | X | 3 | 2-22C |
| 783 | BAY | 10 | | X | 3 | 2-22C |
| 785 | BAY | 14 | | X | 3 | 2-22C |
| 787 | BAY | 12 | | X | 3 | 2-22C |
| 795 | BAY | 10 | | X | 1 | 2-22C |
| 800 | OAK | 8 | | X | 3 | 2-22C |
| 851 | BAY | 24 | X | | 2 | 2-22C |
| 48A | BAY | 12 | X | | 2 | 2-22C |
| 105 | TREE** | 12-20 | X | | 1 | 2-22D |
| 125 | OAK | 24 | | X | 1 | 2-22D |
| 126 | OAK | 30 | | X | 1 | 2-22D |
| 127 | OAK | 16 | | X | 1 | 2-22D |
| 151 | OAK | 36B | | X | 2 | 2-22D |
| 443 | OAK | 36B | | X | 2 | 2-22D |
| 464 | OAK | 24 | | X | 2 | 2-22D |
| 469 | OAK | 36B | | X | 2 | 2-22D |
| 471 | OAK | 50B | | X | 2 | 2-22D |

## Oakland Zoo - California Project - Tree Survey

### Protected Trees

| Tree Number | Type | Trunk Diameter | Remove | To Remain - 10' of Const. | Construction Phase | Sheet Location |
|---|---|---|---|---|---|---|
| 472 | OAK | 8 | | X | 2 | 2-22D |
| 473 | OAK | 12 | | X | 2 | 2-22D |
| 475 | OAK | 18 | | X | 2 | 2-22D |
| 479 | OAK | 18 | | X | 2 | 2-22D |
| 512 | OAK | 18-18 | | X | 2 | 2-22D |
| 513 | OAK | 10-10 | | X | 2 | 2-22D |
| 514 | OAK | 10-8 | | X | 5 | 2-22D |
| 515 | OAK | 6 | | X | 5 | 2-22D |
| 520 | OAK | 8 | X | | 5 | 2-22D |
| 521 | OAK | 12-12-10-10 | X | | 5 | 2-22D |
| 733 | OAK | 14 | | X | 2 | 2-22D |
| 735 | OAK | 18 | | X | 3 | 2-22D |
| 739 | OAK | 18 | | X | 1 | 2-22D |
| 817 | OAK | 10 | | X | 1 | 2-22D |
| 848 | OAK | 8 | X | | 1 | 2-22D |
| 850 | BAY | 12 | X | | 3 | 2-22D |
| 480B | OAK | 10 | | X | 2 | 2-22D |
| 557A | OAK | 12-8 | X | | 4 | 2-22D |
| 592A | OAK | 30 | X | | 5 | 2-22D |
| 13 | OAK | 10 | | X | 1 | 2-22E |
| 101 | OAK | 8 | | X | 1 | 2-22E |
| 875 | OAK | 6 | X | | 1 | 2-22E |
| 26A | OAK | 6-4 | X | | 1 | 2-22E |
| 27B | OAK | 24 | | X | 1 | 2-22E |
| | | | Total Protected Trees Removed | Total Protected Trees within 10' of Construction | | |
| | | | 51 | 110 | | |

### Unprotected Trees

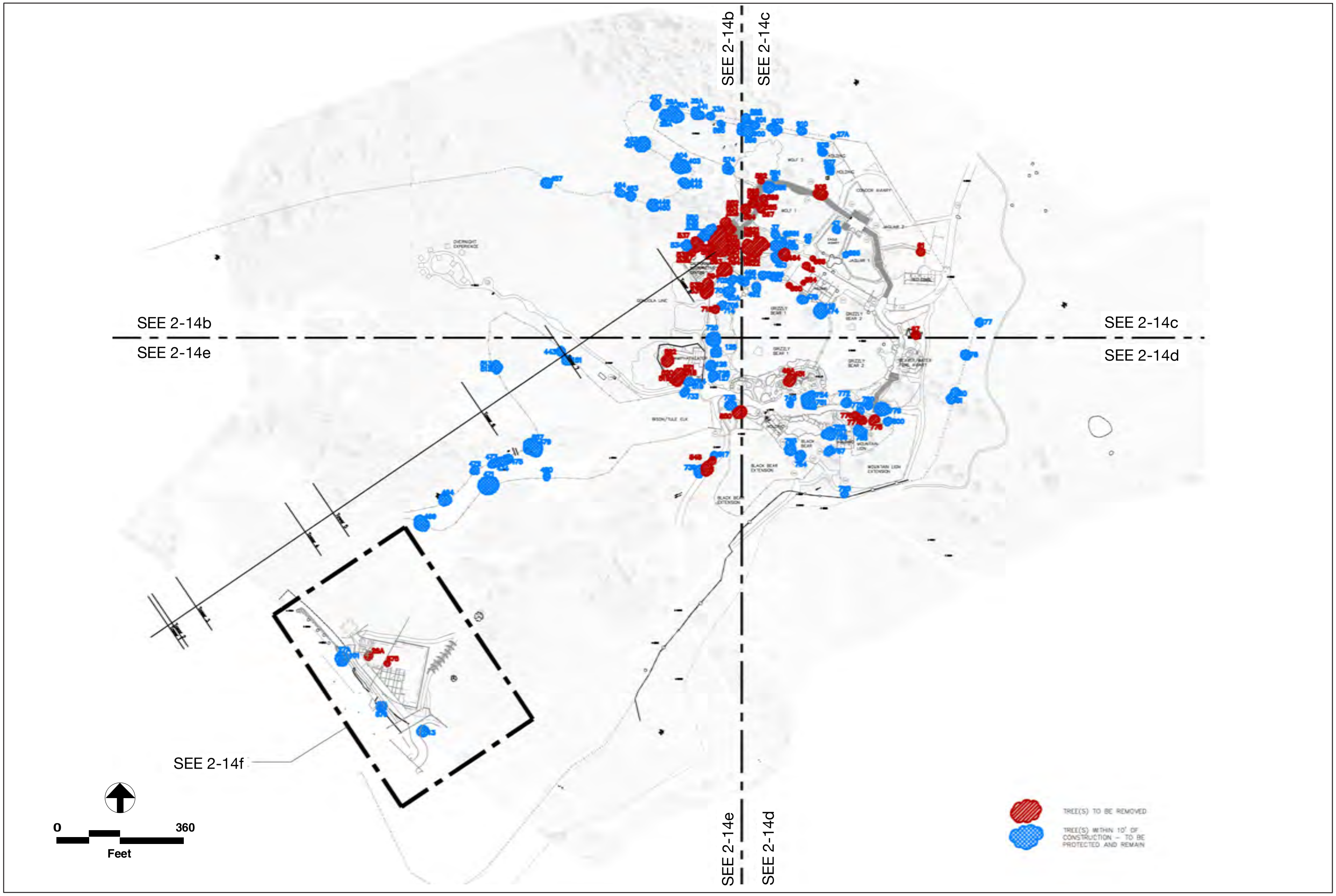
| | | | | | | |
|---|---|---|---|---|---|---|
| 852 | EUC | 60 | X | | 2 | 2-22B |
| | EUC | Multi-Trunk | X | | 2 | 2-22A |
| | | | Total Unprotected Trees Removed | Total Unprotected Trees within 10' of Construction | | |
| | | | 2 | 0 | | |

* The designation "B" after the trunk diameter indicates the measurment is taken at the base of the trunk

** Species to be verified but assumed protected.

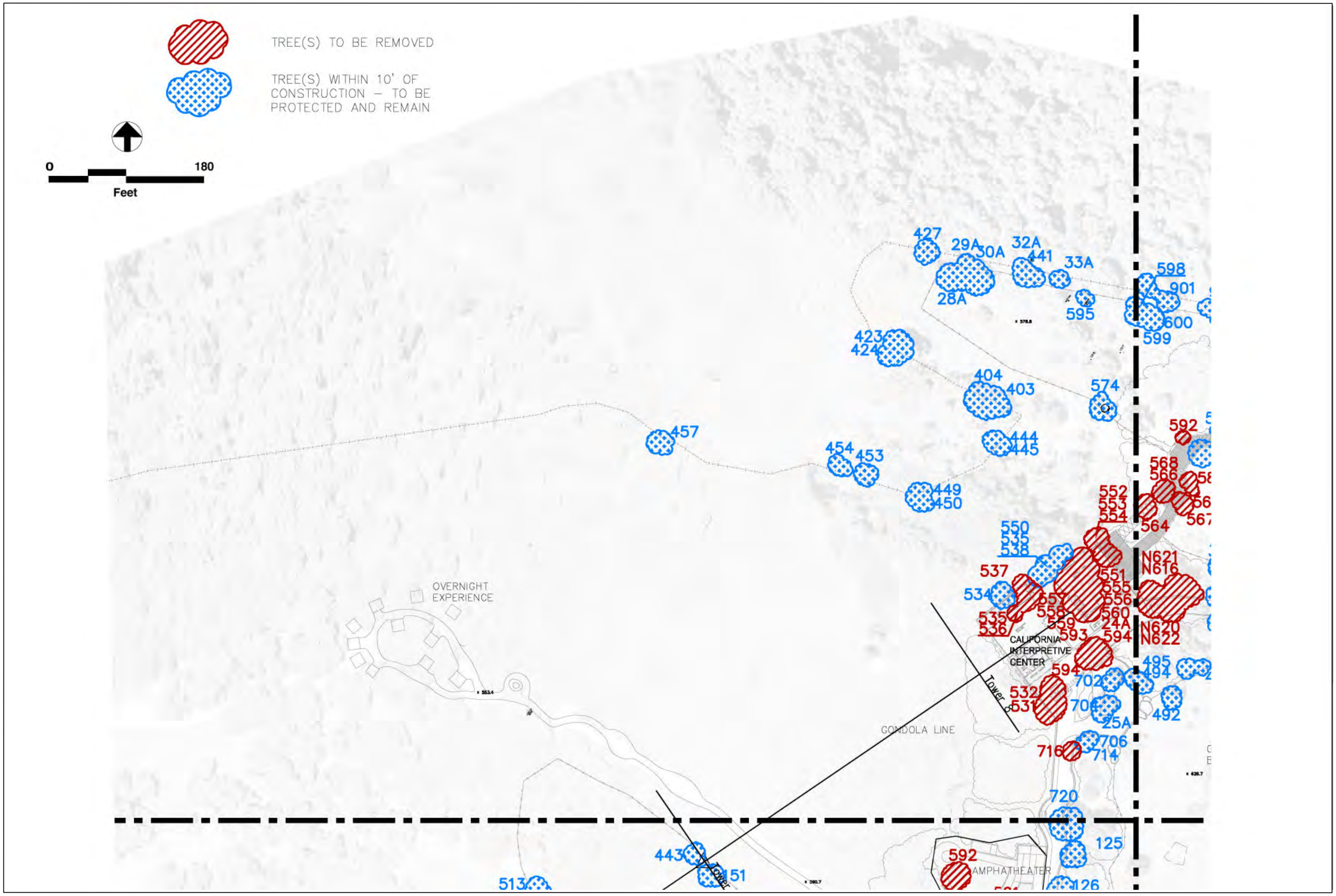
GENERAL NOTES:

1. PLS Surveys Inc., an Oakland-based surveying company, surveyed the trees within the Oakland Zoo's California Exhibit and Veterinary Medical Hospital Master Plan area on several occasions in 2009 and 2010. Provided with a plan of the Zoo's project, PLS Surveys tagged those trees projected for removal and within 10-feet of construction. Some trees already included a unique identifying tag resulting from prior surveys while other trees required new tags and number systems. The latest tree surveys were then reviewed by Seattle-based PJA Architects, the Oakland Zoo's principal architect for the Master Plan. PJA Architects compared and verified the PLS Surveys tree survey against the latest planned project to determine potential impact to trees.



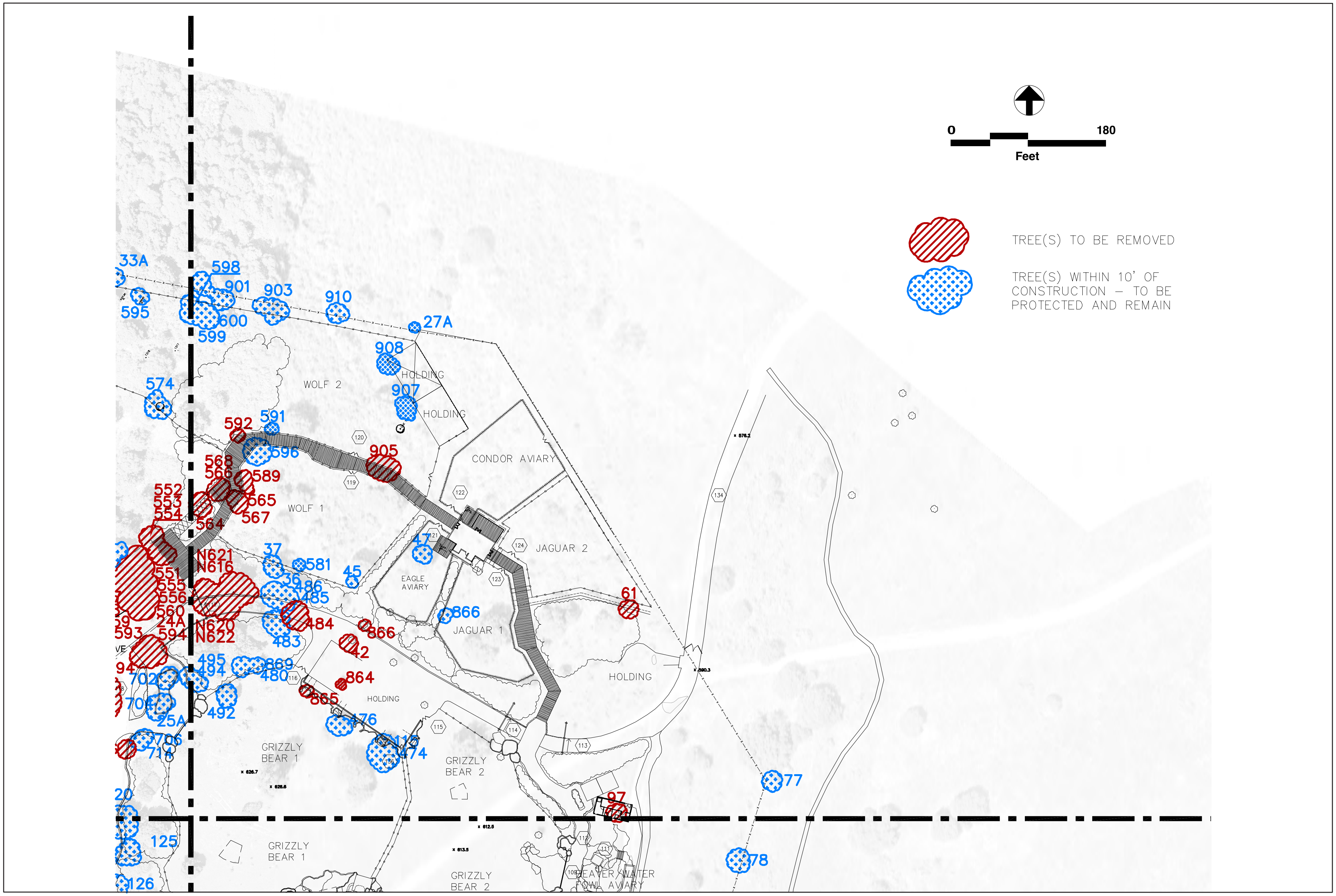

SOURCE: PJA

**Figure 3.3-3**
Proposed Master Plan Amendment: Trees Proposed for Removal and Trees Within 10 Feet of Proposed Construction - Key



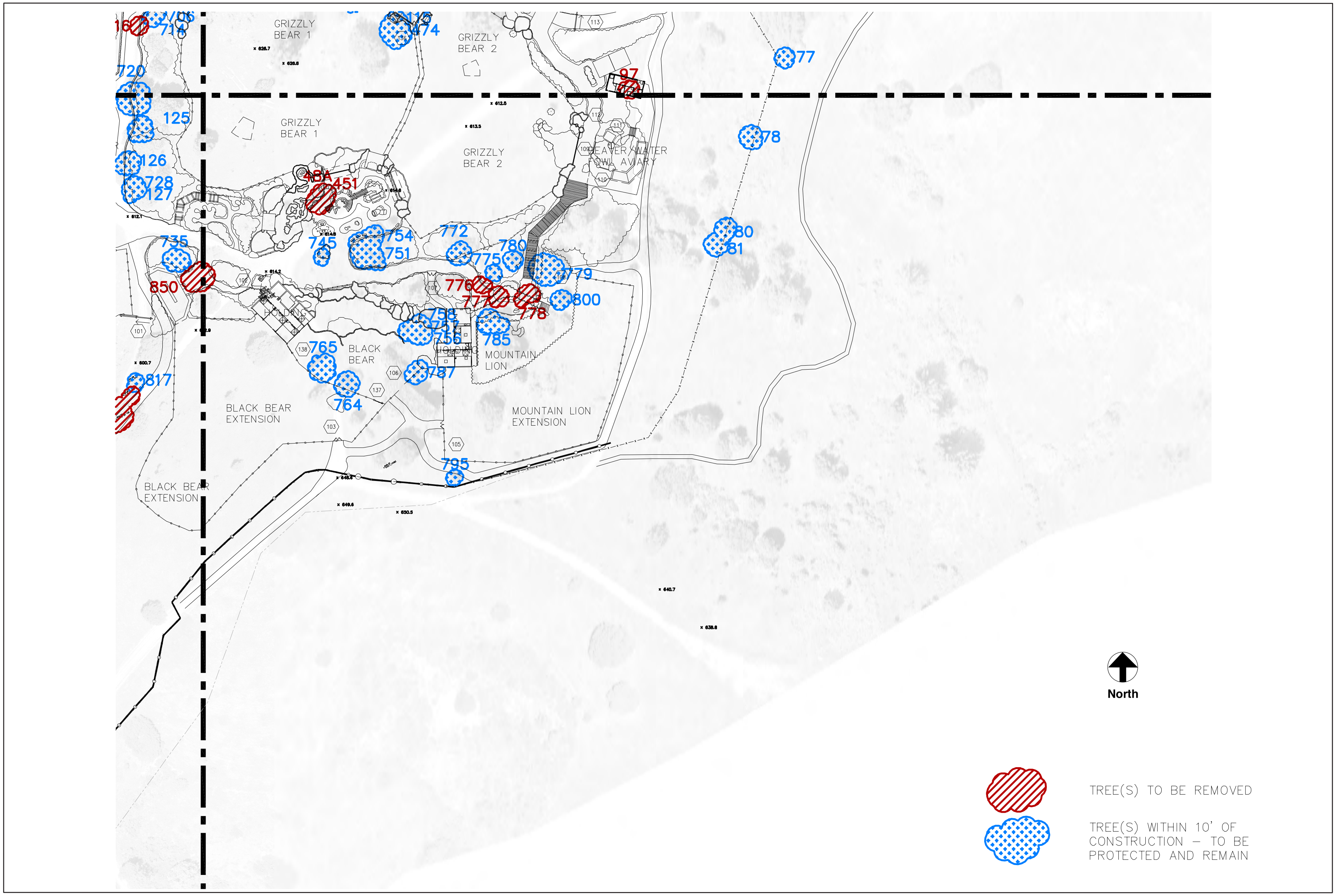

SOURCE: PJA

**Figure 3.3-4**
Proposed Master Plan Amendment: Trees Proposed for Removal
and Trees Within 10 Feet of Proposed Construction – Area 1



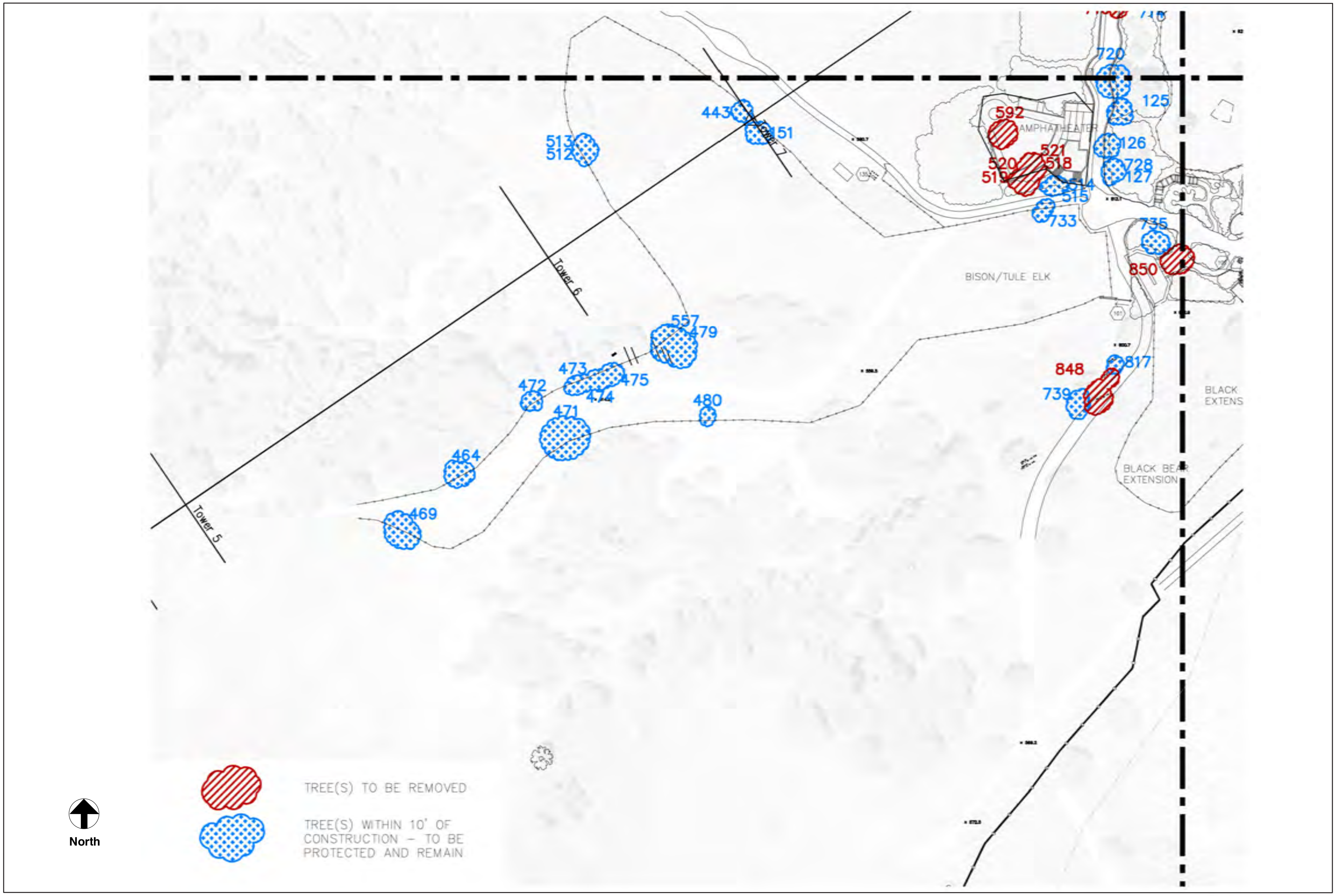
SOURCE: PJA

**Figure 3.3-5**
Proposed Master Plan Amendment: Trees Proposed for Removal and Trees Within 10 Feet of Proposed Construction – Area 2



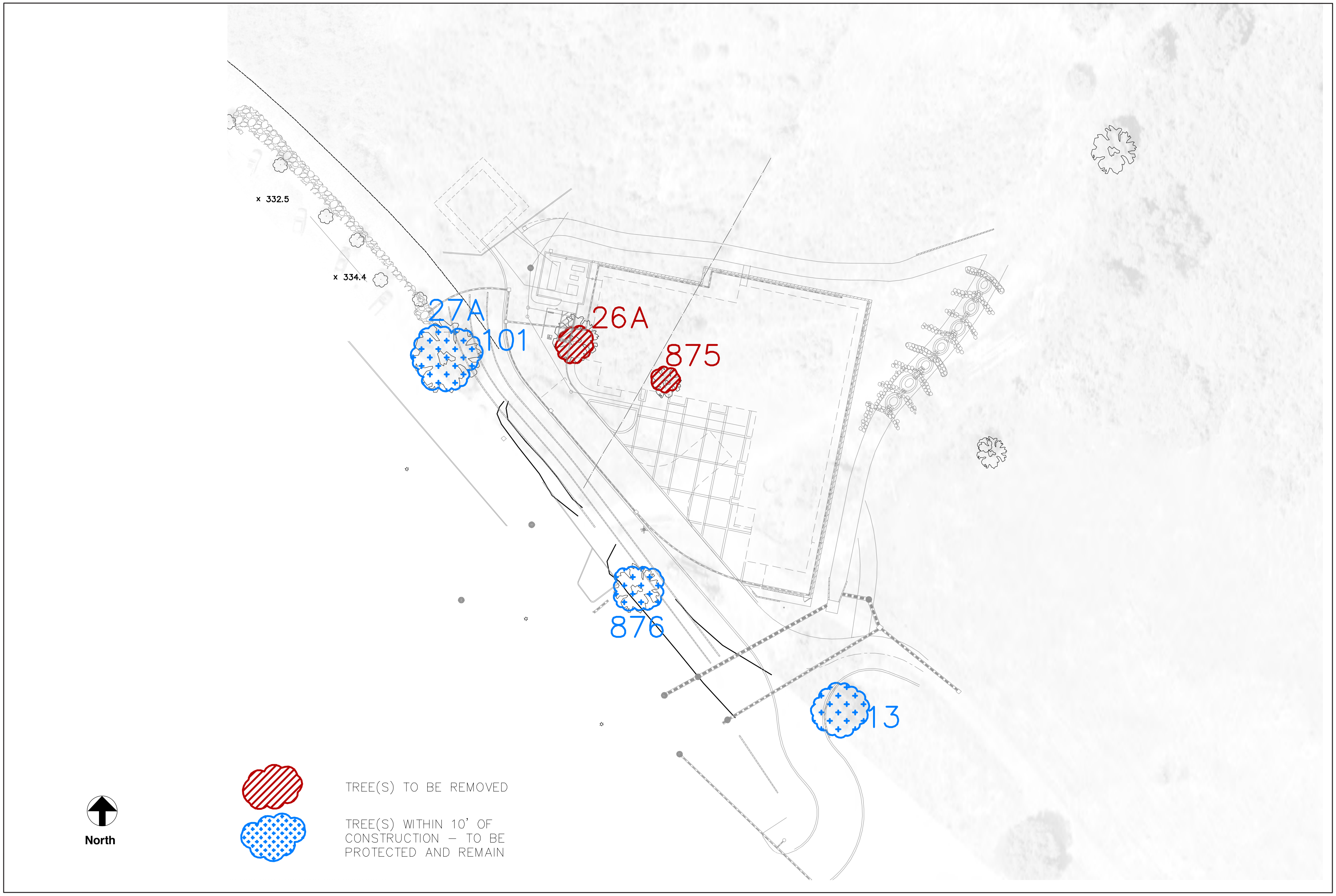

SOURCE: PJA

**Figure 3.3-6**
Proposed Master Plan Amendment: Trees Proposed for Removal and Trees Within 10 Feet of Proposed Construction – Area 3




SOURCE: PJA

**Figure 3.3-7**
Proposed Master Plan Amendment: Trees Proposed for Removal and Trees Within 10 Feet of Proposed Construction – Area 4




SOURCE: PJA

**Figure 3.3-8**
Proposed Master Plan Amendment: Trees Proposed for Removal and Trees Within 10 Feet of Proposed Construction – Area 5

APPENDIX

H

# CLIMATE CHANGE TECHNICAL REPORT

# Climate Change Technical Report

Amendment to Oakland Zoo Master Plan: Subsequent Mitigated Negative Declaration/Addendum

Prepared for:
**Placemakers**
**Emeryville, California**

Prepared by:
**ENVIRON International Corporation**
**San Francisco, California**

Date:
**February 2011**

Project Number:
**03-23540A**

**D R A F T**

# Contents

**DRAFT**

**List of Tables**



**List of Appendices**

**DRAFT**

# Acronyms

| | |
|---|---|
| AB | Assembly Bill |
| AB 32 | California Global Warming Solutions Act of 2006 |
| ARB | California Air Resources Board |
| ATCM | Airborne Toxic Control Measure |
| BAAQMD | Bay Area Air Quality Management District |
| BGM | BAAQMD Greenhouse Gas Model |
| C | carbon |
| CAPCOA | California Air Pollution Control Officers Association |
| CCAR | California Climate Action Registry |
| CEC | California Energy Commission |
| CEQA | California Environmental Quality Act |
| CEUS | California Commercial End-Use Survey |
| $CH_4$ | methane |
| $CO_2$ | carbon dioxide |
| $CO_2e$ | $CO_2$ equivalents |
| EBMUD | East Bay Municipal Utility District |
| EMFAC | Emission |
| ENVIRON | ENVIRON International Corporation |
| GHG | greenhouse gas |
| GRP | General Reporting Protocol |
| GWP | global warming potential |
| HFC | hydrofluorocarbons |
| IPCC | Intergovernmental Panel on Climate Change |
| kW | kilowatt |
| kWh | kilowatt-hour |
| kW-hr/yr | kilowatt-hours/year |
| lbs | pounds |
| LCA | Life Cycle Assessment |
| MW | megawatts |
| MW-h | megawatts per hour |
| $N_2O$ | nitrous oxide |
| $O_2$ | oxygen |
| PG&E | Pacific Gas and Electric |
| RPS | California's Renewables Portfolio Standard |
| sqft | square feet |
| tonnes | Metric tonnes; 1,000 kilograms |
| URBEMIS | Urban Emissions Model |
| USEPA | United States Environmental Protection Agency |
| VMT | vehicle miles traveled |

# Executive Summary

The Oakland Zoo is proposing to amend the Oakland Zoo Master Plan. (herein referred to as the "Project"). The Project would result in an expansion of the Oakland Zoo facilities including the development of a Veterinary Medical Hospital and the construction of exhibits and facilities comprising the California! Project. This technical report evaluates the potential impacts on climate change resulting from implementation of the Project.

The development of this Project will result in both one-time and annual greenhouse gas (GHG) emissions. This report provides an inventory surveying the emissions that would result from approving the Project. Because the Bay Area Air Quality Management District (BAAQMD) is the primary agency responsible for comprehensive air pollution control in the entire San Francisco Bay Area Air Basin, this report follows BAAQMD emissions calculation guidance. In June 2010, BAAQMD adopted a threshold of significance for operational GHG emissions from land-use development projects in its June 2010 California Environmental Quality Act (CEQA) Guidelines.[1] The June 2010 BAAQMD CEQA Guidelines include recommended significance thresholds, assessment methodologies, and mitigation strategies for GHG emissions. BAAQMD presents several different criteria that could be used for determining significance of a project's operational GHG emissions. The BAAQMD significance criteria used in this report is a "bright line" metric based on total anticipated GHG emissions from the Project. This metric is 1100 tonnes per year for operational emissions.

The Project inventory considers eight categories of GHG emissions: non-residential buildings, mobile sources, area sources, diesel emergency generators, water-use, solid waste, construction, and vegetation change. The electrical power for the Project will be supplied by Pacific Gas and Electric (PG&E). Accordingly, indirect GHG emissions from electricity usage are calculated using the PG&E carbon-intensity factor adjusted for future mandated renewable energy requirements.

Table ES-1 presents Project emissions. Table ES-1 also compares the Project's GHG emissions to the BAAQMD threshold of 1100 tonnes. The project's design features enable the project to be 855 tonnes per year, which is below BAAQMD's threshold. Accordingly, this project is below the level of significance for GHG emissions.

[1] Available online at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_June%202010.ashx

**Table ES.1 Summary of Greenhouse Gas Emissions for the Project**

| Source | GHG Emissions | Unit | Percent of Annual $CO_2$e Emissions |
|---|---|---|---|
| **Stationary Sources** | | | |
| Emergency Generators | 14 | tonnes $CO_2$e / year | |
| **BAAQMD CEQA Threshold of Significance** | 10,000 | | |
| **Exceeds Threshold?** | **No** | | |
| **Sources other than Stationary Sources** | | | |
| Buildings[1] | 343 | tonnes $CO_2$e / year | 40.1% |
| Holding Areas and Gondola | 64 | | 7.4% |
| Mobile | 397 | | 46.4% |
| Water | 4 | | 0.5% |
| Animal Waste - Ruminants | 14 | | 1.6% |
| Animal Waste - Manure | 7 | | 0.9% |
| Municipal Solid Waste[2] | 9 | | 1.1% |
| Annualized Construction[3] | 12 | | 1.4% |
| Annualized Vegetation[4] | 6 | | 0.7% |
| **Total (annual emissions)** | 855 | | 100% |
| **BAAQMD CEQA Threshold of Significance** | **1,100** | **tonnes $CO_2$e / year** | |
| **Exceeds Threshold?** | **No** | | |

**Notes**

1. The emission factor used for Building Energy Use and all other emissions due to indirect electricity use does not take into account the Renewables Portfolio Standard.

2. Emissions from solid waste are conservatively included in the inventory for comparison with the BAAQMD threshold of significance. However, the BAAQMD's derivation of the 1,100 tonne per year threshold did not take into account emissions associated with landfills.

3. Construction emissions are annualized over a 40-year period. 40 years is considered the average life expectancy of a building before it is remodeled with considerations for increased energy efficiency. The BAAQMD thresholds were originally developed for project operation impacts only. Therefore, combining both the construction emissions and operation emissions for comparison to the threshold represents a conservative analysis of potential greenhouse gas impacts.

4. Vegetation emissions are annualized based on a 20-year active growth period as recommended by the Intergovernmental Panel on Climate Change (IPCC), and are included in the inventory for comparison to the threshold of significance. The BAAQMD CEQA Guidelines do not contain recommendations regarding whether to include GHG emissions from vegetation in an emissions inventory. Since the BAAQMD significance threshold of 1,100 tonnes per year did not factor in vegetation emissions, including these emissions represents a conservative analysis.

# 1 Introduction

This technical report evaluates the potential impacts on climate change resulting from implementation of the Amendment to Oakland Zoo Master Plan (herein referred to as the "Project"). This report includes an evaluation of Project greenhouse gas (GHG) emissions and their potential contribution to climate change using methodology provided in Bay Area Air Quality Management District (BAAQMD) California Environmental Quality Act (CEQA) Guidelines[2].

The Project is a proposed non-residential development to be built in the city of Oakland. The Project includes the following land uses: Veterinary Medical Hospital, California Interpretive Center, zoo exhibits and associated utilities.

The Project will result in one-time and annual (direct and indirect) emissions of GHGs. Employees and patrons of the Project will use electricity, heat buildings and water (typically with natural gas), and are transported in motor vehicles, all of which directly or indirectly emit GHGs. This report discusses the regulatory developments surrounding global climate change and provides an estimate of an emissions inventory that would result from entitling the Project.

The principal GHGs resulting from such activities are carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$). $CO_2$ is considered the most important GHG, due primarily to the large quantity of emissions produced by fossil fuel combustion, especially during the generation of electricity and powering of motor vehicles. $CH_4$ and $N_2O$ are also emitted by fossil fuel combustion, though their emissions are much smaller than $CO_2$.

The effect that each of these gases can have on global warming is a combination of the mass of their emissions and their global warming potential (GWP). GWP indicates, on a pound for pound basis, the predicted contribution of a gas to global warming relative to the predicted contribution by the same mass of $CO_2$. $CH_4$ and $N_2O$ are substantially more potent GHGs than $CO_2$. GHG emissions are typically reported in terms of tonnes[3] of $CO_2$ equivalents ($CO_2e$). $CO_2e$ are calculated as the product of the mass emitted of a given GHG and its specific GWP. While $CH_4$ and $N_2O$ have much higher GWPs than $CO_2$, $CO_2$ is emitted in such vastly higher quantities that it accounts for the majority of GHG emissions in $CO_2e$, both from residential developments and human activity in general.

## 1.1 Regulatory Framework for the GHG Inventory

The BAAQMD is the primary agency responsible for comprehensive air pollution control in the entire San Francisco Bay Area Air Basin. In June 2010, BAAQMD adopted a threshold of

[2] BAAQMD. 2010. California Environmental Quality Act Air Quality Guidelines. June.
[3] In this report, "tonnes" will be used to refer to metric tonnes (1,000 kilograms). "Tons" will be used to refer to short tons (2,000 pounds).

significance for operational GHG emissions from land-use development projects in its 2010 CEQA Guidelines ("BAAQMD Guidelines"). The BAAQMD Guidelines include the development of recommended significance thresholds, assessment methodologies, and mitigation strategies for GHG emissions.

BAAQMD presents three different criteria that could be used for determining significance of a project's operational GHG emissions. One option includes a numeric "bright line" threshold of 1,100 metric tonnes $CO_2$e per year for operational emission sources including residential and non-residential building energy use, mobile source emissions, area source emissions, and indirect emissions associated with water usage. The second option is a metric based on the service population (the residential population plus the number of jobs associated with the land-uses). This metric is 4.6 tonnes per service population per year for operational emissions. The third option is compliance with a qualified Climate Action Plan that includes enforceable measures to reduce GHG emissions consistent with Assembly Bill (AB) 32 (California Global Warming Solutions Act of 2006) goals or Executive Order S-03-05 targets.

In the adopted June 2010 CEQA thresholds of significance, climate change thresholds of significance criteria for construction emissions are not included.[4] However, the 2010 CEQA Guidelines suggest that the lead agency quantify and disclose GHG emissions that would occur during construction. The 2010 CEQA Guidelines also encourage the lead agency to incorporate best management practices to reduce GHG emissions during construction, as applicable. Accordingly, the estimated construction related impacts are quantified and included in the threshold comparison in this analysis.

Legislation and rules regarding climate change, as well as the scientific understanding of the extent to which different activities emit GHGs, continue to evolve; as such, the inventory in this report is a reflection of the guidance and knowledge currently available.

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[4] BAAQMD, 2010. California Environmental Quality Act Air Quality Guidelines. June. Available at http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_June%202010.ashx

# 2 GHG Emissions Inventory

This evaluation follows BAAQMD emissions calculation guidance.[5] The greenhouse gas inventory takes into account indirect and direct operational emissions from building energy use, non-building energy use (such as the gondola system), emissions associated with vehicular travel to the project by visitors and employees, emission associated with enteric fermentation and manure management, and emissions from wastewater treatment. In addition to the above annual operational emissions, the inventory quantifies one-time emissions from construction activities and from the net change in vegetation associated with the project. As noted above, BAAQMD has not proposed significance thresholds for construction emissions.

## 2.1 Operational Emissions

Operational emissions would occur every year after buildout. This section outlines the operational GHG emissions.

### 2.1.1 Emission Factors

As noted above, indirect GHG emissions are associated with electricity use. The electricity used in a building is typically generated offsite at the power plant. GHG emission are emitted during power generation; because of this, electricity use in a building generally causes emissions in an indirect manner. The Project would be supplied power by Pacific Gas and Electric (PG&E). The average 2006-2008 PGE carbon-intensity factor is presented in Table 2.1 in pounds (lbs) of $CO_2$e per megawatt hour (MW-h).[6] These emission factors take into account the mix of energy sources used to generate electricity for PG&E[7] for each year, and the relative carbon intensities of these sources. PG&E's 2006, 2007, and 2008 mix of energy sources contains some portion of renewable sources. The Renewables Portfolio Standard (RPS) requires that utilities increase this mix to 20% by 2010.[8] Consistent with BAAQMD methodology for the development of the bright line threshold of 1,100 tonnes per year, the benefits achieved due to the 2010 RPS target have not been taken into account in this analysis. If the proposed 33% renewables target for 2020 were achieved, the $CO_2$ emission factor would decrease even further. This 33% renewables goal was not accounted for in this analysis because it has not yet become law.

### 2.1.2 Building Energy Use

The amount of energy used and the associated GHG emissions emitted per square foot of available space vary with the type of building. For example, food stores are far more energy intensive than warehouses, which have little climate-conditioned space. The Oakland Zoo

5 BAAQMD, 2010. California Environmental Quality Act, Air Quality Guidelines. June. http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_December%202010.ashx

6 California Climate Action Registry (CCAR) Database. PG&E PUP Report. 2006, 2007, and 2008.

7 Natural gas, nuclear, coal, wind, solar, biogas, biomass, hydropower, and geothermal.

8 The RPS requires 33%, but currently, only the commitment to 20% is law. 2002 Senate Bill 1078 and 2006 Senate Bill 107.

provided data summarizing the buildings planned for the Project and the area of floor space planned for each building: the Veterinary Medical Hospital and California Interpretive Center. The California Interpretive Center includes a restaurant, gift shop, classroom space, office space, staff break room, locker room, library and interpretive center, and storage and mechanical rooms. In addition to these enclosed and conditioned buildings, the Project will include semi-enclosed spaces for the gondola and animal holding activities. Energy use associated with the gondola and animal holding is described in Section 2.1.3.

GHGs are emitted as a result of activities in buildings for which electricity and natural gas are used as energy sources. Combustion of any type of fuel emits $CO_2$ and other GHGs directly into the atmosphere; when this occurs in a building this is a direct emission source[9] associated with that building. GHGs are also emitted during the generation of electricity from fossil fuels. When electricity is used in a building, the electricity generation typically takes place offsite at the power plant; electricity use in a building generally causes GHG emissions in an indirect manner.

While fuel combustion in electricity generations results in $CH_4$ and $N_2O$ creation, the emissions of these GHGs typically comprise less than 1% of $CO_2e$ emissions from electricity generation and natural gas consumption.[10] As such, these minor emissions are not accounted for here.

#### 2.1.2.1 Estimate of Non-residential Energy Use Intensity

ENVIRON developed $CO_2$ intensity values ($CO_2$ emissions per square feet [sqft] per year) for building types planned for the Project using data from the California Commercial End-Use Survey (CEUS).[11] The building types and subcategories and mapping between Project building types and CEUS building types are shown in Table 2.2.

The CEUS data is based on a survey conducted in 2002 of existing buildings. Each building type has a characteristic electricity and natural gas use per square foot of building space. Energy use in buildings is divided into energy consumed by the built environment and energy consumed by uses that are independent of the construction of the building such as plug-in appliances ("plug-in" energy use). In California, Title 24 governs energy consumed by the built environment, mechanical systems, and some fixed lighting. Plug-in energy use can be further subdivided by specific end-use (refrigeration, cooking, office equipment, etc.). Table 2.3 lists the breakdown of electricity use among several end uses for electricity in various non-residential CEUS building types. Table 2.4 lists the percentage breakdown of end uses for natural gas in various non-residential CEUS building types. The end use data provide an estimate of the percent of the total energy use comprised by Title 24 regulated (built environment) and plug-in electricity in each building type.

[9] California Climate Action Registry (CCAR) General Reporting Protocol (GRP), Version 3.0 (April). Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_V3_April2008_FINAL.pdf, Chapter 8
[10] Ibid., Tables C1 and C2. The methane and nitrous oxide emission factors are negligible compared to the total $CO_2$ emission factor for electricity generation in California.
[11] California Energy Commission (CEC). California Commercial End-Use Survey Results. Data available from Itron Inc. at http://capabilities.itron.com/CeusWeb/Chart.aspx

Baseline Title 24 usage rates shown in Table 2.4 have been adjusted to reflect improvements in Title 24 building codes since their introduction in 2002. California Energy Commission (CEC) discusses average savings for improvements from 2002 to 2005 ("Impact Analysis for 2005 Energy Efficiency Standards") as well as from 2005 to 2008 ("Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings"), as shown in Table 2.5. ENVIRON used these CEC average savings percentages to account for reductions in energy use due to Title 24. Table 2.6 shows the projected energy use for Project buildings listed by building type.

#### 2.1.2.2 Estimation of Annual GHG Emissions from Project Buildings

$CO_2$ emissions related to the consumption of the electricity quantified as described above are calculated based on emission factors incorporating local energy suppliers' mix of generation sources, as described in Section 2.1.1.

Table 2.7 shows the yearly $CO_2$ emissions from the Project by incorporating the emission factors developed as discussed above and the square footage of each of the Project building categories. Total emissions from Project building energy use are 343 tonnes $CO_2e$/year.

### 2.1.3 Non Building Energy Use

The Project includes several structures in which energy is used which do not fall into the traditional building categories included in the CEUS database discussed above. These include the animal holding areas, the machine room, and the gondola. GHG emissions for these non-building facilities were calculated based on energy demand data provided by the Oakland Zoo[12] and the same Project specific electricity emission factors discussed above. These calculations are shown in Table 2.8. Total emissions from non-building energy use are 64 tonnes $CO_2e$/year.

### 2.1.4 Diesel Generators

This section describes the estimation of GHG emissions from the use of four diesel emergency generators proposed for the Project. These include a fire service pump, a backup generator for the Veterinary Medical Hospital, and an auxiliary engines and emergency backup engine for the Gondola (see Table 2.9).

Emissions from fuel combustion are calculated based on the gallons of fuel used and emission factors (mass of pollutant per volume of fuel). The anticipated size of each engine was provided by the Oakland Zoo. Fuel usage was based on publically available data for Caterpillar engines of similar size[13]. The engines were assumed to operate in accordance with the Airborne Toxic Control Measure (ATCM)[14], which limits engine use to a maximum of 50 hours of non

[12] E-mail from Nik Haas-Dehejia of Oakland Zoo to ENVIRON on 2/10/2010.
[13] Datasheets for the engines used are included in Appendix C. The data sheets are also available for download from the Caterpillar website at http://www.cat.com/cda/layout?f=413765&m=39280&x=7
[14] Air Toxic Control Measure for Stationary Compression Ignition Engines. October

emergency use per year. Emission factors from the California Climate Action registry (CCAR) were used. The four diesel emergency engines are estimated to emit 13.5 tonnes of $CO_2$e per year, as shown in Table 2.9.

### 2.1.5 Water and Wastewater Supply and Treatment Systems

This section describes the calculation of indirect emissions from the production of electricity to convey, treat and distribute water and wastewater. The amount of electricity required to treat and supply water depends on the volume of water involved as well as the sources of the water. According to the Oakland Zoo, the Project would generate a total water demand of 7.1 million gallons of potable water per year. The categories of water demand include indoor use (faucets, toilets, etc.), cleaning of animal holding areas, and irrigation. All of the potable water except that used for irrigation was assumed to become wastewater.

The potable water will be supplied by East Bay Municipal Utility District (EBMUD).[15] Three processes are necessary to supply potable water to residential and commercial users: (1) supply and conveyance of the water from the source; (2) treatment of the water to potable standards; and (3) distribution of the water to individual users. After use, the wastewater is treated and reused as reclaimed water. The emission factors and GHG emissions for all these processes are shown in Table 2.10. The annual emissions from water treatment and distribution, wastewater treatment, and distribution of recycled water are approximately 4.1 tonnes of $CO_2$e per year, broken down in categories described in the following paragraphs.

Water is typically supplied to communities from several sources including the local underground aquifer, gravity-dominated systems such as the Hetch Hetchy aqueduct, the State Water Supply, and recycled and reclaimed water. Energy is required to pump this water from the sources and convey it to the Project. Based on the estimated potable water demand, energy intensity factors for the supply, treatment[16], and distribution of water, and the PG&E carbon intensity factor, GHG emissions associated with potable water use were calculated as shown in Table 2.10. Supplying, treating[17], and distributing potable water in the Project is estimated to account for 2.7 tonnes $CO_2$e emissions per year.

Emissions associated with wastewater treatment include indirect emissions necessary to power the treatment process and direct emissions from degradation of organic material in the wastewater. Consistent with the 2010 CEQA Guidelines, only indirect emissions from wastewater are included in this inventory.[18] All potable water as well as the non-potable water

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2007. http://www.arb.ca.gov/diesel/ag/documents/finalreg101807.pdf

[15] Water demand and supply information was provided by the Oakland Zoo and Aliquot Associates, Inc. on 12/27/2010

[16] Treatment is based on the average value presented by CEC. CEC 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.

~~EC-700-2005-011-SF.~~

[18] BAAQMD. 2010. California Environmental Quality Act Air Quality Guidelines. June. Page 4-7. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_

used to clean animal holding areas was assumed to become wastewater. The electricity required to operate a wastewater treatment plant is estimated to be 2,500 kilowatt per hour (kW-hr) per million gallons of wastewater.[19] Based on the expected amount of wastewater requiring treatment, this energy intensity factor, and the PG&E carbon-intensity factor, indirect emissions due to wastewater treatment were calculated as shown in Table 2.10. Wastewater treatment indirect emissions in the Project are estimated to account for 1.4 tonnes of $CO_2$e emissions per year.

### 2.1.6 Mobile emissions

This section estimates GHG emissions from mobile sources associated with the Project. The mobile source emissions considered for this Project will be from the typical daily operation of motor vehicles by visitors to the Zoo and by employees to the Zoo.[20]

ENVIRON estimated GHG emissions based upon all peak-year miles traveled by additional visitors to the Zoo attributable to the Project, personnel employed within the Project, and additional commercial work trips associated with the project (e.g. delivery vehicles). The estimated increase in vehicle trips associated with the Project due to visitors and employees was provided to ENVIRON by AECOM.[21] The increase in vehicles due to commercial work trips associated with the project was estimated based on URBEMIS defaults. Trip lengths are based upon URBan EMISions Model (URBEMIS) defaults for trip types for commercial land uses (commercial-based commute, commercial-based work, and commercial-based customer), allocated per URBEMIS methodology. Total vehicle miles traveled (VMT) were calculated in URBEMIS by multiplying the number of trips by the average trip length for each type of trip. The details and assumptions are shown in Tables 2.11-2.12.

The $CO_2$ emissions from mobile sources were calculated using URBEMIS 2007 with the trip lengths and trip rates described above and emission factors for running and starting emissions from EMFAC2007. EMFAC emission factors from the year 2015 were used based on the BAAQMD fleet mix. The year 2015 was conservatively selected as the first year following construction of the Project. Table 2.12 shows the emission factors and $CO_2$e emissions calculated for the Project. For mobile sources, the United States Environmental Protection Agency (USEPA) recommends assuming that $CH_4$, $N_2O$, and hydrofluorocarbons (HFCs) are 5% of the emissions on a $CO_2$e basis, taking into account their GWPs. ENVIRON accounted for these additional GHG emissions by dividing the $CO_2$ emissions by 0.95. Emissions associated with mobile sources for the Project are estimated to be 397 tonnes $CO_2$e per year. URBEMIS output files are included in Appendix A.

June%202010.ashx
[19] CEC 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF.
[20] All visitor trips associated with the project were conservatively assumed to be new.
[21] Bill Burton of AECOM to ENVIRON by e-mail on 11/3/2010.

The USEPA recently granted the waiver for California for its GHG emission standards for motor vehicles. AB 1493 is expected to reduce running emissions for passenger cars and light trucks by 20% relative to the year 2009 by the year 2020[22] and will continue to decrease emissions in the future. Emissions reductions associated with AB 1493 were not taken into account in this analysis.

### 2.1.7 Solid Waste

The landfilling of solid waste generates emissions from both the decomposition of the waste in the landfill and the vehicle activity involved in transporting waste. Consistent with BAAQMD Guidance, ENVIRON estimated GHG emissions from transport of solid waste to the landfill and from methane emissions associated with the waste degradation in the landfill. ENVIRON used the BAAQMD Greenhouse Gas Model (BGM) to estimate emissions. The BGM uses the volume of waste generated, distance the landfill, truck capacity[23], and, if applicable, energy recovery characteristics of the landfill to estimate emissions. The tons of land filled solid waste were estimated based on the 2010 solid waste generation rates of the existing Zoo scaled based on the expected increase in attendance generated by the Project. Solid waste generation and disposal data for the existing Zoo operations were provided by the Oakland Zoo and the Waste Management Corporation. Recycled materials, green waste, and manure were excluded from the calculation. Emissions from manure management are discussed in section 2.1.8.2. The majority of the Project's solid waste is sent to the Altamont landfill, which conducts landfill gas recovery. The inputs and outputs to the BGM model are shown in Table 2.13. The emissions from solid waste are estimated to be 9 tonnes per year.

### 2.1.8 Animal Husbandry

#### 2.1.8.1 Enteric Fermentation

Methane is produced in the digestive systems of ruminant animals when microbial fermentation occurs in a process termed enteric fermentation. Methane produced in this manner is considered a direct emission of GHGs. The Project includes the introduction of five additional bison, a ruminant animal. ENVIRON calculated methane emissions from enteric fermentation using the Intergovernmental Panel on Climate Change (IPCC) Tier 1 guidance, as described in Table 2.14. Enteric fermentation is estimated to contribute 13.5 tonnes of $CO_2$e per year to the Project inventory.

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[22] ARB. "Comparison of Greenhouse Gas Reductions for the United States and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations". February 25, 2008. Calculated based on the data provided in Table 4 and Table 10.

[23] Truck capacity was estimated based on data for tonnage per trip provided by the Oakland Zoo and Waste Management. The Oakland Zoo uses a pickup truck to transport the majority of solid waste to the David Street facility. The BGM model assumes use of a heavy heavy duty truck. Consequently, actual emissions for this stage of transit may be lower than those estimated by the model.

#### 2.1.8.2 Manure Management (Onsite Composting)

GHGs can be emitted from manure in varying amounts depending on the animal source and the manure handling methods. Manure from the majority of animals at the Project will be treated off-site. However, manure from the herbivorous animals (the bison herd) will be composted on site and used on site. ENVIRON calculated emissions from the management of manure from bison as shown in Table 2.15. ENVIRON followed Intergovernmental Panel on Climate Change (IPCC) Tier 1 methodology to calculate methane and nitrous oxide emissions from manure composting. In the absence of a methane emission factor for North American Bison, ENVIRON used the emission factor for dairy cattle, the highest emitting category of animal in the region. Emissions of methane and nitrous oxide from the composting of manure on-site are estimated to be 7 tonnes of $CO_2$e per year.

## 2.2 One time Emissions

### 2.2.1 Vegetation Change

This section presents the calculation of the positive and negative GHG emissions associated with vegetation removal and re-vegetation at the Project. The permanent removal of existing vegetation can contribute to net GHG increases by reducing existing carbon sequestration capacity.[24] New planting can add to the sequestration capacity of a Project. The difference between the total before-project sequestered $CO_2$ and the after-project sequestered $CO_2$ is the one-time $CO_2$ released from clearing the vegetation less the $CO_2$ sequestered by new plantings.[25] $CH_4$ and $N_2O$ are assumed to contribute a negligible amount of GWP when compared to the $CO_2$ emissions from vegetation change.

The BAAQMD Guidance does not contain recommendations regarding changes in emissions due to carbon sequestration by tree planning associated with land use projects. Changes in carbon sequestration associated with the project are one-time emissions. In this inventory, GHG emissions associated with vegetation change are calculated, and are conservatively taken into account in comparison to the significance threshold.

#### 2.2.1.1 Quantifying the One-Time Release by Changes in Carbon Sequestration Capacity Due to Land Use Changes

The one-time release of GHGs due to permanent changes in carbon sequestration capacity caused by changes in land use was calculated using the following four steps:

1. Identify and quantify the change in area of various land types due to the Project (i.e. alluvial scrub, non-native grassland, agricultural, etc.). Areas temporarily disturbed that will

[24] In this section, it is assumed that all mature land-types (at least 20 years old) are at steady-state. See The World Resource Institute (WRI) "Land Use, Land-Use Change, and Forestry Guidance for GHG Project Accounting" protocol available online at: http://www.ghgprotocol.org/DocRoot/97hb6BCSAAG2bImO7c9d/LULUCF%20Final.pdf

[25] In this section we assume that mature ecosystems do not have a net influx or outflux of carbon.

eventually recover to become vegetated will not be counted as vegetation removed as there is no net change in vegetation or land use.[26]

2. Estimate the biomass associated with each land type. For the purposes of this report, ENVIRON has listed the land types that are present at the Project site and characterized them using the available general vegetation types found in the IPCC publication Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines).[27] This characterization is shown in Table 2.16.

   California vegetation is heavily dominated by scrub and chaparral vegetation which may not be accurately characterized by default forest or grass land properties. Consequently, ecological zones and biomass based subdivisions identified in the IPCC Guidelines were used to sub-categorize the vegetation as tree or scrub dominated. Forest land and grass land categories and subcategories were used to determine the $CO_2$ emissions resulting from land use impacts at the Project.

3. Calculate $CO_2$ emissions from the net change of vegetation – when vegetation is removed, it may undergo biodegradation,[28] or it may be combusted. Either pathway results in the carbon (C) present in the plants being combined with oxygen ($O_2$) to form $CO_2$.

4. Calculate the overall change in sequestered $CO_2$.

Table 2.16 shows the effective change in the amount of sequestered $CO_2$ due to the change in land use of the developed area for each land type. Table 2.17 shows the $CO_2$ sequestration potential per acre for IPCC land types relevant to the Project. The total one-time equivalent $CO_2$ emissions attributable to the net change of vegetation are approximately 390 tonnes of $CO_2$e per year.

### 2.2.1.2 Calculating $CO_2$ Sequestration by Trees

Planting individual trees in the Project will sequester $CO_2$. Trees are only net carbon sinks when they are actively growing.[29] Table 2.18 presents default annual $CO_2$ sequestration rates on a per tree basis, based on values provided by the IPCC. Approximately 370 net new trees will be planted in the Project.[30,31] Planting these trees will sequester approximately 274 tonnes

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[26] This assumption facilitates the calculation as a yearly growth rate and $CO_2$ removal rate does not have to be calculated. As long as the disturbed land will indeed return to its original state, this assumption is valid for time periods over 20 years.

[27] Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

[28] Cleared vegetation may also be deposited in a landfill or compost area, where some anaerobic degradation which will generate $CH_4$ may take place. However, for the purposes of this section, we are assuming that only aerobic biodegradation will take place which will result in $CO_2$ emissions only.

[29] In this report, the IPCC default value active growing period of 20 years will be assumed. Actual active growing periods are subject to, among other things, species, climate regime, and planting density. Thereafter, the accumulation of carbon in biomass slows with age, and will be completely offset by losses from clipping, pruning, and occasional death.

[30] Site-specific tree planting data provided by the Oakland Zoo by e-mail on 12/16/2010

[31] Note that this number includes trees that may potentially be removed. This analysis conservatively accounts for both tree removal and the reduction in oak woodland acreage, and accordingly may be overestimating the

of $CO_2$. This sequestration brings the net $CO_2$ one-time sequestration of $CO_2$ from vegetation to -116 tonnes (a net increase in the amount of $CO_2$ released). The net $CO_2$ emissions from vegetation changes are presented in Table 2.19.

### 2.2.2 Construction Activities

This section describes the estimation of GHG emissions from construction of the Project. There are two major components of construction for each phase of the Project: site grading and building construction.[32] The building construction component can be broken down into three subcomponents: building construction, architectural painting, and asphalt paving. GHG emissions from these construction activities are largely attributable to fuel use from construction equipment and worker commuting.

The GHG emissions from construction activities were calculated using the same methodology used to calculate criteria pollutant emissions. The methodology is described in detail in ENVIRON's "Air Quality Technical Report." The construction phasing equipment and worker schedules were provided by the Oakland Zoo and are included as Appendix B.1. Emission factors are included in Appendices B.2 and B.4. The calculated GHG emissions are summarized in Table 2.20.

#### 2.2.2.1 Uncertainties in Construction GHG Emissions Calculations

ENVIRON was provided with the phase length and the number of each type of construction equipment used during construction of buildings.[33] The number of worker and vendor trips represent URBEMIS default values and settings. As such, these values are somewhat uncertain.

### 2.2.3 Life Cycle Emissions

An estimate of "life-cycle" GHG emissions (i.e., GHG emissions from the processes used to manufacture and transport materials used in the buildings and infrastructure) was also performed. This estimate is used for comparison purposes only and is not included in the final GHG inventory because these emissions would be attributable to other industry sectors under AB 32. For instance, the concrete industry is required by law to report emissions and undergo certain early action emission reduction measures. Furthermore, somewhat arbitrary boundaries must be drawn to define the processes considered in the life-cycle analysis of building materials.[34] Recognizing the uncertainties associated with a life-cycle analysis, the California Air Pollution Control Officers Association (CAPCOA) released a white paper that states: "The full life-cycle of GHG emissions from construction activities is not accounted for in the modeling

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reduction in carbon sequestration capacity from vegetation change.

[32] Many projects have a third phase, demolition. In this case, there are no existing structures at the Project site.

[33] Site-specific construction activity data provided by the Oakland Zoo by e-mail on 11/22/2010.

[34] For instance, in the case of building materials, the boundary could include the energy to make the materials, the energy used to make the machine that made the materials, and the energy used to make the machine that made the machine that made the materials.

tools available, and the information needed to characterize GHG emissions from manufacture, transport, and end-of-life of construction materials would be speculative at the CEQA analysis level."[35]

The life cycle assessment (LCA) evaluates the life-cycle GHG emissions associated with the building materials for this Project. The life-cycle GHG emissions include the embodied energy from the materials' manufacture and the energy used to transport those materials to the site. The materials analyzed in the report include materials buildings and site infrastructure.

ENVIRON estimated the life-cycle GHG emissions for buildings by conducting an analysis of available literature on LCAs for buildings. According to the literature, approximately 75 to 97 percent of GHG emissions from buildings are associated with energy usage during the operational phase; the other 3 to 25 percent of the GHG emissions are due to material manufacture and transport.[36] Using the GHG emissions from the operation of buildings, 3 to 25 percent of building operational emissions represents between 13 and 135 tonnes $CO_2$ per year (Table 2.21).

ENVIRON also estimated the life-cycle GHG emissions for certain components of infrastructure (e.g. roads, storm drains, and utilities). The analysis considered the manufacture and transport of concrete and asphalt only, because it assumed that other construction materials such as steel would be present in much smaller quantities. Because the manufacture of concrete has a higher $CO_2$ emission factor and most construction estimates higher quantities of concrete than asphalt, the majority of the emissions for infrastructure result from the manufacture of concrete. Because the asphalt and concrete are locally sourced, the transportation emissions are relatively small (Table 2.24). If a 40-year lifespan of the infrastructure is assumed, the total annualized emissions from embodied energy in infrastructure materials are approximately 5.3 percent of the Project emissions. The details for this estimation are presented in Tables 2.23 through 2.25.

The overall life-cycle emissions, annualized by 40 years, would be 57 to 180 tonnes $CO_2$/year, or 6.8 to 21 percent of the annualized GHG emissions from the Project. The bulk of these emissions would be from general life cycle analysis studies and do not reflect Project-specific information.

As previously indicated, the calculations and results presented in the LCA are estimates and are used only for a general comparison to the overall GHG emissions estimated for the Project. However, due to the open-ended nature of LCAs, and to the fact that literature evaluation, not site-specific studies, was used to analyze most of the embodied energy, the analysis should be

[35] CAPCOA. 2008. CEQA & Climate Change: Evaluating and Addressing Greenhouse Gas Emissions from Projects Subject to the California Environmental Quality Act. http://www.capcoa.org/ceqa/?docID=ceqa&PHPSESSID=df1348d67eff0fc2a8263d19d10dd .

[36] References in the available literature used to determine this range are listed in Table 2.21.

considered to yield highly uncertain results. Additionally, the analysis likely double-counts emissions from other industry sectors.

# 3 Comparison to Thresholds

As discussed above, BAAQMD has adopted quantitative CEQA thresholds of significance for operational-related GHG emission impacts.

The BAAQMD Guidelines are accompanied by methods and guidance on how to prepare a GHG emission inventory. For operational emissions, BAAQMD suggests quantifying residential, non-residential, mobile, water, and area sources. The guidance recommends generalized values for energy use for various land use types and generalized emission factors which don't account for local electricity emission factors or newer vehicle efficiency regulations. The operational emissions estimated for the Project would include additional source categories not included in the BAAQMD methodology for quantifying GHG operational emissions such as enteric fermentation. The exclusion of these sources from the inventory would likely lower the operational emissions. The methodologies presented in this report for quantification of GHG operational emissions are based on using more refined data sources than indicated in the 2010 CEQA Guidelines and are the most appropriate to use for the Project.

The significance threshold provides that if a Project's total operational GHG emissions are less than 1,100 metric tonnes $CO_2$e per year, the Project GHG emissions are not significant. The Project-related operational emissions are 855 tonnes $CO_2$e per year as listed in Table ES.1 and described in Section 2. Therefore, the Project-related operational emissions would be less than 1,100 tonnes $CO_2$e per year and would result in a less-than-significant impact on climate change.

**DRAFT**

# Tables

**Table 2.1**
**Emission Factors for Different Energy Sources**
**Oakland Zoo**
**Oakland, CA**

| **Energy Source** | **Scenario** | **Unit** | **Conversion Factor [lb $CO_2$/Unit]** | **Conversion Factor [tonne $CO_2$/Unit]** |
|---|---|---|---|---|
| Electricity[1] | Average of 2006, 2007, and 2008 emission factors | kWh | 0.578 | 2.62E-04 |
| Natural Gas[2] | - | kBTU | 0.117 | 5.31E-05 |

**Notes:**
1. Electricity emission factors for PG&E for 2006 and 2007are from ARB's Local Government Operations Protocol (LGOP), Version 1.1, Table G.6. The  electricity emission factors for PG&E for 2008 is provided in PG&E's Power/Utility Protocol (PUP) Report available at: https://www.climateregistry.org/CARROT/public/reports.aspx
2. Emission factor for natural gas obtained from California Climate Action Registry Reporting Protocol, Table C.7.

**Abbreviations:**
ARB - California Air Resources Board
$CO_2$ - carbon dioxide
kBTU - 1000 British thermal units
kWh - kilowatt-hour
lb - pound
LGOP - Local Government Operations Protocol
PG&E - Pacific Gas and Electric

**Sources:**
ARB Local Government Operations Protocol, Version 1.1. Appendix G. Accessed October 2010. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf

PG&E 2008 Annual Entity Emissions: Electric Power Generation/Electric Utility Sector. http://www.climateregistry.org/CarrotDocs/19/2008/2008_PG&E_CCAR_PUP_Spreadsheet_FINAL_2-11-10.xls

California Climate Action Registry. 2009. General Reporting Protocol, Version 3.1. Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

**Table 2.2**
**Building Types Present in Oakland Zoo California! Exhibit**
**Oakland Zoo**
**Oakland, CA**

| General Building Type[1] | Building Area[2] (SF) | Refined Building Type[3] | %[4] | Modeled CEUS Building Category[5] | Building Area (SF) |
|---|---|---|---|---|---|
| Restaurant | 7,315 | - | 100% | Restaurant | 7,315 |
| Veterinary Hospital | 17,000 | - | 100% | Health Care | 17,000 |
| Visitor Center | 18,145 | Visitor Center - Education | 74% | School | 13,428 |
| Visitor Center | | Visitor Center - Office | 26% | Small Office | 4,718 |

**Notes:**
1. Three main building types provided by Oakland Zoo.
2. Building areas were provided by the Oakland Zoo on 11/29/2010.
3. The subcategories of General Building Type provided by Oakland Zoo.
4. The percentage of each Modeled Building Category present in the Refined Building Type.
5. The CEUS building type used in modeling that represents each Refined Building Type.

**Abbreviations:**
CEUS - California Commercial End-Use Survey
SF - Square Feet

**Sources:**
Land use breakdown provided by Oakland Zoo, presented as it maps to CEUS building types.

**Table 2.3**
**Non-Residential Electricity End-Use**
**Oakland Zoo**
**Oakland, CA**

| | | CEUS Building Type | | | |
|---|---|---|---|---|---|
| **End Use[1]** | **Title 24 System[2]** | **Health Care** | **Restaurant** | **School** | **Small Office** |
| Air Compressor | No | 1% | 0% | 0% | 1% |
| Cooking | No | 3% | 32% | 3% | 1% |
| Cooling | Yes | 16% | 5% | 7% | 14% |
| Exterior Lighting | No | 2% | 3% | 14% | 6% |
| Heating | Yes | 5% | 0% | 1% | 2% |
| Interior Lighting | No | 25% | 18% | 47% | 32% |
| Miscellaneous | No | 12% | 2% | 2% | 12% |
| Motors | No | 6% | 1% | 2% | 2% |
| Office Equipment | No | 5% | 2% | 7% | 15% |
| Process | No | 0% | 0% | 0% | 0% |
| Refrigeration | No | 4% | 31% | 8% | 3% |
| Ventilation | Yes | 21% | 4% | 9% | 13% |
| Water Heating | Yes | 0% | 2% | 0% | 1% |

**Notes:**
1. All end use percentages for each CEUS Building Type are taken directly from CEUS database.
2. Only end uses regulated by Title 24 are included in the Title 24 building envelope energy budget. Hard-wired lighting (exterior lighting and some interior lighting) are part of Title 24, but are not considered part of the building envelope energy budget.

**Abbreviations:**
CEUS - California Commerical End-Use Survey

**Source:**
California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/

**Table 2.4**
**Non-Residential Gas End-Use**
**Oakland Zoo**
**Oakland, CA**

| | | CEUS Building Type | | | |
|---|---|---|---|---|---|
| **End Use[1]** | **Title 24 System[2]** | **Health Care** | **Restaurant** | **School** | **Small Office** |
| Gas Cooking | No | 2% | 74% | 8% | 0% |
| Gas Cooling | Yes | 3% | 0% | 4% | 0% |
| Gas Heating | Yes | 44% | 3% | 60% | 93% |
| Gas Water Heating | Yes | 39% | 22% | 28% | 7% |
| Gas Miscellaneous | No | 0% | 0% | 0% | 0% |
| Gas Process | No | 12% | 0% | 0% | 0% |

**Notes:**
1. All end use percentages for each CEUS Building Type are taken directly from CEUS database.
2. Only end uses regulated by Title 24 are included in the Title 24 building envelope energy budget.

**Abbreviations:**
CEUS - California Commerical End-Use Survey

**Source:**
California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/

**Table 2.5**
**Title 24 Improvements by End Use**
**Oakland Zoo**
**Oakland, CA**

| End Use | Reduction from 2001 to 2005[2] | Reduction from 2005 to 2008[2] |
|---|---|---|
| Air Compressors | 0.0% | 0.0% |
| Cooking | 0.0% | 0.0% |
| Cooling | 6.7% | 8.3% |
| Exterior Lighting[1] | 9.8% | 11.7% |
| Gas Cooking | 0.0% | 0.0% |
| Gas Cooling | 10.4% | 9.3% |
| Gas Heating | 3.1% | 15.9% |
| Gas Hot Water | 0.0% | 0.0% |
| Gas Miscellaneous | 0.0% | 0.0% |
| Gas Process | 0.0% | 0.0% |
| Heating | 4.9% | 37.2% |
| Interior Lighting[1] | 4.9% | 5.9% |
| Miscellaneous | 0.0% | 0.0% |
| Motors | 0.0% | 0.0% |
| Office Equipment | 0.0% | 0.0% |
| Process | 0.0% | 0.0% |
| Refrigeration | 0.0% | 0.0% |
| Ventilation | 5.0% | 1.5% |
| Water Heating | 0.0% | 0.0% |

**Notes:**

1. Exterior lighting was assumed to be covered by Title 24 lighting and therefore has the reduction taken. Interior lighting was assumed to be 50% Title 24 and 50% non-Title 24 uses. Therefore only half of the reduction for lighting was applied.

2. The percentage reductions for each end use category are taken directly from the CEC's "Impact Analysis for 2005 Energy Efficiency Standards" (2002 to 2005) as well as from the "Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings" (2005 to 2008). This represents the percentage to adjust each end use to reflect improvements in Title 24 building codes since 2002. ENVIRON used the 2002 CEUS data to represent energy use for buildings that are minimally compliant with the 2001 Title 24 standards. CEUS did not collect information on the ages of the buildings surveyed. Because older buildings tend to be less energy efficient, and the majority of the buildings in the survey were likely constructed before 2001, the 2002 CEUS data likely overestimates energy use for a 2001 Title 24-compliant building.

**Abbreviations:**

CEC - California Energy Commission
CEUS - California Commercial End-Use Survey

**Sources:**

California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/

California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF

California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

**Table 2.6**
**Non-Residential Energy Use**
**Oakland Zoo**
**Oakland, CA**

| Building Type | CEUS Building Type | Energy Type | Units | T24 Energy Use Base[1,2] | T24 Energy Use 2008[2,3] | Non-Title 24 Energy Use[4] | Project Energy Use[5] |
|---|---|---|---|---|---|---|---|
| | | | | [Unit/SF/yr] | | | |
| Restaurant | Restaurant | Electricity | kWh | 10.44 | 9.28 | 20.97 | 30.26 |
| | | Gas | kBTU | 43.05 | 42.00 | 128.03 | 170.02 |
| Veterinary Hospital | Health Care | Electricity | kWh | 12.88 | 11.27 | 5.52 | 16.79 |
| | | Gas | kBTU | 94.93 | 85.33 | 15.80 | 101.13 |
| Visitor Center - Education | School | Electricity | kWh | 4.23 | 3.71 | 1.27 | 4.98 |
| | | Gas | kBTU | 17.95 | 15.64 | 1.63 | 17.26 |
| Visitor Center - Office | Small Office | Electricity | kWh | 9.73 | 8.58 | 4.76 | 13.33 |
| | | Gas | kBTU | 29.90 | 24.74 | 0.08 | 24.82 |

**Notes:**

1. Baseline usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). Energy use rates are based on 2002 consumption data. ENVIRON used data for Pacific Gas and Electric (PG&E), Zone 5, which is the sector in which Oakland Zoo is located.
2. Includes Title 24-regulated building envelope uses of electricity (heating, cooling, ventilation, water heating) and gas (heating, water heating) and all lighting.
3. ENVIRON multiplied the T24 Energy Use Base for each T24 end use category by the reduction factors for 2001 to 2005 and 2005 to 2008 and summed all applicable end use categories.
4. Includes all other uses of electricity (cooking, refrigeration office equipment, miscellaneous, process, motors, air compressors) and gas (cooling, cooking, miscellaneous, process) not included in the Title 24-regulated building envelope or lighting.
5. Project Energy Use sums the previous two columns (T24 Energy Use 2008 and Non-Title 24 Energy Use).

**Abbreviations:**
CEC - California Energy Commission
CEUS - California Commerical End-Use Survey
kBTU - kilo (1000) British thermal units
kWh - kilowatt hour
PG&E - Pacific Gas and Electric
SF - square feet
T24 - Title 24
yr - year

**Sources:**
California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003-07-11_400-03-014.PDF
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_IMPACT_ANALYSIS.PDF

**Table 2.7**
**GHG Emissions from Non-Residential Buildings**
**Oakland Zoo**
**Oakland, CA**

| Building Type | CEUS Building Type | Size | Energy Type | Unit | Project Energy Use [1] | $CO_2e$ Emissions[2] | Total $CO_2e$ Emissions[3] |
|---|---|---|---|---|---|---|---|
| | | [SF] | | | [Unit/SF/yr] | [tonnes $CO_2e$/SF/yr] | [tonnes $CO_2e$/yr] |
| Restaurant | Restaurant | 7,315 | Electricity | kWh | 30.26 | 7.93E-03 | 58 |
| | | | Gas | kBTU | 170.02 | 9.02E-03 | 66 |
| Veterinary Hospital | Health | 17000 | Electricity | kWh | 16.79 | 4.40E-03 | 75 |
| | | | Gas | kBTU | 101.13 | 5.37E-03 | 91 |
| Visitor Center - Education | School | 13428 | Electricity | kWh | 4.98 | 1.30E-03 | 18 |
| | | | Gas | kBTU | 17.26 | 9.16E-04 | 12 |
| Visitor Center - Office | Small Office | 4,718 | Electricity | kWh | 13.33 | 3.49E-03 | 16 |
| | | | Gas | kBTU | 24.82 | 1.32E-03 | 6 |
| | | | | | | **Total Emissions** | **343** |

**Notes:**

1. Baseline usage rates were taken from the 2006 California Commercial End-Use Survey (CEUS), performed by Itron under contract to the California Energy Commission (CEC). Energy usage rates are based on 2002 consumption data. ENVIRON used data for Pacific Gas and Electric (PG&E), Zone 5, which is the sector in which Oakland Zoo would be located.

ENVIRON used the 2002 CEUS data to represent energy use for buildings that are minimally compliant with the 2001 Title 24 standards. Title 24 usage rates have been adjusted to reflect improvements in Title 24 building codes from 2002 to 2005 according to CEC's "Impact Analysis for 2005 Energy Efficiency Standards", as well as from 2005 to 2008 according to the "Impact Analysis 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings".

2. GHG emission factors are calculated by multiplying the corresponding usage rates or usages by the conversion factors.
3. The total GHG emissions are calculated by multiplying the corresponding usage rates or usages by the conversion factors and the total square footage of the buildings.

**Abbreviations:**

CEC - California Energy Commission
CEUS - California Commerical End-Use Survey
$CO_2e$ - carbon dioxide equivalent
GHG - greenhouse gas
kBTU - kilo (1000) British thermal units
kWh - kilowatt hour
PG&E - Pacific Gas and Electric
SF - square feet
yr - year

**Sources:**

California Energy Commission. 2006. California Commercial End-Use Survey. Prepared by Itron Inc. Available at: Available at: http://www.energy.ca.gov/ceus/
California Energy Commission. 2003. Impact Analysis: 2005 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2005standards/archive/rulemaking/documents/2003
California Energy Commission. 2007. Impact Analysis: 2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings. Available at: http://www.energy.ca.gov/title24/2008standards/rulemaking/documents/2007-11-07_I

**Table 2.8**
**GHG Emissions from Animal Holding Areas and Gondola**
**Oakland Zoo**
**Oakland, CA**

| Structure | Electricity Demand[1] (kWh/yr) | Emission Factor[2] (tonnes $CO_2e$/kWh) | GHG Emissions (tonnes $CO_2e$/yr) |
|---|---|---|---|
| **Animal Holding** | | | |
| Beaver | 2,540 | 2.62E-04 | 0.7 |
| Black Bear | 6,141 | | 1.6 |
| Grizzly Bear | 8,894 | | 2.3 |
| Jaguar | 6,994 | | 1.8 |
| Mountain Lion | 6,157 | | 1.6 |
| Covered Wolf Pen | 7,257 | | 1.9 |
| **Gondola** | | | |
| Machine Room | 8,760 | 2.62E-04 | 2.3 |
| Gondola Equipment | 203,515 | | 53.3 |
| **Total** | | | **64** |

**Notes:**

1. Electricity demand provided by Oakland Zoo.
2. Emission factor based on PG&E 2006 electricity emission factor as recommended by the BAAQMD CEQA Guidelines (June 2010).
3. The Jaguar/Aviary viewing structure, the interpretive kiosk, and the composting toilet were assumed to have no electricity demand.

**Abbreviations:**

BAAQMD - Bay Area Air Quality Management District
CEQA - California Environmental Quality Act
$CO_2e$ - carbon dioxide equivalent
GHG - greenhouse gas
kWh - kilowatt hour
PG&E - Pacific Gas and Electric
yr - year

**Sources:**

Bay Area Air Quality Management District. 2010. California Environmental Quality Act Air Quality Guidelines, June. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/Draft_BAAQMD_CEQA_Guidelines_June_2010_Final.ashx

**Table 2.9**
**Diesel Engines**
**Oakland Zoo**
**Oakland, California**

| Project | Size[1] | Fuel Consumption[2] | Operating Hours | Emission Factor | | | Global Warming Potential[a] | | | $CO_2$ Emissions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$ | $CH_4$ | $N_2O$ | |
| | hp | (gal/hr) | | (kg/gal) | | | | | | (tonnes/yr) |
| Fire Service Pump | 125 | 7.9 | 50 | 10.2 | 0.0015 | 0.0001 | 1 | 21 | 310 | 4.0 |
| Veterinary Hospital Backup Generator | 40 | 2.8 | 50 | | | | | | | 1.4 |
| Gondola Auxiliary Engine | 150 | 10.7 | 50 | | | | | | | 5.5 |
| Gondola Evacuation Unit | 67 | 5.1 | 50 | | | | | | | 2.6 |
| **Total** | | | | | | | | | | **13.5** |

**Notes:**
1. Provided by Oakland Zoo on 12/28/2009 and 01/13/2010.
2. Based on the Caterpillar diesel generators of similar sizes.

**Abbreviations:**
$CO_2$ - Carbon Dioxide
$CH_4$ - Methane
gal - gallon
hp - horsepower
hr - hour
kg - kilogram
$N_2O$ - Dinitrogen Oxide
yr - year

**Reference:**
[a] California Climate Action Registry (CCAR). 2009. General Reporting Protocol. Version 3.1
http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

**Table 2.10**
**GHG Emissions from Water Use**
**Oakland Zoo**
**Oakland, CA**

| Source | Category | Water Demand | Energy Requirements[1] | Conversion Factor[2] | Emission Factor | Total $CO_2e$ Emissions |
|---|---|---|---|---|---|---|
| | | Mgal/yr | kWh/Mgal | tonne $CO_2e$/kWh | tonne $CO_2e$/Mgal | tonne $CO_2e$/yr |
| Potable Water (Supply, Treatment, Distribution)[3] | Indoor Potable Water[4] | 1.5 | 1,450 | 2.62E-04 | 0.38 | 0.6 |
| | Animal Holding Cleaning Water[5] | 0.7 | 1,450 | 2.62E-04 | 0.38 | 0.2 |
| | Irrigation Water [6] | 4.9 | 1,450 | 2.62E-04 | 0.38 | 1.9 |
| Wastewater Treatment[7] | | 2.2 | 2,500 | 2.62E-04 | 0.65 | 1.4 |
| | | | | | **Total** | **4.1** |

**Notes:**

1. Energy requirements for water and wastewater are based on a CEC (2005) study, as per BAAQMD CEQA Guidelines (June 2010).
2. Conversion factor based on the average of PG&E 2006, 2007, and 2007 electricity emission factors, consistent with ARBs Local Government Operation Protocol (LGOP) (See Table 2.1).
3. The energy requirement associated with potable water use is based on information provided in CEC 2005, specific to Northern California, and includes water supply, treatment, and distribution.
4. Indoor optable water use was provided by Aliquot Associates, Inc. on December 27, 2010 and includes water usage from faucets, toilets, and dishwashers.
5. Animal holding cleaning water demand was provided by Oakland Zoo on December 27, 2010.
6. Irrigation water demand was provided by the Oakland Zoo on December 27, 2010.
7. The energy requirement for wastewater treatment is based on information provided in CEC 2005, specific to Northern California. Water used for irrigation was assumed to not be treated. All other water demand was assumed to be wastewater.

**Abbreviations:**

BAAQMD - Bay Area Air
CEC - California Energy
CEQA - California
$CO_2e$ - carbon dioxide
GHG - greenhouse gas
kWh - kilowatt hour
Mgal - million gallons
PG&E - Pacific Gas and
yr - year

**Sources:**

ARB Local Government Operations Protocol, Version 1.1. Appendix G. Accessed October 2010. Available at: http://www.arb.ca.gov/cc/protocols/localgov/pubs/lgo_protocol_v1_1_2010-05-03.pdf
California Energy Commission. November, 2005. California's Water-Energy Relationship. Final Staff Report. CEC-700-2005-011-SF. Accessed December, 2009. Available at: http://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011-SF.PDF
Bay Area Air Quality Management District. 2010. California Environmental Quality Act Air Quality Guidelines, June. Available at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CEQA/BAAQMD%20CEQA%20Guidelines_December%202010.ashx

**Table 2.11**
**Vehicle Trip Generation due to Project**
**Oakland Zoo**
**Oakland, CA**

| Commuter Type | URBEMIS Trip Type[2] | % Trip Type[2] | Annual One-Way Trips[1,3,4] |
|---|---|---|---|
| Employee[1] | Commercial-based Commute | 18.8% | 21,900 |
| Visitor and Other | Commercial-based Non-Work | 9.4% | 10,950 |
| | Commercial-based Customer | 71.7% | 83,332 |
| **Total Trips** | **--** | **100%** | **116,182** |

**Notes:**

1. Number of new employees (30) due to the project was provided by Oakland Zoo. ENVIRON assumed that each employee makes 2 one-way trips each day for a total of 365 days per year and calculated the number of annual trips associated with employees.

2. URBEMIS trip types for commercial land uses are commercial-based commute, commercial-based non-work, and commercial-based customer. ENVIRON assumed that employee trips are represented by the commercial-based commute trip type. Therefore, commercial-based commute trips represent (21,900/116,182) = 18.8% of all trips. This value was entered in URBEMIS for % Worker Commute. URBEMIS then calculates the percentage of trips attributed to commercial-based non-work and commercial-based customer trips based on the following methodology: if the commercial-based commute trip value is less than 50 percent, as is the case for Oakland Zoo, then the commercial-based non commute trip percentage equals one half of the commercial-based commute trip value, and the commercial-based customer trip percentage is the remainder.

3. The number of annual one-way trips for the commercial-based non-work trip type was calculated based on the % Trip Type.

**Table 2.12**
**GHG Emissions from Vehicles**
**Oakland Zoo**
**Oakland, CA**

| Emissions Type | Number of One-Way Trips | VMT[1] | Total $CO_2$ Emissions[2] (tons) | Total $CO_2e$ Emissions[3] (tonnes) |
|---|---|---|---|---|
| **Maximum Annual** | 116,182 | 900,908 | 416 | 397 |

**Notes:**

1. Daily VMT is calculated in URBEMIS based on the daily trip rate and urban trip lengths for BAAQMD. The average daily trip rate used as an input value was calculated by dividing the annual number of one-way trips by 365. Annual VMT was calculated by multiplying the output daily VMT by 365.

2. Annual emissions were calculated in URBEMIS based on 2015 emission factors. ENVIRON assumed that the vehicle fleet would be consistent with the default 2015 EMFAC fleet mix.

3. $CO_2e=CO_2/0.95$: The United States Environmental Protection Agency (USEPA) recommends assuming that $CH_4$, $N_2O$, and HFCs are 5% of emissions on a $CO_2e$ basis.

**Abbreviations:**

BAAQMD - Bay Area Air Quality Management District
$CO_2$ - Carbon Dioxide
$CO_2e$ - Carbon Dioxide Equivalent
URBEMIS - Urban Emissions Model
USEPA - United States Environmental Protection Agency
VMT - Vehicle Miles Traveled

**Sources:**

California Air Resources Board. 2008. *Comparison of Greenhouse Gas Reductions for the United States and Canada under U.S. CAFÉ Standards and California Air Resources Board Greenhouse Gas Regulations.* February 25. Available at: http://www.climatechange.ca.gov/publications/arb/ARB-1000-2008-012/ARB-1000-2008-012.PDF

**Table 2.13**
**Model Inputs and GHG Emissions from Solid Waste Disposal**
**Oakland Zoo**
**Oakland, CA**

| | | |
|---|---|---|
| **Waste Disposal Data** | | |
| Waste from the existing Zoo sent to landfill in 2010[1] | tons | 146.6 |
| Expected increase in attendance due to Project[2,3] | % | 20% |
| Estimated increase in waste disposal due to Project | ton | 29.3 |
| **Waste Transport Data** | | |
| Weighted average round trip distance to landfill[4] | miles | 63.9 |
| Weighted average truck capacity[5,6] | tons | 13.0 |
| | | |
| BGM Estimated Emissions from Solid Waste | tonnes CO2e/yr | 9 |

**Notes:**

1. Solid waste mass data for 2010 was provided by the Zoo and Waste Management Inc. Solid waste data for the first three quarters was scaled up to estimate total annual waste disposal.

2. The California Project is expected to result in a 20% increase in Zoo attendance for two to three years after its opening, decreasing thereafter. ENVIRON conservatively assumed a 20% increase in Zoo visitors throughout the Project lifetime.

3. ENVIRON assumed that the majority of Zoo waste is generated by Zoo visitors. Accordingly, the waste attributable to the Project was assumed to be 20% of the waste generated by the Zoo.

4. Solid waste from the Project was assumed to be transported to two locations, consistent with current Zoo waste. In 2010, 87% of the Oakland Zoo mixed waste stream went through the Davis Street Transfer Station and 15% went to the Waste Management Inc. 98th Avenue facility. Solid waste from the Davis Street facility was subsequently hauled to the Altamont Landfill. Project specific trip distances were used in the BGM model based on these locations.

5. Data on vehicle types for each segment of travel were provided by the Oakland Zoo. Truck capacity was calculated based on the average tons per trip in 2010, weighted by miles traveled by each vehicle type.

**Table 2.14**
**GHG Emissions from Enteric Fermentation (Ruminants)**
**Oakland Zoo**
**Oakland, CA**

| Ruminant Animal[1] | IPCC Animal Weight[2] | IPCC $CH_4$ Emission Factor[2] | Oakland Zoo Animal Weight[1] | Oakland Zoo $CH_4$ Emission Factor[3] | Number of Animals[1] | Total $CH_4$ Emissions | Total $CO_2e$ Emissions[4] |
|---|---|---|---|---|---|---|---|
| | (kg) | (kg $CH_4$ / animal / yr) | (kg) | (kg $CH_4$ / animal / yr) | | (tonnes $CH_4$ / yr) | (tonnes $CO_2e$ / yr) |
| Bison | 300 | 55.0 | 703 | 128.9 | 5 | 0.6 | 13.5 |

**Notes:**
1. Species, number of animals, and average animal weight provided by Oakland Zoo.
2. IPCC Tier 1 calculation methodology was used. Table 10.10 of IPCC 2006 provides a $CH_4$ emission factor for buffalo based on an average weight of 300 kg.
3. An Oakland Zoo-specific $CH_4$ emission factor for bison was calculated by scaling the IPCC emission factor by the Oakland Zoo-specific animal weight.
4. $CO_2e$ emissions were calculated by multiplying the $CH_4$ emissions by their global warming potential. The global warming potential for $CH_4$ (21) can be found in Table C.1 of CCAR 2008.

**Abbreviations:**
CCAR - California Climate Action Registry
$CH_4$ - methane
$CO_2e$ - carbon dioxide equivalent
IPCC - Intergovernmental Panel on Climate Change
kg - kilogram
yr - year

**Sources:**

IPCC. Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10: Emissions from Livestock and Manure Management. 2006. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_10_Ch10_Livestock.pdf

CCAR. General Reporting Protocol, Version 3.1. 2009. Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

**Table 2.15**
**GHG Emissions from Manure Composting**
**Oakland Zoo**
**Oakland, CA**

| ANIMAL CHARACTERISTICS | | | | |
|---|---|---|---|---|
| **Herbivore Animal[1]** | **Animal Mass[2] (kg / animal)** | **Number of Animals[2]** | -- | |
| Bison | 703 | 5 | | |
| **METHANE EMISSIONS** | | | | |
| **$CH_4$ EF[3] (kg $CH_4$ / animal / yr)** | **Total $CH_4$ Emissions[4] (tonnes $CH_4$ / yr)** | **$CO_2$e Emissions[5] (tonnes $CO_2$e / yr)** | -- | |
| 63 | 0.315 | 6.6 | | |
| **NITROUS OXIDE EMISSIONS** | | | | |
| **Nitrogen Excretion Rate[6]** | **Total Nitrogen Excretion[7]** | **$N_2O$ EF[8]** | **Total $N_2O$ Emissions[9]** | **$CO_2$e Emissions[10]** |
| **(kg N / kg animal mass / day)** | **(kg N / yr)** | **(kg $N_2O$ / kg N)** | **(tonnes $N_2O$ / yr)** | **(tonnes $CO_2$e / yr)** |
| 0.00032 | 411 | 0.006 | 0.002 | 0.8 |
| **TOTAL $CO_2$e EMISSIONS** | | | | |
| | | **(tonnes $CO_2$e / yr)** | -- | |
| | **FROM METHANE :** | 6.6 | | |
| | **FROM NITROUS OXIDE :** | 0.8 | | |
| | **TOTAL :** | 7 | | |

**Notes:**

1. Only manure from herbivores is composted. Manure from all other animals is flushed to sewage.
2. Species and number of animals provided by Oakland Zoo.
3. IPCC Tier 1 calculation methodology was used. The default $CH_4$ emission factor is provided in Table 10.14 of IPCC 2006 (for 15 degrees Celsius, based on historical climate data obtained through the Western Regional Climate Center). Since no emission factor for North American bison was available, ENVIRON conservatively used the emission factor provided for North American dairy cows, which is the species of animal with the highest emission factor for that region.
4. Total $CH_4$ emissions were calculated by multiplying the $CH_4$ emission factor by the number of animals and converting from kg to tonnes.
5. $CO_2$e emissions were calculated by multiplying the $CH_4$ emissions by their global warming potential. The global warming potential for $CH_4$ (21) can be found in Table C.1 of CCAR 2008.
6. IPCC Tier 1 calculation methodology was used. The default nitrogen excretion rate is provided in Table 10.19 of IPCC 2006. The value for buffalo in North America is used.
7. Total nitrogen excretion was calculated by multiplying the daily nitrogen excretion rate by the number of animals, the per animal mass, and 365 days.
8. The default $N_2O$ emission factor is provided in Table 10.21 of IPCC 2006. The value for composting - in vessel is used.
9. Total $N_2O$ emissions were calculated by multiplying the $N_2O$ emission factor by the total amount of nitrogen excreted and converting from kg to tonnes.
10. $CO_2$e emissions were calculated by multiplying the $N_2O$ emissions by their global warming potential. The global warming potential for $N_2O$ (310) can be found in Table C.1 of CCAR 2008.

**Abbreviations:**

CCAR - California Climate Action Registry
$CH_4$ - methane
$CO_2$e - carbon dioxide equivalent
EF - emission factor
IPCC - Intergovernmental Panel on Climate Change
N - Nitrogen
$N_2O$ - nitrous oxide
kg - kilogram
yr - year

**Sources:**


IPCC. Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10: Emissions from Livestock and Manure Management. 2006. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_10_Ch10_Livestock.pdf

IPCC. Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11: N2O Emissions from Managed Soils, and CO2 Emissions from Lime and Urea Application. 2006. Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf

CCAR. General Reporting Protocol, Version 3.1. 2009. Available at: http://www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf

**Table 2.16**
**$CO_2$ Sequestration Change due to Land Use Change**
**Oakland Zoo**
**Oakland, CA**

| Vegetation Type[1] | IPCC Designation[2] | IPCC Sub qualification | Tons Dry Matter Carbon/Acre[3] | Sequestered $CO_2$ / Acre[4] | Total Impacted Area[5] | $CO_2$ Sequestration Capacity of Removed Vegetation |
|---|---|---|---|---|---|---|
| | | | [tonne/acre] | [tonne/acre] | [acres] | [tonne] |
| Chamise Chaparral | Forest Land | Scrub | 3.901 | 14.3 | 0.56 | 8 |
| Grassland | Grassland | | 1.175 | 4.3 | 10.22 | 44 |
| Scrubland | Forest Land | Scrub | 3.901 | 14.3 | 7.74 | 111 |
| Oak Woodland | Forest Land | Trees | 30.409 | 111.5 | 2.04 | 227 |
| **GRAND TOTAL** | | | | | 20.56 | 390 |

**Notes:**

1. Land types shown here were provided by Oakland Zoo and represent vegetation that will be potentially removed upon development.
2. Land types are mapped to generalized IPCC Land Designations (IPCC 2006).
3. Dry matter carbon per acre was determined from information contained in Table 4-2.
4. It is conservatively assumed that all carbon is eventually converted into $CO_2$. Multiply the mass of carbon by 3.67 to calculate the final mass of $CO_2$ (the molecular mass of $CO_2$ / the molecular mass of carbon is 44/12 or 3.67).
5. Data provided by Oakland Zoo. A positive number indicates the amount of land removed and a negative number indicates that this land type is added.

**Abbreviations:**

$CO_2$ - carbon dioxide
IPCC - Intergovernmental Panel on Climate Change

**Sources:**

Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

**Table 2.17**
**Carbon per Acre for IPCC Land Types**
**Oakland Zoo**
**Oakland, CA**

| IPCC Designation | Sub qualification | Above Ground Biomass[1] [tonne d.m./acre] | Ratio of Above Ground / Below Ground Biomass[2] | Total Biomass [tonne d.m./Hectare] | Total Biomass[3] [tonne d.m./acre] | Tonnes Dry Matter Carbon/Acre[4] [tonne/acre] |
|---|---|---|---|---|---|---|
| Forest Land | Scrub | 5.7 | 2.17 | 20.5 | 8.3 | 3.9 |
| Forest Land | Trees | 52.6 | 4.35 | 159.9 | 64.7 | 30.4 |
| Grassland | | 0.0 | 0.00 | 6.2 | 2.5 | 1.2 |

**Notes:**

1. Numbers listed are used in conjunction with above ground/below ground ratios to calculate total biomass per acre. Values from source converted to tonne/acre.

2. This value is used to calculate total biomass when data for the total biomass is not available for a particular land type.

3. Total biomass is either 1.) Listed directly in the IPCC protocol, or 2.) Calculated from above ground biomass and the Above Ground / Below Ground biomass ratios as follows: Total = Above + (Above / [Above:Below Ratio] ). Values from source converted to tonne/acre as necessary.

4. Total biomass multiplied by carbon fraction in plant material (0.47) to calculate carbon content. From IPCC (2006), default value for Forest Land (Table 4.3 of IPCC).

**Abbreviations:**

d.m. - dry mass
IPCC - Intergovernmental Panel on Climate Change

**Sources:**

Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

**Table 2.18**
**$CO_2$ Sequestration Capacity of Removed Trees and New Plantings**
**Oakland Zoo**
**Oakland, CA**

| Vegetation Species[1] | IPCC Species Class Designation[1] | Sequestered $CO_2$ / Unit[2] | Unit | Total Quantity of New Vegetation[3] | Unit | $CO_2$ Sequestration Capacity of New Vegetation[4] |
|---|---|---|---|---|---|---|
| | | [tonne/unit/year] | | | | [tonne] |
| Mixed, TBD[4] | Mixed Hardwood | 0.037 | trees | 370 | trees | 274 |
| **Total** | | | | **370** | **trees** | **274** |

**Notes:**

1. Site-specific quantity of trees to be planted provided by Oakland Zoo via e-mail on December 16, 2010. A specific tree palette was not designated, so ENVIRON assumed "Mixed Hardwood" for the IPCC species class designation.

2. Species class-specific sequestration values are provided in Table 8.2 of "2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4."

3. Note that this number includes trees that may potentially be removed. This analysis conservatively accounts for both tree removal and the reduction in oak woodland acreage, and accordingly may overestimate the reduction in carbon sequestration capacity from vegetation change.

4. An active growing period of 20 years was assumed for the new trees planted.

**Abbreviations:**
$CO_2$ - carbon dioxide
IPCC - Intergovernmental Panel on Climate Change
TBD - to be determined

**Sources:**

Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines). Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.htm

**Table 2.19**
**Change in $CO_2$ Sequestration Due to Land Use Changes and New Vegetation Plantings**
**Oakland Zoo**
**Oakland, CA**

| $CO_2$ Sequestration Capacity of Vegetation | $CO_2$ Sequestration Capacity of New Vegetation | Net Change in $CO_2$ Sequestration Capacity[1] |
|---|---|---|
| [tonne] | [tonne] | [tonne] |
| -390 | 274 | -116 |

**Notes:**
1. A negative value represents a decrease in sequestration capacity and thus a net increase in $CO_2$.

**Abbreviations:**
$CO_2$ - carbon dioxide

**Table 2.20**

**GHG Emissions from Construction Activities[1]**

**Oakland Zoo**
**Oakland, California**

| Project | GHG Emissions by Source Type (tonne) | | |
|---|---|---|---|
| | On-site Equipment[2] | Mobile Sources[3] | Total |
| California Project | 162 | 252 | 414 |
| Veterinary Hospital | 18 | 63 | 81 |
| Total | 180 | 315 | 495 |

**Notes:**
1. GHG emissions form construction acitivities are calculated using the same methodology as that used for criteria pollant emissions calculation described in the Air Quality Technical Report.
2. The detailed construction data provided by Oakland Zoo including phase schedule, manpower, equipment types and quantity are presented in Appendix B.
3. Include delivery trucks, hauling trucks, and workers' private vehicles.

**Abbreviations:**
GHG: Greenhouse Gas

**Table 2.21**

**Life Cycle GHG Emissions From Materials[1] Used for Buildings**

**Oakland Zoo**

**Oakland, California**

| Non-Residential Buildings and Animal Holdings[2] | Embodied Energy as Percentage of Overall Energy[3] | |
|---|---|---|
| | 3% | 25% |
| (tonnes $CO_2$ / year) | | |
| 406 | 13 | 135 |

**Notes:**

1. All materials were analyzed. See references below for more details.
2. Represents $CO_2$ emissions from electricity and natural gas use.
3. Percentages are based upon LCA studies below. The studies compared energy used in the manufacture and transport of materials to energy use from electricity and natural gas. Varying lifetimes of homes were assumed in each study. As homes become more energy efficient, the portion of GHGs from embodied energy increases.

**Abbreviations:**

$CO_2$ = Carbon Dioxide

GHG = Greenhouse Gas

LCA = Life Cycle Analysis

**Sources:**

Scheuer, C., G.A. Keoleian, and P. Reppe. (2003) Life cycle energy and environmental performance of a new university building: Modeling challenges and design implications. *Energy and Buildings* , **35**(10): p. 1049.

Keoleian, G.A., S. Blanchard, and P. Reppe. (2000) Life-cycle energy, costs, and strategies for improving a single-family house. *Journal of Industrial Ecology* , **4**(2): p. 135.

Sartori, I. and A.G. Hestnes. (2007) Energy use in the life cycle of conventional and low-energy buildings: A review article. *Energy and Buildings* , **39**(3): p. 249.

Winther, B.N. and A.G. Hestnes. (1999) Solar versus green: The analysis of a Norwegian row house. *Solar Energy* , **66**(6): p. 387.

Adalberth, K., A. Almgren, and E.H. Petersen. (2001) Life Cycle Assessment of Four Multi-Family Buildings. *International Journal of Low Energy and Sustainable Buildings* , **2**.

**Table 2.22**
**GHG Emission Factors for the Manufacture of Cement**
**Oakland Zoo**
**Oakland, California**

| Data Source | Calcining Emissions[4] | Fossil Fuel Emissions[5] |
|---|---|---|
| | (tonnes $CO_2$/tonne cement) | |
| EIA[1] | 0.5 | NA |
| USEPA AP-42[2] | 0.5 | NA |
| | 0.75 - 1.19 | |
| | 0.92 | |
| Battelle[3] | 0.99 | |

**Notes:**

1. From the Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. Calculations are detailed in the Documentation for Emissions of Greenhouse Gases in the United States 2004, pg 35 - 38.

2. From AP-42 section 11.6: Portland Cement Manufacturing. Approximately 500 kg of $CO_2$ are released per Mg of cement produced during the calcining process; total manufacturing emissions depend on energy consumption (pg 11.6-6). Table 11.6-8 specifies 2,100 lbs $CO_2$ per ton of clinker produced (ENVIRON used the higher value instead of 1,800 lbs / ton to be conservative). Clinker is a precursor to cement. Using a clinker factor of 0.88 lb clinker/lb cement (from the Battelle report) yields an emission factor of 0.92 tonnes $CO_2$/tonne cement.

3. From Table 1-2 of the Battelle report. The North American average emission factor is 0.99 kg $CO_2$/kg cement; the global average is 0.87 kg $CO_2$/kg cement.

4. There are two main sources of $CO_2$ emissions from the manufacture of cement: the calcining process and fossil fuel combustion. Calcining emissions result from the chemical reaction of converting limestone ($CaCO_3$) to calcium oxide (CaO) and carbon dioxide (CO2). CaO is a precursor to concrete and $CO_2$ is released to the atmosphere.

5. Fossil fuel combustion usually provides the energy necessary to manufacture cement. The emissions from the fossil fuel combustion vary depending on the type of fuel used; in general the combustion accounts for slightly less than half of the $CO_2$ emissions from the manufacture of cement.

**Abbreviations:**

AP-42 = Compilation of Air Pollutant Emission Factors
$CO_2$ = carbon dioxide
EIA = Energy Information Administration
USEPA = Environmental Protection Agency
kg = kilogram
lb = pound
NA = Not Available
Mg = megagram = 1,000 kg

**Sources:**

EIA Energy Market and Economic Impacts of S.280, the Climate Stewardship and Innovation Act of 2007. August 2007. http://www.eia.doe.gov/oiaf/servicerpt/csia/special_topics.html
EPA AP42 Section 11.6: Portland Cement Manufacturing. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s06.pdf
Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.

**Table 2.23**
**GHG Emissions from Manufacture of Materials**
**Oakland Zoo**
**Oakland Zoo, California**

| Material | Emission Factor | Volume of Material[1] | Mass of Material[1] | Emissions from Manufacture of Material[2] |
|---|---|---|---|---|
| | (tonnes $CO_2$/tonne material) | ($yd^3$) | (tonnes) | (tonnes $CO_2$) |
| **Infrastructure[1]** | | | | |
| Cement (in concrete)[3] | 0.990 | 28,701 | 1,802 | 1,783 |
| Asphalt | 0.018 | 3,375 | 245 | 4 |
| **TOTAL** | | | | **1,788** |

**Notes:**
1. Quantity of material for infrastructure was provided by Oakland Zoo via email on January 15, 2010.
2. Because the manufacture of cement is the main contributor to $CO_2$ emissions in the production of concrete, ENVIRON assumed that the emissions from the manufacture of cement are equal to the emissions from the overall manufacture of concrete.
3. Concrete is composed of cement, water, aggregate, and chemical admixtures; concrete mixtures are approximately 15% cement by volume (Portland Cement Association). Cement accounts for almost all of the $CO_2$ emissions associated with the manufacture of conrete. The cement emission factors provided by AP-42 cover a wide range of processing technologies and emission factors, so ENVIRON used the cement emission factor provided by the Battelle report.

**Abbreviations:**
$CO_2$ = carbon dioxide
$yd^3$ = cubic yard

**Sources:**
Battelle. Humphreys, K. and Mahasenan, M. Climate Change: Toward a Sustainable Cement Industry. March 2002.
EPA AP42 section 11.1: Hot Mix Asphalt Plants. Tables 11.1-5 and 11.1-7. http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s01.pdf
CH2MHill. Conceptual Design Report: Newhall Ranch Water Reclamation Facility, Los Angeles County, California. July 31, 2006.
Portland Cement Association. Cement and Concrete Basics. http://www.cement.org/basics/concretebasics_concretebasics.asp
Zhang, Z. and Wilson, F. Life-Cycle Assessment of a Sewage-Treatment Plant in South-East Asia. J.CIWEM, 2000, 14, February.
Kiewit. South Bay Water Reclamation Plant. http://www.kiewit.com/markets/pro_2098031.html
AP-42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

**Table 2.24**
**GHG Emissions from Transportation of Buildings and Infrastructure Raw Materials**
**Oakland Zoo**
**Oakland, CA**

| Material | Total Mass Transported | Distance from Mixing Plant[2] | Mass-Distance[3] | Emission Factor[4] | | Emissions to Transport to Construction Site[5] |
|---|---|---|---|---|---|---|
| | | | | Rail | Trucks | Total |
| | (tonnes material) | (miles) | (tonne-miles) | (grams $CO_2$/tonne-mile) | | (tonnes $CO_2$) |
| **Infrastructure** | | | | | | |
| Concrete[1] | 1,802 | 6 | 10,809 | 26 | 253 | 2.7 |
| Asphalt | 245 | 6 | 1,468 | | | 0.4 |
| **TOTAL** | | | | | | **3.1** |

**Notes:**

1. For manufacturing emissions, only the amount of cement is considered; however, for transportation emissions, the entire mass of concrete is considered because the concrete mix is transported from the source locations.
2. The material transportation distance was provided by Oakland Zoo.
3. Mass distance is the mass of material multipled by the distance traveled.
4. Emission factors for rail and truck calculated from DOE EERE energy intensity indicators. EERE data is presented in Btu / ton mile. These were converted using AP-42 conversion factors for energy in different types of fuel, and CCAR GRP emission factors for mass CO2 emitted per gallon of fuel. Rail and Trucks are assumed to run on diesel.
5. Emissions calculated by multiplying the mass-distance by the emission factor. Because of the close proximity of the source locations to Oakland Zoo, ENVIRON conservatively assumed that all materials will be transported by truck. The emission factor for rail transportation is significantly lower; transporting materials by rail instead of truck will result in lower emissions.

**Abbreviations:**

Btu - British Thermal Unit
CCAR - California Climate Action Registry
$CO_2$ - Carbon Dioxide
DOE - Department of Energy
EERE - Energy Efficiency and Renewable Energy
GHG- Green House Gases
GRP - General Reporting Protocol

**Sources:**

DOE EERE energy intensity indicators. http://intensityindicators.pnl.gov/trend_data.stm Transportation sector data.

AP42 conversions available at http://www.epa.gov/ttn/chief/ap42/appendix/appa.pdf

**Table 2.25**
**Summary of Life Cycle GHG Emissions from Buildings and Infrastructure**
**Oakland Zoo**
**Oakland, CA**

| Emissions Source[1] | | Emissions from Manufacture of Materials[3] | Emissions from Transportation of Materials[4] | Total Emissions | Assumed Lifetime of Emissions Source[5] | Total Annualized Emissions[6] | Total Annual $CO_2$ Emissions[7] | LCA Fraction of Total Emissions[8] |
|---|---|---|---|---|---|---|---|---|
| | | (tonnes $CO_2$) | | | (years) | (tonnes $CO_2$ / year) | (tonnes $CO_2$ / year) | (%) |
| Buildings[2] | Low Estimate | 503 | | 503 | 40 | 13 | 855 | 1.5% |
| | High Estimate | 5,416 | | 5,416 | | 135 | | 15.8% |
| Infrastructure | | 1,788 | 3 | 1,791 | | 45 | | 5.2% |
| TOTAL | | 2,293 - 7,207 | | 2,293 - 7,207 | | 57 - 180 | | 6.7% - 21% |

**Notes:**
1. ENVIRON estimated LCA emissions from two sources: buildings and infrastructure.
2. Emissions from buildings are shown as a range from a low to a high estimate based on the range presented in Table 4.20. The values in Table 4.20 are multiplied by the assumed lifetime of of 40 years to yield total emissions in tonnes $CO_2$.
3. Emissions from the manufacture of materials for infrastructure are from Table 4.22.
4. Emissions from the transportation of materials for infrastructure are from Table 4.23.
5. The assumed lifetime of emissions source may be adjusted; here ENVIRON has assumed a conservatively short lifetime of 40 years.
6. Total emissions are divided by the assumed lifetime of emissions sources to yield the total annualized emissions.
7. From the Climate Change Technical Report.
8. The LCA fraction of total emissions is calculated by dividing the total annualized emissions by the total emissions.

**Abbreviations:**
$CO_2$ = carbon dioxide
LCA = Life Cycle Assessment

**Sources:**
Values are calculated using Tables 4.20 through 4.23 and the emissions presented in the Climate Change Technical Report.

# Appendix A
## Mobile Source URBEMIS File Output

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Urbemis 2007 Version 9.2.4

Detail Report for Annual Operational Unmitigated Emissions (Tons/Year)

File Name: U:\Oakland Zoo\Calculations\Mobile\Oakland Zoo_UPDATED.urb924

Project Name: Oakland Zoo

Project Location: Bay Area Air District

On-Road Vehicle Emissions Based on: Version : Emfac2007 V2.3 Nov 1 2006

Off-Road Vehicle Emissions Based on: OFFROAD2007

OPERATIONAL EMISSION ESTIMATES (Annual Tons Per Year, Unmitigated)

| Source | ROG | NOX | CO | SO2 | PM10 | PM25 | CO2 |
|---|---|---|---|---|---|---|---|
| Zoo | 0.18 | 0.26 | 2.40 | 0.00 | 0.55 | 0.10 | 293.41 |
| TOTALS (tons/year, unmitigated) | 0.18 | 0.26 | 2.40 | 0.00 | 0.55 | 0.10 | 293.41 |

Does not include correction for passby trips

Does not include double counting adjustment for internal trips

Analysis Year: 2015 Season: Annual

Emfac: Version : Emfac2007 V2.3 Nov 1 2006

Summary of Land Uses

| Land Use Type | Acreage | Trip Rate | Unit Type | No. Units | Total Trips | Total VMT |
|---|---|---|---|---|---|---|
| Zoo | | 219.18 | unknown | 1.00 | 219.18 | 1,740.09 |
| | | | | | 219.18 | 1,740.09 |

Vehicle Fleet Mix

| Vehicle Type | Percent Type | Non-Catalyst | Catalyst | Diesel |
|---|---|---|---|---|
| Light Auto | 53.8 | 0.2 | 99.6 | 0.2 |

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Vehicle Fleet Mix

| Vehicle Type | Percent Type | Non-Catalyst | Catalyst | Diesel |
|---|---|---|---|---|
| Light Truck < 3750 lbs | 12.7 | 0.8 | 96.8 | 2.4 |
| Light Truck 3751-5750 lbs | 19.9 | 0.0 | 100.0 | 0.0 |
| Med Truck 5751-8500 lbs | 6.6 | 0.0 | 100.0 | 0.0 |
| Lite-Heavy Truck 8501-10,000 lbs | 0.9 | 0.0 | 77.8 | 22.2 |
| Lite-Heavy Truck 10,001-14,000 lbs | 0.6 | 0.0 | 50.0 | 50.0 |
| Med-Heavy Truck 14,001-33,000 lbs | 1.0 | 0.0 | 20.0 | 80.0 |
| Heavy-Heavy Truck 33,001-60,000 lbs | 0.4 | 0.0 | 0.0 | 100.0 |
| Other Bus | 0.1 | 0.0 | 0.0 | 100.0 |
| Urban Bus | 0.1 | 0.0 | 0.0 | 100.0 |
| Motorcycle | 3.2 | 50.0 | 50.0 | 0.0 |
| School Bus | 0.1 | 0.0 | 0.0 | 100.0 |
| Motor Home | 0.6 | 0.0 | 83.3 | 16.7 |

Travel Conditions

| | Residential | | | Commercial | | |
|---|---|---|---|---|---|---|
| | Home-Work | Home-Shop | Home-Other | Commute | Non-Work | Customer |
| Urban Trip Length (miles) | 10.8 | 7.3 | 7.5 | 9.5 | 7.4 | 7.4 |
| Rural Trip Length (miles) | 16.8 | 7.1 | 7.9 | 14.7 | 6.6 | 6.6 |
| Trip speeds (mph) | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 | 35.0 |
| % of Trips - Residential | 32.9 | 18.0 | 49.1 | | | |

% of Trips - Commercial (by land use)

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Travel Conditions

| | Residential | | | Commercial | | |
|---|---|---|---|---|---|---|
| | Home-Work | Home-Shop | Home-Other | Commute | Non-Work | Customer |
| Zoo | | | | 27.4 | 13.7 | 58.9 |

Operational Changes to Defaults

**D R A F T**

# Appendix B
## Construction Calculation Details

# Appendix B.1

# Construction Phasing Schedule and Equipment List

# PHASE I - April 2011 - March 2012

| Oakland Zoo - California Exhibit | | Hours of Operation | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fence, Service Road | | Approximate Quarter of Use | | | | | | |
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2011 | | | 2012 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Perimeter Fence | | | | | | | | |
| | Drill Rig | 16 | | | | | | |
| | Flatbed | 4 | | | | | | |
| | Bobcat | 40 | | | | | | |
| Service Road | | | | | | | | |
| | Bulldozer | 90 | | | | | | |
| | Compactor | 24 | | | | | | |
| | Front-end Loader | 30 | | | | | | |
| | Paver | 16 | | | | | | |
| | Material Trucking | 8 | | | | | | |
| | Dump Truck | 10 | | | | | | |
| | Water Truck | 40 | | | | | | |

| Oakland Zoo - Veterinary Medical Hospital | | Hours of Operation | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | Approximate Month of Use | | | | | | |
| | | 2011 | | | 2012 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Dumpster - Pick-up | | 2 | 4 | 2 | 4 | 0 | | |
| Boom Lift | | 0 | 6 | 6 | 6 | 0 | | |
| Forklift | | 6 | 6 | 6 | 0 | 0 | | |
| Bulldozer | | 16 | 0 | 0 | 0 | 0 | | |
| Excavator | | 64 | 0 | 0 | 0 | 0 | | |
| Compact Excavator | | 0 | 0 | 0 | 16 | 0 | | |
| Compactor | | 32 | 0 | 0 | 16 | 0 | | |
| Backhoe | | 40 | 0 | 0 | 24 | 0 | | |
| Front-end Loader | | 64 | 0 | 0 | 16 | 0 | | |
| Paver | | 0 | 0 | 0 | 16 | 0 | | |
| Material Trucking | | 16 | 0 | 0 | 0 | 0 | | |
| Dump Truck | | 4 | 0 | 0 | 0 | 0 | | |
| Ready Mix Trucks | | 15 | 0 | 0 | 10 | 0 | | |
| Small-Med Flatbed | | 15 | 6 | 0 | 0 | 0 | | |
| Flatbed Semi Trucks | | 0 | 4 | 0 | 0 | 0 | | |
| Full Flatbed Semi Trucks (All) | | 0 | 16 | 18 | 12 | 0 | | |

# PHASE II - April 2012 - March 2013

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Gondola, Grissly Exhibit, Campsite, Bison, Activity Zone, Site Utilities & Pathways | | Hours of Operation Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2012 | | | 2013 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Gondola | | | | | | | | |
| | Tracked Excavator | 24 | 60 | | | | | |
| | Ready Mix Trucks | 37 | 20 | | | | | |
| | Small-Med Flatbed | 6 | 24 | | | | | |
| | Bobcat | 8 | 24 | | | | | |
| | 75 Ton Crane | 24 | 0 | | | | | |
| | Helicopter | 8 | 0 | | | | | |
| Grizzly Exhibit | | | | | | | | |
| Activity Zone | | | | | | | | |
| Overnight Campsite | | | | | | | | |
| Bison/Elk Extension | | | | | | | | |
| | Dumpster - Pick-up | 8 | 8 | 8 | 8 | | | |
| | Forklift | 2 | 8 | 8 | 8 | | | |
| | Portalbe Toilets - Servicing | 10 | 10 | 10 | 10 | | | |
| | Excavator | 80 | | 24 | | | | |
| | Bulldozer | 90 | 8 | | | | | |
| | Compactor | 16 | 8 | 8 | | | | |
| | Front-end Loader | 16 | 24 | 24 | 40 | | | |
| | Bobcat | 16 | 12 | 12 | 60 | | | |
| | Dump Truck | 10 | 6 | 6 | 16 | | | |
| | Ready Mix Trucks | | 10 | 10 | 10 | | | |
| | Med Flatbed | 8 | 8 | 8 | 8 | | | |
| | Small-Med Flatbed | 16 | 16 | 24 | 24 | | | |
| Main Site Utilities | | | | | | | | |
| | Excavator | 60 | | | | | | |
| | Backhoe | 60 | | 40 | 40 | | | |
| | Backfill Compactor | 40 | | 10 | | | | |
| | Dump Truck | 7 | 20 | 8 | 10 | | | |
| | Small-Med Flatbed | 10 | 8 | 8 | 8 | | | |
| | Ready Mix Trucks | 2 | 2 | | 10 | | | |
| | Paver | | | | 16 | | | |

# PHASE III - April 2013 - March 2014

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Wolf Exhibit, Eagle Aviary, Black Bear, Mountain Lion, Interpretive Kiosk, Site Utilities | | Hours of Operation Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2013 | | | 2014 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Wolf Exhibit | | | | | | | | |
| Eagle Aviary | | | | | | | | |
| Black Bear Exhibit | | | | | | | | |
| Mountain Lion Exhibit | | | | | | | | |
| Interpretive Kiosk | | | | | | | | |
| | Dumpster - Pick-up | 12 | 12 | 12 | 12 | | | |
| | Forklift | 8 | 16 | 8 | 8 | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | 6 | | | |
| | Bulldozer | 120 | 20 | 20 | 80 | | | |
| | Compactor | 16 | | | 24 | | | |
| | Front-end Loader | 120 | 60 | 60 | 80 | | | |
| | Dump Truck | 100 | 20 | 20 | 80 | | | |
| | Ready Mix Trucks | | 24 | 24 | 6 | | | |
| | Med Flatbed | | 10 | 10 | 8 | | | |
| | Drill Rig | | 8 | 8 | | | | |

# PHASE IV - April 2014 - March 2015

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Visitor Center, Jaguar Exhibit<br>Condor Interpretive Station | | Hours of Operation<br>Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2014 | | | | | | |
| | | Q2 | Q3 | Q4 | | | | |
| Visitor Center | | | | | | | | |
| | Dumpster - Pick-up | 8 | 10 | 10 | | | | |
| | Truck Cranes | | | 4 | | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | | | | |
| | Small-Med Flatbed | 30 | 30 | 30 | | | | |
| Jaguar Exhibit | | | | | | | | |
| Condor Interpretive Station | | | | | | | | |
| | Boom Lift | | 24 | 32 | | | | |
| | Forklift | 20 | 20 | 20 | | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | | | | |
| | Bulldozer | 16 | | 32 | | | | |
| | Compactor | 16 | | 32 | | | | |
| | Front-end Loader | 24 | 8 | 60 | | | | |
| | Material Trucking | 8 | 16 | 16 | | | | |
| | Dump Truck | 16 | | 8 | | | | |
| | Ready Mix Trucks | 10 | | 6 | | | | |
| | Small-Med Flatbed | 6 | 6 | 8 | | | | |
| | Drill Rig | | 16 | 8 | | | | |

# PHASE V - March 2015 - April 2016

## OAKLAND ZOO - CALIFORNIA EXHIBIT

| Amphitheater<br>Beaver Exhibit, Water Fowl Exhibit | | Hours of Operation<br>Approximate Quarter of Use | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Large Equipment, Heavy Machinery & Trucking | | 2015 | | | 2016 | | | |
| | | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Amphitheater | | | | | | | | |
| Beaver Exhibit | | | | | | | | |
| Water Fowl Exhibit | | | | | | | | |
| | Dumpster - Pick-up | 8 | 8 | 8 | | | | |
| | Boom Lift | | 12 | 16 | | | | |
| | Forklift | 10 | 10 | 10 | | | | |
| | Portable Toilets - Servicing | 6 | 6 | 6 | | | | |
| | Excavator | 60 | 40 | | | | | |
| | Bulldozer | 20 | | 20 | | | | |
| | Compactor | 10 | | 16 | | | | |
| | Front-end Loader | 16 | 24 | 24 | | | | |
| | Material Trucking | 4 | 8 | 8 | | | | |
| | Dump Truck | 20 | 10 | 20 | | | | |
| | Ready Mix Trucks | | 20 | 10 | | | | |
| | Small-Med Flatbed | | 8 | 8 | | | | |

**PROPOSED MASTER PLAN AMENDMENT: CONSTRUCTION PHASING AND NUMBER OF CONSTRUCTION WORKERS**

| Phase | Duration | Construction Workers (peak daily number) |
|---|---|---|
| ***Phase 1*** | ***12 months*** | ***32 workers*** |
| Veterinary Medical Hospital | 12 months | 18 |
| Perimeter Fence | 3 months | 6 |
| Service Road | 2-3 months | 8 |
| ***Phase 2*** | ***8 months*** | ***43 workers*** |
| Gondola People-Moving System (including portion of California Interpretive Center building) | 8 months | 11 |
| Overnight Camping Area | 3 months | 3 |
| Grizzly Bear Exhibit | 8 months | 8 |
| Bison/Tule Elk Feeding Station | 1 month | 4 |
| Small Exhibit Activity Zone | 4 months | 5 |
| Main Site Utilities | 3 months | 12 |
| | | |
| ***Phase 3*** | ***6 months*** | ***31 workers*** |
| Wolf Exhibit | 6 months | 6 |
| Eagle Exhibit and Viewing Structures | 6 months | 14 |
| Black Bear and Mountain Lion Exhibits | 4 months | 3 |
| Interpretive Kiosk | 6 months | 8 |
| | | |
| ***Phase 4*** | ***8 months*** | ***34 workers*** |
| California Interpretive Center | 8 months | 18 |
| Jaguar Exhibit | 6 months | 8 |
| Condor Exhibit | 3 months | 8 |
| | | |
| ***Phase 5*** | ***8 months*** | ***20 workers*** |
| Amphitheater | 4 months | 10 |
| Beaver/Water Fowl Aviary | 6-8 months | 10 |

Source: Oakland Zoo, 2010.

# Appendix B.2

# Construction Equipment Emission Factors

| CY | Project Equipment | OFFROAD Equipment | Horsepower | Load Factor | Emission Factor | Units | Pollutant |
|---|---|---|---|---|---|---|---|
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.18 | g/hp-hr | NOX |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.20 | g/hp-hr | PM10 |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2010 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.16 | g/hp-hr | CH4 |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.58 | g/hp-hr | CO |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.49 | g/hp-hr | NOX |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.75 | g/hp-hr | ROG |
| 2010 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.09 | g/hp-hr | CH4 |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.72 | g/hp-hr | CO |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 6.68 | g/hp-hr | NOX |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 1.04 | g/hp-hr | ROG |
| 2010 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.09 | g/hp-hr | CH4 |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.98 | g/hp-hr | CO |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 6.22 | g/hp-hr | NOX |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 1.00 | g/hp-hr | ROG |
| 2010 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.07 | g/hp-hr | CH4 |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 5.64 | g/hp-hr | NOX |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.74 | g/hp-hr | ROG |
| 2010 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.07 | g/hp-hr | CH4 |
| 2010 | Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2010 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2010 | Excavator | Excavators | 168 | 0.57 | 5.64 | g/hp-hr | NOX |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.74 | g/hp-hr | ROG |
| 2010 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.07 | g/hp-hr | CH4 |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 5.59 | g/hp-hr | NOX |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.74 | g/hp-hr | ROG |
| 2010 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.07 | g/hp-hr | CH4 |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.38 | g/hp-hr | CO |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 6.15 | g/hp-hr | NOX |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.79 | g/hp-hr | ROG |
| 2010 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.12 | g/hp-hr | CH4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2010 | Paver | Pavers | 100 | 0.62 | 4.29 | g/hp-hr | CO |
| 2010 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2010 | Paver | Pavers | 100 | 0.62 | 7.96 | g/hp-hr | NOX |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2010 | Paver | Pavers | 100 | 0.62 | 1.35 | g/hp-hr | ROG |
| 2010 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.07 | g/hp-hr | CH4 |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 5.64 | g/hp-hr | NOX |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.74 | g/hp-hr | ROG |
| 2010 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.02 | g/hp-hr | CO |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 3.11 | g/hp-hr | NOX |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.27 | g/hp-hr | ROG |
| 2010 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.06 | g/hp-hr | CH4 |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.67 | g/hp-hr | CO |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 6.28 | g/hp-hr | NOX |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.64 | g/hp-hr | ROG |
| 2010 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 2.09 | g/hp-hr | CO |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 5.59 | g/hp-hr | NOX |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.57 | g/hp-hr | ROG |
| 2010 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.07 | g/hp-hr | CH4 |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.74 | g/hp-hr | CO |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 6.88 | g/hp-hr | NOX |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.78 | g/hp-hr | ROG |
| 2010 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 2.00 | g/hp-hr | CO |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 5.27 | g/hp-hr | NOX |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.48 | g/hp-hr | ROG |
| 2010 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 2.09 | g/hp-hr | CO |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 5.59 | g/hp-hr | NOX |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.57 | g/hp-hr | ROG |
| 2010 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.15 | g/hp-hr | NOX |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.17 | g/hp-hr | PM10 |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2011 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.14 | g/hp-hr | CH4 |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.37 | g/hp-hr | CO |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.41 | g/hp-hr | NOX |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.52 | g/hp-hr | ROG |
| 2011 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.09 | g/hp-hr | CH4 |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.69 | g/hp-hr | CO |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 6.31 | g/hp-hr | NOX |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.96 | g/hp-hr | ROG |
| 2011 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.08 | g/hp-hr | CH4 |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.94 | g/hp-hr | CO |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 5.81 | g/hp-hr | NOX |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.91 | g/hp-hr | ROG |
| 2011 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 5.25 | g/hp-hr | NOX |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.70 | g/hp-hr | ROG |
| 2011 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2011 | Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2011 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2011 | Excavator | Excavators | 168 | 0.57 | 5.25 | g/hp-hr | NOX |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.70 | g/hp-hr | ROG |
| 2011 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.06 | g/hp-hr | CH4 |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 5.13 | g/hp-hr | NOX |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.68 | g/hp-hr | ROG |
| 2011 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.07 | g/hp-hr | CH4 |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.37 | g/hp-hr | CO |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 5.78 | g/hp-hr | NOX |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.74 | g/hp-hr | ROG |
| 2011 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2011 | Paver | Pavers | 100 | 0.62 | 0.11 | g/hp-hr | CH4 |
| 2011 | Paver | Pavers | 100 | 0.62 | 4.24 | g/hp-hr | CO |
| 2011 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2011 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2011 | Paver | Pavers | 100 | 0.62 | 7.59 | g/hp-hr | NOX |

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|---|---|---|---|---|---|---|---|
| 2011 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2011 | Paver | Pavers | 100 | 0.62 | 1.27 | g/hp-hr | ROG |
| 2011 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 3.39 | g/hp-hr | CO |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 5.25 | g/hp-hr | NOX |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.70 | g/hp-hr | ROG |
| 2011 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 2.72 | g/hp-hr | NOX |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.26 | g/hp-hr | ROG |
| 2011 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.60 | g/hp-hr | CO |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 5.75 | g/hp-hr | NOX |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.60 | g/hp-hr | ROG |
| 2011 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.94 | g/hp-hr | CO |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 5.20 | g/hp-hr | NOX |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.54 | g/hp-hr | ROG |
| 2011 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.07 | g/hp-hr | CH4 |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.49 | g/hp-hr | CO |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 6.52 | g/hp-hr | NOX |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.75 | g/hp-hr | ROG |
| 2011 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.87 | g/hp-hr | CO |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 4.91 | g/hp-hr | NOX |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.45 | g/hp-hr | ROG |
| 2011 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 1.94 | g/hp-hr | CO |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 5.20 | g/hp-hr | NOX |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.54 | g/hp-hr | ROG |
| 2011 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.17 | g/hp-hr | PM10 |
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |

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|---|---|---|---|---|---|---|---|
| 2012 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.12 | g/hp-hr | CH4 |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.19 | g/hp-hr | CO |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.35 | g/hp-hr | NOX |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.33 | g/hp-hr | ROG |
| 2012 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.08 | g/hp-hr | CH4 |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.65 | g/hp-hr | CO |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 5.93 | g/hp-hr | NOX |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.89 | g/hp-hr | ROG |
| 2012 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.08 | g/hp-hr | CH4 |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.91 | g/hp-hr | CO |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 5.39 | g/hp-hr | NOX |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.84 | g/hp-hr | ROG |
| 2012 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 4.87 | g/hp-hr | NOX |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.65 | g/hp-hr | ROG |
| 2012 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2012 | Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2012 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2012 | Excavator | Excavators | 168 | 0.57 | 4.87 | g/hp-hr | NOX |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.65 | g/hp-hr | ROG |
| 2012 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.06 | g/hp-hr | CH4 |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 4.69 | g/hp-hr | NOX |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.63 | g/hp-hr | ROG |
| 2012 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.06 | g/hp-hr | CH4 |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.36 | g/hp-hr | CO |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 5.42 | g/hp-hr | NOX |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.70 | g/hp-hr | ROG |
| 2012 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.11 | g/hp-hr | CH4 |
| 2012 | Paver | Pavers | 100 | 0.62 | 4.19 | g/hp-hr | CO |
| 2012 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2012 | Paver | Pavers | 100 | 0.62 | 7.22 | g/hp-hr | NOX |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2012 | Paver | Pavers | 100 | 0.62 | 1.21 | g/hp-hr | ROG |
| 2012 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |

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|---|---|---|---|---|---|---|---|
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 4.87 | g/hp-hr | NOX |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.65 | g/hp-hr | ROG |
| 2012 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 2.40 | g/hp-hr | NOX |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.25 | g/hp-hr | ROG |
| 2012 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.53 | g/hp-hr | CO |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 5.26 | g/hp-hr | NOX |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.57 | g/hp-hr | ROG |
| 2012 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.80 | g/hp-hr | CO |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 4.84 | g/hp-hr | NOX |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.52 | g/hp-hr | ROG |
| 2012 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.27 | g/hp-hr | CO |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 6.18 | g/hp-hr | NOX |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.72 | g/hp-hr | ROG |
| 2012 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.75 | g/hp-hr | CO |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 4.58 | g/hp-hr | NOX |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.42 | g/hp-hr | ROG |
| 2012 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.05 | g/hp-hr | CH4 |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 1.80 | g/hp-hr | CO |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 4.84 | g/hp-hr | NOX |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.52 | g/hp-hr | ROG |
| 2012 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.16 | g/hp-hr | PM10 |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2013 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.10 | g/hp-hr | CH4 |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.04 | g/hp-hr | CO |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |

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|---|---|---|---|---|---|---|---|
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 5.07 | g/hp-hr | NOX |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 1.15 | g/hp-hr | ROG |
| 2013 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.07 | g/hp-hr | CH4 |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.61 | g/hp-hr | CO |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 5.55 | g/hp-hr | NOX |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.82 | g/hp-hr | ROG |
| 2013 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.07 | g/hp-hr | CH4 |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.88 | g/hp-hr | CO |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 5.02 | g/hp-hr | NOX |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.76 | g/hp-hr | ROG |
| 2013 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 4.52 | g/hp-hr | NOX |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.61 | g/hp-hr | ROG |
| 2013 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2013 | Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2013 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2013 | Excavator | Excavators | 168 | 0.57 | 4.52 | g/hp-hr | NOX |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.61 | g/hp-hr | ROG |
| 2013 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.05 | g/hp-hr | CH4 |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 4.29 | g/hp-hr | NOX |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.57 | g/hp-hr | ROG |
| 2013 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.06 | g/hp-hr | CH4 |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.35 | g/hp-hr | CO |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 5.08 | g/hp-hr | NOX |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.66 | g/hp-hr | ROG |
| 2013 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.10 | g/hp-hr | CH4 |
| 2013 | Paver | Pavers | 100 | 0.62 | 4.15 | g/hp-hr | CO |
| 2013 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2013 | Paver | Pavers | 100 | 0.62 | 6.86 | g/hp-hr | NOX |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2013 | Paver | Pavers | 100 | 0.62 | 1.14 | g/hp-hr | ROG |
| 2013 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.06 | g/hp-hr | CH4 |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 3.38 | g/hp-hr | CO |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 4.52 | g/hp-hr | NOX |

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|---|---|---|---|---|---|---|---|
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.61 | g/hp-hr | ROG |
| 2013 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 2.14 | g/hp-hr | NOX |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.24 | g/hp-hr | ROG |
| 2013 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.49 | g/hp-hr | CO |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 4.81 | g/hp-hr | NOX |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.54 | g/hp-hr | ROG |
| 2013 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.67 | g/hp-hr | CO |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 4.49 | g/hp-hr | NOX |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.49 | g/hp-hr | ROG |
| 2013 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 3.05 | g/hp-hr | CO |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 5.86 | g/hp-hr | NOX |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.69 | g/hp-hr | ROG |
| 2013 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.04 | g/hp-hr | CH4 |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.65 | g/hp-hr | CO |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 4.26 | g/hp-hr | NOX |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.39 | g/hp-hr | ROG |
| 2013 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 1.67 | g/hp-hr | CO |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 4.49 | g/hp-hr | NOX |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.49 | g/hp-hr | ROG |
| 2013 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.16 | g/hp-hr | PM10 |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2014 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.09 | g/hp-hr | CH4 |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.89 | g/hp-hr | CO |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.81 | g/hp-hr | NOX |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.99 | g/hp-hr | ROG |

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|---|---|---|---|---|---|---|---|
| 2014 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.07 | g/hp-hr | CH4 |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.57 | g/hp-hr | CO |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 5.21 | g/hp-hr | NOX |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.74 | g/hp-hr | ROG |
| 2014 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.06 | g/hp-hr | CH4 |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.85 | g/hp-hr | CO |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 4.67 | g/hp-hr | NOX |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.70 | g/hp-hr | ROG |
| 2014 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 4.22 | g/hp-hr | NOX |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.57 | g/hp-hr | ROG |
| 2014 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2014 | Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2014 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2014 | Excavator | Excavators | 168 | 0.57 | 4.22 | g/hp-hr | NOX |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.57 | g/hp-hr | ROG |
| 2014 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.05 | g/hp-hr | CH4 |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 3.35 | g/hp-hr | CO |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 3.91 | g/hp-hr | NOX |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.53 | g/hp-hr | ROG |
| 2014 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.06 | g/hp-hr | CH4 |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.35 | g/hp-hr | CO |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 4.77 | g/hp-hr | NOX |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.62 | g/hp-hr | ROG |
| 2014 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.10 | g/hp-hr | CH4 |
| 2014 | Paver | Pavers | 100 | 0.62 | 4.12 | g/hp-hr | CO |
| 2014 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2014 | Paver | Pavers | 100 | 0.62 | 6.53 | g/hp-hr | NOX |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2014 | Paver | Pavers | 100 | 0.62 | 1.08 | g/hp-hr | ROG |
| 2014 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 4.22 | g/hp-hr | NOX |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.57 | g/hp-hr | ROG |
| 2014 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |

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|---|---|---|---|---|---|---|---|
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.74 | g/hp-hr | NOX |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.22 | g/hp-hr | ROG |
| 2014 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.05 | g/hp-hr | CH4 |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.46 | g/hp-hr | CO |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 4.30 | g/hp-hr | NOX |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.52 | g/hp-hr | ROG |
| 2014 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.56 | g/hp-hr | CO |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 4.10 | g/hp-hr | NOX |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.46 | g/hp-hr | ROG |
| 2014 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 2.85 | g/hp-hr | CO |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 5.49 | g/hp-hr | NOX |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.66 | g/hp-hr | ROG |
| 2014 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.03 | g/hp-hr | CH4 |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.56 | g/hp-hr | CO |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 3.89 | g/hp-hr | NOX |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.37 | g/hp-hr | ROG |
| 2014 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 1.56 | g/hp-hr | CO |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 4.10 | g/hp-hr | NOX |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.46 | g/hp-hr | ROG |
| 2014 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.06 | g/hp-hr | CH4 |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 3.47 | g/hp-hr | CO |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 4.14 | g/hp-hr | NOX |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.16 | g/hp-hr | PM10 |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.66 | g/hp-hr | ROG |
| 2015 | Backfill Compactor | Plate Compactors | 8 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.08 | g/hp-hr | CH4 |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.76 | g/hp-hr | CO |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 4.57 | g/hp-hr | NOX |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.22 | g/hp-hr | PM10 |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.84 | g/hp-hr | ROG |
| 2015 | Bobcat | Skid Steer Loaders | 44 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.06 | g/hp-hr | CH4 |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 3.54 | g/hp-hr | CO |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 568.30 | g/hp-hr | CO2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.00 | g/hp-hr | N2O |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 4.83 | g/hp-hr | NOX |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.22 | g/hp-hr | PM10 |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.67 | g/hp-hr | ROG |
| 2015 | Boom Lift | Aerial Lifts | 60 | 0.46 | 0.01 | g/hp-hr | SOx |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.06 | g/hp-hr | CH4 |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 3.82 | g/hp-hr | CO |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 568.30 | g/hp-hr | CO2 |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.00 | g/hp-hr | N2O |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 4.25 | g/hp-hr | NOX |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.02 | g/hp-hr | PM10 |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.63 | g/hp-hr | ROG |
| 2015 | Backhoe | Tractors/Loaders/Backh | 108 | 0.55 | 0.01 | g/hp-hr | SOx |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 3.75 | g/hp-hr | NOX |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.53 | g/hp-hr | ROG |
| 2015 | Compact Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2015 | Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2015 | Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2015 | Excavator | Excavators | 168 | 0.57 | 3.75 | g/hp-hr | NOX |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.53 | g/hp-hr | ROG |
| 2015 | Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.04 | g/hp-hr | CH4 |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 3.36 | g/hp-hr | CO |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 568.30 | g/hp-hr | CO2 |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.00 | g/hp-hr | N2O |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 3.46 | g/hp-hr | NOX |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.02 | g/hp-hr | PM10 |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.49 | g/hp-hr | ROG |
| 2015 | Forklift | Forklifts | 145 | 0.3 | 0.01 | g/hp-hr | SOx |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.05 | g/hp-hr | CH4 |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 3.34 | g/hp-hr | CO |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 568.30 | g/hp-hr | CO2 |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.00 | g/hp-hr | N2O |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 4.32 | g/hp-hr | NOX |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.02 | g/hp-hr | PM10 |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.58 | g/hp-hr | ROG |
| 2015 | Front-end Loader | Rubber Tired Loaders | 164 | 0.54 | 0.01 | g/hp-hr | SOx |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.09 | g/hp-hr | CH4 |
| 2015 | Paver | Pavers | 100 | 0.62 | 4.08 | g/hp-hr | CO |
| 2015 | Paver | Pavers | 100 | 0.62 | 568.30 | g/hp-hr | CO2 |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.00 | g/hp-hr | N2O |
| 2015 | Paver | Pavers | 100 | 0.62 | 6.14 | g/hp-hr | NOX |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.02 | g/hp-hr | PM10 |
| 2015 | Paver | Pavers | 100 | 0.62 | 1.01 | g/hp-hr | ROG |
| 2015 | Paver | Pavers | 100 | 0.62 | 0.01 | g/hp-hr | SOx |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.05 | g/hp-hr | CH4 |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 3.37 | g/hp-hr | CO |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 568.30 | g/hp-hr | CO2 |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.00 | g/hp-hr | N2O |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 3.75 | g/hp-hr | NOX |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.02 | g/hp-hr | PM10 |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.53 | g/hp-hr | ROG |
| 2015 | Tracked Excavator | Excavators | 168 | 0.57 | 0.01 | g/hp-hr | SOx |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | CH4 |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.01 | g/hp-hr | CO |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 568.30 | g/hp-hr | CO2 |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.00 | g/hp-hr | N2O |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 1.40 | g/hp-hr | NOX |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.02 | g/hp-hr | PM10 |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.20 | g/hp-hr | ROG |
| 2015 | Drill Rig | Bore/Drill Rigs | 291 | 0.75 | 0.01 | g/hp-hr | SOx |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.04 | g/hp-hr | CH4 |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 1.44 | g/hp-hr | CO |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 647.86 | g/hp-hr | CO2 |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.00 | g/hp-hr | N2O |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 3.82 | g/hp-hr | NOX |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.02 | g/hp-hr | PM10 |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.49 | g/hp-hr | ROG |
| 2015 | Water Truck | Off-Highway Trucks | 189 | 0.5 | 0.01 | g/hp-hr | SOx |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 1.47 | g/hp-hr | CO |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 3.73 | g/hp-hr | NOX |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.44 | g/hp-hr | ROG |
| 2015 | 75 Ton Crane | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.06 | g/hp-hr | CH4 |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 2.67 | g/hp-hr | CO |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 568.30 | g/hp-hr | CO2 |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.00 | g/hp-hr | N2O |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 5.14 | g/hp-hr | NOX |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.02 | g/hp-hr | PM10 |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.63 | g/hp-hr | ROG |
| 2015 | Bulldozer | Rubber Tired Dozers | 357 | 0.59 | 0.01 | g/hp-hr | SOx |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.03 | g/hp-hr | CH4 |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 1.48 | g/hp-hr | CO |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 568.30 | g/hp-hr | CO2 |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.00 | g/hp-hr | N2O |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 3.55 | g/hp-hr | NOX |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.02 | g/hp-hr | PM10 |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.34 | g/hp-hr | ROG |
| 2015 | Compactor | Surfacing Equipment | 362 | 0.45 | 0.01 | g/hp-hr | SOx |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.04 | g/hp-hr | CH4 |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 1.47 | g/hp-hr | CO |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 568.30 | g/hp-hr | CO2 |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.00 | g/hp-hr | N2O |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 3.73 | g/hp-hr | NOX |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.02 | g/hp-hr | PM10 |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.44 | g/hp-hr | ROG |
| 2015 | Truck Cranes | Cranes | 399 | 0.43 | 0.01 | g/hp-hr | SOx |

# Appendix B.3

# Construction Mobile EMFAC Outputs

**Modeled Mobile Sources**

| Project Vehicle | EMFAC Vehicle Class | Fuel |
|---|---|---|
| Dump Truck | MHDT | Diesel |
| Dumpster - Pick-up | MHDT | Diesel |
| Flatbed | MHDT | Diesel |
| Flatbed Semi Trucks | MHDT | Diesel |
| Full Flatbed Semi Trucks (All) | MHDT | Diesel |
| Material Trucking | MHDT | Diesel |
| Med Flatbed | MHDT | Diesel |
| Ready Mix Trucks | MHDT | Diesel |
| Small-Med Flatbed | MHDT | Diesel |

| Employee Vehicle | EFMAC Vehicle Class | Fuel |
|---|---|---|
| Passenger Car | LDA | All |
| Light-Duty Truck (GVW <3,750 lb) | LDT1 | All |
| Light-Duty Truck (GVW >3,750 lb) | LDT2 | All |

**Abbreviations**
GVW: Gross Vehicle Weight
LDA: Light-Duty Auto
LDT: Light-Duty Truck
MHDT: Medium Heavy-Duty Truck

**EMFAC Running Log (Oakland Zoo.inp)**

```
Emfac2007-Header
   Version 2 30 3 501
   Scenario-Count 1
End-Header
Begin-Scenario 1
   Title Oakland Zoo
   Program-Mode Emfac
   Area-Method One-County
   Area-Type County
   Area-Number 1 [Alameda County]
   HC-Mode ROG
   PM-Mode PM10
   CYr 2010 2011 2012 2013 2014
   MYr All
   Vehicles LDA LDT1 LDT2 MHD
   Season Annual
   Emfac-Reports RTL
   Emfac-Speed 0 5. 10. 15. 20. 25. 30. 35. 40. 45. 50. 55. 60. 65.
   Emfac-RH 75.
   Emfac-Temp 59.
End-Scenario
```

**Emission Factors by Vehicle Type by Year**

| Year | Vehicle Class | nission Fact | Units | Pollutants | Emission Type |
|---|---|---|---|---|---|
| 2010 | MHDT | 0.242 | g/mile | ROG | Running |
| 2011 | MHDT | 0.233 | g/mile | ROG | Running |
| 2012 | MHDT | 0.224 | g/mile | ROG | Running |
| 2013 | MHDT | 0.214 | g/mile | ROG | Running |
| 2014 | MHDT | 0.204 | g/mile | ROG | Running |
| 2015 | MHDT | 0.194 | g/mile | ROG | Running |
| 2010 | MHDT | 2.061 | g/mile | CO | Running |
| 2011 | MHDT | 2.016 | g/mile | CO | Running |
| 2012 | MHDT | 1.965 | g/mile | CO | Running |
| 2013 | MHDT | 1.91 | g/mile | CO | Running |
| 2014 | MHDT | 1.854 | g/mile | CO | Running |
| 2015 | MHDT | 1.798 | g/mile | CO | Running |
| 2010 | MHDT | 7.102 | g/mile | NOx | Running |
| 2011 | MHDT | 6.511 | g/mile | NOx | Running |
| 2012 | MHDT | 5.937 | g/mile | NOx | Running |
| 2013 | MHDT | 5.384 | g/mile | NOx | Running |
| 2014 | MHDT | 4.866 | g/mile | NOx | Running |
| 2015 | MHDT | 4.38 | g/mile | NOx | Running |
| 2010 | MHDT | 1505 | g/mile | CO2 | Running |
| 2011 | MHDT | 1505 | g/mile | CO2 | Running |
| 2012 | MHDT | 1505 | g/mile | CO2 | Running |
| 2013 | MHDT | 1505 | g/mile | CO2 | Running |
| 2014 | MHDT | 1505 | g/mile | CO2 | Running |
| 2015 | MHDT | 1505 | g/mile | CO2 | Running |
| 2010 | MHDT | 0.014 | g/mile | SOx | Running |
| 2011 | MHDT | 0.014 | g/mile | SOx | Running |
| 2012 | MHDT | 0.014 | g/mile | SOx | Running |
| 2013 | MHDT | 0.014 | g/mile | SOx | Running |
| 2014 | MHDT | 0.014 | g/mile | SOx | Running |
| 2015 | MHDT | 0.014 | g/mile | SOx | Running |
| 2010 | MHDT | 0.295 | g/mile | PM10 | Running |
| 2011 | MHDT | 0.282 | g/mile | PM10 | Running |
| 2012 | MHDT | 0.268 | g/mile | PM10 | Running |
| 2013 | MHDT | 0.255 | g/mile | PM10 | Running |
| 2014 | MHDT | 0.241 | g/mile | PM10 | Running |
| 2015 | MHDT | 0.229 | g/mile | PM10 | Running |
| 2010 | LDA | 0.11 | g/mile | ROG | Running |
| 2011 | LDA | 0.092 | g/mile | ROG | Running |
| 2012 | LDA | 0.077 | g/mile | ROG | Running |
| 2013 | LDA | 0.065 | g/mile | ROG | Running |
| 2014 | LDA | 0.055 | g/mile | ROG | Running |
| 2015 | LDA | 0.047 | g/mile | ROG | Running |
| 2010 | LDA | 2.869 | g/mile | CO | Running |
| 2011 | LDA | 2.56 | g/mile | CO | Running |
| 2012 | LDA | 2.29 | g/mile | CO | Running |
| 2013 | LDA | 2.059 | g/mile | CO | Running |
| 2014 | LDA | 1.853 | g/mile | CO | Running |
| 2015 | LDA | 1.678 | g/mile | CO | Running |
| 2010 | LDA | 0.25 | g/mile | NOx | Running |
| 2011 | LDA | 0.221 | g/mile | NOx | Running |
| 2012 | LDA | 0.196 | g/mile | NOx | Running |
| 2013 | LDA | 0.175 | g/mile | NOx | Running |

| | | | | | |
|---|---|---|---|---|---|
| 2014 | LDA | 0.156 | g/mile | NOx | Running |
| 2015 | LDA | 0.14 | g/mile | NOx | Running |
| 2010 | LDA | 389.562 | g/mile | CO2 | Running |
| 2011 | LDA | 388.335 | g/mile | CO2 | Running |
| 2012 | LDA | 387.131 | g/mile | CO2 | Running |
| 2013 | LDA | 386.107 | g/mile | CO2 | Running |
| 2014 | LDA | 385.222 | g/mile | CO2 | Running |
| 2015 | LDA | 384.281 | g/mile | CO2 | Running |
| 2010 | LDA | 0.004 | g/mile | SOx | Running |
| 2011 | LDA | 0.004 | g/mile | SOx | Running |
| 2012 | LDA | 0.004 | g/mile | SOx | Running |
| 2013 | LDA | 0.004 | g/mile | SOx | Running |
| 2014 | LDA | 0.004 | g/mile | SOx | Running |
| 2015 | LDA | 0.004 | g/mile | SOx | Running |
| 2010 | LDA | 0.013 | g/mile | PM10 | Running |
| 2011 | LDA | 0.013 | g/mile | PM10 | Running |
| 2012 | LDA | 0.013 | g/mile | PM10 | Running |
| 2013 | LDA | 0.013 | g/mile | PM10 | Running |
| 2014 | LDA | 0.013 | g/mile | PM10 | Running |
| 2015 | LDA | 0.013 | g/mile | PM10 | Running |
| 2010 | LDT1 | 0.201 | g/mile | ROG | Running |
| 2011 | LDT1 | 0.175 | g/mile | ROG | Running |
| 2012 | LDT1 | 0.152 | g/mile | ROG | Running |
| 2013 | LDT1 | 0.131 | g/mile | ROG | Running |
| 2014 | LDT1 | 0.112 | g/mile | ROG | Running |
| 2015 | LDT1 | 0.096 | g/mile | ROG | Running |
| 2010 | LDT1 | 5.022 | g/mile | CO | Running |
| 2011 | LDT1 | 4.554 | g/mile | CO | Running |
| 2012 | LDT1 | 4.116 | g/mile | CO | Running |
| 2013 | LDT1 | 3.707 | g/mile | CO | Running |
| 2014 | LDT1 | 3.341 | g/mile | CO | Running |
| 2015 | LDT1 | 3.015 | g/mile | CO | Running |
| 2010 | LDT1 | 0.456 | g/mile | NOx | Running |
| 2011 | LDT1 | 0.412 | g/mile | NOx | Running |
| 2012 | LDT1 | 0.371 | g/mile | NOx | Running |
| 2013 | LDT1 | 0.334 | g/mile | NOx | Running |
| 2014 | LDT1 | 0.301 | g/mile | NOx | Running |
| 2015 | LDT1 | 0.271 | g/mile | NOx | Running |
| 2010 | LDT1 | 479.718 | g/mile | CO2 | Running |
| 2011 | LDT1 | 479.817 | g/mile | CO2 | Running |
| 2012 | LDT1 | 479.717 | g/mile | CO2 | Running |
| 2013 | LDT1 | 479.608 | g/mile | CO2 | Running |
| 2014 | LDT1 | 479.498 | g/mile | CO2 | Running |
| 2015 | LDT1 | 479.156 | g/mile | CO2 | Running |
| 2010 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2011 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2012 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2013 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2014 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2015 | LDT1 | 0.005 | g/mile | SOx | Running |
| 2010 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2011 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2012 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2013 | LDT1 | 0.017 | g/mile | PM10 | Running |
| 2014 | LDT1 | 0.017 | g/mile | PM10 | Running |

| | | | | | |
|---|---|---|---|---|---|
| 2015 | LDT1 | 0.016 | g/mile | PM10 | Running |
| 2010 | LDT2 | 0.115 | g/mile | ROG | Running |
| 2011 | LDT2 | 0.104 | g/mile | ROG | Running |
| 2012 | LDT2 | 0.094 | g/mile | ROG | Running |
| 2013 | LDT2 | 0.084 | g/mile | ROG | Running |
| 2014 | LDT2 | 0.075 | g/mile | ROG | Running |
| 2015 | LDT2 | 0.067 | g/mile | ROG | Running |
| 2010 | LDT2 | 3.55 | g/mile | CO | Running |
| 2011 | LDT2 | 3.342 | g/mile | CO | Running |
| 2012 | LDT2 | 3.139 | g/mile | CO | Running |
| 2013 | LDT2 | 2.939 | g/mile | CO | Running |
| 2014 | LDT2 | 2.744 | g/mile | CO | Running |
| 2015 | LDT2 | 2.561 | g/mile | CO | Running |
| 2010 | LDT2 | 0.44 | g/mile | NOx | Running |
| 2011 | LDT2 | 0.407 | g/mile | NOx | Running |
| 2012 | LDT2 | 0.377 | g/mile | NOx | Running |
| 2013 | LDT2 | 0.347 | g/mile | NOx | Running |
| 2014 | LDT2 | 0.319 | g/mile | NOx | Running |
| 2015 | LDT2 | 0.293 | g/mile | NOx | Running |
| 2010 | LDT2 | 484.079 | g/mile | CO2 | Running |
| 2011 | LDT2 | 484.2 | g/mile | CO2 | Running |
| 2012 | LDT2 | 484.307 | g/mile | CO2 | Running |
| 2013 | LDT2 | 484.402 | g/mile | CO2 | Running |
| 2014 | LDT2 | 484.486 | g/mile | CO2 | Running |
| 2015 | LDT2 | 484.559 | g/mile | CO2 | Running |
| 2010 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2011 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2012 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2013 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2014 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2015 | LDT2 | 0.005 | g/mile | SOx | Running |
| 2010 | LDT2 | 0.029 | g/mile | PM10 | Running |
| 2011 | LDT2 | 0.029 | g/mile | PM10 | Running |
| 2012 | LDT2 | 0.03 | g/mile | PM10 | Running |
| 2013 | LDT2 | 0.031 | g/mile | PM10 | Running |
| 2014 | LDT2 | 0.031 | g/mile | PM10 | Running |
| 2015 | LDT2 | 0.032 | g/mile | PM10 | Running |
| 2010 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2011 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2012 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2013 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2014 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2015 | MHDT | 3.173 | g/idle-hour | ROG | Idling |
| 2010 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2011 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2012 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2013 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2014 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2015 | MHDT | 26.3 | g/idle-hour | CO | Idling |
| 2010 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2011 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2012 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2013 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2014 | MHDT | 75.051 | g/idle-hour | NOx | Idling |
| 2015 | MHDT | 75.051 | g/idle-hour | NOx | Idling |

| | | | | | |
|---|---|---|---|---|---|
| 2010 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2011 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2012 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2013 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2014 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2015 | MHDT | 4098 | g/idle-hour | CO2 | Idling |
| 2010 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2011 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2012 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2013 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2014 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2015 | MHDT | 0.039 | g/idle-hour | SOx | Idling |
| 2010 | MHDT | 0.917 | g/idle-hour | PM10 | Idling |
| 2011 | MHDT | 0.903 | g/idle-hour | PM10 | Idling |
| 2012 | MHDT | 0.891 | g/idle-hour | PM10 | Idling |
| 2013 | MHDT | 0.879 | g/idle-hour | PM10 | Idling |
| 2014 | MHDT | 0.869 | g/idle-hour | PM10 | Idling |
| 2015 | MHDT | 0.861 | g/idle-hour | PM10 | Idling |
| 2010 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2011 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2012 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2013 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2014 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2015 | LDA | 0 | g/idle-hour | ROG | Idling |
| 2010 | LDA | 0 | g/idle-hour | CO | Idling |
| 2011 | LDA | 0 | g/idle-hour | CO | Idling |
| 2012 | LDA | 0 | g/idle-hour | CO | Idling |
| 2013 | LDA | 0 | g/idle-hour | CO | Idling |
| 2014 | LDA | 0 | g/idle-hour | CO | Idling |
| 2015 | LDA | 0 | g/idle-hour | CO | Idling |
| 2010 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2011 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2012 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2013 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2014 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2015 | LDA | 0 | g/idle-hour | NOx | Idling |
| 2010 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2011 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2012 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2013 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2014 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2015 | LDA | 0 | g/idle-hour | CO2 | Idling |
| 2010 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2011 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2012 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2013 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2014 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2015 | LDA | 0 | g/idle-hour | SOx | Idling |
| 2010 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2011 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2012 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2013 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2014 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2015 | LDA | 0 | g/idle-hour | PM10 | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | ROG | Idling |

| | | | | | |
|---|---|---|---|---|---|
| 2011 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | ROG | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | CO | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | NOx | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | CO2 | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | SOx | Idling |
| 2010 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2011 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2012 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2013 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2014 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2015 | LDT1 | 0 | g/idle-hour | PM10 | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | ROG | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | CO | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | NOx | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | CO2 | Idling |

| | | | | | |
|---|---|---|---|---|---|
| 2012 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | CO2 | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | SOx | Idling |
| 2010 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2011 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2012 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2013 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2014 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2015 | LDT2 | 0 | g/idle-hour | PM10 | Idling |
| 2010 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2011 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2012 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2013 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2014 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2015 | MHDT | 3.173 | g/idle-hour | ROG | Startup |
| 2010 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2011 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2012 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2013 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2014 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2015 | MHDT | 26.3 | g/idle-hour | CO | Startup |
| 2010 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2011 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2012 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2013 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2014 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2015 | MHDT | 75.051 | g/idle-hour | NOx | Startup |
| 2010 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2011 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2012 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2013 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2014 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2015 | MHDT | 4098 | g/idle-hour | CO2 | Startup |
| 2010 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2011 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2012 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2013 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2014 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2015 | MHDT | 0.039 | g/idle-hour | SOx | Startup |
| 2010 | MHDT | 0.917 | g/idle-hour | PM10 | Startup |
| 2011 | MHDT | 0.903 | g/idle-hour | PM10 | Startup |
| 2012 | MHDT | 0.891 | g/idle-hour | PM10 | Startup |
| 2013 | MHDT | 0.879 | g/idle-hour | PM10 | Startup |
| 2014 | MHDT | 0.869 | g/idle-hour | PM10 | Startup |
| 2015 | MHDT | 0.861 | g/idle-hour | PM10 | Startup |
| 2010 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2011 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2012 | LDA | 0 | g/idle-hour | ROG | Startup |

| | | | | | |
|---|---|---|---|---|---|
| 2013 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2014 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2015 | LDA | 0 | g/idle-hour | ROG | Startup |
| 2010 | LDA | 0 | g/idle-hour | CO | Startup |
| 2011 | LDA | 0 | g/idle-hour | CO | Startup |
| 2012 | LDA | 0 | g/idle-hour | CO | Startup |
| 2013 | LDA | 0 | g/idle-hour | CO | Startup |
| 2014 | LDA | 0 | g/idle-hour | CO | Startup |
| 2015 | LDA | 0 | g/idle-hour | CO | Startup |
| 2010 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2011 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2012 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2013 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2014 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2015 | LDA | 0 | g/idle-hour | NOx | Startup |
| 2010 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2011 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2012 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2013 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2014 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2015 | LDA | 0 | g/idle-hour | CO2 | Startup |
| 2010 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2011 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2012 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2013 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2014 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2015 | LDA | 0 | g/idle-hour | SOx | Startup |
| 2010 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2011 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2012 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2013 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2014 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2015 | LDA | 0 | g/idle-hour | PM10 | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | ROG | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | CO | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | NOx | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | CO2 | Startup |

| | | | | | |
|---|---|---|---|---|---|
| 2014 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | CO2 | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | SOx | Startup |
| 2010 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2011 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2012 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2013 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2014 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2015 | LDT1 | 0 | g/idle-hour | PM10 | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | ROG | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | CO | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | NOx | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | CO2 | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | SOx | Startup |
| 2010 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2011 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2012 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2013 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2014 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2015 | LDT2 | 0 | g/idle-hour | PM10 | Startup |
| 2010 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2011 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2012 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2013 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2014 | MHDT | 0 | g/trip | ROG | Hot Soak |

| | | | | | |
|---|---|---|---|---|---|
| 2015 | MHDT | 0 | g/trip | ROG | Hot Soak |
| 2010 | LDA | 0.256 | g/trip | ROG | Hot Soak |
| 2011 | LDA | 0.247 | g/trip | ROG | Hot Soak |
| 2012 | LDA | 0.238 | g/trip | ROG | Hot Soak |
| 2013 | LDA | 0.23 | g/trip | ROG | Hot Soak |
| 2014 | LDA | 0.222 | g/trip | ROG | Hot Soak |
| 2015 | LDA | 0.214 | g/trip | ROG | Hot Soak |
| 2010 | LDT1 | 0.331 | g/trip | ROG | Hot Soak |
| 2011 | LDT1 | 0.325 | g/trip | ROG | Hot Soak |
| 2012 | LDT1 | 0.317 | g/trip | ROG | Hot Soak |
| 2013 | LDT1 | 0.309 | g/trip | ROG | Hot Soak |
| 2014 | LDT1 | 0.3 | g/trip | ROG | Hot Soak |
| 2015 | LDT1 | 0.291 | g/trip | ROG | Hot Soak |
| 2010 | LDT2 | 0.212 | g/trip | ROG | Hot Soak |
| 2011 | LDT2 | 0.217 | g/trip | ROG | Hot Soak |
| 2012 | LDT2 | 0.221 | g/trip | ROG | Hot Soak |
| 2013 | LDT2 | 0.225 | g/trip | ROG | Hot Soak |
| 2014 | LDT2 | 0.227 | g/trip | ROG | Hot Soak |
| 2015 | LDT2 | 0.228 | g/trip | ROG | Hot Soak |
| 2010 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2011 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2012 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2013 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2014 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2015 | MHDT | 0 | g/hour | ROG | Diurnal |
| 2010 | LDA | 0.06 | g/hour | ROG | Diurnal |
| 2011 | LDA | 0.056 | g/hour | ROG | Diurnal |
| 2012 | LDA | 0.053 | g/hour | ROG | Diurnal |
| 2013 | LDA | 0.05 | g/hour | ROG | Diurnal |
| 2014 | LDA | 0.047 | g/hour | ROG | Diurnal |
| 2015 | LDA | 0.045 | g/hour | ROG | Diurnal |
| 2010 | LDT1 | 0.08 | g/hour | ROG | Diurnal |
| 2011 | LDT1 | 0.078 | g/hour | ROG | Diurnal |
| 2012 | LDT1 | 0.075 | g/hour | ROG | Diurnal |
| 2013 | LDT1 | 0.072 | g/hour | ROG | Diurnal |
| 2014 | LDT1 | 0.069 | g/hour | ROG | Diurnal |
| 2015 | LDT1 | 0.067 | g/hour | ROG | Diurnal |
| 2010 | LDT2 | 0.051 | g/hour | ROG | Diurnal |
| 2011 | LDT2 | 0.05 | g/hour | ROG | Diurnal |
| 2012 | LDT2 | 0.05 | g/hour | ROG | Diurnal |
| 2013 | LDT2 | 0.05 | g/hour | ROG | Diurnal |
| 2014 | LDT2 | 0.049 | g/hour | ROG | Diurnal |
| 2015 | LDT2 | 0.049 | g/hour | ROG | Diurnal |
| 2010 | MHDT | 0 | g/min | ROG | Evaporative |
| 2011 | MHDT | 0 | g/min | ROG | Evaporative |
| 2012 | MHDT | 0 | g/min | ROG | Evaporative |
| 2013 | MHDT | 0 | g/min | ROG | Evaporative |
| 2014 | MHDT | 0 | g/min | ROG | Evaporative |
| 2015 | MHDT | 0 | g/min | ROG | Evaporative |
| 2010 | LDA | 0.026 | g/min | ROG | Evaporative |
| 2011 | LDA | 0.023 | g/min | ROG | Evaporative |
| 2012 | LDA | 0.02 | g/min | ROG | Evaporative |
| 2013 | LDA | 0.019 | g/min | ROG | Evaporative |
| 2014 | LDA | 0.017 | g/min | ROG | Evaporative |
| 2015 | LDA | 0.015 | g/min | ROG | Evaporative |

| | | | | | |
|---|---|---|---|---|---|
| 2010 | LDT1 | 0.605 | g/min | ROG | Evaporative |
| 2011 | LDT1 | 0.602 | g/min | ROG | Evaporative |
| 2012 | LDT1 | 0.591 | g/min | ROG | Evaporative |
| 2013 | LDT1 | 0.576 | g/min | ROG | Evaporative |
| 2014 | LDT1 | 0.558 | g/min | ROG | Evaporative |
| 2015 | LDT1 | 0.538 | g/min | ROG | Evaporative |
| 2010 | LDT2 | 0.379 | g/min | ROG | Evaporative |
| 2011 | LDT2 | 0.384 | g/min | ROG | Evaporative |
| 2012 | LDT2 | 0.385 | g/min | ROG | Evaporative |
| 2013 | LDT2 | 0.384 | g/min | ROG | Evaporative |
| 2014 | LDT2 | 0.381 | g/min | ROG | Evaporative |
| 2015 | LDT2 | 0.376 | g/min | ROG | Evaporative |

# Appendix B.4

# Construction Helicopter EMDS Outputs

# EDMS 5.1.2 Emissions Inventory Report
# Aircraft Emissions by Mode
# Study: Oakland Zoo 2
# Scenario - Airport: Baseline - Metropolitan Oakland Intl
# Year: 2011
# Units: Grams per Year
# Generated: 01/12/10 11:23:59

| # Type | Engine | ID | Euro. Grou | Mode | CO2 | CO | THC | NMHC | VOC |
|---|---|---|---|---|---|---|---|---|---|
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Startup | N/A | N/A | N/A | N/A | N/A |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Taxi Out | 173839.8 | 48.182 | 7.118 | 8.23 | 8.187 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Takeoff | 20014.29 | 5.547 | 0.819 | 0.948 | 0.943 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Climb Out | 40059.05 | 11.103 | 1.64 | 1.896 | 1.887 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Approach | 42944.6 | 11.903 | 1.758 | 2.033 | 2.022 |
| Bell UH-1 Iroquois | T400-CP-400 | #1 | H2 | Taxi In | 64046.24 | 17.751 | 2.622 | 3.032 | 3.016 |

| Mode | Mode Duration (min) | |
|---|---|---|
| | **Model Default** | **Assumption For Emissions Calculation** |
| Taxi Out | 19 | 480 |
| Takeoff | 2.27 | 480 |
| Climbout | 4.53 | 480 |
| Approach | 6.8 | 480 |
| Landing Roll | 0 | 480 |
| Taxi in | 7 | 480 |

| TOG | NOx | SOx | PM-10 | PM-2.5 | Fuel Cons | Formaldeh | Methyl alc | Benzene ( | Acetaldehy | Naphthale | O-xylene ( | Isopropylb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 8.23 | 312.078 | 71.189 | N/A | N/A | 55099.77 | 1.013 | 0.149 | 0.138 | 0.352 | 0.045 | 0.014 | 0 |
| 0.948 | 35.93 | 8.196 | N/A | N/A | 6343.674 | 0.117 | 0.017 | 0.016 | 0.04 | 0.005 | 0.002 | 0 |
| 1.896 | 71.914 | 16.405 | N/A | N/A | 12697.01 | 0.233 | 0.034 | 0.032 | 0.081 | 0.01 | 0.003 | 0 |
| 2.033 | 77.094 | 17.586 | N/A | N/A | 13611.6 | 0.25 | 0.037 | 0.034 | 0.087 | 0.011 | 0.003 | 0 |
| 3.032 | 114.976 | 26.227 | N/A | N/A | 20299.92 | 0.373 | 0.055 | 0.051 | 0.13 | 0.016 | 0.005 | 0 |

| Ethylbenz | Styrene (II | 1,3-butadi | Acrolein (I | Toluene (I | Phenol (ca | M & P-xyle | Propionalc | Acetone (I | 2-methylna | Benzaldeh | N-heptane | Ethane |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.014 | 0.025 | 0.139 | 0.202 | 0.053 | 0.06 | 0.023 | 0.06 | 0.03 | 0.017 | 0.039 | 0.005 | 0.043 |
| 0.002 | 0.003 | 0.016 | 0.023 | 0.006 | 0.007 | 0.003 | 0.007 | 0.003 | 0.002 | 0.004 | 0.001 | 0.005 |
| 0.003 | 0.006 | 0.032 | 0.046 | 0.012 | 0.014 | 0.005 | 0.014 | 0.007 | 0.004 | 0.009 | 0.001 | 0.01 |
| 0.004 | 0.006 | 0.034 | 0.05 | 0.013 | 0.015 | 0.006 | 0.015 | 0.008 | 0.004 | 0.01 | 0.001 | 0.011 |
| 0.005 | 0.009 | 0.051 | 0.074 | 0.019 | 0.022 | 0.009 | 0.022 | 0.011 | 0.006 | 0.014 | 0.002 | 0.016 |

| Ethylene | Acetylene | Propane | 2-methyl-2 | Methylglyc | 1-Methylna | 1,2,4-trime | N-propylbe | p-Tolualde | 1-butene | Glyoxal | 2-methylpe | 1,3,5-trime |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1.272 | 0.324 | 0.006 | 0.035 | 0.124 | 0.02 | 0.029 | 0.004 | 0.004 | 0.144 | 0.149 | 0.034 | 0.004 |
| 0.146 | 0.037 | 0.001 | 0.004 | 0.014 | 0.002 | 0.003 | 0.001 | 0 | 0.017 | 0.017 | 0.004 | 0.001 |
| 0.293 | 0.075 | 0.001 | 0.008 | 0.029 | 0.005 | 0.007 | 0.001 | 0.001 | 0.033 | 0.034 | 0.008 | 0.001 |
| 0.314 | 0.08 | 0.002 | 0.009 | 0.031 | 0.005 | 0.007 | 0.001 | 0.001 | 0.036 | 0.037 | 0.008 | 0.001 |
| 0.469 | 0.119 | 0.002 | 0.013 | 0.046 | 0.007 | 0.011 | 0.002 | 0.001 | 0.053 | 0.055 | 0.012 | 0.002 |

| N-pentane | 1-pentene | Valeraldeh | N-octane | 1-octene | N-nonane | N-dodecar | Propylene | Butyraldeh | 1-nonene | N-decane | 2-methyl-2 | 1,2,3-trime |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.016 | 0.064 | 0.02 | 0.005 | 0.023 | 0.005 | 0.038 | 0.373 | 0.01 | 0.02 | 0.026 | 0.015 | 0.009 |
| 0.002 | 0.007 | 0.002 | 0.001 | 0.003 | 0.001 | 0.004 | 0.043 | 0.001 | 0.002 | 0.003 | 0.002 | 0.001 |
| 0.004 | 0.015 | 0.005 | 0.001 | 0.005 | 0.001 | 0.009 | 0.086 | 0.002 | 0.005 | 0.006 | 0.004 | 0.002 |
| 0.004 | 0.016 | 0.005 | 0.001 | 0.006 | 0.001 | 0.009 | 0.092 | 0.002 | 0.005 | 0.007 | 0.004 | 0.002 |
| 0.006 | 0.024 | 0.007 | 0.002 | 0.008 | 0.002 | 0.014 | 0.137 | 0.004 | 0.007 | 0.01 | 0.006 | 0.003 |

| o-Tolualde | N-Hexade | 3-methyl-1 | 2-methyl-1 | Cis-2-bute | Isovaleralc | 1-hexene | 1-Methyl-2 | 1-Methyl-3 | Tolualdehy | 1-Methyl-4 | Cis-2-pent | N-tridecan |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.019 | 0.004 | 0.009 | 0.012 | 0.017 | 0.003 | 0.061 | 0.005 | 0.013 | 0.023 | 0.005 | 0.023 | 0.044 |
| 0.002 | 0 | 0.001 | 0.001 | 0.002 | 0 | 0.007 | 0.001 | 0.001 | 0.003 | 0.001 | 0.003 | 0.005 |
| 0.004 | 0.001 | 0.002 | 0.003 | 0.004 | 0.001 | 0.014 | 0.001 | 0.003 | 0.005 | 0.001 | 0.005 | 0.01 |
| 0.005 | 0.001 | 0.002 | 0.003 | 0.004 | 0.001 | 0.015 | 0.001 | 0.003 | 0.006 | 0.001 | 0.006 | 0.011 |
| 0.007 | 0.001 | 0.003 | 0.004 | 0.006 | 0.001 | 0.022 | 0.002 | 0.005 | 0.008 | 0.002 | 0.008 | 0.016 |

| N-Tetrade | N-Pentade | N-heptade | Trans-2-pe | 4-methyl-1 | 2-methyl-1 | 1-decene | N-undecar | Trans-2-he | Crotonalde | Heptene | Dimethyl r | C-10 Olefi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 0.034 | 0.014 | 0.001 | 0.03 | 0.006 | 0.003 | 0.015 | 0.037 | 0.002 | 0.085 | 0.036 | 0.007 | 0.481 |
| 0.004 | 0.002 | 0 | 0.003 | 0.001 | 0 | 0.002 | 0.004 | 0 | 0.01 | 0.004 | 0.001 | 0.055 |
| 0.008 | 0.003 | 0 | 0.007 | 0.001 | 0.001 | 0.004 | 0.008 | 0.001 | 0.02 | 0.008 | 0.002 | 0.111 |
| 0.008 | 0.004 | 0 | 0.007 | 0.001 | 0.001 | 0.004 | 0.009 | 0.001 | 0.021 | 0.009 | 0.002 | 0.119 |
| 0.013 | 0.005 | 0 | 0.011 | 0.002 | 0.001 | 0.006 | 0.013 | 0.001 | 0.031 | 0.013 | 0.003 | 0.177 |

| C-10 Para | C-14 Alkaı | C-15 Alkaı | C-16 Alkaı | C-18 Alkaı | C-4 Benze | C-5 Benze | Decanol | Dodecano |
|---|---|---|---|---|---|---|---|---|
| N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 1.202 | 0.015 | 0.015 | 0.012 | 0 | 0.054 | 0.027 | 0.481 | 0.24 |
| 0.138 | 0.002 | 0.002 | 0.001 | 0 | 0.006 | 0.003 | 0.055 | 0.028 |
| 0.277 | 0.004 | 0.003 | 0.003 | 0 | 0.012 | 0.006 | 0.111 | 0.055 |
| 0.297 | 0.004 | 0.004 | 0.003 | 0 | 0.013 | 0.007 | 0.119 | 0.059 |
| 0.443 | 0.006 | 0.005 | 0.004 | 0 | 0.02 | 0.01 | 0.177 | 0.089 |

**D R A F T**

# Appendix C
## Diesel Engine Analysis Details

# DIESEL GENERATOR SET

CATERPILLAR®

## STANDBY 80-100 kW
## PRIME 72-90 kW

### 60 Hz

| Model | Standby kW (kVA) | Prime kW (kVA) |
|---|---|---|
| D80-6 | 80 (100) | 72 (90) |
| D80-2S | 80 (80) | 72 (72) |
| D100-6 | 100 (125) | 90 (112.5) |
| D100-6S | 100 (100) | 90 (90) |

Tier 3 EPA Approved, Emissions Certified

## FEATURES

### GENERATOR SET

- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### ENGINE

- Governor, electronic
- Electrical system, 12 VDC
- Cartridge type filters
- Battery rack and cables
- Coolant and lube drains piped to edge of base

### GENERATOR

- Insulation system, class H
- Drip proof generator air intake (NEMA 2, IP23)
- Electrical design in accordance with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33

### CONTROL SYSTEM

- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

### MOUNTING ARRANGEMENT

- Heavy-duty fabricated steel base with lifting points
- Anti-vibration pads to ensure vibration isolation
- Complete OSHA guarding
- Stub-up pipe ready for connection to silencer pipework
- Flexible fuel lines to base with NPT connections

### COOLING SYSTEM

- Radiator and cooling fan complete with protective guards
- Standard ambient temperatures up to 50° C (122° F)

### CIRCUIT BREAKER

- UL/CSA listed
- 3-pole with solid neutral
- NEMA 1 steel enclosure, vibration isolated
- Electrical stub-up area directly below circuit breaker

### AUTOMATIC VOLTAGE REGULATOR

- Voltage within ± 0.5% 3-phase and ± 1.0% single phase at steady state from no load to full load
- Provides fast recovery from transient load changes

### EQUIPMENT FINISH

- All electroplated hardware
- Anticorrosive paint protection
- High gloss polyurethane paint for durability and scuff resistance

### QUALITY STANDARDS

- BS4999, BS5000, BS5514, EN61000-6, IEC60034, NEMA MG-1.33, NFPA 110 (with optional equipment)

### DOCUMENTATION

- Operation and maintenance manuals provided
- Wiring diagrams included

### WARRANTY

- All equipment carries full manufacturer's warranty.

## OPTIONAL EQUIPMENT*

### ENCLOSURE
- B Series weather protective enclosure (includes internal silencer system)
  – Single point lift
  – Panel viewing window
  – External emergency stop pushbutton
- Sound attenuated enclosure (includes internal silencer system)

### SILENCER SYSTEM – OPEN UNIT
- Level 1 silencer
- Level 2 silencer
- Level 3 silencer
- Mounting kit
- Through-wall installation kits

### ENGINE
- Battery heater
- Lube oil drain pump
- High lube oil temperature shutdown
- Lube oil sump heater

### CIRCUIT BREAKER
- Auxiliary voltfree contacts
- Shunt trip (100+ amp breakers)

### GENERATOR
- Anti-condensation heater
- Permanent magnet generator
- AREP excitation system (3-Phase only)
- Generator upgrade 1 size (3-Phase only)

### CONTROL SYSTEM
- No control system
- EMCP 3.2 digital control panel

### MOUNTING ACCESSORIES
- Seismic (Zone 4) vibration isolators

### FUEL SYSTEM
- UL listed closed top-diked skid-mounted fuel tank base (12/24-hour capacity) with fuel alarm (low level/leak detected)
- Critical high fuel alarm
- Critical low fuel level shutdown

### COOLING SYSTEM
- Coolant heater
- Low coolant temperature alarm
- Low coolant level shutdown
- Radiator transition flange

### REMOTE ANNUNCIATORS
- 16-channel remote annunciator panel (supplied loose)

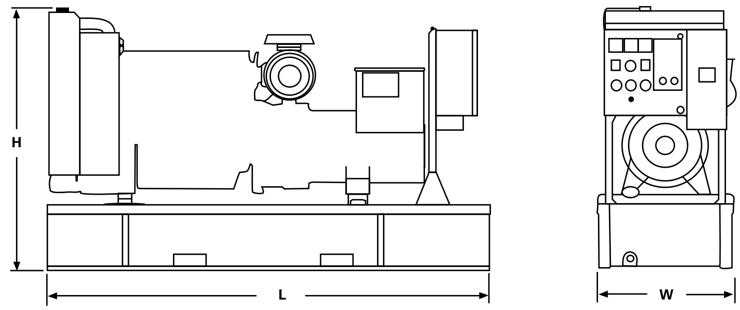
### MISCELLANEOUS ACCESSORIES
- Toolkit
- Additional operator’s manual pack
- Special enclosure color
- UL listing
- CSA certification
- French or Spanish language labels

### EXTENDED SERVICE CONTRACTS
- Extended Service Coverage available

### TESTING
- Factory test and report at both 1.0 pf and 0.8 pf

* Some options may not be available on all models.
Not all options are listed.

## GENERATOR SET DIMENSIONS AND WEIGHTS




| Model | Length mm (in) | Width mm (in) | Height mm (in) | Weight kg (lb)* |
|---|---|---|---|---|
| **D80-6** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 960 (2,116) |
| **D80-2S** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 934 (2,059) |
| **D100-6** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 1389 (3,062) |
| **D100-6S** | 2400 (94.5) | 838 (32.9) | 1400 (55.1) | 1066 (2,350) |

**NOTE:** General configuration not to be used for installation. See specific dimensional drawings for detail.

*Includes oil and coolant

# SPECIFICATIONS

## GENERATOR

Voltage regulation . . . . . . . . . ± 0.5% 3-phase and ± 1.0% single phase at steady state from no load to full load
Frequency . . . . . ± 0.25% for constant load, no load to full load
Waveform distortion . . . . . . . . . . . . . . . . . . THD < 4%, at no load
Radio interference . . . . . . . . . . . . . . Compliance with EN61000-6
Telephone interference. . . . . . . . . . . . . . . . . . . TIF < 50, THF < 2%
Overspeed limit . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2250 rpm
Insulation. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Class H
Temperature rise . . . . . . . . . . . . . . . . . . . . . . Within Class H limits
Available voltages . . . . . . . 1-phase – 120/240, 115/230, 110/220
3-phase – 277/480, 266/460, 120/240, 127/220, 120/208, 347/600
Deration . . . . . . . . . . . . . . . Consult factory for available outputs
Ratings . . . . . . . . . . . . . . . At 30° C (86° F), 152.4 m (500 ft), 60% humidity, 1.0 pf (1-phase), 0.8 pf (3-phase)

## ENGINE

Manufacturer . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Caterpillar
Type . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4-cycle
Bore – mm (in) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 105.0 (4.13)
Stroke – mm (in). . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 127.0 (5.00)
Governor Type . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Electronic
Class. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . G2
Piston speed – m/sec (ft/sec) . . . . . . . . . . . . . . . . . . . . . 7.62 (25.0)
Engine speed – rpm . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1800
Air cleaner type . . . . . . . . . . . . . . . . . . . . . Dry, replaceable paper element type with restriction indicator

**D80-6, D80-2S – C4.4**
Aspiration. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Turbocharged
Cylinder configuration. . . . . . . . . . . . . . . . . . . . . . . . . . . . . In-line 4
Displacement – L (cu in). . . . . . . . . . . . . . . . . . . . . . . . . . . 4.4 (269)
Compression ratio . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 19.2:1
Max power at rated rpm – kW (hp)
  Standby. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 97 (130)
  Prime . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 88 (118)
BMEP – kPa (psi)
  Standby . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1476 (213)
  Prime. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1335 (194)
Regenerative power – kW (hp) . . . . . . . . . . . . . . . . . . . 13.8 (18.5)

**D100-6, D100-6S – C4.4**
Aspiration. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Turbocharged
Cylinder configuration. . . . . . . . . . . . . . . . . . . . . . . . . . . . . In-line 4
Displacement – L (cu in). . . . . . . . . . . . . . . . . . . . . . . . . . . 4.4 (269)
Compression ratio . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 19.2:1
Max power at rated rpm – kW (hp)
  Standby. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 117 (156.9)
  Prime . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 106 (142.1)
BMEP – kPa (psi)
  Standby . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1612 (233)
  Prime. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1771 (257)
Regenerative power – kW (hp) . . . . . . . . . . . . . . . . . . . 13.8 (18.5)

## CONTROL PANEL

- Heavy duty sheet steel enclosure with lockable hinged door
- Vibration isolated from generating set
- LCD display
- AC metering
- DC metering
- Fail to start shutdown
- Low oil pressure shutdown
- High engine temperature
- Low/high battery voltage
- Underspeed/overspeed
- Loss of engine speed detection
- 2 spare fault channels
- 20 event fault log
- 2 LED status indicators
- Lockdown emergency stop push button

# RATING DEFINITIONS AND CONDITIONS

**Standby** – Applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings. The generator is peak rated (as defined in ISO8528-3).

**Prime** – Applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. There is no limitation to the annual hours of operation and the generator set can supply 10 percent overload power for 1 hour in 12 hours.

CATERPILLAR®

## D80-6 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 80 | 100 | 72 | 90 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8 | 2.1 | 8 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 24.7 | 6.5 | 22.7 | 6 |
| 75% load | L/hr | gal/hr | 19.7 | 5.2 | 18.2 | 4.8 |
| 50% load | L/hr | gal/hr | 14.6 | 3.9 | 13.5 | 3.6 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 53.6 | 3,051 | 50.2 | 2,857 |
| Total heat radiated to room at rated power | kW | Btu/min | 15.9 | 905 | 9.3 | 529 |
| Radiator fan load | kW | hp | 4.8 | 6.4 | 4.8 | 6.4 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3/min$ | cfm | 7.6 | 268 | 7.7 | 272 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3/min$ | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3/min$ | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3/min$ | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3/min$ | cfm | 18.77 | 663 | 16 | 572 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 522 | 972 | 524 | 975 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 97 | | 97 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V 120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** (30% voltage dip) | (kVA) | | | | | |
| | Self excited | 239 | 223 | 207 | 188 | 239 |
| | PM excited** | 311 | 291 | 270 | 247 | 311 |
| | AREP excited | 311 | 291 | 270 | 247 | 311 |
| **Full Load Efficiencies:** | Standby | 91.7 | 91.6 | 91.4 | 90.9 | 91.7 |
| | Prime | 91.9 | 91.8 | 91.7 | 91.3 | 91.8 |
| **Reactances (per unit):** | $X_d$ | 2.69 | 2.93 | 3.21 | 3.58 | 2.69 |
| Reactances shown are applicable to the standby rating. | $X'_d$ | 0.09 | 0.10 | 0.11 | 0.12 | 0.09 |
| | $X''_d$ | 0.045 | 0.049 | 0.053 | 0.060 | 0.045 |
| | $X_q$ | 1.62 | 1.76 | 1.92 | 2.15 | 1.62 |
| | $X''_q$ | 0.056 | 0.061 | 0.066 | 0.074 | 0.056 |
| | $X_2$ | 0.051 | 0.056 | 0.061 | 0.068 | 0.051 |
| | $X_0$ | 0.005 | 0.005 | 0.006 | 0.007 | 0.005 |
| **Time Constants:** | | $t'_d$ 50 ms | $t''_d$ 5 ms | $t'_{do}$ 1480 ms | $t_a$ 8 ms | |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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## D80-2S (1-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** (at 240V) | kW | kVA | 80 | 80 | 72 | 72 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8 | 2.1 | 8 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 24.7 | 6.5 | 22.7 | 6.0 |
| 75% load | L/hr | gal/hr | 19.7 | 5.2 | 18.2 | 4.8 |
| 50% load | L/hr | gal/hr | 14.6 | 3.9 | 13.5 | 3.6 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 53.6 | 3,051 | 50.2 | 2,857 |
| Total heat radiated to room at rated power | kW | Btu/min | 15.9 | 905 | 9.3 | 529 |
| Radiator fan load | kW | hp | 4.8 | 6.4 | 4.8 | 6.4 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 7.6 | 268 | 7.7 | 271 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 18.7 | 663 | 16 | 572 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 522 | 972 | 524 | 975 |
| **Generator Set Noise Rating*** (without attenuation) at 1 m (3 ft) | dB(A) | | 97 | | 97 | |

| Generator Technical Data | | 120/240V | 115/230V | 110/220V |
|---|---|---|---|---|
| **Motor Starting Capability:** (30% voltage dip) | (kVA) | | | |
| | Self excited | 150 | 160 | 170 |
| | PM excited** | 150 | 160 | 170 |
| **Full Load Efficiencies:** | Standby | 87.9 | 88.5 | 89.1 |
| | Prime | 88.4 | 89.0 | 89.5 |
| **Reactances (per unit):** Reactances shown are applicable to the standby rating. | $X_d$ | 2.14 | 2.33 | 2.54 |
| | $X'_d$ | 0.16 | 0.17 | 0.19 |
| | $X''_d$ | 0.082 | 0.089 | 0.096 |
| | $X_q$ | 1.28 | 1.40 | 1.53 |
| | $X''_q$ | 0.101 | 0.109 | 0.120 |

| **Time Constants:** | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 80 ms | 7 ms | 1431 ms | 12 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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## D100-6 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 100 | 125.0 | 90 | 112.5 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8.0 | 2.1 | 8.0 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 29.8 | 7.9 | 26.8 | 7.1 |
| 75% load | L/hr | gal/hr | 23.7 | 6.3 | 21.9 | 5.8 |
| 50% load | L/hr | gal/hr | 17.5 | 4.6 | 16.3 | 4.3 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | Ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 65.6 | 3,731 | 59.7 | 3,396 |
| Total heat radiated to room at rated power | kW | Btu/min | 20.7 | 1,177 | 18.3 | 1,041 |
| Radiator fan load | kW | hp | 5.0 | 6.7 | 5.0 | 6.7 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 8.4 | 297 | 8.5 | 300 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 17.5 | 618 | 16 | 572 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 522 | 972 | 524 | 975 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 98 | | 97 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V<br>120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** | (kVA) | | | | | |
| (30% voltage dip) | Self excited | 206 | 191 | 177 | 160 | 191 |
| | PM excited** | 271 | 252 | 233 | 211 | 252 |
| | AREP excited | 271 | 252 | 233 | 211 | 252 |
| **Full Load Efficiencies:** | Standby | 91.1 | 90.9 | 90.6 | 90.1 | 91.0 |
| | Prime | 91.5 | 91.3 | 91.0 | 90.6 | 91.4 |
| **Reactances (per unit):** | $X_d$ | 3.58 | 3.90 | 4.26 | 4.77 | 3.90 |
| | $X'_d$ | 0.14 | 0.15 | 0.17 | 0.19 | 0.15 |
| Reactances shown are applicable to the standby rating. | $X''_d$ | 0.083 | 0.091 | 0.099 | 0.111 | 0.091 |
| | $X_q$ | 2.15 | 2.34 | 2.56 | 2.86 | 2.34 |
| | $X''_q$ | 0.104 | 0.113 | 0.123 | 0.138 | 0.113 |
| | $X_2$ | 0.094 | 0.102 | 0.112 | 0.125 | 0.102 |
| | $X_0$ | 0.005 | 0.005 | 0.006 | 0.006 | 0.005 |
| **Time Constants:** | | $t'_d$ 100 ms | $t''_d$ 10 ms | $t'_{do}$ 2555 ms | $t_a$ 15 ms | |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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## D100-6S (1-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** (at 240V) | kW | kVA | 100 | 100 | 90 | 90 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4 | | | | | | |
| Total oil capacity | L | U.S. gal | 8 | 2.1 | 8 | 2.1 |
| Oil pan | L | U.S. gal | 7 | 1.9 | 7 | 1.9 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 29.7 | 7.8 | 27.3 | 7.2 |
| 75% load | L/hr | gal/hr | 23.7 | 6.3 | 21.9 | 5.8 |
| 50% load | L/hr | gal/hr | 17.6 | 4.6 | 16.3 | 3 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 65 | | 65 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 17.0 | 4.5 | 17.0 | 4.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 10.2 | 33.5 | 10.2 | 33.5 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 140 | 2,679 | 10 140 | 2,679 |
| Minimum temperature to engine | °C | °F | 70 | 158 | 70 | 158 |
| Temperature rise across engine | °C | °F | 7 | 44.6 | 7 | 44.6 |
| Heat rejected to coolant at rated power | kW | Btu/min | 61.0 | 3,472 | 57.0 | 3,244 |
| Total heat radiated to room at rated power | kW | Btu/min | 18.0 | 1,025 | 15.0 | 854 |
| Radiator fan load | kW | hp | 4.8 | 6.4 | 4.8 | 6.4 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 8.4 | 297 | 8.5 | 300 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 8 | 32 | 8 | 32 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 230 | 8,135 | 230 | 8,135 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 933 | 26.4 | 933 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.120 | 0.48 | 0.120 | 0.48 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 192 | 6,780 | 192 | 6,780 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in/mercury | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 22.5 | 794 | 20.0 | 705 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 580 | 1,076 | 540 | 1,004 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 98 | | 97 | |

| Generator Technical Data | | 120/240V | 115/230V | 110/220V |
|---|---|---|---|---|
| **Motor Starting Capability:** | (kVA) | | | |
| (30% voltage dip) | Self excited | 187 | 175 | 162 |
| | PM excited** | 187 | 175 | 162 |
| **Full Load Efficiencies:** | Standby | 90.5 | 90.0 | 89.4 |
| | Prime | 90.9 | 90.4 | 89.4 |
| **Reactances (per unit):** | $X_d$ | 2.67 | 2.91 | 3.18 |
| Reactances shown | $X'_d$ | 0.21 | 0.23 | 0.25 |
| are applicable to | $X''_d$ | 0.127 | 0.138 | 0.151 |
| the standby rating. | $X_q$ | 1.60 | 1.74 | 1.90 |
| | $X''_q$ | 0.151 | 0.164 | 0.180 |

| **Time Constants:** | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 165 ms | 13 ms | 2734 ms | 20 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12



LEHE7189-05 (01-09)
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# DIESEL GENERATOR SET

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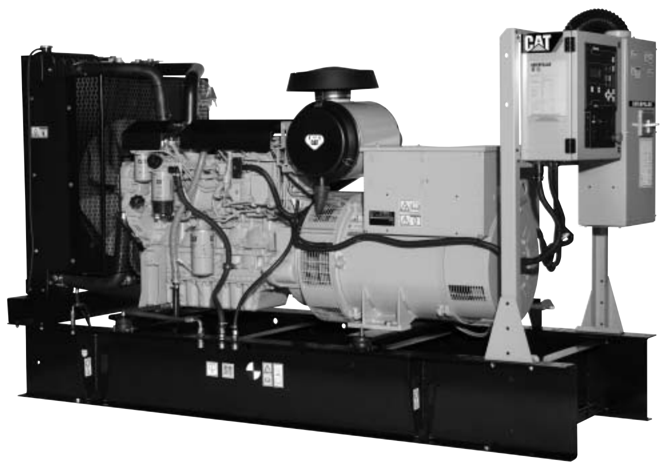

Picture shown may not reflect actual package

## STANDBY 125-150 kW
## PRIME 114-135 kW
### 60 Hz

| Model | Standby kW (kVA) | Prime kW (kVA) |
|---|---|---|
| D125-6 | 125 (156.3) | 114 (142.5) |
| D150-8 | 150 (187.5) | 135 (168.8) |

Tier 3 EPA Approved, Emissions Certified

## FEATURES

### GENERATOR SET
- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### ENGINE
- Governor, electronic
- Electrical system, 12 VDC
- Cartridge type filters
- Battery rack and cables
- Coolant and lube drains piped to edge of base

### GENERATOR
- Insulation system, class H
- Drip proof generator air intake (NEMA 2, IP23)
- Electrical design in accordance with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33

### CONTROL SYSTEM
- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

### MOUNTING ARRANGEMENT
- Heavy-duty fabricated steel base with lifting points
- Anti-vibration pads to ensure vibration isolation
- Complete OSHA guarding
- Stub-up pipe ready for connection to silencer pipework
- Flexible fuel lines to base with NPT connections

### COOLING SYSTEM
- Radiator and cooling fan complete with protective guards
- Standard ambient temperatures up to 50° C (122° F)

### CIRCUIT BREAKER
- UL/CSA listed
- 3-pole with solid neutral
- NEMA 1 steel enclosure, vibration isolated
- Electrical stub-up area directly below circuit breaker

### AUTOMATIC VOLTAGE REGULATOR
- Voltage within ± 0.5% 3-phase at steady state from no load to full load
- Provides fast recovery from transient load changes

### EQUIPMENT FINISH
- All electroplated hardware
- Anticorrosive paint protection
- High gloss polyurethane paint for durability and scuff resistance

### QUALITY STANDARDS
- BS4999, BS5000, BS5514, EN61000-6, IEC60034, NEMA MG-1.33, NFPA 110 (with optional equipment)

### DOCUMENTATION
- Operation and maintenance manuals provided
- Wiring diagrams included

### WARRANTY
- All equipment carries full manufacturer's warranty.

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## OPTIONAL EQUIPMENT*

### ENCLOSURE
- B Series weather protective enclosure (includes internal silencer system)
- Sound attenuated enclosure (includes internal silencer system)
  – Single point lift
  – Panel viewing window
  – External emergency stop pushbutton

### SILENCER SYSTEM – OPEN UNIT
- Level 1 silencer
- Level 2 silencer
- Level 3 silencer
- Mounting kit
- Through-wall installation kits

### ENGINE
- Battery heater
- Lube oil drain pump
- High lube oil temperature shutdown
- Lube oil sump heater

### CIRCUIT BREAKER
- Auxiliary voltfree contacts
- Shunt trip

### GENERATOR
- Anti-condensation heater
- Permanent magnet generator
- AREP excitation system
- Generator upgrade 1 size

### CONTROL SYSTEM
- No control system
- EMCP 3.2 digital control panel

### MOUNTING ACCESSORIES
- Seismic (Zone 4) vibration isolators

### FUEL SYSTEM
- UL listed closed top-diked skid-mounted fuel tank base (12/24-hour capacity) with fuel alarm (low level/leak detected)
- Critical high fuel alarm
- Critical low fuel level shutdown

### COOLING SYSTEM
- Coolant heater
- Low coolant temperature alarm
- Low coolant level shutdown
- Radiator transition flange

### REMOTE ANNUNCIATORS
- 16-channel remote annunciator panel (supplied loose)

### MISCELLANEOUS ACCESSORIES
- Toolkit
- Additional operator's manual pack
- Special enclosure color
- UL listing
- CSA certification
- French or Spanish language labels

### EXTENDED SERVICE CONTRACTS
- Extended Service Coverage available

* Some options may not be available on all models.
Not all options are listed.

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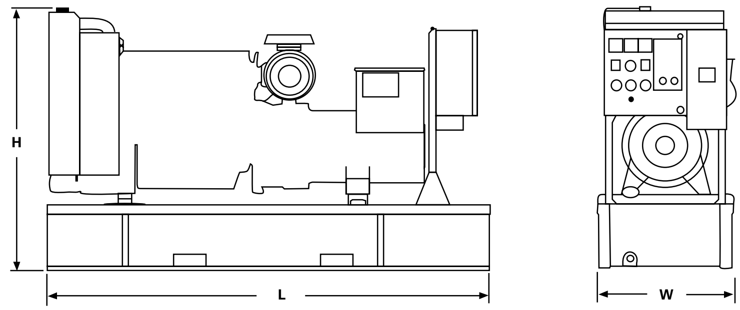
## GENERATOR SET DIMENSIONS AND WEIGHTS




| Model | Length mm (in) | Width mm (in) | Height mm (in) | Weight kg (lb)* |
|---|---|---|---|---|
| D125-6 | 2780 (109.4) | 900 (35.4) | 1543 (60.7) | 1347 (2,970) |
| D150-8 | 2780 (109.4) | 900 (35.4) | 1543 (60.7) | 1407 (3,102) |

**NOTE:** General configuration not to be used for installation. See specific dimensional drawings for detail.

*Includes oil and coolant

## SPECIFICATIONS

### GENERATOR

Voltage regulation . . . . . . . . . . . . . . . . . ± 0.5% 3-phase at steady state from no load to full load
Frequency . . . . . ± 0.25% for constant load, no load to full load
Waveform distortion . . . . . . . . . . . . . . . . . . THD < 4%, at no load
Radio interference . . . . . . . . . . . . . . Compliance with EN61000-6
Telephone interference. . . . . . . . . . . . . . . . . . . TIF < 50, THF < 2%
Overspeed limit . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2250 rpm
Insulation. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Class H
Temperature rise . . . . . . . . . . . . . . . . . . . . . . Within Class H limits
Available voltages . . . . . . . . . . . . . . . . . . . . . . . 277/480, 266/460, 120/240, 127/220, 120/208, 347/600
Deration . . . . . . . . . . . . . . . Consult factory for available outputs
Ratings . . . . . . . . . . . . . . . . . . . . At 30° C (86° F), 152.4 m (500 ft), 60% humidity, 0.8 pf

### ENGINE

Manufacturer . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Caterpillar
Type . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4-cycle
Bore – mm (in) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 105.0 (4.13)
Stroke – mm (in) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 127.0 (5.00)
Governor Type . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . Electronic
Class. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . G2
Piston speed – m/sec (ft/sec) . . . . . . . . . . . . . . . . . . . . . 7.62 (25.0)
Engine speed – rpm . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1800
Air cleaner type . . . . . . . . . . . . . . . . . . . . . Dry, replaceable paper element type with restriction indicator

**D125-6 – C6.6 ACERT**
Aspiration . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ATAAC
Cylinder configuration. . . . . . . . . . . . . . . . . . . . . . . . . . . . . In-line 6
Displacement – L (cu in). . . . . . . . . . . . . . . . . . . . . . . . . . . 6.6 (404)
Compression ratio . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 16.3:1
Max power at rated rpm – kW (hp)
  Standby . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 161.6 (217)
  Prime . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 144.6 (194)
BMEP – kPa (psi)
  Standby . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1633 (237)
  Prime. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1461 (212)
Regenerative power – kW (hp) . . . . . . . . . . . . . . . . . . . . . 14.9 (20)

**D150-8 – C6.6 ACERT**
Aspiration . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ATAAC
Cylinder configuration. . . . . . . . . . . . . . . . . . . . . . . . . . . . . In-line 6
Displacement – L (cu in). . . . . . . . . . . . . . . . . . . . . . . . . . . 6.6 (404)
Compression ratio . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 16.3:1
Max power at rated rpm – kW (hp)
  Standby . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 171.3 (230)
  Prime . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 154.4 (207)
BMEP – kPa (psi)
  Standby . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1731 (251)
  Prime. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1560 (226)
Regenerative power – kW (hp) . . . . . . . . . . . . . . . . . . . . . 14.9 (20)

### CONTROL PANEL

- Heavy duty sheet steel enclosure with lockable hinged door
- Vibration isolated from generating set
- LCD display
- AC metering
- DC metering
- Fail to start shutdown
- Low oil pressure shutdown
- High engine temperature
- Low/high battery voltage
- Underspeed/overspeed
- Loss of engine speed detection
- 2 spare fault channels
- 20 event fault log
- 2 LED status indicators
- Lockdown emergency stop push button

## RATING DEFINITIONS AND CONDITIONS

**Standby** – Applicable for supplying continuous electrical power (at variable load) in the event of a utility power failure. No overload is permitted on these ratings. The generator is peak rated (as defined in ISO8528-3).

**Prime** – Applicable for supplying continuous electrical power (at variable load) in lieu of commercially purchased power. There is no limitation to the annual hours of operation and the generator set can supply 10 percent overload power for 1 hour in 12 hours.

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## D125-6 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 125 | 156.3 | 114 | 142.5 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4/CI4 | | | | | | |
| Total oil capacity | L | U.S. gal | 16.5 | 4.4 | 16.5 | 4.4 |
| Oil pan | L | U.S. gal | 15.5 | 4.1 | 15.5 | 4.1 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 40.6 | 10.7 | 36.0 | 9.5 |
| 75% load | L/hr | gal/hr | 31.6 | 8.3 | 30.0 | 7.9 |
| 50% load | L/hr | gal/hr | 24.5 | 6.5 | 23.2 | 6.1 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 100 | | 100 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 21.0 | 5.5 | 21.0 | 5.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 8.0 | 26.0 | 8.0 | 26.0 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 200 | 2,693 | 10 200 | 2,693 |
| Minimum temperature to engine | °C | °F | 85 | 185 | 85 | 185 |
| Temperature rise across engine | °C | °F | 7.9 | 14.2 | 7.9 | 14.2 |
| Heat rejected to coolant at rated power | kW | Btu/min | 74.9 | 4,262 | 69.8 | 3,971 |
| Total heat radiated to room at rated power | kW | Btu/min | 13.0 | 740 | 12.1 | 688 |
| Radiator fan load | kW | hp | 8.0 | 10.7 | 8.0 | 10.7 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 12.6 | 445 | 12.3 | 434 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 5 | 20 | 5 | 20 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 327 | 11,548 | 327 | 11,548 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 923 | 26.4 | 923 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.12 | 0.50 | 0.12 | 0.50 |
| Cooling air flow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 317 | 11,195 | 317 | 11,195 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in Hg | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 29.7 | 1,049 | 28.6 | 1,010 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 437 | 819 | 427 | 801 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 97 | | 97 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V 120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** | (kVA) | | | | | |
| (30% voltage dip) | Self excited | 360 | 335 | 311 | 283 | N/A |
| | PM excited** | 469 | 437 | 406 | 370 | 437 |
| | AREP excited | 469 | 437 | 406 | 370 | 437 |
| **Full Load Efficiencies:** | Standby | 92.7 | 92.6 | 92.5 | 92.3 | 92.6 |
| | Prime | 92.8 | 92.8 | 92.7 | 92.5 | 92.8 |
| **Reactances (per unit):** | $X_d$ | 2.74 | 2.99 | 3.27 | 3.65 | 2.99 |
| Reactances shown are applicable to the standby rating. | $X'_d$ | 0.10 | 0.10 | 0.11 | 0.13 | 0.10 |
| | $X''_d$ | 0.057 | 0.062 | 0.068 | 0.076 | 0.062 |
| | $X_q$ | 1.65 | 1.79 | 1.96 | 2.19 | 1.79 |
| | $X''_q$ | 0.068 | 0.074 | 0.080 | 0.090 | 0.074 |
| | $X_2$ | 0.063 | 0.068 | 0.075 | 0.083 | 0.068 |
| | $X_0$ | 0.004 | 0.005 | 0.005 | 0.006 | 0.005 |

| Time Constants: | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 100 ms | 10 ms | 2865 ms | 15 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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## D150-8 (3-Phase)

Materials and specifications are subject to change without notice.

| Generator Set Technical Data – 1800 rpm/60 Hz | | | Standby | | Prime | |
|---|---|---|---|---|---|---|
| **Power Rating** | kW | kVA | 150 | 187.5 | 135 | 168.8 |
| **Lubricating System** | | | | | | |
| Type: full pressure | | | | | | |
| Oil filter: spin-on, full flow | | | | | | |
| Oil cooler: watercooled | | | | | | |
| Oil type required: API CH4/CI4 | | | | | | |
| Total oil capacity | L | U.S. gal | 16.5 | 4.4 | 16.5 | 4.4 |
| Oil pan | L | U.S. gal | 15.5 | 4.1 | 15.5 | 4.1 |
| **Fuel System** | | | | | | |
| Generator set fuel consumption | | | | | | |
| 100% load | L/hr | gal/hr | 44.7 | 11.8 | 41.5 | 11.0 |
| 75% load | L/hr | gal/hr | 36.8 | 9.7 | 34.3 | 9.1 |
| 50% load | L/hr | gal/hr | 28.4 | 7.5 | 26.6 | 7.0 |
| **Engine Electrical System** | | | | | | |
| Voltage/ground: 12/negative | | | | | | |
| Battery charging generator ampere rating | amps | | 100 | | 100 | |
| **Cooling System** | | | | | | |
| Water pump type: centrifugal | | | | | | |
| Radiator system capacity incl. engine | L | U.S. gal | 21.0 | 5.5 | 21.0 | 5.5 |
| Maximum coolant static head | m $H_2O$ | ft $H_2O$ | 8.0 | 26.0 | 8.0 | 26.0 |
| Coolant flow rate | L/hr | U.S. gal/hr | 10 200 | 2,693 | 10 200 | 2,693 |
| Minimum temperature to engine | °C | °F | 85 | 185 | 85 | 185 |
| Temperature rise across engine | °C | °F | 7.9 | 14.2 | 7.9 | 14.2 |
| Heat rejected to coolant at rated power | kW | Btu/min | 78.4 | 4,461 | 73.5 | 4,182 |
| Total heat radiated to room at rated power | kW | Btu/min | 13.6 | 774 | 12.7 | 723 |
| Radiator fan load | kW | hp | 8.0 | 10.7 | 8.0 | 10.7 |
| **Air Requirements** | | | | | | |
| Combustion air flow | $m^3$/min | cfm | 12.9 | 456 | 12.6 | 445 |
| Maximum air cleaner restriction | kPa | in $H_2O$ | 5 | 20 | 5 | 20 |
| Radiator cooling air (zero restriction) | $m^3$/min | cfm | 327 | 11,548 | 327 | 11,548 |
| Generator cooling air | $m^3$/min | cfm | 26.4 | 923 | 26.4 | 923 |
| Allowable air flow restriction (after radiator) | kPa | in $H_2O$ | 0.12 | 0.50 | 0.12 | 0.50 |
| Cooling airflow (@ rated speed) | | | | | | |
| Rate with restriction | $m^3$/min | cfm | 317 | 11,195 | 317 | 11,195 |
| **Exhaust System** | | | | | | |
| Maximum allowable backpressure | kPa | in Hg | 15 | 4.4 | 15 | 4.4 |
| Exhaust flow at rated kW | $m^3$/min | cfm | 31.5 | 1,112 | 30.5 | 1,077 |
| Exhaust temperature at rated kW – | | | | | | |
| Dry exhaust | °C | °F | 625 | 1,157 | 610 | 1,130 |
| **Generator Set Noise Rating*** | | | | | | |
| (without attenuation) at 1 m (3 ft) | dB(A) | | 97.3 | | 97.3 | |

| Generator Technical Data | | 277/480V | 266/460V | 127/220V | 120/240V<br>120/208V | 347/600V |
|---|---|---|---|---|---|---|
| **Motor Starting Capability:** | (kVA) | | | | | |
| (30% voltage dip) | Self excited | 420 | 391 | 363 | 330 | N/A |
| | PM excited** | 548 | 511 | 476 | 433 | 511 |
| | AREP excited | 548 | 511 | 476 | 433 | 511 |
| **Full Load Efficiencies:** | Standby | 92.9 | 92.9 | 92.9 | 92.5 | 92.9 |
| | Prime | 93.1 | 93.1 | 93.1 | 92.8 | 93.1 |
| **Reactances (per unit):** | $X_d$ | 2.90 | 3.16 | 3.45 | 3.86 | 3.16 |
| | $X'_d$ | 0.10 | 0.11 | 0.12 | 0.13 | 0.11 |
| Reactances shown are applicable to the standby rating. | $X''_d$ | 0.058 | 0.063 | 0.069 | 0.078 | 0.063 |
| | $X_q$ | 1.74 | 1.89 | 2.07 | 2.32 | 1.89 |
| | $X''_q$ | 0.069 | 0.075 | 0.082 | 0.092 | 0.075 |
| | $X_2$ | 0.063 | 0.069 | 0.075 | 0.084 | 0.069 |
| | $X_0$ | 0.005 | 0.005 | 0.006 | 0.007 | 0.005 |

| Time Constants: | $t'_d$ | $t''_d$ | $t'_{do}$ | $t_a$ |
|---|---|---|---|---|
| | 100 ms | 10 ms | 2966 ms | 15 ms |

* dB(A) levels are for guidance only
** With PMG Excited Option AVR12

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## DIESEL GENERATOR SET

CATERPILLAR®

Image shown may not reflect actual package.

# STANDBY
# 30 ekW 37 kVA
# 60 Hz 1800 rpm 480 Volts

**Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.**

## FEATURES

**Caterpillar Model D30-10 3 phase**

### FUEL/EMISSIONS STRATEGY
- EPA Tier 4 interim

### DESIGN CRITERIA
- The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

### FULL RANGE OF ATTACHMENTS
- Wide range of bolt-on system expansion attachments, factory designed and tested
- Flexible packaging options for easy and cost effective installation

### SINGLE-SOURCE SUPPLIER
- Fully prototype tested with certified torsional vibration analysis available

### WORLDWIDE PRODUCT SUPPORT
- Caterpillar® dealers provide extensive post sale support including maintenance and repair agreements
- Caterpillar dealers have over 1,600 dealer branch stores operating in 200 countries
- The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

### CAT® C2.2 DIESEL ENGINE
- Reliable, rugged, durable design
- Field-proven in thousands of applications worldwide
- Four-stroke diesel engine combines consistent performance and excellent fuel economy with minimum weight
- Electronic engine control

### GENERATOR SET
- Complete system designed and built at ISO 9001 certified facilities
- Factory tested to design specifications at full load conditions

### CONTROL SYSTEM
- EMCP 3.1 digital control panel
- Vibration isolated NEMA 1 enclosure with lockable hinged door
- DC and AC wiring harnesses

## FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

| System | Standard | Optional |
|---|---|---|
| Air Inlet | • Dry replaceable paper element type with restriction indicator | |
| Cooling | • Radiator and cooling fan complete with protective guards<br>• Standard ambient temperatures up to 40 degrees C (104 degrees F) | • Coolant heater<br>• Low coolant temperature alarm<br>• Low coolant level shutdown<br>• Radiator transition flange |
| Engine | • Governor, mechanical<br>• Electrical system, 12 VDC<br>• Cartridge type filters<br>• Battery rack and cables<br>• Coolant and lube drains piped to edge of base | • Governor, electronic<br>• Battery heater<br>• Lube oil drain pump<br>• High lube oil temperature shutdown<br>• Lube oil sump heater |
| Generator | • Class H insulation<br>• Drip proof generator air intake (NEMA 2,IP23)<br>• Electrical design in accordance with with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33<br>• IP23 Protection | • Anti-condensation space heater |
| Circuit Breaker | • UL/CSA listed<br>• 3-pole with solid neutral<br>• NEMA 1 steel enclosure, vibration isolated<br>• Electrical stub-up area directly below circuit breaker | • Auxilary voltfree contacts |
| Control Panels | • EMCP 3.1 digital control panel<br>• Vibration isolated NEMA 1 enclosure with lockable hinged door<br>• DC and AC Wiring harnesses | • EMCP 3.2 digital control panel |
| Mounting | • Heavy-duty fabricated steel base with lifting points<br>• Anti-vibration pads<br>• Complete OSHA guarding<br>• Stub-up pipe ready for connection to silencer pipework<br>• Flexible fuel lines to base with NPT connections | • Seismic (Zone 4) vibration isolators |
| General | • High gloss polyurethane paint, Caterpillar yellow except rails and radiators gloss black<br>• Anticorrosive paint protection<br>• All electroplated hardware | • Toolkit<br>• Additional operator's manual pack<br>• Special enclosure color<br>• UL Listing, CSA Certification<br>• French or Spanish language labels |

## SPECIFICATIONS

### CAT GENERATOR

Frame Size.............................................................LC1014S
Excitation..........................................................Self Excited
Pitch.........................................................................0.6667
Number of Poles.................................................................4
Number of bearings..................................... Single Bearing
Number of Leads...........................................................012
IP Rating.......................................................................IP23
Overspeed capability......................................................125
Wave form deviation (Line Wave Form to Line).......002.00
Paralleling kit droop transformer......................... Standard
Voltage regulator.3 Phase sensing with selectible volts/Hz
Telephone Influence Factor............................. Less than 50

### CAT ENGINE

C2.2 In-line 4, 4-cycle diesel
Bore - mm............................................. 84.00 mm (3.31 in)
Stroke - mm........................................ 100.00 mm (3.94 in)
Displacement-L...................................... 2.20 L (134.25 in³)
Compression ratio.....................................................23.5:1
Aspiration........................................................................TA

### Control Panel

Heavy duty sheet steel enclosure with lockable hinged door
Vibration isolated from generating set
LCD display
AC metering
DC metering
Fail to start shutdown
Low oil pressure shutdown
High engine temperature
Low / high battery voltage
Underspeed/overspeed
Loss of engine speed detection
2 spare fault channels
20 event fault log
2 LED status indicators
Lockdown emergency stop push button

# TECHNICAL DATA

| Open Generator Set - - 1800 rpm/60 Hz/480 Volts | P3524A | |
|---|---|---|
| **EPA Tier 4 interim** | | |
| **Generator Set Package Performance** | | |
| Genset Power rating @ 0.8 pf | 37.5 kVA | |
| Genset Power rating with fan | 30 ekW | |
| **Fuel Consumption** | | |
| 100% load with fan | 10.7 L/hr | 2.8 Gal/hr |
| **Cooling System** [1] | | |
| Air flow restriction (system) | 0.12 kPa | 0.48 in. water |
| Air flow (max @ rated speed for radiator arrangement) | 75 $m^3$/min | 2649 cfm |
| Engine coolant capacity | 3.6 L | 1.0 gal |
| **Exhaust System** | | |
| Exhaust gas flow rate | 2.5 $m^3$/min | 88.3 cfm |
| Exhaust flange size (internal diameter) | 6.4 mm | 0.3 in |
| **Heat Rejection** | | |
| Heat rejection to exhaust (total) | 33 kW | 1877 Btu/min |
| Heat rejection to atmosphere from generator | 3.3 kW | 187.7 Btu/min |
| **Alternator**[2] | | |
| Motor starting capability @ 30% voltage dip | 70 skVA | |
| Frame | LC1014S | |
| Temperature Rise | 130 ° C | 234 ° F |
| **Emissions (Nominal)** | | |
| NOx g/hp-hr | 5.43 g/hp-hr | |
| CO g/hp-hr | .78 g/hp-hr | |
| HC g/hp-hr | .09 g/hp-hr | |
| PM g/hp-hr | .323 g/hp-hr | |

[1] For ambient and altitude capabilities consult your Caterpillar dealer. Airflow restriction (system) is added to existing restriction from factory.
[2] Generator temperature rise is based on a 40 C (104 F) ambient per NEMA MG1-32.

## RATING DEFINITIONS AND CONDITIONS

**Meets or Exceeds International Specifications:** AS1359, CSA, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, UL508A, 72/23/EEC, 98/37/EC, 2004/108/EC

**Standby** - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year. Standby power in accordance with ISO8528. Fuel stop power in accordance with ISO3046. Standby ambients shown indicate ambient temperature at 100% load which results in a coolant top tank temperature just below the shutdown temperature.

**Ratings** are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

**Fuel rates** are based on fuel oil of 35° API [16° C (60° F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Caterpillar representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Caterpillar dealer.

# Standby 30 ekW 37 kVA
**60 Hz 1800 rpm 480 Volts**

CATERPILLAR®

## DIMENSIONS

| Package Dimensions | | |
|---|---|---|
| Length | 1893.1 mm | 74.5 in |
| Width | 714.0 mm | 28.1 in |
| Height | 1406.3 mm | 55.4 in |
| Weight | 487 kg | 1074.1 lb |

NOTE: For reference only - do not use for installation design. Please contact your local dealer for exact weight and dimensions.

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Performance No.:P3524A

Feature Code: NAC098P

Gen. Arr. Number: 3215082

Sourced: U.S. Sourced

LEHE0078-00 12/09

## DIESEL GENERATOR SET

CATERPILLAR®

Image shown may not reflect actual package.

# STANDBY
## 50 ekW 62 kVA
## 60 Hz 1800 rpm 480 Volts

**Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.**

## FEATURES

**Caterpillar Model D50-6 3 phase**

### FUEL/EMISSIONS STRATEGY
• EPA Tier 3

### DESIGN CRITERIA
• The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

### FULL RANGE OF ATTACHMENTS
• Wide range of bolt-on system expansion attachments, factory designed and tested
• Flexible packaging options for easy and cost effective installation

### SINGLE-SOURCE SUPPLIER
• Fully prototype tested with certified torsional vibration analysis available

### WORLDWIDE PRODUCT SUPPORT
• Caterpillar® dealers provide extensive post sale support including maintenance and repair agreements
• Caterpillar dealers have over 1,600 dealer branch stores operating in 200 countries
• The Cat® S•O•S℠ program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products

### CAT® C4.4 DIESEL ENGINE
• Reliable, rugged, durable design
• Field-proven in thousands of applications worldwide
• Four-stroke diesel engine combines consistent performance and excellent fuel economy with minimum weight
• Electronic engine control

### GENERATOR SET
• Complete system designed and built at ISO 9001 certified facilities
• Factory tested to design specifications at full load conditions

### CONTROL SYSTEM
• EMCP 3.1 digital control panel
• Vibration isolated NEMA 1 enclosure with lockable hinged door
• DC and AC wiring harnesses

## FACTORY INSTALLED STANDARD & OPTIONAL EQUIPMENT

| System | Standard | Optional |
|---|---|---|
| Air Inlet | • Dry replaceable paper element type with restriction indicator | |
| Cooling | • Radiator and cooling fan complete with protective guards<br>• Standard ambient temperatures up to 50 degrees C (122 degrees F) | • Coolant heater<br>• Low coolant temperature alarm<br>• Low coolant level shutdown<br>• Radiator transition flange |
| Engine | • Governor, mechanical<br>• Electrical system, 12 VDC<br>• Cartridge type filters<br>• Battery rack and cables<br>• Coolant and lube drains piped to edge of base | • Governor, electronic<br>• Battery heater<br>• Lube oil drain pump<br>• High lube oil temperature shutdown<br>• Lube oil sump heater |
| Generator | • Class H insulation<br>• Drip proof generator air intake (NEMA 2,IP23)<br>• Electrical design in accordance with with BS5000 Part 99, EN61000-6, IEC60034-1, NEMA MG-1.33<br>• IP23 Protection | • Anti-condensation space heater<br>• Permanent magnet excitation<br>• Internal Excitation<br>• Generator upgrade 1 size |
| Circuit Breaker | • UL/CSA listed<br>• 3-pole with solid neutral<br>• NEMA 1 steel enclosure, vibration isolated<br>• Electrical stub-up area directly below circuit breaker | • Auxiliary voltfree contacts<br>• Shunt trip |
| Control Panels | • EMCP 3.1 digital control panel<br>• Vibration isolated NEMA 1 enclosure with lockable hinged door<br>• DC and AC Wiring harnesses | • No control system<br>• EMCP 3.2 digital control panel |
| Mounting | • Heavy-duty fabricated steel base with lifting points<br>• Anti-vibration pads to ensure vibration isolation<br>• Complete OSHA guarding<br>• Stub-up pipe ready for connection to silencer pipework<br>• Flexible fuel lines to base with NPT connections | • Seismic (Zone 4) vibration isolators |
| General | • High gloss polyurethane paint, Caterpillar yellow except rails and radiators gloss black<br>• Anticorrosive paint protection<br>• All electroplated hardware | • Toolkit<br>• Additional operator's manual pack<br>• Special enclosure color<br>• UL Listing, CSA Certification<br>• French or Spanish language labels |

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## SPECIFICATIONS

### CAT GENERATOR

Frame Size.......LC2014D
Excitation.......Self Excited
Pitch.......0.6667
Number of Poles.......4
Number of bearings....... Single Bearing
Number of Leads.......012
IP Rating.......IP23
Overspeed capability.......125
Wave form deviation (Line Wave Form to Line).......002.00
Paralleling kit droop transformer....... Standard
Voltage regulator.3 Phase sensing with selectible volts/Hz
Telephone Influence Factor.......Less than 50

### CAT ENGINE

C4.4 In-line 4, 4-cycle diesel
Bore - mm.......105.00 mm (4.13 in)
Stroke - mm.......127.00 mm (5.0 in)
Displacement-L....... 4.40 L (268.5 $in^3$)
Aspiration.......T
Fuel system.......Common Rail
Governor type....... Mechanical

### Emissions

Nox g/hp-hr.......5.90
CO g/hp-hr.......1.34
HC g/hp-hr.......0.27
PM g/hp-hr....... 0.40

### Control Panel

Heavy duty sheet steel enclosure with lockable hinged door
Vibration isolated from generating set
LCD display
AC metering
DC metering
Fail to start shutdown
Low oil pressure shutdown
High engine temperature
Low / high battery voltage
Underspeed/overspeed
Loss of engine speed detection
2 spare fault channels
20 event fault log
2 LED status indicators
Lockdown emergency stop push button

# TECHNICAL DATA

| Open Generator Set - - 1800 rpm/60 Hz/480 Volts | P3454A | |
|---|---|---|
| **Tier 3** | | |
| **Generator Set Package Performance** | | |
| Genset Power rating @ 0.8 pf | 62.5 kVA | |
| Genset Power rating with fan | 50 ekW | |
| **Fuel Consumption** | | |
| 100% load with fan | 19.2 L/hr | 5.1 Gal/hr |
| **Cooling System** [1] | | |
| Ambient air temperature | 61 ° C | 142 ° F |
| Air flow restriction (system) | 0.12 kPa | 0.48 in. water |
| Air flow (max @ rated speed for radiator arrangement) | 134 $m^3$/min | 4732 cfm |
| Engine Coolant capacity with radiator/exp. tank | 6.7 L | 1.8 gal |
| Engine coolant capacity | .7 L | 0.2 gal |
| Radiator coolant capacity | 6.0 L | 1.6 gal |
| **Inlet Air** | | |
| Combustion air inlet flow rate | 5.3 $m^3$/min | 187.2 cfm |
| **Exhaust System** | | |
| Exhaust stack gas temperature | 571.0 ° C | 1059.8 ° F |
| Exhaust gas flow rate | 13.7 $m^3$/min | 483.8 cfm |
| Exhaust flange size (internal diameter) | 6.4 mm | 0.3 in |
| **Heat Rejection** | | |
| Heat rejection to exhaust (total) | 67 kW | 3810 Btu/min |
| Heat rejection to atmosphere from generator | 6.2 kW | 352.6 Btu/min |
| **Alternator**[2] | | |
| Motor starting capability @ 30% voltage dip | 115 skVA | |
| Frame | LC2014D | |
| Temperature Rise | 130 ° C | 234 ° F |
| **Lube System** | | |
| Sump refill with filter | 6.0 L | 1.6 gal |

[1] For ambient and altitude capabilities consult your Caterpillar dealer. Airflow restriction (system) is added to existing restriction from factory.
[2] Generator temperature rise is based on a 40 C (104 F) ambient per NEMA MG1-32.

## RATING DEFINITIONS AND CONDITIONS

**Meets or Exceeds International Specifications:** AS1359, CSA, IEC60034-1, ISO3046, ISO8528, NEMA MG 1-22, NEMA MG 1-33, UL508A, 72/23/EEC, 98/37/EC, 2004/108/EC

**Standby** - Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year. Standby power in accordance with ISO8528. Fuel stop power in accordance with ISO3046. Standby ambients shown indicate ambient temperature at 100% load which results in a coolant top tank temperature just below the shutdown temperature.

**Ratings** are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions.

**Fuel rates** are based on fuel oil of 35° API [16° C (60° F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29° C (85° F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Caterpillar representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Caterpillar dealer.

CATERPILLAR®

## DIMENSIONS

| Package Dimensions | | |
|---|---|---|
| **Length** | **2208.0 mm** | **86.93 in** |
| **Width** | **1000.0 mm** | **39.37 in** |
| **Height** | **1265.9 mm** | **49.84 in** |
| **Weight** | **306 kg** | **675 lb** |

NOTE: For reference only - do not use for installation design. Please contact your local dealer for exact weight and dimensions. (General Dimension Drawing #3301887).

Performance No.: P3454A

Feature Code: NAC088P

Gen. Arr. Number: 2652660

Source: U.S. Sourced



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APPENDIX

I

# DRAINAGE REPORT

# DRAINAGE REPORT

## Knowland Park Zoo
## Preliminary Design – Veterinarian Hospital
## Preliminary Design- California Exhibit and Access Road

ROBERT C. WONG
RE. NO. 43748

Prepared by: Aliquot Associates, Inc.
1390 South Main Street, Suite 310
Walnut Creek, CA. 94596

Aliquot Project No. 208022
DATE: August 10, 2010

# TABLE OF CONTENTS



<u>FIGURES</u>

# PRELIMINARY DRAINAGE STUDY
# OAKLAND ZOO VETERINARY HOSPITAL and CALIFORNIA EXHIBIT

## PROJECT DESCRIPTION

The project consists of the proposed construction of a veterinarian hospital located in the southeastern area of the Knowland Park Zoo property, a proposed maintenance access road from the Vet hospital to the California Exhibit and within California - exhibits, night houses, and access surfaces for pedestrians and maintenance vehicles.

The hospital site is situated northeast of the upper overflow parking lots in the vicinity of the existing Administration Building. The site is located below an existing swale on a fill previously deposited by the City of Oakland during the early years of the park's operations. This area has been and is currently used as a storage yard for animal feed, manure and equipment. Most of the pad area is barren without vegetation. The site erodes during rainfall; silt and minor debris from the yard is carried with the sheet flow drainage across the site and discharges into the paved parking lots directly below the site into the Zoo's storm drain system.

The Veterinarian Hospital will be constructed first. In addition to the Veterinarian Hospital, an access road for maintenance vehicles will lead to the California Exhibit. The access road is planned to be constructed next and the California Exhibit will be constructed further in the future.

## EXECTUTIVE SUMMARY

This report validates that the Veterinary Hospital site can be developed without drainage impact:

- Veterinary Hospital flows are detained on-site, and do not increase peak flows in Arroyo Viejo Creek along Golf Links Road.

- The Veterinary Hospital flows do not impact downstream Zoo drainage facilities due to the employed detention Basin.

- The 10 year design storm drain pipes, 15-year and 100-year detention facility and 100 year design drainage release are adequately sized to detain and convey the flows of the Veterinary Hospital site and along the maintenance access road to the California Exhibit, after the road is paved.

- The California Exhibit preliminary design is consistent with the City's drainage policies and ordinances and the Alameda Countywide Clean Water Program (ACCWP).

- The California Exhibit site plan is preliminary, and the design provided will accommodate changes to the plan. All drainage will be treated and detained to regulate flows within the exhibit boundaries of California and the Veterinarian Site detention facility.

- Reported flooding, which occurs in the adjoining neighborhood is reduced.

## REPORT SCOPE AND OBJECTIVE

The objective of this drainage report is to determine pre-development and post-development runoff for the 15-year and 100-year intensity storm events at the proposed Veterinary Hospital site and the Access Road to California and detain the increase in flow so that post project flows do not exceed pre project flows. The 15-year and 100-year storm events were used in accordance with the requirements of the City of Oakland's Storm Drainage Design Guidelines for detention. Preliminary site design is provided in this report for the Veterinary Hospital site (Figure 4, Grading and Drainage Plan).

This study also includes preliminary design and illustration of the planned California Exhibit with estimated detention volumes, which will be mitigated on-site.

Storm water management is also discussed and illustrated in this report. Preliminary drawings with the design of water treatment BMPs are included in the grading plans of the Veterinary Hospital construction drawings. BMPs, type and location, for the California Exhibit and Access Maintenance Road to California are illustrated.

## DESIGN METHODS

This report evaluates the potential drainage impacts caused by the development of the Veterinary Hospital site and the improvement of the existing access road, which will lead to the proposed California Exhibit. In addition this report offers design recommendations to mitigate these potential impacts of drainage. The goal of the calculations is to detain the excess flow from the 15-year and 100-year storms to simulate pre-development conditions and not exceed the peak flow at the Zoo's discharge point into the Arroyo Viejo Creek at Golf Links Road.

The City of Oakland's *Storm Drainage Design Guidelines,* was the initial basis for this analysis. However, there were some deviations due to the location of the storm water detention being proposed. The City recommends the use of a "Modified Triangular Hydrograph" for the design of detention basins in small drainage areas. For this project, the metering structure is NOT at the downstream end of the study area. To further this methodology, the revised design also incorporates a diversion structure to split the storm water runoff between the North and South systems. Since there were numerous routing issues with downstream drainage sub-areas, it was more appropriate to use the Corps of Engineer's HEC-HMS software and employ some of the standards adopted by Alameda County in their *Hydrology and Hydraulics Manual*. The County's standards were used as a basis for the City's standards and there are numerous cross references in the City's standards back to the County's. The primary difference in these calculations was following the County's use of the Snyder Unit Hydrograph as opposed to the City's Flow Hydrograph. The Snyder method is incorporated into and supported by HEC-HMS whereas the City's isn't.

The hydrology model reviews the existing and proposed flow rates at a point approximately 200 feet northwest of the proposed vet hospital, noted herein as "Str. #23**".** This location is the convergence point between the various improvements appurtenant to the vet hospital and the existing runoff from the site and its contributing drainage area.

The other area of concern is labeled Junction #9. This is the common convergence point in the South drainage system where portions of the parking lot drainage merge with other sub-regional runoff. This area, which lies adjacent to a residential neighborhood, has a history of drainage problems. It is of utmost necessity that any new development fully mitigates its associated runoff so as not to exacerbate this situation. With that goal, this project includes a proposal to redirect a portion of the historical "Southern" drainage to the detention basin and ultimately into the North System.

The storms modeled included the 6 hr-15 yr, 6 hr-100 yr and 24 hr-100 yr events. The output runs from the HEC-HMS software, along with summary input data are attached as an appendix.

Another aspect of this study includes development of the California Exhibit. Pre and post-project runoff rates for the three sub-areas and flow to the detention facility near the Veterinarian Hospital are included in this analysis. Preliminary detention calculations for the California drainage areas were determined by using the modified rational method to obtain pre and post-project 100 year flows along with the Modified Triangular Hydrograph method. The areas studied were modeled to have the metering structure immediately downstream so the Modified Triangular Hydrograph method was appropriate.

Hydromodification and Storm Water Treatment design is according to the municipal regional stormwater National Pollutant Discharge Elimination System (NPDES) permit. This report illustrates solutions, which will mitigate storm water pollutants; actual design will accompany improvement plans upon application for permitting. For the Veterinary Hospital and the Access Road, calculations have been performed for treatment only. For the California Exhibit, schematic design has been provided, as there are plenty of opportunities for mitigation due to the low impact of impervious surface in the large development envelope. Preliminary sizes have been determined based on percentage of treatment per square footage of impervious surface. BAHM can be used to obtain exact basin sizes once final plans are submitted.

## VETERINARIAN HOSPITAL AND ACCESS ROAD TO CALIFORNIA

### Existing Upland Hydrologic Conditions

The site is located in the Oakland hills. The hills run north/south. The peaks of the watershed that flank the upper reaches of the Veterinary Hospital site drainage area (Drainage Area A, See Figure 2) are approximately 450 feet apart in the north/south direction. The upper reach of this drainage area is approximately 1,500 feet southeast from the point of collection at the Veterinary Hospital site. The elevation change is from 626 at the highest point to 355 at the lowest point on the Veterinary Hospital site, yielding an average slope around 18%. The City of Oakland classifies itself in Hydrological Soil Group, D. The total drainage area of Area A is 18.90 acres.

The proposed Hospital is situated downstream of the outlet of the swale of Drainage Area A (See Figure 2). Drainage from the swale sheet flows across the storage yard (proposed site of the Veterinary Hospital) and into the parking lot below it. The proposed building and surrounding impervious surfaces occupy only 0.89 acres of the 18.90 total acres of upland watershed.

An existing fire access road, leading to the proposed California project, will be improved to a paved maintenance access road. Sheet flow from the hill above the road enters the road bed and is carried along the inside edge of the road to the proposed veterinary hospital site at the lower flows. During larger flows, drainage breaches the road bed and flows into the rear yards of the residences below (see Figure 5, "Breach Points"). In the lower stretch of the road (Area D, Figure 2) the breached drainage is intercepted by the existing upper parking lots below the Veterinary Hospital and enters drainage facilities within the Zoo and into the South System. In the upper areas of the road (Areas B & C, Figure 2), during higher flows, drainage sheet flows across the road at breach points A and B to the rear yards of the existing neighborhood below it. Some minor flooding from drainage breaching the road has been reported by adjacent residents along a portion of this length.

During a meeting with the City of Oakland, staff indicated flooding occurred in the existing drainage swale in the neighborhood southeast of the main parking lot (Figure 2, area designated as "AREA OF FLOODING").

Light debris, silt, and gravel were observed where the existing storage yard (proposed location of Veterinarian site) meets the existing upper parking lot. These deposits are not produced by drainage Area A, but are deposited from flows from the access road to California. The Oakland Fire Department grades the road each year and places rock on the dirt road to maintain access. Loose gravel and silt from the graded road is carried down during storms and deposited in the existing parking lot.

**Existing Downstream Drainage Facilities and Overland Flows**

The Zoo property has two basic systems downstream of the Vet hospital and road to California. For the purposes of this report, these two systems are referred to as the North System and South System, each consisting of existing drainage facilities. Along the North System, the pipe route is interrupted with open ditches. The Zoo has been improving both systems as it has opened each new exhibit, since 1985. Storm drain pipes have been enlarged mostly to 18" and 24" pipes, up to 36". Although these improvements have improved drainage throughout, due to the contribution of tributary drainage areas within the Zoo property, the overall systems remain undersized to convey flow from the 10 year storm event.

The South System, collecting drainage from the southern portion of the Zoo property and the neighborhood to the southeast of the main parking lot, commences in the southern portion of the upper parking lots, just below the Hospital site. The system alternates between 24" and 18" pipe sizes along its route. From its commencement point, near the Veterinary Hospital site, the 24" pipe runs westerly through the main parking lot, past the admission entrance, and connects to an old 18" pipe running northerly to the Seka Deer and through the Sun Bear and Children's Zoo exhibits, then past the guard entrance building discharging into the Arroyo Viejo Creek along Golf Links Road (See Figure 1). The existing 18" pipe commences at a point at the bottom of a slope of the main parking lot, at the Zoo's southern boundary. This 18" pipe collects drainage from the creek through the adjoining neighborhood to the southeast. An existing back water condition occurs at the inlet of the 18" pipe in the creek within the neighborhood to the southeast (See Figures 1 & 2). City staff reported there have been complaints of flooding occurring during large storm events.

Both the North and South Systems are inadequate to handle the 10 year flow. Along their routes the systems create existing detention upstream of inadequate pipes and within natural localized surface low spots. As the water attempts to build up enough head to push the water through the undersized pipes throughout their routes and through the 18" outfall to the creek, some of the flow runs overland into natural surface sumps, then continues via surface flow; some flow into other catch basins and the remaining, sheet flows directly into the creek. This situation continues upstream through the flatter sloping pipes in various locations within the Zoo.

Drainage from the northern area of the Zoo property is collected and conveyed through an antiquated system of pipes and ditches in the North System, contributed by the upper reaches of the Zoo property and various exhibits along its route. Other upland areas in the northern section of the Zoo property also contribute to this system. Drainage Area A (Figure 2), above the vet hospital contributes mostly to the North System. Figure 2A shows the approximate split of water to the north and south systems in pre-development.

Currently, flow from Drainage Area A and the access road sheets over the proposed hospital site, divides into two directions when entering the upper parking lot, then surface flows over the parking lot into catch basins in both the North and South Systems. At low flow, it has been observed that approximately 30% of the drainage flows to the South System and 70% flows to the North System. At the 10 year event, it is estimated 10% of the flow is to the South System and 90% of the flow is to the North System. These estimates are rough; the exact percentage of the existing flow going in either the north or the south system is not significant for the purpose of this report, since the two flows remain within the Zoo grounds, merge, and then discharge at the Arroyo Viejo Creek along Golf links Road in a single 18” outfall.

At existing high flows from Drainage Area A, it is apparent from the grades of the upper parking lots that drainage predominantly flows to the North System after leaving the Veterinary Hospital site. Based on a study, using a gutter flow calculation (See cross section in Figure 6), the current flow to the North System remains in the existing upper parking lot and gutter flows along the curb to an existing catch basin (Junction 3), then discharges to a lower catch basin, then 200 feet north through an 18” pipe to a small inadequate earth ditch. A series of ditches and pipes continue which route flow to the creek. The gutter flow calculation was done to insure drainage from the 10 year event did not breach the curb of the parking lot and enter the south system. This calculation shows it remains in the parking lot and flows to the North System. Other sources of runoff, which do not find catch basins or overwhelm inadequate drainage facilities during high flows, contribute to the sheet flow we observe as ubiquitous throughout the Zoo.

**Effect of Development to Downstream Drainage Facilities**

The purpose of this report is <u>not</u> to analyze for repair or to upgrade the existing inadequate Zoo drainage systems, but it is to show that post development flows <u>are not increased and thus do not impact Arroyo Viejo Creek</u> at Golf Links Road. In addition, by collection of upstream runoff in the design of the Veterinary Hospital site, the development will relieve the flooding in the neighborhood to the southeast of the main parking lot in the Area of Flooding (see figure 3). Construction of the access road will also control breaching of runoff to the neighborhood below it.

Minor flooding also currently occurs in the adjoining neighborhood below Drainage areas B1 (See Figure 3). This flooding will not be exasperated by paving the access road. Flow rates into the swale will remain constant. All water from drainage areas B, C, and D besides area B1 will be picked up along the road and carried to the diversion structure (see Figure 9, Diversion Structure Detail). The water in the diversion structure is split so that 50% enters the south system through the existing 24" RCP pipe under the parking lot and 50% enters the north system via the detention basin. Figure 3B shows the split of water to the north and south systems in post-development.

After construction of the access maintenance road to California drainage will not breach the road at Breach Points A, B and C. Road drainage will be intercepted by drop inlets, then conveyed across the road to bio-retention basins, treated, then routed to a storm drain under the road. The storm drain then conveys the flow to a diversion structure (see Figure 9) near the detention basin (see figure 3A and Grading and Drainage plan, Figure 4). The cross section (Figure 7) and the detail on Figure 5 show how natural drainage from the hill above the access road will be separated from pavement drainage. Hill drainage from sub-basin B1 will flow into the natural swale to a cross culvert under the road at the Breach Point B (see Figures 3 and 5) and continue in the existing natural swale, following the predevelopment drainage pattern. The remainder of the sub-basins along the access road flow to the diversion structure where they are dispersed 50% to South system and 50% to the detention basin in the North System.

It is prudent not to divert additional drainage from the Veterinarian Hospital to the South System to avoid exasperating the back water condition in the neighborhood to the southeast of the parking lot where the area of flooding occurs (Area G, Figure 2, see area designated as "AREA OF FLOODING"). For this reason, a conservative approach of handling runoff from both Drainage Area A and the access road is to route run-off into the North system. The increased flow generated by the Veterinarian Hospital is <u>compensated</u> by detention of flows from Drainage Area A1 and the access road is routed directly into the detention basin through the diversion structure.

See Table 1 - "Drainage Basin Areas and Routing" and the Hydrology Model Schematic in the Appendix. Table 1A is a simplified version of Table 1 that shows the Pre and Post flows and where each sub-basin drains. Figure 3B shows where each sub-basin will drain in post-development.

Table 2 (below) shows post-development flows have been reduced at junction 9, the South System and Str. # 23, the North System; there is no impact to downstream facilities or adjacent neighborhoods

**Proposed Drainage Facilities and Detention**

Location of an open detention basin downstream to regulate 15-year and 100-year flows were first considered in a depressed lawn area near the entrance gate to the Zoo, just north of the entrance drive of the lower parking lot. A backwater calculation was run from the creek upstream into the Children's Zoo storm drain system and as a result, it showed that the SD was undersized. A head is required to push the water through, which results in ponding and overland flow upstream of the outlet.

The Children's Zoo was designed and constructed during the past 10 years. An existing 18" pipe was abandoned and replaced with new 24" pipes throughout this new exhibit. A number of pipe segments were constructed at minimal slopes as low as 1%. In analyzing the pre-development (existing) flows of the South System watershed, these pipes are not adequate to convey the 10 year storm event without ponding. After determining this, it is concluded that an open detention facility downstream of the Children's Zoo is not feasible without expensive replacement or bypass pipes within both the North and South Systems or drainage facilities intercepting sheet flow at the lower areas of the Zoo.

The design recommended in this report employs an open detention facility along the east side of the Veterinary Hospital shown on Figure 4. Drainage from area A1 and the access road run directly into this proposed detention basin. The runoff stored within and released from this detention basin was calculated to offset the increase in post-development flow from the following improvements:

- Increase in flow produced by the new Veterinary Hospital.
- Increase in flow produced by the paving of the access maintenance road to California
- Increase in flow produced by impervious surfaces in California in drainage area A1.

**Detention Basin Design**

The Veterinary Hospital is located below a natural swale with a 15-year flow rate of 16 CFS. The Veterinary Hospital is located downstream of the outlet of this swale in the existing maintenance and storage yard, where drainage currently sheet flows across. The swale widens in a fan shape as it approaches the yard. The building is L shaped and rotated on the site to fit the shape of the topography. The rear corner of the building is positioned north of where the existing pad below the creek begins to fan out, allowing ample space for the realigned and extended swale to bypass the new Veterinarian building. The building finished floor is lowered below the existing pad grade 10 feet. The creek has been extended to cascade down a series of pools transitioning into a 0.5% gradient along the east side of the proposed Veterinary Hospital and then enters a control structure (See Detail Figure 8). A four foot high wall separates the building site from the creek. Drainage entering the control structure is first metered by an orifice in the wall of the structure for the 15 year storm. An overflow weir at the top of the upstream wall of the structure is designed for conveyance to achieve the desired detention while not violating the required 2 foot minimum freeboard during the 100 year storm. In keeping with the required freeboard, the maximum water surface elevation for the 100 year storm event is 2 feet or more below the lowest elevation along the building.

By design of this detention basin, there is excess capacity. By use of an orifice and metering flow, the design leaves additional capacity for detention. The peak flow elevation of both the 24 and 6 hour 100-year storms is 356.51 feet, 2.3 feet below the lowest elevation along the Veterinary building foundation of 358.8. Only 2 feet of freeboard is required, leaving an additional 0.3 vertical feet of detention storage.

The results of the HEC-HMS runs are summarized below in Table 2:

**TABLE 2**

| | **North Drainage System @ Str. #23** | | | **South Drainage System @ Junc. 9** | |
|---|---|---|---|---|---|
| **Storm** | **Existing (cfs)** | **Proposed (cfs)** | **Basin Peak Elevation** | **Existing (cfs)** | **Proposed (cfs)** |
| 6hr 15 yr | 20.37 | 20.18 | 354.45 | 31.52 | 30.15 |
| 6 hr 100 yr | 28.67 | 27.87 | 356.48 | 43.61 | 41.58 |
| 24 hr 100 yr | 28.82 | 28.25 | 356.51 | 43.83 | 41.79 |

Routing through the detention basin is only runoff from Drainage Area A, a portion of the hill flow above the access road, and the post development paved condition of the access road. Increased flow from proposed improvements of the Veterinarian Hospital is offset by detaining additional flow from Area A1. The detention facility is sized and metered to offset the increased flow from these areas. This arrangement of offsetting the Veterinarian Hospital and expanded parking lot by detaining additional flow from sub-basin A1, provides the opportunity to treat impervious surfaces of the hospital down-grade of the detention basin. See Appendix A for HEC-HMS runs and other data.

During the event of a plugged system, a storm drainage release is designed to sheet flow to the upper parking lot and to the North System.

**Detention Basin Maintenance**

Vector Control

Included with the routing models is a graph of the basin performance indicating it will fully drain (except the required base flow) within 24 hours after the end of the 24 hour-100 year event per the City's requirements regarding vector control (see appendix).

Silt and Debris Maintenance

Drainage from sub-basin A1 and flows from the access road to California, consisting of hill sheet flow and treated street water is the only drainage which enters the detention basin. The access road, in its current unimproved condition, carries gravel and silt from the road, which will enter the diversion structure and some of it will enter the detention basin.

After the access road to California is paved, the amount of gravel and silt will be greatly reduced and only natural erosion from the upland swale and sheet flow from the hills will contribute silt; gravel will be eliminated. After development of both the vet building and the access road silt volumes will be greatly reduced.

Two maintenance roads for access to the detention basin and to the creek area above the detention basin are shown on Figure 4, Grading and Drainage plan. These roads will allow equipment to enter for maintenance. A maintenance plan will be provided before occupancy of the veterinarian building.

## California Hydrology and Detention

Another aspect of this study was the future hilltop development of the California project. This is intended to be a "green" facility, incorporating green roofs, pervious pavements and other features to minimize drainage impacts, but without mitigation an increase in runoff will occur. The runoff factor for all facilities with green roofs is slightly increased from pre-development levels, but the increase in time of concentration for water landing on the roofs offsets the increase in C factor and therefore there is no increase in runoff from pre- to post-development. The sidewalk/pedestrian path around the exhibits will be a pervious material and no increase in runoff is expected from pre-development. The three sub-areas that do not drain into either the North or South drainage systems will require detention facilities to reduce the minor increase in runoff to pre-project levels. The access road through California will be paved with AC and therefore require detention. The roofs that are not green roofs will require detention. The increase in pavement and roofs was factored into the overall sub-drainage areas to create an increase in C factor from pre- to post-development. Pre and post-project runoff rates for these areas were included in this analysis. Storage volumes were determined using the modified rational method for the 100 year storm along with the modified triangular hydrograph method per the City of Oakland's storm drainage design guidelines. The results are shown below in Table 3:

**Table 3**

| **Mitigation Storage for Future "California" Project** | | | | |
|---|---|---|---|---|
| | | | | |
| | **Existing Peak Runoff (cfs)** | **Developed Peak Runoff (cfs)** | **Required Storage Volume (cubic ft)** | **Comments** |
| **Drainage Area K1 (Amphitheater)** | 13.47 | 13.70 | 200 | |
| **Drainage Area K1 (AC paving)** | 13.47 | 13.70 | 200 | |
| **Drainage Area K2 (Visitor Center)** | 9.75 | 10.25 | 464 | |
| **Drainage Area K2 (AC paving)** | 9.75 | 9.92 | 160 | |
| **Drainage Area L (AC,Grizzly roof)** | 10.33 | 10.89 | 564 | |
| **Drainage Area L (Jaguar roof)** | 10.33 | 10.52 | 192 | |
| **Drainage Area M1** | 5.55 | 5.55 | 0 | No increase |
| **Drainage Area M2** | 9.54 | 9.73 | 267 | |

## STORM WATER MANAGEMENT (WATER QUALITY AND HYDROMODIFICATION)

### Veterinary Hospital

Hydromodification and Storm Water Management of water discharged from the development of the Veterinary Hospital will be obtained through a vegetated swale located along the eastern edge of the upper parking lot north of the site (see Figure 4 ). The vegetated swale is sized using the flow-based sizing criteria from ACCWP's C.3 Stormwater Technical Guidance.

### Paved Maintenance Access Road

Figure 5B shows the preliminary design for treatment and conveyance of increased flow to the detention basin. The catch basin locations and 12" pipe are shown on Figure 5B. Rain gardens are placed on the outside of the road where the natural topography widens. Drainage from the road is separated from drainage from the hill above the road (see detail, Figure 5B). The storm drain pipe under the concrete ditch collects treated water and clean water from the hill and conveys it down the access road. Figure 5 shows the exchange drainage from impervious road surface to a bio-retention planter to the storm drain. Detention will occur in the creek adjacent to the Veterinary Hospital.

### California Exhibit

The entire project creates more than 1 acre of impervious surface and therefore hydromodification will be implemented on this project. California has been studied and determined that hydromodification and treatment will be mitigated on-site by reducing the flows and treating runoff through use of some or all of the following: rain gardens, pervious surfaces, runoff coefficient reduction due to landscaping plantings, green roof systems and other mitigating implementation. Water quality treatment will be required for the main access road through the exhibit and all roofs that are not green roofs. Runoff from these roofs and pavement will first be treated for C-3 water quality and then routed to open detention basins that will be incorporated into the landscape. Figure 5A shows typical implementation of these BMPs and detention. Table 4 below shows the estimated surface areas of post-BMPs for treatment and hydromodification of estimated impervious surfaces.

**TABLE 4 Treatment Areas, California Exhibit**

| | | | |
|---|---|---|---|
| Drainage Area | Impervious Surface Area SF | Treatment Factor 4% Surface Area S.F. | Hydromodification Factor 7% Surface Area S.F. |
| Area A-1 (Black Bear) | 2,600 | 104 | 182 |
| Area A-1 (AC paving) | 4,600 | 184 | 322 |
| Area K1 (Amphitheater) | 8,950 | 358 | 627 |
| Area K1 (AC paving) | 6,925 | 277 | 485 |
| Area K2 (Visitor Center) | 14,585 | 584 | 1,021 |
| Area K2 (AC paving) | 5,800 | 232 | 406 |
| Area L (AC, Grizzly roof) | 10,850 | 434 | 760 |
| Area L (Jaguar roof) | 2,600 | 104 | 182 |
| Area M1 | N/A | | |
| Area M2 (Roofs) | 2,700 | 108 | 189 |

*7% sizing factor used as a preliminary estimate of the surface area needed to size BMP's for hydromodification

Final treatment plans and calculations will be provided with the improvement plans for site development. BAHM will be used to determine exact basin sizes and due to the large development area ample space will be available to construct the necessary BMP. The BAHM results may produce a larger square footage required than the sizing factor of 7%. The square footages listed in the Hydromodification column in Table 4 can be held and the basins can be deeper since there are no vertical limitations for the California project. The use of Filterra catch basins or other higher flow treatment devices will be employed to eliminate grading impacts caused by in-ground bioretention planters in steep or treed areas.

**END**

8/7/2009

# TABLE 1 Oakland Zoo, Drainage Basin Areas and Routing

| PreDevl Basin # | Post Devl Basin # | Pre Devl. Area, Acs | Post Devel. Area, Acs | PreDevl. Flows to N. System | PreDevl. Flows to S. System | PostDevl. Flows to N. System-Str. #23 | PostDevl. Flows to S. System-Junc. 9 | Notes |
|---|---|---|---|---|---|---|---|---|
| A | | 18.9 | | | | | | |
| | A-1 | | 14.1 | Str. 23 (90%) | Str. 20* (10%) | Detention Basin | None | Detention basin> Str.23 |
| | A-2 | | 0.89 | Str. 23 (90%) | Str. 20* (10%) | Str. 23 | None | Vet Site, Detain more of A-1 |
| | A-3 | | 1.59 | Str. 23 (90%) | Str. 20* (10%) | Str. 23 | None | Hill |
| | A-4 | | 0.23 | Str.23 | None | Str. 23 | None | Walls and landscape |
| | A-5 | | 1.61 | Str.23 | None | Str. 23 | None | Hill |
| | A-6 | | 0.48 | Str.23 | None | Str. 23 | None | Parking lot |
| | | | | | | | | |
| | | | | | | | | |
| 20% E. Parking Lot Expansion | | | 0.41 | Str. 23 | | | | 100% compensated in Detention Basin |
| | | | | | | | | |
| B | | 4.26 | | | | | | |
| | B-1 | | 2.05 | | In Swale, breach Pt. B | | Junction 9 | New Culvert at swale |
| | B-2 | | 1.7 | | In Swale, breach Pt. B | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | B-3 | | 0.25 | | Along Rd. to swale | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | B-4 | | 0.22 | | Breach Pt. C. to Str. 20* | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | B-5 | | 0.043 | | Breach Pt. C. to Str. 20* | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | | | | | | | | |
| C | | 0.99 | | | | | | |
| | C-1 | | 0.19 | | Breach Pt. A | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | C-2 | | 0.8 | | Breach Pt. A | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | | | | | | | | |
| D | | 1.48 | | | | | | |
| | D-1 | | 1.35 | | Breach Pt. C | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | D-2 | | 0.13 | | | 50% to Det. Basin | 50% to Str.20A | To Diversion Structure>Det. Basin &Str. 20A |
| | | | | | | | | |
| E | | 1.23 | | | | | | |
| | E-1 | | 0.41 | | Str. 20* | Str. 23 | | Gutter flow parking lot |
| | E-2 | | 0.82 | | Str. 20* | | Str. 20A | |
| | | | | | | | | |
| F | | | 0.89 | | Str. # 24 (Ex. DI) | Str. # 24 (Ex. DI) | | |
| | | | | | | | | |
| G | | | 17.98 | | Inlet Ex. 18" pipe | | Inlet Ex.18" SD | |
| | | | | | | | | |
| H | | | 1.83 | | Str. 19 | | Str. 19 (Junction 9) | |

*** Structure 20 will be abandoned**
**NOTE: REFER TO FIGURE 3A FOR STR. ID**

# TABLE 1A

## PRE- & POST-PROJECT FLOWS AND SUB-BASIN ROUTING

| PEAK FLOW | | | | | | | |
|---|---|---|---|---|---|---|---|
| North Drainage System @ Str. #23 | | | | South Drainage System @ Junc. 9 | | | |
| Storm | Pre (cfs) | Post (cfs) | Comments | Storm | Pre (cfs) | Post (cfs) | |
| 6 hr 15 yr | 20.37 | 20.18 | Flow routed through detention basin in post development | 6 hr 15 yr | 31.52 | 30.15 | |
| 6 hr 100 yr | 28.67 | 27.87 | | 6 hr 100 yr | 43.61 | 41.58 | |
| 24 hr 100 yr | 28.82 | 28.25 | | 24 hr 100 yr | 43.83 | 41.79 | |
| | A1, A2, A3, A4, A5, A6 | A1, A2, A3, A4, A5, A6, B2*, B3*, B4*, B5*, C1*, C2*, D1*, D2*, E1 | | | B1, B2, B3, B4, B5, C1, C2, D1, D2, E1, E2, F, G, H | B1, B2*, B3*, B4*, B5*, C1*, C2*, D1*, D2*, E2, F, G, H | |

Note: B1 continues in same flow pattern for pre and post development
*Water flows into diversion structure and is split such that 50% flows to the North and 50% to the South

# Figure 1

## Existing Storm Drain System

CB1
(E)CB
RIM=215.00
FL NEW 12"=202.00

STR#5
(E)CB
RIM=202.80
FL 24" IN=197.00
FL 12" IN=199.5
FL 24" OUT=196.90

STR#6
(E)CB
RIM=205.04
FL IN 198.58
FL OUT 198.54

STR#7
(E)CB
RIM=216.5
FL 24" IN=204.10
FL 24" OUT=204.00

STR#8
(E)CB
RIM=216.20
FL 8" IN(S)=211.34
FL 8" IN(E)=211.34
FL 24" IN=210.77
FL 24" OUT=210.67

STR#9
(E)SDMH
RIM=217.00
FL 24" IN=211.11
FL 12" IN=211.11
FL 24" OUT=211.01

STR#10
(E)SDMH
RIM=227.35
FL 24" IN=220.13
FL 12" IN=221.23
FL 24" OUT=220.03

STR#11
(E)CB
RIM=229.00
FL 24" IN=221.68
FL 24" OUT=221.58

STR#12
(E)SDMH
RIM=230.65
FL 24" IN=222.07
FL 24" OUT=221.97

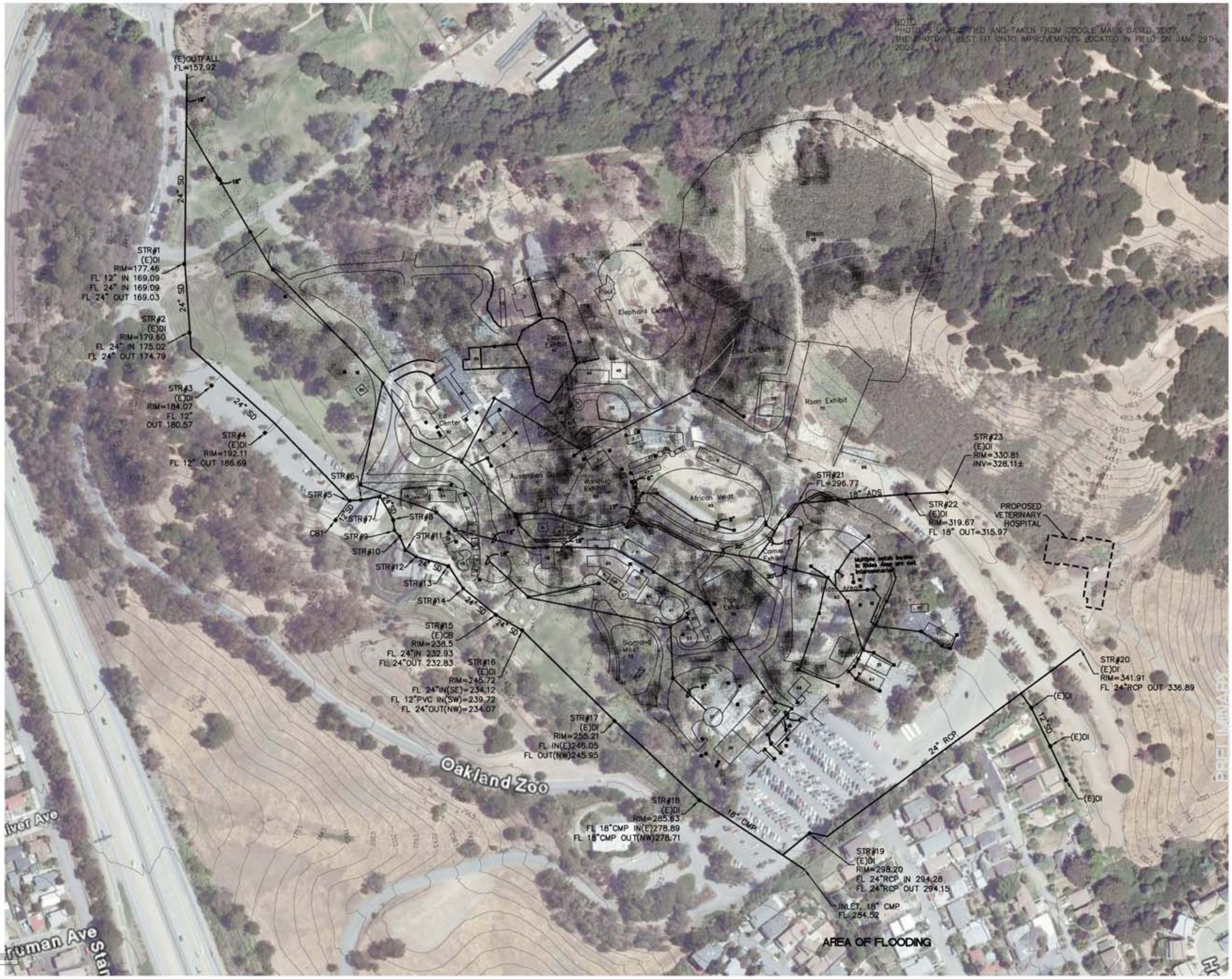
STR#13
(E)CB
RIM=231.10
FL 24" IN=224.79
FL 12" IN=224.79
FL 24" OUT=224.69

STR#14
(E)SDMH
RIM=234.40
FL 24" IN=226.12
FL 12" IN(SE)=226.12
FL 12" IN(S)=229.58
FL 24" OUT=226.02

STR#15
(E)CB
RIM=238.5
FL 24" IN=232.93
FL 24" OUT=232.83

STR#16
(E)DI
RIM=245.72
FL 24" IN(SE)234.12
FL 12" PVC IN(SW)239.72
FL 24" OUT(NW)234.07

100 50 0 100
SCALE IN FEET

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| --- | --- | --- | --- |

# FIGURE 1 - EXISTING STORM DRAIN SYSTEM
## KNOWLAND PARK-OAKLAND ZOO

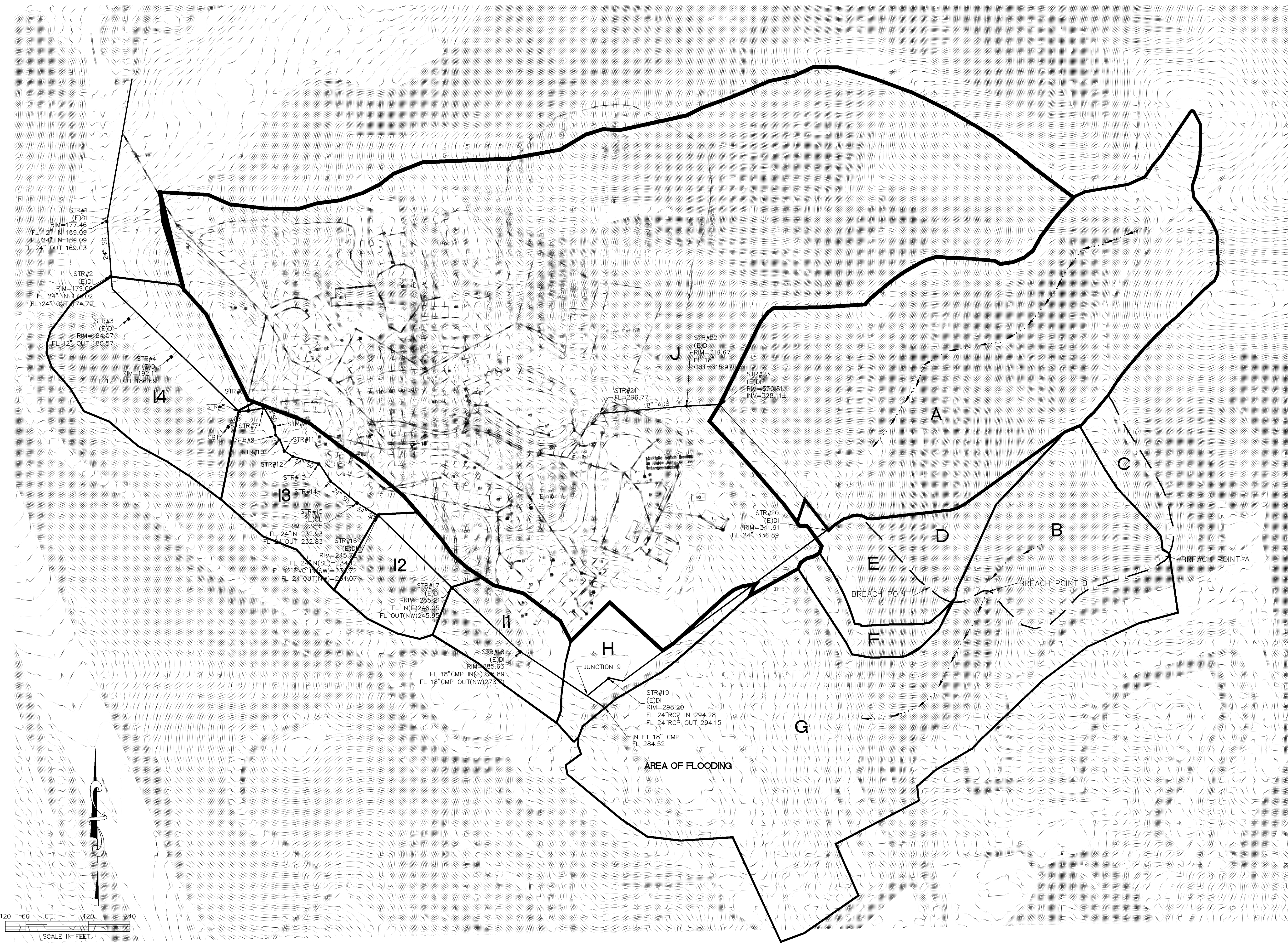
OAKLAND ALAMEDA COUNTY CALIFORNIA

JOB NO 208022
SCALE 1"=100'
DATE 8/01/09
DESIGN
DRAWN MC
APPROVED

DRAWING NUMBER
1
1 OF 1

# Figure 2

## Drainage Area Map – Pre Development




PRELIMINARY
NOT FOR CONSTRUCTION

# FIGURE 2 - DRAINAGE AREA MAP
## PRE-DEVELOPMENT
## KNOWLAND PARK-OAKLAND ZOO

OAKLAND | ALAMEDA COUNTY | CALIFORNIA

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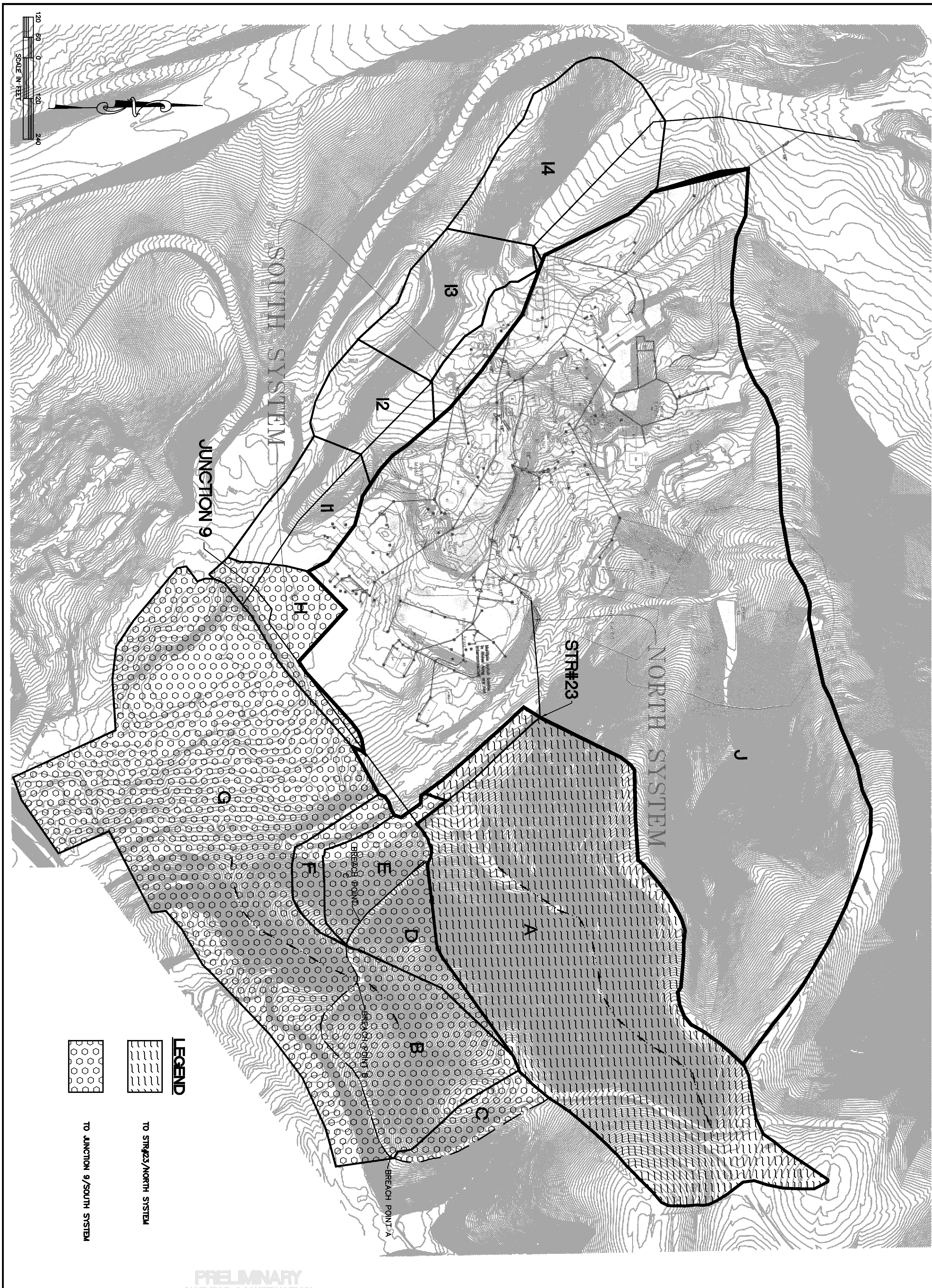
| | | | |

REGISTERED PROFESSIONAL ENGINEER · ROBERT C. WONG · No. 43748 · Exp. Mar. 31, 2009 · CIVIL · STATE OF CALIFORNIA

JOB NO 208022
SCALE 1"=120'
DATE 8/5/09
DESIGN
DRAWN MC
APPROVED

DRAWING NUMBER
1
1 OF 1




PRELIMINARY
NOT FOR CONSTRUCTION

| | |
|---|---|
| JOB NO | 206022 |
| SCALE | 1"=120' |
| DATE | 2/18/2010 |
| DESIGN | |
| DRAWN | MC |
| APPROVED | |

DRAWING NUMBER
1
1 OF 1

# FIGURE 2A - DRAINAGE AREA MAP
## PRE-DEVELOPMENT
## KNOWLAND PARK-OAKLAND ZOO

OAKLAND ALAMEDA COUNTY CALIFORNIA

| No. | BY | DATE | REVISIONS |
|---|---|---|---|
| | | | |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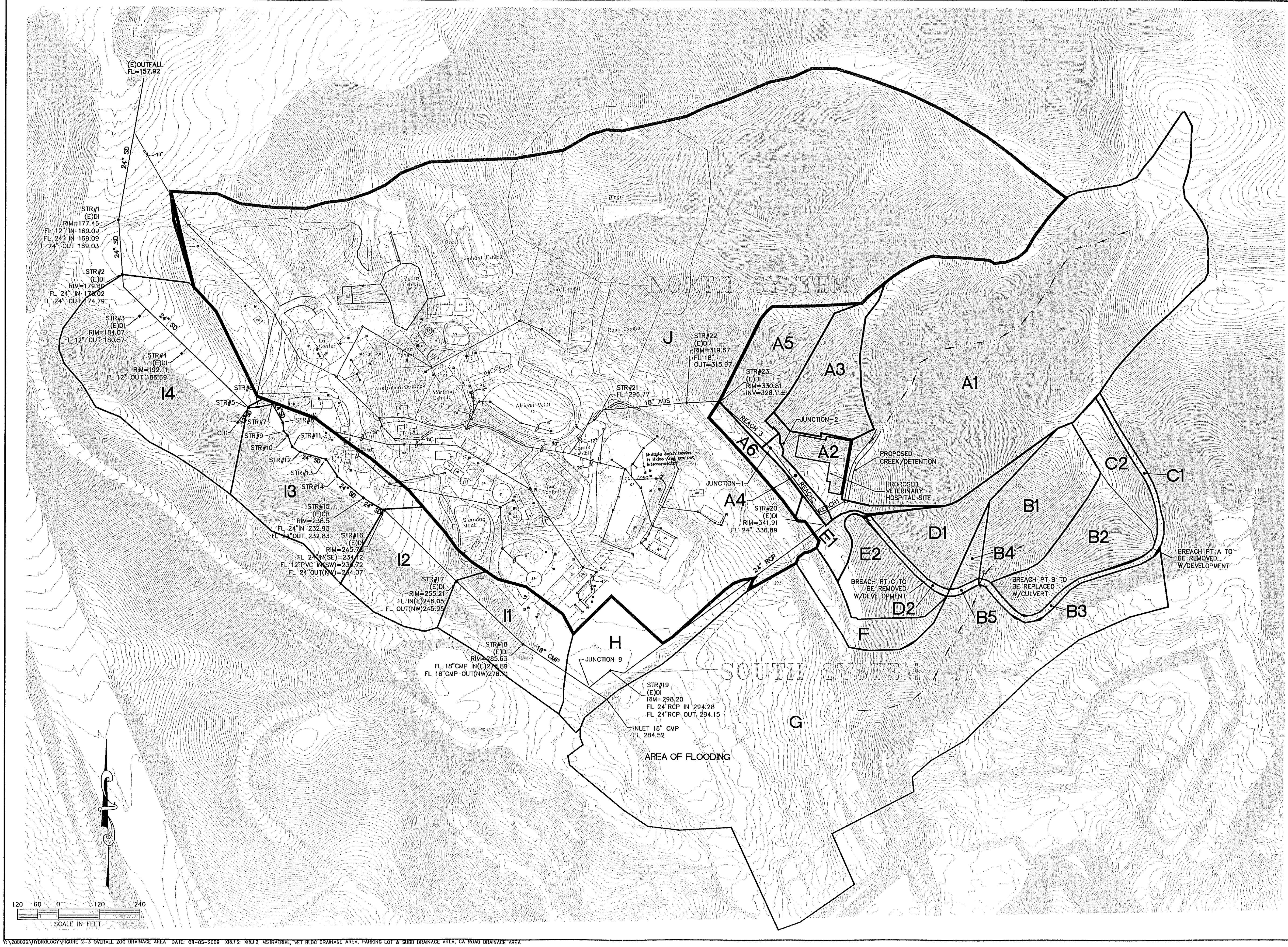
# Figure 3

## <u>Drainage Area Map – Post Development</u>

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# FIGURE 3 - DRAINAGE AREA MAP
## POST-DEVELOPMENT
## KNOWLAND PARK-OAKLAND ZOO

OAKLAND ALAMEDA COUNTY CALIFORNIA

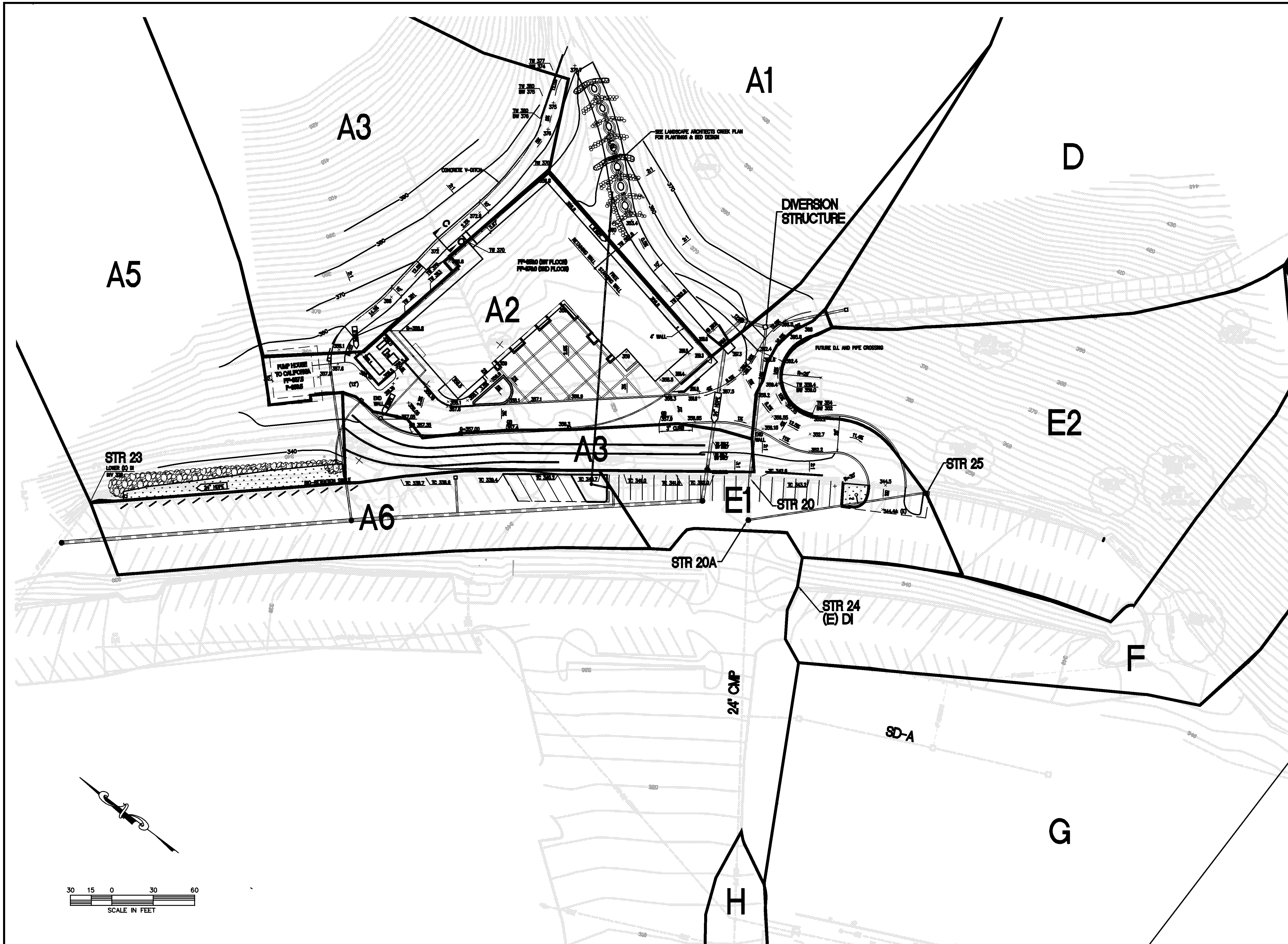
JOB NO 208022
SCALE 1"=120'
DATE 8/01/09
DESIGN
DRAWN MC
APPROVED

DRAWING NUMBER
1
1 OF 1

DRAWING: Y:\208022\HYDROLOGY\FIGURE 2-3 OVERALL ZOO DRAINAGE AREA DATE: 08-05-2009 XREFS: XREF2, MSTRAERIAL, VET BLDG DRAINAGE AREA, PARKING LOT & SUBD DRAINAGE AREA, CA ROAD DRAINAGE AREA

# Figure 3A

## <u>Drainage Area Map Post Development</u>

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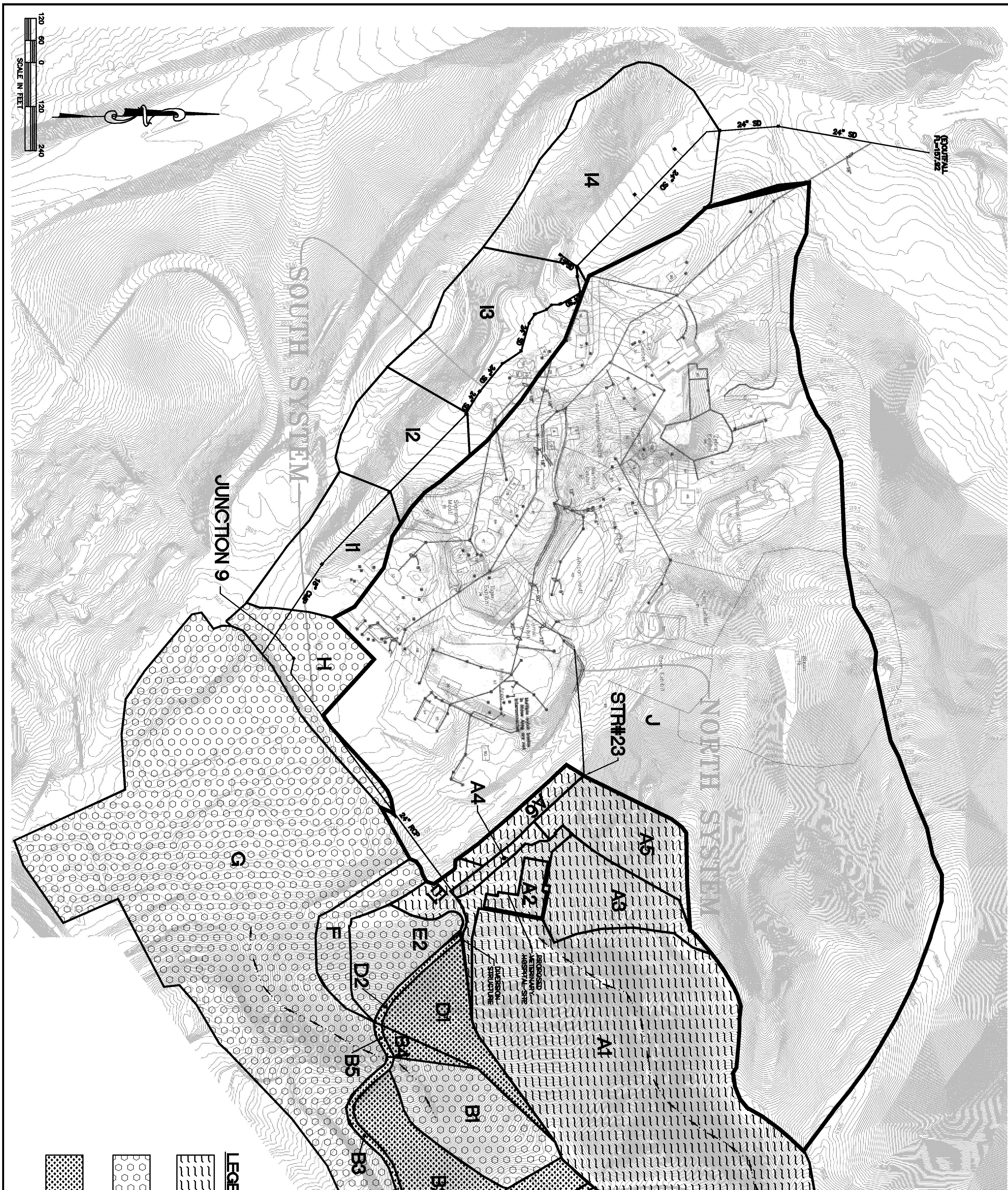
|---|---|---|---|

# FIGURE 3A – DRAINAGE AREA MAP
## POST-DEVELOPMENT
## KNOWLAND PARK-OAKLAND ZOO

OAKLAND — ALAMEDA COUNTY — CALIFORNIA

| | |
|---|---|
| JOB NO | 208022 |
| SCALE | 1"=30' |
| DATE | 8/01/2009 |
| DESIGN | VJD |
| DRAWN | MC |
| APPROVED | RCW |

DRAWING NUMBER
3A
1 OF 1




| | |
|---|---|
| JOB NO | 208022 |
| SCALE | 1"=120' |
| DATE | 2/18/2010 |
| DESIGN | |
| DRAWN | MC |
| APPROVED | |

# FIGURE 3B - DRAINAGE AREA MAP

## POST-DEVELOPMENT

## KNOWLAND PARK-OAKLAND ZOO

OAKLAND ALAMEDA COUNTY CALIFORNIA

DRAWING NUMBER 1

1 OF 1

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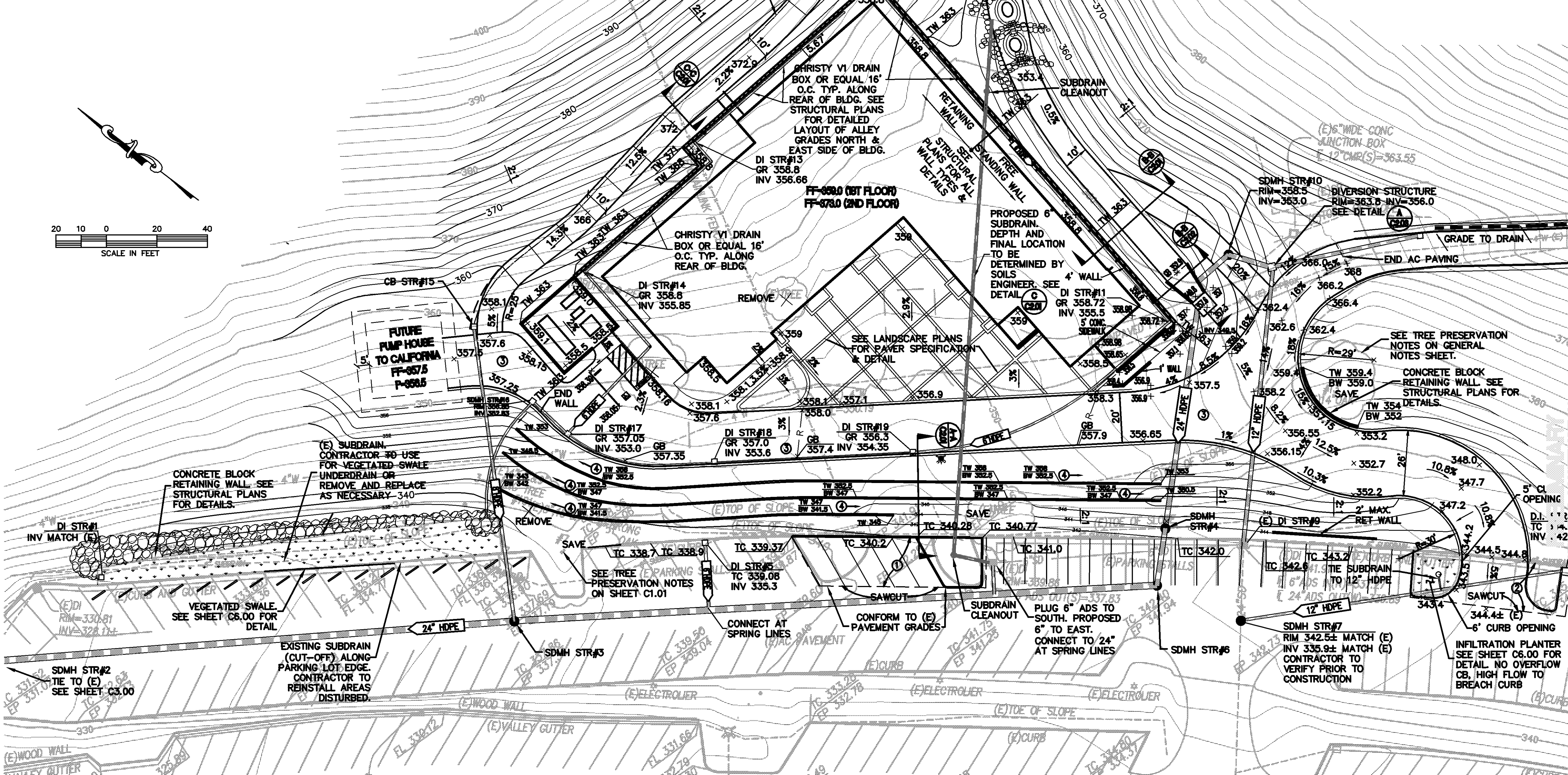
# Figure 4

## <u>Grading and Drainage Plan</u>

| STR# | TYPE | NOTES |
|---|---|---|
| | CP1212 | CENTRAL PRECAST 12"x12" OR EQUAL W/NON TRAFFIC STEEL GRATE |
| | MANHOLE TYPE 1 | PER CITY STANDARD DETAIL D-11 |
| | MANHOLE TYPE 1 | PER CITY STANDARD DETAIL D-11 |
| | MANHOLE TYPE 1 | PER CITY STANDARD DETAIL D-11 |
| | CP1818 | CENTRAL PRECAST 18"x18" OR EQUAL W/TRAFFIC RATED STEEL GRATE |
| | MANHOLE TYPE 1 | PER CITY STANDARD DETAIL D-11 |
| | MANHOLE TYPE 1 | PER CITY STANDARD DETAIL D-11 |
| | CP1818 | CENTRAL PRECAST 18"x18" OR EQUAL W/TRAFFIC RATED STEEL GRATE |
| | (E) DI | CONNECT 24" TO (E) DI |
| | MANHOLE TYPE 1 | PER CITY STANDARD DETAIL D-11 |
| | CP1212 | CENTRAL PRECAST 12"x12" OR EQUAL W/NON TRAFFIC STEEL GRATE |
| | CP1212 | CENTRAL PRECAST 12"x12" OR EQUAL W/NON TRAFFIC STEEL GRATE |
| | CP1212 | CENTRAL PRECAST 12"x12" OR EQUAL W/NON TRAFFIC STEEL GRATE |
| | CP1212 | CENTRAL PRECAST 12"x12" OR EQUAL W/NON TRAFFIC STEEL GRATE |
| | CP2424 | CENTRAL PRECAST 24"x24" W/6" S.O. OR EQUAL W/NON TRAFFIC STEEL GRATE |
| | CP1818 | CENTRAL PRECAST 18"x18" OR EQUAL W/TRAFFIC RATED STEEL GRATE |
| | CP1818 | CENTRAL PRECAST 18"x18" OR EQUAL W/TRAFFIC RATED STEEL GRATE |
| | CP1818 | CENTRAL PRECAST 18"x18" OR EQUAL W/TRAFFIC RATED STEEL GRATE |
| | CP1818 | CENTRAL PRECAST 18"x18" OR EQUAL W/TRAFFIC RATED STEEL GRATE |

NOTES

1. REMOVE & REPLACE AC PAVING 2" AC, 10" AB
2. REMOVE AND REPLACE AC PAVING 3" AC, 12" AB
3. SEE LANDSCAPE PLANS FOR IRRIGATION SLEEVE LOCATIONS AND DETAIL SHOWN ON CIVIL PLANS AS REFERENCE ONLY.
4. STEP WALL DOWN 12" EVERY 8' TO END OF WALL




# FIGURE 4 - GRADING AND DRAINAGE PLAN

## VETERINARY HOSPITAL SITE

## KNOWLAND PARK - OAKLAND ZOO

OAKLAND ALAMEDA COUNTY CALIFORNIA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JOB NO 206022
SCALE 1"=30'
DATE 12/28/09
DESIGN
DRAWN MC
APPROVED

DRAWING NUMBER
1
1 OF 1

# Figure 5

## California & Access Road C.3 Exhibit and Drainage Area Map

# FIGURE 5A - CALIFORNIA DRAINAGE PLAN
## KNOWLAND PARK - OAKLAND ZOO

OAKLAND | ALAMEDA COUNTY | CALIFORNIA

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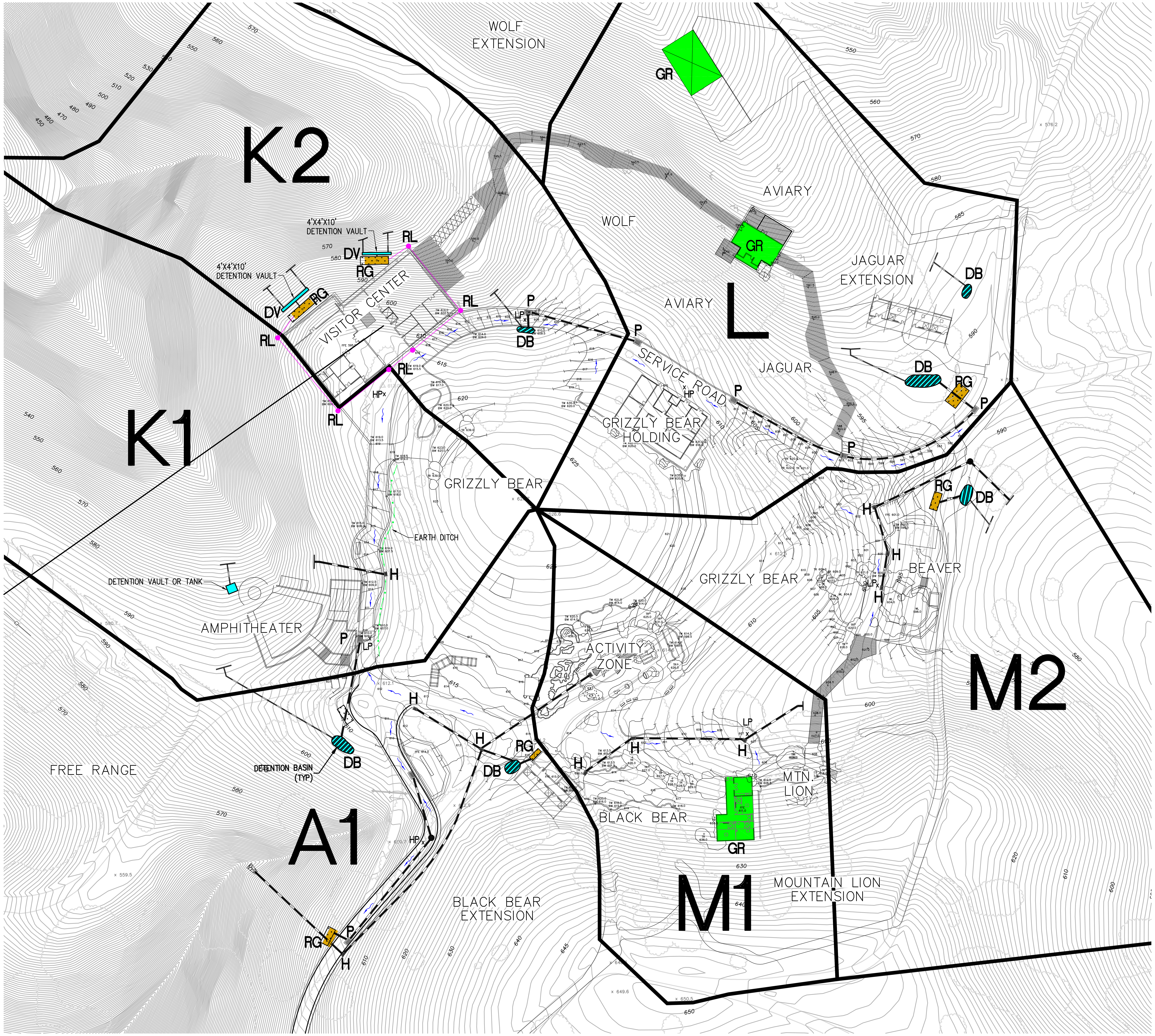


**LEGEND**

| | |
|---|---|
| RL | ROOF LEADER |
| | STORM DRAIN PIPE FOR VISITOR CENTER ROOF LEADER |
| | EARTH DITCH |
| RG | RAIN GARDEN |
| GR | GREEN ROOF |
| DB | DETENTION BASIN |
| DV | DETENTION VALVE |
| H | DRAINAGE COLLECTED FROM HILL ONLY |
| P | DRAINAGE COLLECTED FROM PAVEMENT TO C-3 BMP |
| HP x | HIGH POINT |
| LP x | LOW POINT |
| | RUNOFF DIRECTION |

80 40 0 80 160
SCALE IN FEET


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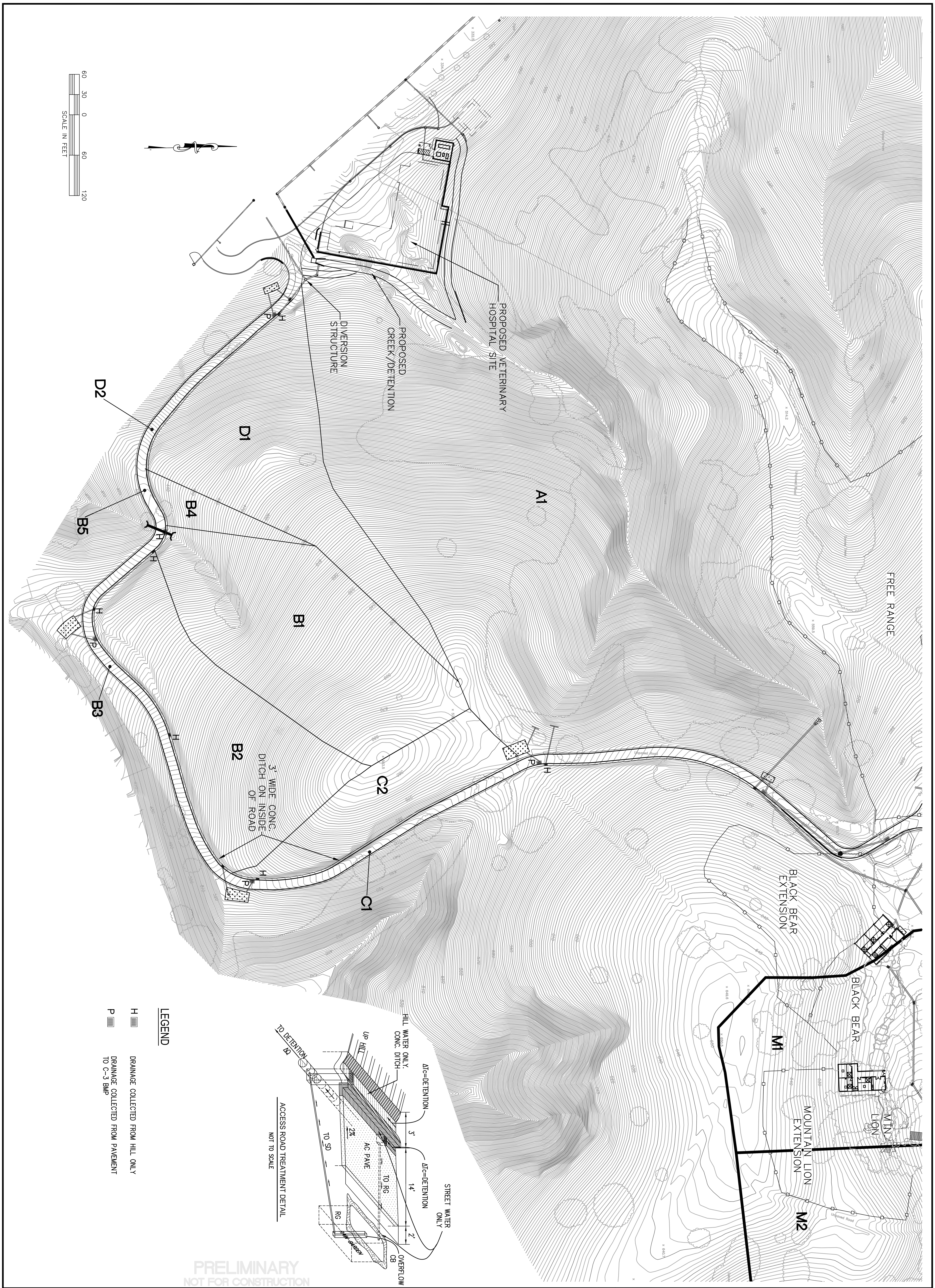
JOB NO 208022.00
SCALE 1"=80'
DATE 2/18/2010
DESIGN FW
DRAWN FW
APPROVED

DRAWING NUMBER
1
1 OF 1

Y:\208022\Exhibits\Erosion Control\Erosion Control Exhibit.dwg 2/12/2010 4:18:04 PM PST




| | | |
|---|---|---|
| JOB NO 208022.00 | FIGURE 5B | |
| SCALE 1"=60' | MAINTENANCE ACCESS ROAD DRAINAGE | |
| DATE 2/18/2010 | KNOWLAND PARK - OAKLAND ZOO | |
| DESIGN | | |
| DRAWN MC | | |
| APPROVED | OAKLAND ALAMEDA COUNTY CALIFORNIA | |

DRAWING NUMBER 1 1 OF 1

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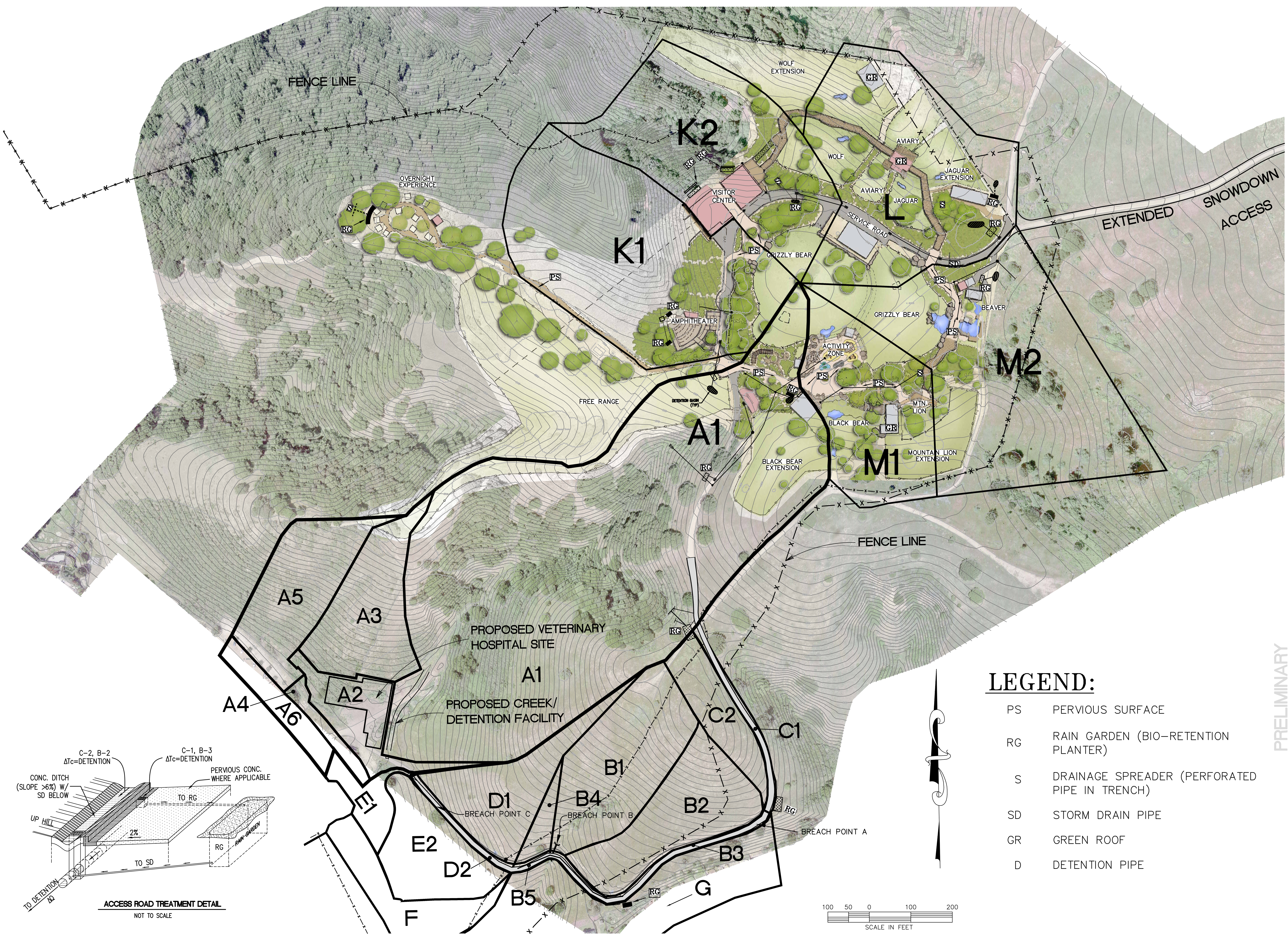


## LEGEND:

| | |
|---|---|
| PS | PERVIOUS SURFACE |
| RG | RAIN GARDEN (BIO-RETENTION PLANTER) |
| S | DRAINAGE SPREADER (PERFORATED PIPE IN TRENCH) |
| SD | STORM DRAIN PIPE |
| GR | GREEN ROOF |
| D | DETENTION PIPE |

PRELIMINARY
NOT FOR CONSTRUCTION

# FIGURE 5 - C3 AND DRAINAGE AREAS
## VET HOSPITAL, ACCESS ROAD AND CALIFORNIA
## KNOWLAND PARK-OAKLAND ZOO

OAKLAND ALAMEDA COUNTY CALIFORNIA

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SCALE 1"=100'
DATE 2/19/2010
DESIGN
DRAWN MC
APPROVED

DRAWING NUMBER
1
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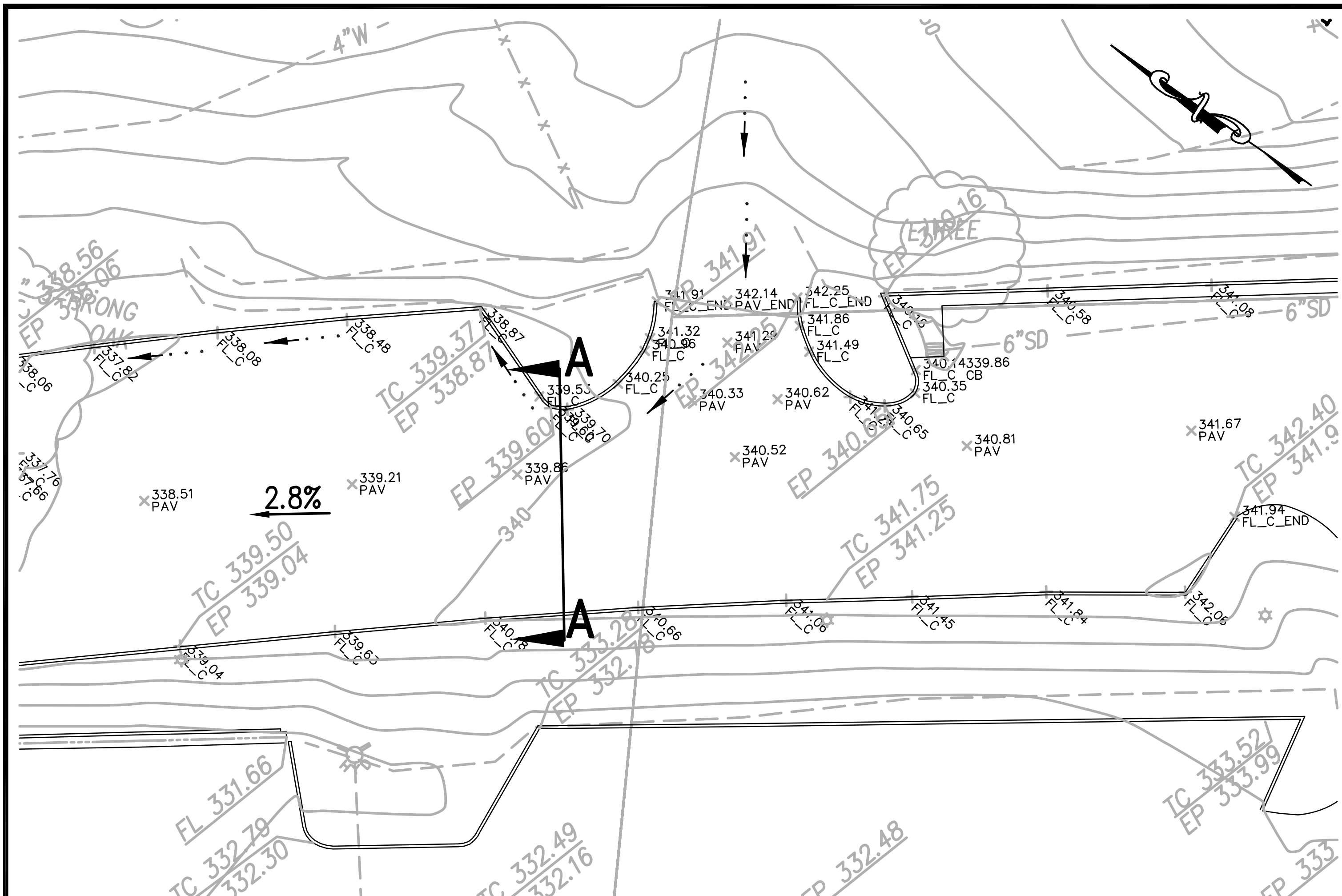
# Figure 6

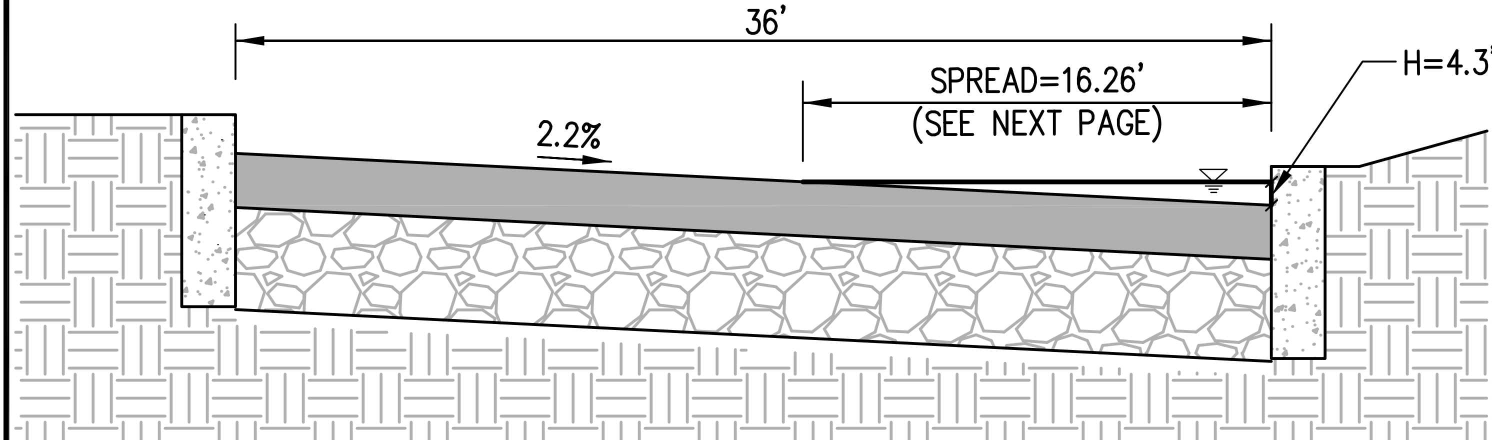
## <u>Gutter Flow Cross Section</u>

EXISTING UPPER PARKING AREA




**PLAN VIEW**

1"=30'




**CROSS-SECTION A-A**

NOT TO SCALE

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Subject FIGURE 6-GUTTER FLOW CROSS SECTION

Job No. 208022.00 Scale 1"=30'

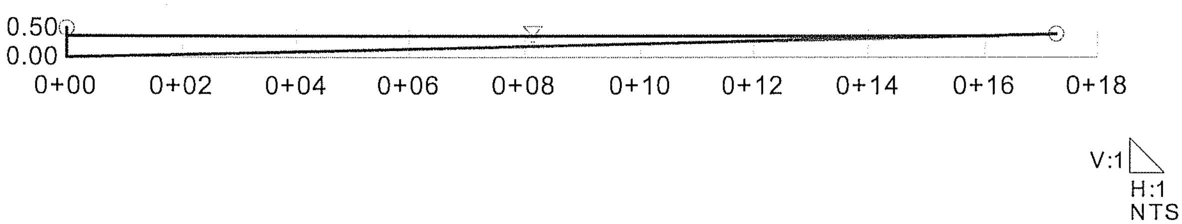
By FW Date 02-16-2009 Chkd.

SHEET 1 OF 1

# Cross Section
## Cross Section for Gutter Section

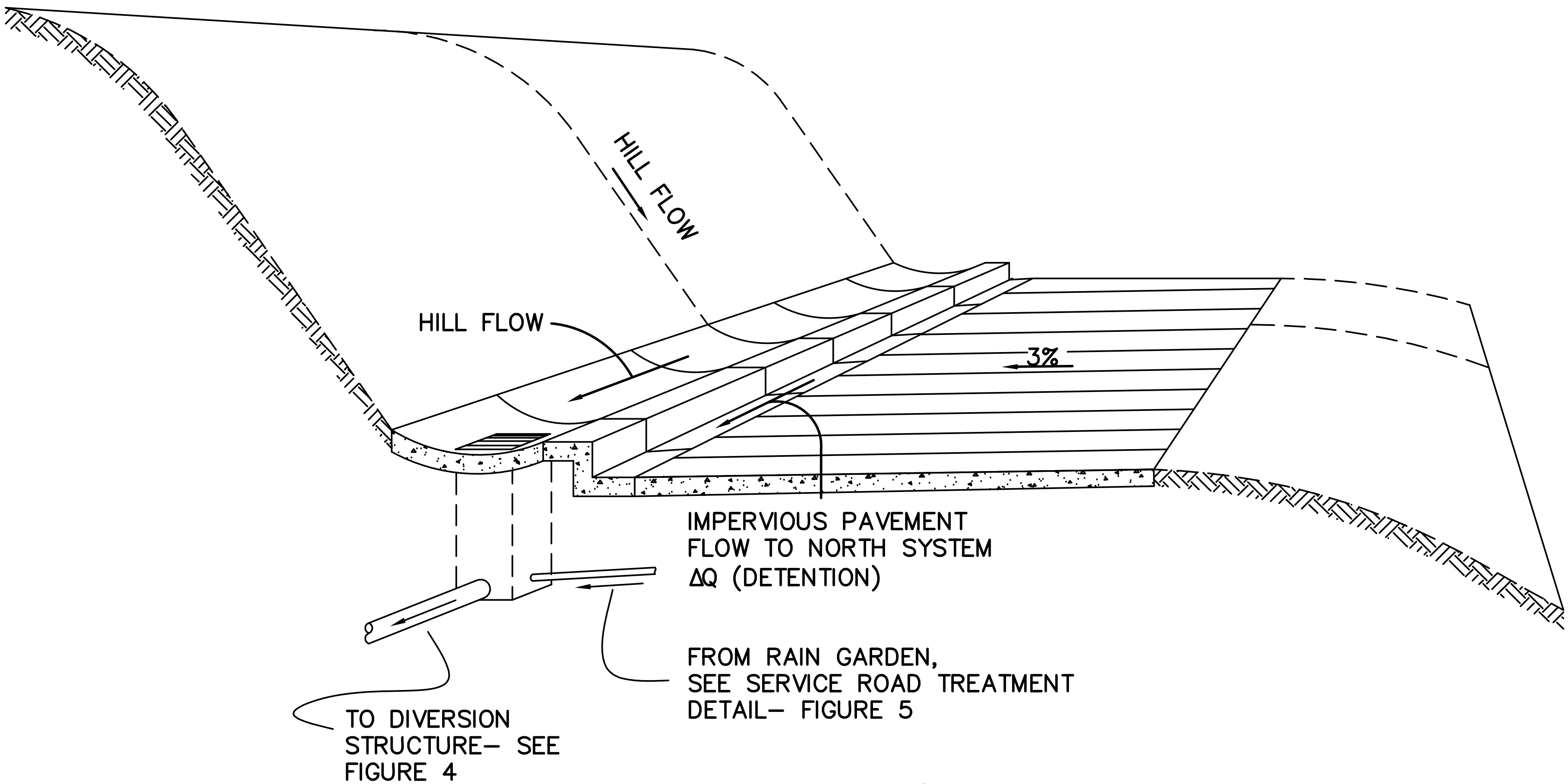
| Project Description | |
|---|---|
| Worksheet | Gutter Section - |
| Type | Gutter Section |
| Solve For | Spread |

| Section Data | | |
|---|---|---|
| Slope | 028000 | ft/ft |
| Discharge | 19.61 | cfs |
| Gutter Width | 0.00 | ft |
| Gutter Cross Slo| | 000000 | ft/ft |
| Road Cross Slop | 022000 | ft/ft |
| Spread | 16.26 | ft |
| Mannings Coeffic | 0.014 | |



# Figure 7

## <u>Cross Section, Access Road to California</u>



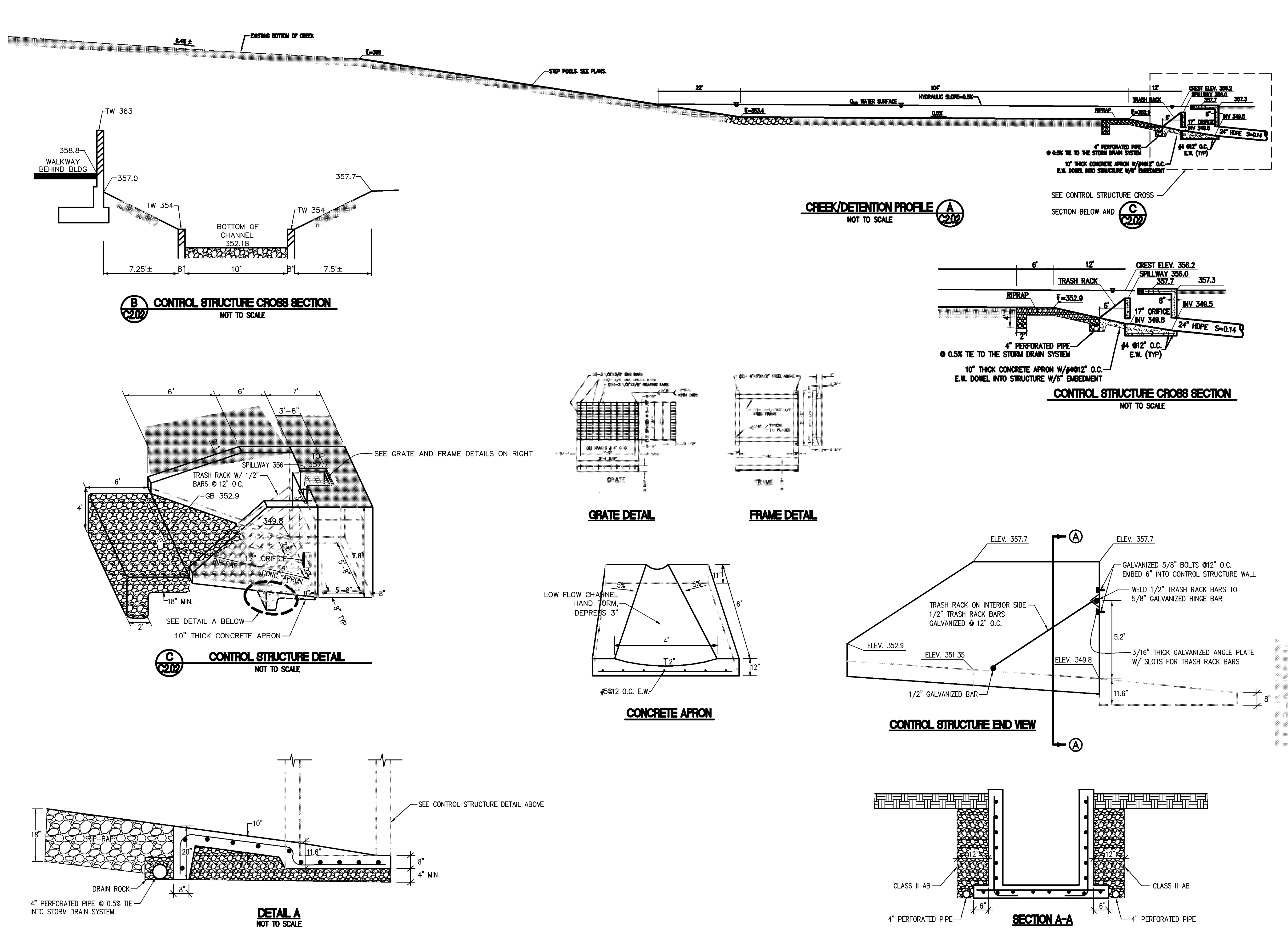

**ACCESS ROAD TO CALIFORNIA**

NOTE: THE INCREASE IN FLOW (ΔQ) FROM PAVING THE ACCESS ROAD WILL DETAINED IN THE VETERINARY HOSPITAL DETENTION FACILITY. ALSO SEE SERVICE ROAD TREATMENT DETAIL, FIGURE 5.

**FIGURE 7**

# Figure 8

## Detention Basin & Control Structure Cross Section





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# FIGURE 8 - DETENTION BASIN AND CONTROL STRUCTURE DETAIL
## KNOWLAND PARK - OAKLAND ZOO

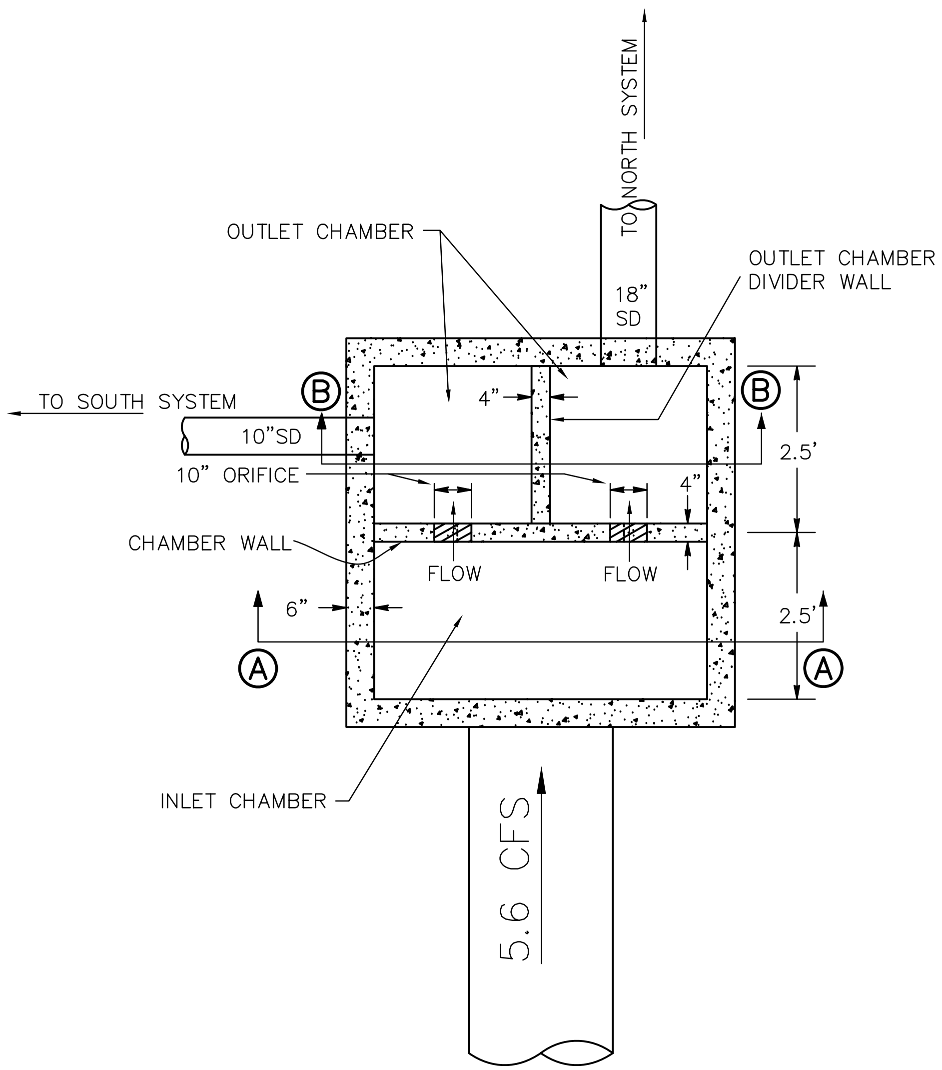
OAKLAND ALAMEDA COUNTY CALIFORNIA

JOB NO 206022
SCALE NTS
DATE 12/28/09
DESIGN
DRAWN MC
APPROVED

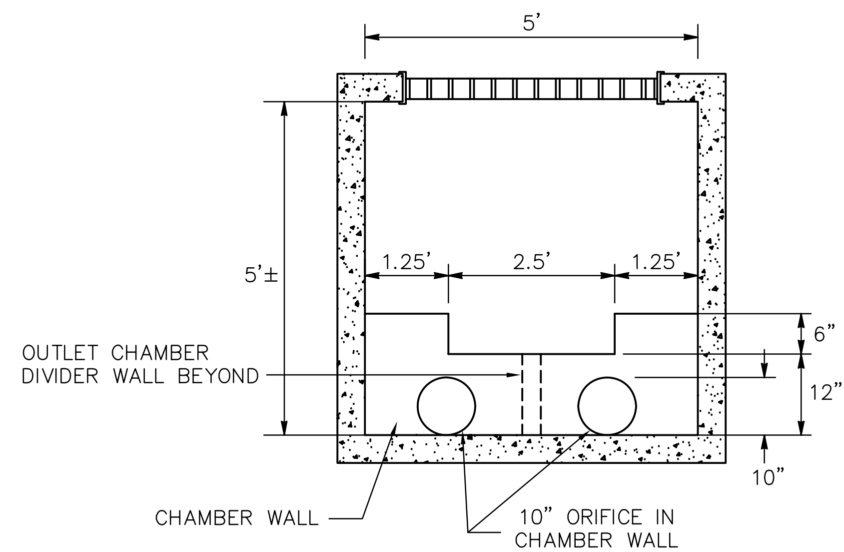
DRAWING NUMBER
1
1 OF 1

# Figure 9
# <u>Diversion Structure Detail</u>

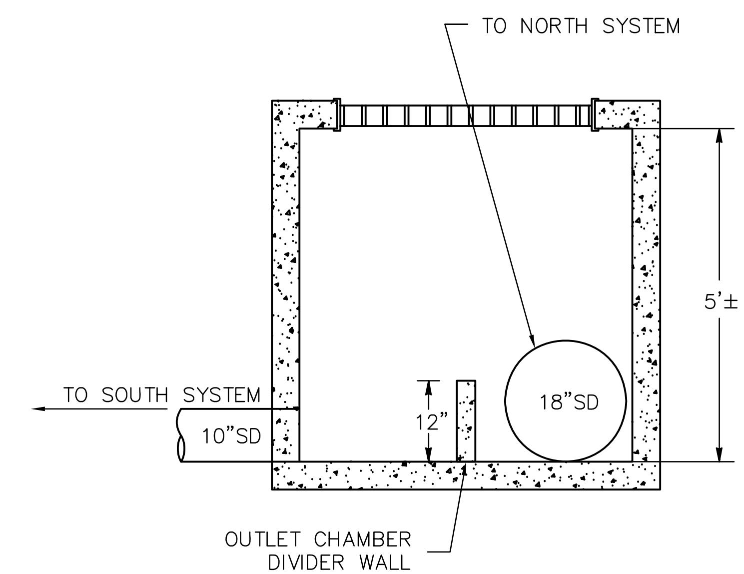
DIVERSION BOX @ 50% FLOW TO NORTH
& 50% FLOW TO SOUTH




PLAN VIEW



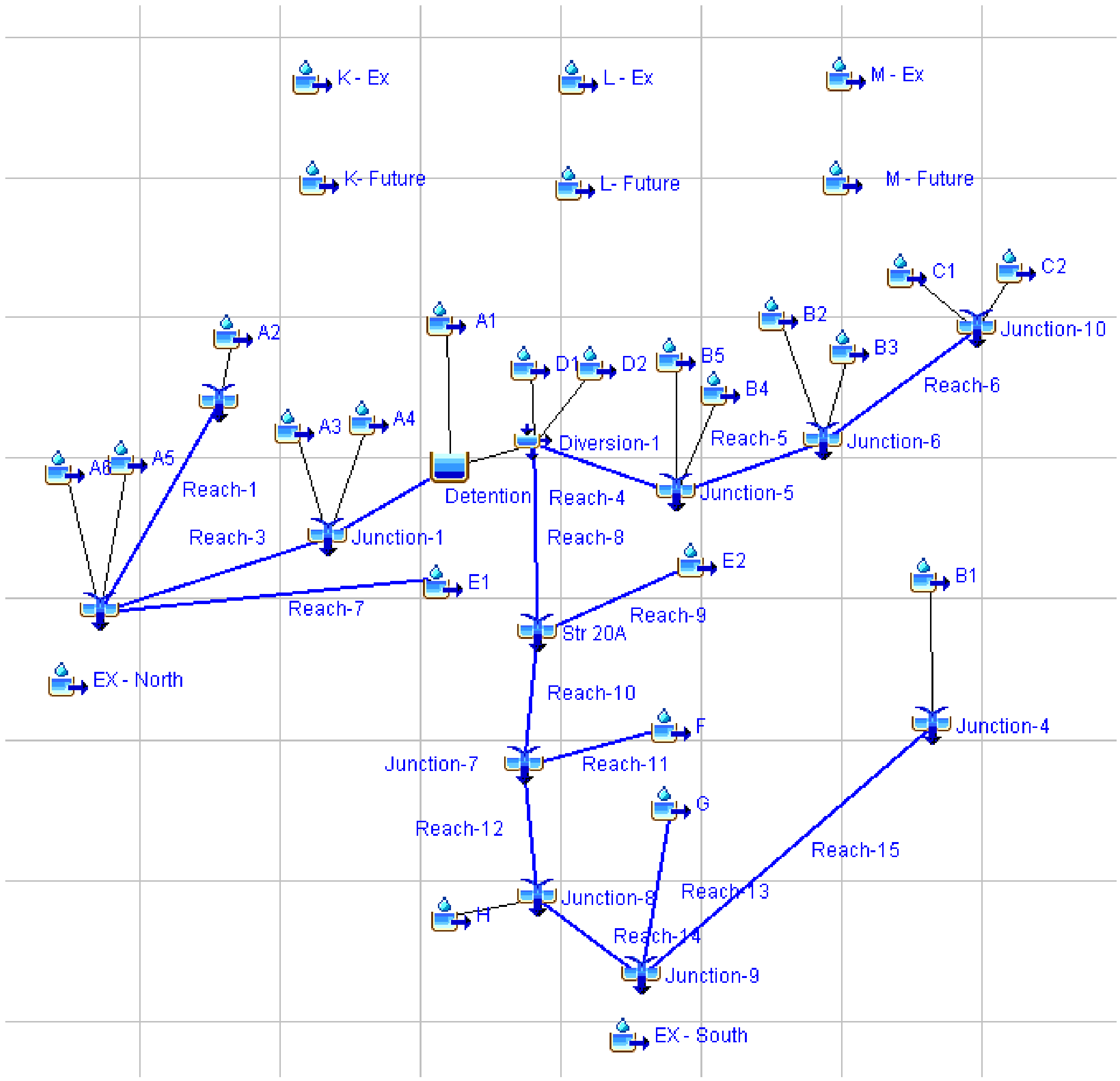

SECTION A




SECTION B

# FIGURE 9
# DIVERSION STRUCTURE

# APPENDIX A




**Hydrology Model Schematic**

Project: A9006 Simulation Run: 6hr-15 yr

Start of Run: 01Jan2000, 00:00 Basin Model: Knowland Zoo
End of Run: 03Jan2000, 00:00 Meteorologic Model: 6h15y
Compute Time: 07Aug2009, 11:56:29 Control Specifications: 15year

Volume Units: IN

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A1 | 0.0220 | 16.04 | 01Jan2000, 03:35 | 1.88 |
| A2 | 0.0014 | 1.09 | 01Jan2000, 03:30 | 2.84 |
| A3 | 0.0025 | 1.87 | 01Jan2000, 03:30 | 1.99 |
| A4 | 0.0004 | 0.29 | 01Jan2000, 03:30 | 1.29 |
| A5 | 0.0025 | 1.87 | 01Jan2000, 03:30 | 1.95 |
| A6 | 0.0008 | 0.62 | 01Jan2000, 03:30 | 3.24 |
| B1 | 0.0032 | 2.39 | 01Jan2000, 03:30 | 1.82 |
| B2 | 0.0027 | 2.02 | 01Jan2000, 03:30 | 1.90 |
| B3 | 0.0004 | 0.31 | 01Jan2000, 03:30 | 2.31 |
| B4 | 0.0003 | 0.22 | 01Jan2000, 03:30 | 1.35 |
| B5 | 0.0004 | 0.31 | 01Jan2000, 03:30 | 2.31 |
| C1 | 0.0003 | 0.23 | 01Jan2000, 03:30 | 2.31 |
| C2 | 0.0013 | 0.97 | 01Jan2000, 03:30 | 1.93 |
| D1 | 0.0021 | 0.95 | 01Jan2000, 03:30 | 0.85 |
| D2 | 0.0002 | 0.15 | 01Jan2000, 03:30 | 2.31 |
| Detention | 0.0297 | 15.06 | 01Jan2000, 03:50 | 1.59 |
| Diversion-1 | 0.0077 | 2.58 | 01Jan2000, 03:30 | 0.83 |
| E1 | 0.0006 | 0.45 | 01Jan2000, 03:30 | 2.03 |
| E2 | 0.0013 | 0.97 | 01Jan2000, 03:30 | 2.11 |
| EX - North | 0.0295 | 20.37 | 01Jan2000, 03:40 | 1.91 |
| EX - South | 0.0432 | 31.52 | 01Jan2000, 03:35 | 2.45 |
| F | 0.0006 | 0.46 | 01Jan2000, 03:30 | 2.99 |
| G | 0.0281 | 21.55 | 01Jan2000, 03:30 | 2.61 |
| H | 0.0029 | 2.25 | 01Jan2000, 03:30 | 2.82 |
| Junction-1 | 0.0326 | 16.72 | 01Jan2000, 03:45 | 1.62 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Junction-10 | 0.0016 | 1.20 | 01Jan2000, 03:30 | 2.00 |
| Junction-2 | 0.0014 | 1.09 | 01Jan2000, 03:30 | 2.84 |
| Junction-4 | 0.0032 | 2.39 | 01Jan2000, 03:30 | 1.82 |
| Junction-5 | 0.0054 | 4.06 | 01Jan2000, 03:30 | 1.96 |
| Junction-6 | 0.0047 | 3.53 | 01Jan2000, 03:30 | 1.97 |
| Junction-7 | 0.0019 | 4.01 | 01Jan2000, 03:30 | 5.77 |
| Junction-8 | 0.0048 | 6.25 | 01Jan2000, 03:30 | 3.99 |
| Junction-9 | 0.0361 | 30.15 | 01Jan2000, 03:30 | 2.73 |
| K - Ex | 0.0154 | 11.50 | 01Jan2000, 03:30 | 1.88 |
| K- Future | 0.0154 | 11.59 | 01Jan2000, 03:30 | 2.06 |
| L - Ex | 0.0070 | 5.23 | 01Jan2000, 03:30 | 1.88 |
| L- Future | 0.0070 | 5.29 | 01Jan2000, 03:30 | 2.14 |
| M - Ex | 0.0148 | 10.92 | 01Jan2000, 03:30 | 1.86 |
| M - Future | 0.0148 | 11.07 | 01Jan2000, 03:30 | 1.90 |
| Reach-1 | 0.0014 | 1.09 | 01Jan2000, 03:30 | 2.84 |
| Reach-10 | 0.0013 | 3.55 | 01Jan2000, 03:30 | 7.05 |
| Reach-11 | 0.0006 | 0.46 | 01Jan2000, 03:30 | 2.99 |
| Reach-12 | 0.0019 | 4.00 | 01Jan2000, 03:30 | 5.77 |
| Reach-13 | 0.0281 | 21.55 | 01Jan2000, 03:30 | 2.61 |
| Reach-14 | 0.0048 | 6.25 | 01Jan2000, 03:30 | 3.99 |
| Reach-15 | 0.0032 | 2.39 | 01Jan2000, 03:35 | 1.82 |
| Reach-2 | 0.0297 | 15.04 | 01Jan2000, 03:50 | 1.59 |
| Reach-3 | 0.0326 | 16.72 | 01Jan2000, 03:45 | 1.62 |
| Reach-4 | 0.0054 | 4.06 | 01Jan2000, 03:30 | 1.96 |
| Reach-5 | 0.0047 | 3.53 | 01Jan2000, 03:30 | 1.97 |
| Reach-6 | 0.0016 | 1.20 | 01Jan2000, 03:30 | 2.00 |
| Reach-7 | 0.0006 | 0.45 | 01Jan2000, 03:30 | 2.03 |
| Reach-8 | 0.0000 | 2.58 | 01Jan2000, 03:30 | |
| Reach-9 | 0.0013 | 0.97 | 01Jan2000, 03:30 | 2.11 |
| Str 20A | 0.0013 | 3.55 | 01Jan2000, 03:30 | 7.05 |
| Str 23 | 0.0379 | 20.18 | 01Jan2000, 03:45 | 1.73 |

Project: A9006 Simulation Run: 6hr 100yr

Start of Run: 01Feb2000, 00:00
End of Run: 03Feb2000, 00:00
Compute Time: 07Aug2009, 11:53:45

Basin Model: Knowland Zoo
Meteorologic Model: 6h100y
Control Specifications: 100year

Volume Units: IN

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A1 | 0.0220 | 22.22 | 01Feb2000, 03:35 | 2.76 |
| A2 | 0.0014 | 1.48 | 01Feb2000, 03:30 | 3.69 |
| A3 | 0.0025 | 2.58 | 01Feb2000, 03:30 | 2.64 |
| A4 | 0.0004 | 0.40 | 01Feb2000, 03:30 | 1.93 |
| A5 | 0.0025 | 2.59 | 01Feb2000, 03:30 | 2.89 |
| A6 | 0.0008 | 0.85 | 01Feb2000, 03:30 | 4.08 |
| B1 | 0.0032 | 3.31 | 01Feb2000, 03:30 | 2.69 |
| B2 | 0.0027 | 2.79 | 01Feb2000, 03:30 | 2.82 |
| B3 | 0.0004 | 0.42 | 01Feb2000, 03:30 | 3.15 |
| B4 | 0.0003 | 0.31 | 01Feb2000, 03:30 | 2.00 |
| B5 | 0.0004 | 0.42 | 01Feb2000, 03:30 | 3.15 |
| C1 | 0.0003 | 0.32 | 01Feb2000, 03:30 | 3.15 |
| C2 | 0.0013 | 1.34 | 01Feb2000, 03:30 | 2.57 |
| D1 | 0.0021 | 1.56 | 01Feb2000, 03:30 | 1.64 |
| D2 | 0.0002 | 0.21 | 01Feb2000, 03:30 | 3.15 |
| Detention | 0.0297 | 20.63 | 01Feb2000, 03:50 | 2.36 |
| Diversion-1 | 0.0077 | 3.69 | 01Feb2000, 03:30 | 1.24 |
| E1 | 0.0006 | 0.63 | 01Feb2000, 03:30 | 4.07 |
| E2 | 0.0013 | 1.34 | 01Feb2000, 03:30 | 2.80 |
| EX - North | 0.0295 | 28.40 | 01Feb2000, 03:40 | 2.55 |
| EX - South | 0.0432 | 43.52 | 01Feb2000, 03:35 | 3.44 |
| F | 0.0006 | 0.63 | 01Feb2000, 03:30 | 3.72 |
| G | 0.0281 | 29.61 | 01Feb2000, 03:30 | 3.63 |
| H | 0.0029 | 3.08 | 01Feb2000, 03:30 | 3.92 |
| Junction-1 | 0.0326 | 22.57 | 01Feb2000, 03:50 | 2.38 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Junction-10 | 0.0016 | 1.66 | 01Feb2000, 03:30 | 2.68 |
| Junction-2 | 0.0014 | 1.48 | 01Feb2000, 03:30 | 3.69 |
| Junction-4 | 0.0032 | 3.31 | 01Feb2000, 03:30 | 2.69 |
| Junction-5 | 0.0054 | 5.60 | 01Feb2000, 03:30 | 2.78 |
| Junction-6 | 0.0047 | 4.87 | 01Feb2000, 03:30 | 2.80 |
| Junction-7 | 0.0019 | 5.65 | 01Feb2000, 03:30 | 8.12 |
| Junction-8 | 0.0048 | 8.71 | 01Feb2000, 03:30 | 5.58 |
| Junction-9 | 0.0361 | 41.58 | 01Feb2000, 03:30 | 3.81 |
| K - Ex | 0.0154 | 15.91 | 01Feb2000, 03:30 | 2.72 |
| K- Future | 0.0154 | 16.00 | 01Feb2000, 03:30 | 2.93 |
| L - Ex | 0.0070 | 7.23 | 01Feb2000, 03:30 | 2.74 |
| L- Future | 0.0070 | 7.30 | 01Feb2000, 03:30 | 3.05 |
| M - Ex | 0.0148 | 15.12 | 01Feb2000, 03:30 | 2.75 |
| M - Future | 0.0148 | 15.32 | 01Feb2000, 03:30 | 2.81 |
| Reach-1 | 0.0014 | 1.48 | 01Feb2000, 03:30 | 3.69 |
| Reach-10 | 0.0013 | 5.02 | 01Feb2000, 03:30 | 10.15 |
| Reach-11 | 0.0006 | 0.63 | 01Feb2000, 03:30 | 3.72 |
| Reach-12 | 0.0019 | 5.64 | 01Feb2000, 03:30 | 8.12 |
| Reach-13 | 0.0281 | 29.61 | 01Feb2000, 03:30 | 3.63 |
| Reach-14 | 0.0048 | 8.71 | 01Feb2000, 03:30 | 5.58 |
| Reach-15 | 0.0032 | 3.31 | 01Feb2000, 03:35 | 2.69 |
| Reach-2 | 0.0297 | 20.49 | 01Feb2000, 03:55 | 2.36 |
| Reach-3 | 0.0326 | 22.57 | 01Feb2000, 03:50 | 2.38 |
| Reach-4 | 0.0054 | 5.60 | 01Feb2000, 03:30 | 2.78 |
| Reach-5 | 0.0047 | 4.87 | 01Feb2000, 03:30 | 2.80 |
| Reach-6 | 0.0016 | 1.66 | 01Feb2000, 03:30 | 2.68 |
| Reach-7 | 0.0006 | 0.63 | 01Feb2000, 03:30 | 4.06 |
| Reach-8 | 0.0000 | 3.69 | 01Feb2000, 03:30 | |
| Reach-9 | 0.0013 | 1.34 | 01Feb2000, 03:30 | 2.80 |
| Str 20A | 0.0013 | 5.02 | 01Feb2000, 03:30 | 10.15 |
| Str 23 | 0.0379 | 26.74 | 01Feb2000, 03:50 | 2.52 |

Project: A9006 Simulation Run: 24hr - 100y

Start of Run: 01Feb2000, 00:00
End of Run: 03Feb2000, 00:00
Compute Time: 07Aug2009, 11:47:52

Basin Model: Knowland Zoo
Meteorologic Model: 24h100y
Control Specifications: 100year

Volume Units: IN

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A1 | 0.0220 | 22.33 | 01Feb2000, 12:35 | 4.75 |
| A2 | 0.0014 | 1.49 | 01Feb2000, 12:30 | 6.31 |
| A3 | 0.0025 | 2.60 | 01Feb2000, 12:30 | 4.64 |
| A4 | 0.0004 | 0.40 | 01Feb2000, 12:30 | 3.64 |
| A5 | 0.0025 | 2.60 | 01Feb2000, 12:30 | 4.86 |
| A6 | 0.0008 | 0.85 | 01Feb2000, 12:30 | 6.71 |
| B1 | 0.0032 | 3.32 | 01Feb2000, 12:30 | 4.66 |
| B2 | 0.0027 | 2.81 | 01Feb2000, 12:30 | 4.79 |
| B3 | 0.0004 | 0.42 | 01Feb2000, 12:30 | 5.78 |
| B4 | 0.0003 | 0.31 | 01Feb2000, 12:30 | 3.97 |
| B5 | 0.0004 | 0.42 | 01Feb2000, 12:30 | 5.78 |
| C1 | 0.0003 | 0.32 | 01Feb2000, 12:30 | 5.78 |
| C2 | 0.0013 | 1.35 | 01Feb2000, 12:30 | 4.54 |
| D1 | 0.0021 | 1.57 | 01Feb2000, 12:30 | 1.73 |
| D2 | 0.0002 | 0.21 | 01Feb2000, 12:30 | 5.78 |
| Detention | 0.0297 | 21.98 | 01Feb2000, 12:50 | 4.03 |
| Diversion-1 | 0.0077 | 3.71 | 01Feb2000, 12:30 | 2.02 |
| E1 | 0.0006 | 0.64 | 01Feb2000, 12:30 | 6.45 |
| E2 | 0.0013 | 1.34 | 01Feb2000, 12:30 | 4.73 |
| EX - North | 0.0295 | 28.82 | 01Feb2000, 12:40 | 4.54 |
| EX - South | 0.0432 | 43.83 | 01Feb2000, 12:35 | 5.73 |
| F | 0.0006 | 0.63 | 01Feb2000, 12:30 | 5.84 |
| G | 0.0281 | 29.76 | 01Feb2000, 12:30 | 6.02 |
| H | 0.0029 | 3.09 | 01Feb2000, 12:30 | 6.55 |
| Junction-1 | 0.0326 | 24.06 | 01Feb2000, 12:50 | 4.07 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Junction-10 | 0.0016 | 1.67 | 01Feb2000, 12:30 | 4.77 |
| Junction-2 | 0.0014 | 1.49 | 01Feb2000, 12:30 | 6.31 |
| Junction-4 | 0.0032 | 3.32 | 01Feb2000, 12:30 | 4.66 |
| Junction-5 | 0.0054 | 5.63 | 01Feb2000, 12:30 | 4.89 |
| Junction-6 | 0.0047 | 4.90 | 01Feb2000, 12:30 | 4.87 |
| Junction-7 | 0.0019 | 5.68 | 01Feb2000, 12:30 | 13.29 |
| Junction-8 | 0.0048 | 8.76 | 01Feb2000, 12:30 | 9.22 |
| Junction-9 | 0.0361 | 41.79 | 01Feb2000, 12:30 | 6.32 |
| K - Ex | 0.0154 | 15.99 | 01Feb2000, 12:30 | 4.69 |
| K- Future | 0.0154 | 16.08 | 01Feb2000, 12:30 | 5.02 |
| L - Ex | 0.0070 | 7.27 | 01Feb2000, 12:30 | 4.71 |
| L- Future | 0.0070 | 7.33 | 01Feb2000, 12:30 | 5.20 |
| M - Ex | 0.0148 | 15.20 | 01Feb2000, 12:30 | 4.72 |
| M - Future | 0.0148 | 15.40 | 01Feb2000, 12:30 | 4.81 |
| Reach-1 | 0.0014 | 1.49 | 01Feb2000, 12:30 | 6.31 |
| Reach-10 | 0.0013 | 5.05 | 01Feb2000, 12:30 | 16.73 |
| Reach-11 | 0.0006 | 0.63 | 01Feb2000, 12:30 | 5.84 |
| Reach-12 | 0.0019 | 5.67 | 01Feb2000, 12:30 | 13.29 |
| Reach-13 | 0.0281 | 29.76 | 01Feb2000, 12:30 | 6.02 |
| Reach-14 | 0.0048 | 8.76 | 01Feb2000, 12:30 | 9.22 |
| Reach-15 | 0.0032 | 3.32 | 01Feb2000, 12:35 | 4.66 |
| Reach-2 | 0.0297 | 21.84 | 01Feb2000, 12:50 | 4.03 |
| Reach-3 | 0.0326 | 24.06 | 01Feb2000, 12:50 | 4.07 |
| Reach-4 | 0.0054 | 5.63 | 01Feb2000, 12:30 | 4.89 |
| Reach-5 | 0.0047 | 4.90 | 01Feb2000, 12:30 | 4.87 |
| Reach-6 | 0.0016 | 1.67 | 01Feb2000, 12:30 | 4.77 |
| Reach-7 | 0.0006 | 0.63 | 01Feb2000, 12:30 | 6.45 |
| Reach-8 | 0.0000 | 3.71 | 01Feb2000, 12:30 | |
| Reach-9 | 0.0013 | 1.34 | 01Feb2000, 12:30 | 4.73 |
| Str 20A | 0.0013 | 5.05 | 01Feb2000, 12:30 | 16.73 |
| Str 23 | 0.0379 | 28.25 | 01Feb2000, 12:50 | 4.30 |

APPENDIX

J

# NOISE

# APPENDIX J-1

## Operational Noise Data

## OAKLAND ZOO

**Average Annual and Daily Zoo Vehicle Attendance**

| Scenario | Annual Vehicle Attendance: Without CA Exhibit | Annual Vehicle Attendance: With CA Exhibit | Average Daily Vehicle Attendance: Without CA Exhibit Wkday | Without CA Exhibit Wknd | With CA Exhibit Wkday | With CA Exhibit Wknd |
|---|---|---|---|---|---|---|
| **Existing Conditions** | 174,806 | 216,472 | 1940 | 4520 | 2315 | 5060 |
| **Year 2015 Conditions** | 166,667 | 208,333 | 1740 | 4320 | 2115 | 4860 |
| **Year 2035 Conditions** | 166,667 | 194,444 | 1740 | 4320 | 1985 | 4680 |

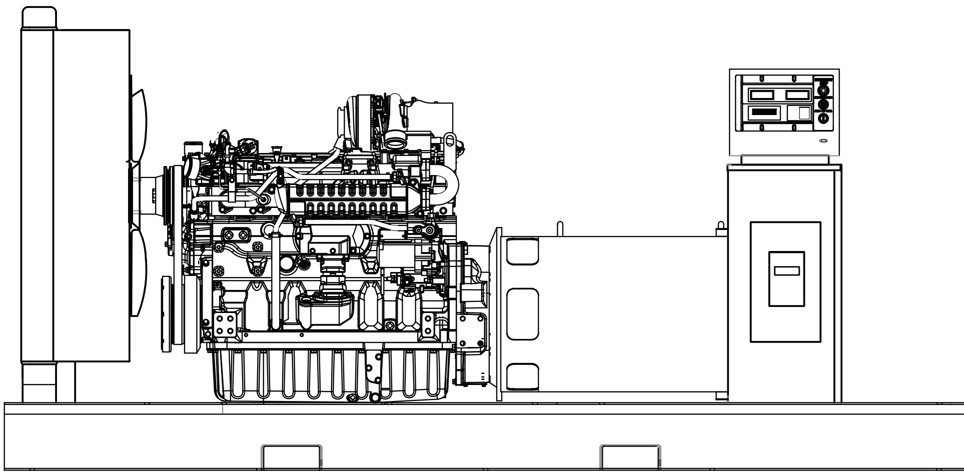
**Average Daily Vehicle Traffic**

| Intersection | | Dir. | | Year 2015 Baseline Conditions Wkday | Wknd | Year 2015 Project Trips (150,000 annual visitors) Wkday | Wknd | Year 2015 plus Project Wkday | Wknd | Year 2035 Baseline Conditions Wkday | Wknd | Year 2035 Project Trips (100,000 annual visitors) Wkday | Wknd | Year 2015 plus Project Wkday | Wknd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intersection # 1 | Zoo Drive / Mountain Blvd / Golf Links Road / | North | L | 995 | 1,124 | 181 | 140 | 1,176 | 1,264 | 990 | 1,124 | 119 | 94 | 1,110 | 1,218 |
| | | | T | 18 | 15 | 3 | 2 | 22 | 17 | 18 | 15 | 2 | 1 | 20 | 17 |
| | | | R | 41 | 31 | 8 | 4 | 49 | 34 | 41 | 31 | 5 | 3 | 46 | 33 |
| | | South | L | 190 | 130 | 0 | 0 | 190 | 130 | 190 | 130 | 0 | 0 | 190 | 130 |
| | | | T | 27 | 61 | 5 | 8 | 32 | 69 | 27 | 61 | 3 | 5 | 30 | 66 |
| | | | R | 2,790 | 600 | 0 | 0 | 2,790 | 600 | 2,790 | 600 | 0 | 0 | 2,790 | 600 |
| | | East | L | 2,785 | 1,040 | 0 | 0 | 2,785 | 1,040 | 2,785 | 1,040 | 0 | 0 | 2,785 | 1,040 |
| | | | T | 2,721 | 2,117 | 0 | 0 | 2,721 | 2,117 | 2,757 | 2,145 | 0 | 0 | 2,757 | 2,145 |
| | | | R | 237 | 2,473 | 45 | 309 | 282 | 2,782 | 237 | 2,473 | 29 | 206 | 266 | 2,679 |
| | | West | L | 22 | 76 | 4 | 10 | 27 | 86 | 22 | 76 | 3 | 6 | 25 | 83 |
| | | | T | 2,892 | 2,027 | 0 | 0 | 2,892 | 2,027 | 2,930 | 2,054 | 0 | 0 | 2,930 | 2,054 |
| | | | R | 175 | 60 | 0 | 0 | 175 | 60 | 175 | 60 | 0 | 0 | 175 | 60 |
| | | **Total** | | **12,893** | **9,754** | **246** | **473** | **13,140** | **10,226** | **12,964** | **9,809** | **161** | **315** | **13,125** | **10,124** |
| Intersection # 2 | Golf Links Road / I-580 NB Ramp | North | L | 4,057 | 3,264 | 0 | 0 | 4,057 | 3,264 | 5,464 | 4,396 | 0 | 0 | 5,464 | 4,396 |
| | | | T | 38 | 43 | 0 | 0 | 38 | 43 | 52 | 58 | 0 | 0 | 52 | 58 |
| | | | R | 1,548 | 2,575 | 18 | 124 | 1,566 | 2,699 | 2,052 | 3,125 | 12 | 82 | 2,064 | 3,207 |
| | | South | L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | East | L | 5,101 | 3,460 | 0 | 0 | 5,101 | 3,460 | 5,810 | 3,460 | 0 | 0 | 5,810 | 3,460 |
| | | | T | 2,798 | 3,131 | 25 | 178 | 2,823 | 3,309 | 3,224 | 3,131 | 16 | 119 | 3,240 | 3,249 |
| | | | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | West | L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | T | 3,654 | 2,554 | 107 | 92 | 3,761 | 2,646 | 7,983 | 5,115 | 71 | 62 | 8,054 | 5,177 |
| | | | R | 1,647 | 2,022 | 74 | 48 | 1,721 | 2,070 | 3,403 | 4,334 | 49 | 32 | 3,451 | 4,366 |
| | | **Total** | | **18,843** | **17,049** | **224** | **442** | **19,066** | **17,491** | **27,988** | **23,619** | **147** | **295** | **28,135** | **23,914** |
| Intersection # 3 | Golf Links Road / I-580 SB Ramp / 98th Avenue | North | L | 439 | 310 | 0 | 0 | 439 | 310 | 451 | 310 | 0 | 0 | 451 | 310 |
| | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | R | 5,252 | 4,037 | 6 | 28 | 5,258 | 4,065 | 5,448 | 4,037 | 4 | 19 | 5,452 | 4,055 |
| | | South | L | 1,505 | 2,122 | 17 | 124 | 1,523 | 2,246 | 1,997 | 2,516 | 11 | 82 | 2,008 | 2,598 |
| | | | T | 4,931 | 4,622 | 0 | 0 | 4,931 | 4,622 | 6,642 | 6,225 | 0 | 0 | 6,642 | 6,225 |
| | | | R | 366 | 420 | 0 | 0 | 366 | 420 | 493 | 566 | 0 | 0 | 493 | 566 |
| | | East | L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | T | 881 | 673 | 4 | 26 | 885 | 699 | 1,846 | 1,202 | 3 | 18 | 1,848 | 1,220 |
| | | | R | 1,874 | 1,597 | 0 | 0 | 1,874 | 1,597 | 3,982 | 3,426 | 0 | 0 | 3,982 | 3,426 |
| | | West | L | 5,784 | 4,342 | 94 | 78 | 5,878 | 4,420 | 7,611 | 5,632 | 62 | 52 | 7,673 | 5,684 |
| | | | T | 1,692 | 1,219 | 13 | 15 | 1,705 | 1,234 | 2,254 | 1,602 | 9 | 10 | 2,263 | 1,612 |
| | | | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | **Total** | | **22,724** | **19,342** | **135** | **270** | **22,859** | **19,613** | **30,723** | **25,514** | **88** | **180** | **30,811** | **25,695** |
| Intersection # 4 | 106th Avenue / Malcolm Avenue / Zoo Drive | North | L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | South | L | 9 | 0 | 2 | 0 | 11 | 0 | 9 | 0 | 1 | 0 | 10 | 0 |
| | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | R | 395 | 540 | 72 | 68 | 467 | 608 | 395 | 540 | 47 | 45 | 442 | 585 |
| | | East | L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | T | 2,394 | 595 | 0 | 0 | 2,394 | 595 | 2,827 | 705 | 0 | 0 | 2,827 | 705 |
| | | | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | West | L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | T | 2,547 | 1,682 | 0 | 0 | 2,547 | 1,682 | 3,064 | 2,005 | 0 | 0 | 3,064 | 2,005 |
| | | | R | 11 | 0 | 0 | 0 | 11 | 0 | 13 | 0 | 0 | 0 | 13 | 0 |
| | | **Total** | | **5,355** | **2,817** | **74** | **68** | **5,428** | **2,885** | **6,307** | **3,250** | **49** | **45** | **6,356** | **3,295** |
| Intersection # 5 | 106th Avenue / I-580 NB Ramp | North | L | 278 | 101 | 0 | 0 | 278 | 101 | 290 | 105 | 0 | 0 | 290 | 105 |
| | | | T | 329 | 141 | 0 | 0 | 329 | 141 | 342 | 147 | 0 | 0 | 342 | 147 |
| | | | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | South | L | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | T | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | R | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | East | L | 3,459 | 2,880 | 0 | 0 | 3,459 | 2,880 | 3,869 | 3,225 | 0 | 0 | 3,869 | 3,225 |
| | | | T | 2,374 | 1,450 | 0 | 0 | 2,374 | 1,450 | 2,658 | 1,624 | 0 | 0 | 2,658 | 1,624 |
| | | | R | 517 | 175 | 0 | 0 | 517 | 175 | 576 | 196 | 0 | 0 | 576 | 196 |
| | | West | L | 26 | 0 | 0 | 0 | 26 | 0 | 32 | 0 | 0 | 0 | 32 | 0 |
| | | | T | 1,808 | 1,753 | 47 | 43 | 1,855 | 1,797 | 2,154 | 2,061 | 31 | 29 | 2,185 | 2,090 |
| | | | R | 1,025 | 1,024 | 25 | 24 | 1,050 | 1,049 | 1,226 | 1,206 | 17 | 16 | 1,243 | 1,222 |
| | | **Total** | | **9,817** | **7,526** | **72** | **68** | **9,889** | **7,593** | **11,147** | **8,563** | **47** | **45** | **11,195** | **8,608** |
| Intersection # 6 | 106th Avenue / Foothill Boulevard | North | L | 124 | 275 | 0 | 0 | 124 | 275 | 157 | 345 | 0 | 0 | 157 | 345 |
| | | | T | 602 | 2,138 | 0 | 0 | 602 | 2,138 | 765 | 2,682 | 0 | 0 | 765 | 2,682 |
| | | | R | 1,842 | 275 | 0 | 0 | 1,842 | 275 | 2,316 | 345 | 0 | 0 | 2,316 | 345 |
| | | South | L | 1,896 | 854 | 0 | 0 | 1,896 | 854 | 2,433 | 1,110 | 0 | 0 | 2,433 | 1,110 |
| | | | T | 1,595 | 395 | 0 | 0 | 1,595 | 395 | 2,006 | 513 | 0 | 0 | 2,006 | 513 |
| | | | R | 2,194 | 235 | 0 | 0 | 2,194 | 235 | 2,758 | 305 | 0 | 0 | 2,758 | 305 |
| | | East | L | 232 | 1,185 | 0 | 0 | 232 | 1,185 | 299 | 1,596 | 0 | 0 | 299 | 1,596 |
| | | | T | 2,324 | 1,864 | 0 | 0 | 2,324 | 1,864 | 2,970 | 2,510 | 0 | 0 | 2,970 | 2,510 |
| | | | R | 254 | 1,788 | 0 | 0 | 254 | 1,788 | 332 | 2,409 | 0 | 0 | 332 | 2,409 |
| | | West | L | 1,128 | 151 | 2 | 5 | 1,129 | 156 | 1,459 | 188 | 1 | 4 | 1,461 | 192 |
| | | | T | 654 | 927 | 43 | 32 | 697 | 960 | 797 | 1,159 | 29 | 22 | 826 | 1,180 |
| | | | R | 427 | 1,530 | 2 | 5 | 428 | 1,535 | 556 | 2,046 | 1 | 4 | 557 | 2,049 |
| | | **Total** | | **13,270** | **11,617** | **47** | **43** | **13,317** | **11,660** | **16,847** | **15,208** | **31** | **29** | **16,878** | **15,237** |
| Intersection # 7 | 106th Avenue / MacArthur Boulevard | North | L | 1,037 | 203 | 0 | 0 | 1,037 | 203 | 1,396 | 262 | 0 | 0 | 1,396 | 262 |
| | | | T | 2,405 | 2,091 | 0 | 0 | 2,405 | 2,091 | 3,226 | 2,707 | 0 | 0 | 3,226 | 2,707 |
| | | | R | 559 | 1,024 | 0 | 0 | 559 | 1,024 | 739 | 1,326 | 0 | 0 | 739 | 1,326 |
| | | South | L | 359 | 513 | 0 | 0 | 359 | 513 | 555 | 793 | 0 | 0 | 555 | 793 |
| | | | T | 2,279 | 1,840 | 0 | 0 | 2,279 | 1,840 | 3,522 | 2,843 | 0 | 0 | 3,522 | 2,843 |
| | | | R | 285 | 245 | 0 | 0 | 285 | 245 | 440 | 379 | 0 | 0 | 440 | 379 |
| | | East | L | 288 | 272 | 0 | 0 | 288 | 272 | 357 | 325 | 0 | 0 | 357 | 325 |
| | | | T | 2,189 | 2,092 | 0 | 0 | 2,189 | 2,092 | 2,628 | 2,502 | 0 | 0 | 2,628 | 2,502 |
| | | | R | 840 | 261 | 0 | 0 | 840 | 261 | 1,036 | 313 | 0 | 0 | 1,036 | 313 |
| | | West | L | 658 | 1,133 | 29 | 22 | 686 | 1,154 | 1,110 | 1,975 | 19 | 14 | 1,129 | 1,989 |
| | | | T | 2,248 | 1,912 | 13 | 11 | 2,261 | 1,923 | 4,200 | 3,515 | 9 | 7 | 4,209 | 3,522 |
| | | | R | 192 | 667 | 2 | 0 | 194 | 667 | 369 | 1,253 | 1 | 0 | 370 | 1,253 |
| | | **Total** | | **13,339** | **12,253** | **43** | **32** | **13,382** | **12,285** | **19,578** | **18,193** | **29** | **22** | **19,606** | **18,214** |

# SD230 Liquid Cooled Diesel Engine Generator Sets

Standby Power Rating
**230KW 60 Hz**

Prime Power Rating
**205KW 60 Hz**



**Power Matched**
**9.0 LITER DEERE ENGINE**
**Turbocharged, Aftercooled**
**Tier III Compliant**

## FEATURES

- **INNOVATIVE DESIGN & PROTOTYPE TESTING** are key components of GENERAC'S success in "IMPROVING POWER BY DESIGN." But it doesn't stop there. Total commitment to component testing, reliability testing, environmental testing, destruction and life testing, plus testing to applicable CSA, NEMA, EGSA, and other standards, allows you to choose GENERAC POWER SYSTEMS with the confidence that these systems will provide superior performance.
- **TEST CRITERIA:**
  - ✓ PROTOTYPE TESTED
  - ✓ SYSTEM TORSIONAL TESTED
  - ✓ ELECTRO-MAGNETIC INTERFERENCE
  - ✓ NEMA MG1 EVALUATION
  - ✓ MOTOR STARTING ABILITY
  - ✓ SHORT CIRCUIT TESTING
  - ✓ UL 2200 COMPLIANCE AVAILABLE
  - ✓ TIER III COMPLIANCE
- **SOLID-STATE, FREQUENCY COMPENSATED DIGITAL VOLTAGE REGULATION.** This state-of-the-art power maximizing regulation system is standard on all Generac models. It provides optimized FAST RESPONSE to changing load conditions and MAXIMUM MOTOR STARTING CAPABILITY by electronically torque-matching the surge loads to the engine.
- **SINGLE SOURCE SERVICE RESPONSE** from Generac's dealer network provides parts and service know-how for the entire unit, from the engine to the smallest electronic component. You are never on your own when you own a GENERAC POWER SYSTEM.
- **ECONOMICAL DIESEL POWER.** Low cost operation due to modern diesel engine technology. Better fuel utilization plus lower cost per gallon provide real savings.
- **LONGER ENGINE LIFE.** Generac heavy-duty diesels provide long and reliable operating life.
- **GENERAC TRANSFER SWITCHES, SWITCHGEAR AND ACCESSORIES.** Long life and reliability is synonymous with GENERAC POWER SYSTEMS. One reason for this confidence is that the GENERAC product line includes its own transfer systems, accessories, switchgear and controls for total system compatibility.

GENERAC®
POWER SYSTEMS, INC.

# APPLICATION
# & ENGINEERING DATA

SD230

## GENERATOR SPECIFICATIONS

TYPE ............ Four-pole, revolving field
ROTOR INSULATION ............ Class H
STATOR INSULATION ............ Class H
TOTAL HARMONIC DISTORTION ............ <3.0%
TELEPHONE INFLUENCE FACTOR (TIF) ............ <50
ALTERNATOR ............ Self-ventilated and drip-proof
BEARINGS (PRE-LUBED & SEALED) ............ 2
COUPLING ............ Flexible Disc
LOAD CAPACITY (STANDBY) ............ 100%

***NOTE: Emergency loading in compliance with NFPA 99, NFPA 110. Generator rating and performance in accordance with ISO8528-5, BS5514, SAE J1349, ISO3046 and DIN6271 standards.***

**EXCITATION SYSTEM**

PERMANENT MAGNET PILOT EXCITER ........ Eighteen-pole exciter ✓
Magnetically coupled DC current ✓
Mounted outboard of main bearing ✓
REGULATION ............ H100 Controller Digital ✓
3 Phase Sensing, ± 1% regulation ✓

## GENERATOR FEATURES

❒ Revolving field heavy duty generator
❒ Directly connected to the engine
❒ Operating temperature rise 120 °C above a 40 °C ambient
❒ Insulation is Class H rated at 150 °C rise
❒ All prototype models have passed three phase short circuit testing
❒ PMG

## CONTROL PANEL FEATURES

❒ TWO FOUR LINE LCD DISPLAYS READ:

- Voltage (all phases)
- Power factor
- kVAR
- Engine speed
- Run hours
- Fault history
- Coolant temperature
- Low oil pressure shutdown
- Overvoltage
- Low coolant level
- Not in auto position (flashing light)
- ATS selection
- Current (all phases)
- kW
- Transfer switch status
- Low fuel pressure
- Service reminders
- Oil pressure
- Time and date
- High coolant temperature shutdown
- Overspeed
- Low coolant level
- Exercise speed

❒ INTERNAL FUNCTIONS:

- $I^2T$ function for alternator protection from line to neutral and line to line short circuits
- Emergency stop
- Programmable auto crank function
- 2 wire start for any transfer switch
- Communicates with the Generac HTS transfer switch
- Built-in 7 day exerciser
- Adjustable engine speed at exerciser
- RS232 port for GenLink® control
- RS485 port remote communication
- Canbus addressable
- Governor controller and voltage regulator are built into the master control board
- Temperature range -40 °C to 70 °C

## ENGINE SPECIFICATIONS

MAKE ............ DEERE
MODEL ............ See Exhaust Emission Sheet
ENGINE FAMILY ......... First digit is Cert. Yr. (i.e. 7, 8, 9) _JDXL09.0102
CYLINDERS ............ 6 in-line
DISPLACEMENT ............ 9.0 Liter (548 cu. in.)
BORE ............ 118 mm (4.661 in.)
STROKE ............ 136 mm (5.354 in.)
COMPRESSION RATIO ............ 16.0:1
INTAKE AIR ............ Turbocharged, Aftercooled
CONNECTING RODS ............ 6-Carbon Steel
CYLINDER HEAD ............ Cast Iron with Overhead Valve
PISTONS ............ 6-Heat Resistant Aluminum Alloy
CRANKSHAFT ............ Case Hardened, Die Forged, Carbon Steel
ENGINE CRANKCASE VENT ............ Open

**VALVE TRAIN**

LIFTER TYPE ............ Solid
INTAKE VALVE MATERIAL ............ Special Heat Resistant Steel
EXHAUST VALVE MATERIAL ........ Sellited Faced Heat Resistant Steel
HARDENED VALVE SEATS ............ Replaceable
VALVES PER CYCLE ............ 4

**ENGINE GOVERNOR**

❒ ELECTRONIC ............ Standard
FREQUENCY REGULATION, NO-LOAD TO FULL LOAD ............ Isochronous
STEADY STATE REGULATION ............ ±0.25%

**LUBRICATION SYSTEM**

TYPE OF OIL PUMP ............ Gear
OIL FILTER ............ Bypass and Full flow, cartridge
CRANKCASE CAPACITY ............ 40 Liters (10 U.S. gallons)

**COOLING SYSTEM**

TYPE OF SYSTEM ............ Pressurized, closed recovery
WATER PUMP ............ Pre-lubed, self-sealing
TYPE OF FAN ............ Pusher
NUMBER OF FAN BLADES ............ 7
DIAMETER OF FAN ............ 762 mm (30 in.)
COOLANT HEATER ............ 240V, 2000W

**FUEL SYSTEM**

FUEL ............ #2D Fuel (Min Cetane #40)
(Fuel should conform to ASTM Spec.)
FUEL FILTER ............ 10 Micron
FUEL INJECTION PUMP ............ Denso HP4
INJECTORS ............ Multi-hole, nozzle type
ENGINE TYPE ............ Direct injection
FUEL LINE (Supply) ............ 9.53 mm (0.375 in.)
FUEL RETURN LINE ............ 9.53 mm (0.375 in.)

**ELECTRICAL SYSTEM**

BATTERY CHARGE ALTERNATOR ............ 35 Amps at 24 V
STARTER MOTOR VOLTS/ROLLING CURRENT ............ 24 V / 600A
RECOMMENDED BATTERY ............ (2)—12V, 31
GROUND POLARITY ............ Negative

Rating definitions - Standby: Applicable for supplying emergency power for the duration of the utility power outage. No overload capability is available for this rating. (All ratings in accordance with BS5514, ISO3046 and DIN6271). Prime (Unlimited Running Time): Applicable for supplying electric power in lieu of commercially purchased power. Prime power is the maximum power available at variable load. A 10% overload capacity is available for 1 hour in 12 hours. (All ratings in accordance with BS5514, ISO3046, ISO8528 and DIN6271).

GENERAC®
POWER SYSTEMS, INC.

**SD230**

## OPERATING DATA

| | STANDBY | | | | PRIME | | | |
|---|---|---|---|---|---|---|---|---|
| | SD230 | | | | SD230 | | | |
| **GENERATOR OUTPUT VOLTAGE/KW-60Hz** | | | Rated AMP | | | | Rated AMP | |
| 120/208V, 3-phase, 0.8 pf (NOTE: Consult your Generac dealer for additional voltages.) | 230 | | 799 | | 205 | | 712 | |
| 120/240V, 3-phase, 0.8 pf | 230 | | 692 | | 205 | | 617 | |
| 277/480V, 3-phase, 0.8 pf | 230 | | 346 | | 205 | | 309 | |
| 600V, 3-phase, 0.8 pf | 230 | | 277 | | 205 | | 247 | |
| **MOTOR STARTING KVA** | | | | | | | | |
| Maximum at 35% instantaneous voltage dip | 240V | | 480V | | 240V | | 480V | |
| with standard alternator; 60 Hz | 692 | | 922 | | 692 | | 922 | |
| with optional alternator; 60 Hz | 1007 | | 1340 | | 1007 | | 1340 | |
| **FUEL** | | | | | | | | |
| Fuel consumption @ % Load | 25% | 50% | 75% | 100% | 25% | 50% | 75% | 100% |
| kW @ % Load | 57.5 | 115 | 173 | 230 | 51.3 | 103 | 154 | 205 |
| gal./hr. | 5.1 | 8.9 | 13.0 | 16.8 | 4.5 | 7.9 | 11.6 | 15.0 |
| liters/hr. | 19.1 | 33.7 | 49.2 | 63.8 | 17.1 | 30.1 | 43.9 | 56.8 |
| Total Fuel Flow gal./hr. | 60-62 | | | | 60-62 | | | |
| Maximum Fuel Return Line Pressure | 80 Inches Water Column, 2.9 psi | | | | 80 Inches Water Column, 2.9 psi | | | |
| **COOLING** | | | | | | | | |
| Coolant capacity System - lit. (US gal.) | 48 (12.7) | | | | 48 (12.7) | | | |
| Coolant flow/min. 60 Hz - lit. (US gal.) | 280 (74) | | | | 280 (74) | | | |
| Heat rejection to coolant BTU/hr. | 360,000 | | | | 330,000 | | | |
| Inlet air 60 Hz- $m^3$/min. (cfm) | 493 (17,400) | | | | 493 (17,400) | | | |
| Max. operating air temp. onto radiator* °C (°F) | 60 (140) | | | | 60 (140) | | | |
| Max. operating ambient temp.* °C (°F) | 50 (122) | | | | 50 (122) | | | |
| **COMBUSTION AIR REQUIREMENTS** | | | | | | | | |
| Flow at rated power 60 Hz - $m^3$/min. (cfm) | 19.5 (687) | | | | 16.9 (598) | | | |
| **EXHAUST** | | | | | | | | |
| Exhaust flow at rated output 60 Hz - $m^3$/min. (cfm) | 54.8 (1936) | | | | 48.9 (1726) | | | |
| Max recommended back pressure Kpa (Hg) | 10.0 (3") | | | | 10.0 (3") | | | |
| Exhaust temp at rated output °C (°F) | 410 (770) | | | | 393 (740) | | | |
| Exhaust outlet size | 5" | | | | 5" | | | |
| **ENGINE** | | | | | | | | |
| Rated RPM 60 Hz | 1800 | | | | 1800 | | | |
| HP at rated KW 60 Hz | 356 | | | | 422 | | | |
| Piston speed 60 Hz - m/min. (ft./min.) | 490 (1606) | | | | 490 (1606) | | | |
| BMEP 60 Hz - psi | 283 | | | | 252 | | | |
| **POWER ADJUSTMENTS FOR AMBIENT CONDITIONS** | | | | | | | | |
| Temperature 4.1% for every 10°C above - °C | 40 | | | | 40 | | | |
| 2.4% for every 10°F above - °F | 104 | | | | 104 | | | |
| Altitude -0.8% for every 100 m above - m | 2293 | | | | 2293 | | | |
| 2.6% for every 1000 ft. above - ft. | 7500 | | | | 7500 | | | |

Note: Values given are maximum temperatures to which power adjustments can be applied. Consult your Generac Power Systems representative if operating conditions exceed these maximums.

# STANDARD ENGINE & SAFETY FEATURES



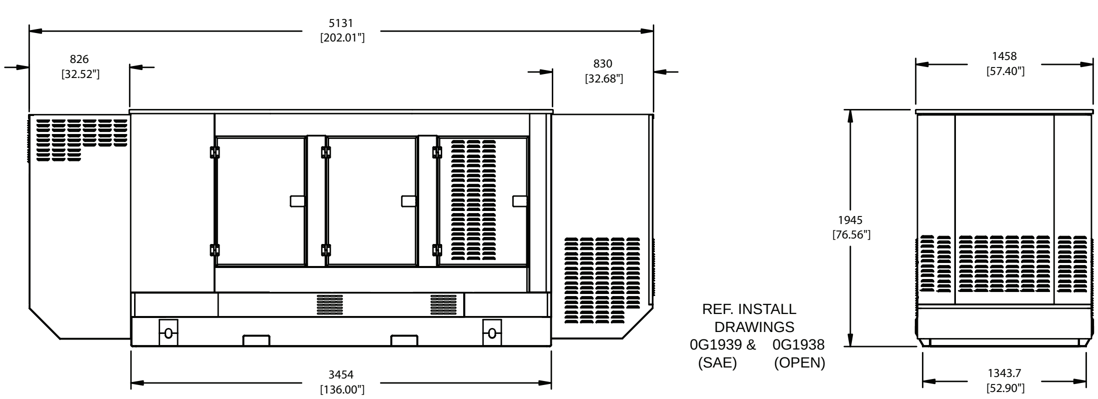
- High Coolant Temperature Automatic Shutdown
- Low Coolant Level Automatic Shutdown
- Low Oil Pressure Automatic Shutdown
- Overspeed Automatic Shutdown (Solid-state)
- Crank Limiter (Solid-state)
- Oil Drain Extension
- Radiator Drain Extension
- Factory-Installed Cool Flow Radiator
- Closed Coolant Recovery System
- UV/Ozone Resistant Hoses
- Rubber-Booted Engine Electrical Connections
- Secondary Fuel Filter
- Fuel Lockoff Solenoid
- Stainless Steel Flexible Exhaust Connection
- Battery Charge Alternator
- Battery Cables
- Battery Tray
- Vibration Isolation of Unit to Mounting Base
- 24 Volt, Solenoid-activated Starter Motor
- Air Cleaner
- Fan Guard
- Control Console
- Coolant Heater
- Isochronous Governor
- Radiator Duct Adapter

# OPTIONS

- **OPTIONAL COOLING SYSTEM ACCESSORIES**
  - ❍ Coolant Heater 208/240 VAC
- **OPTIONAL FUEL ACCESSORIES**
  - ❍ Flexible Fuel Lines
  - ❍ UL Listed Base Tanks
  - ❍ Base Tank Low Fuel Alarm
  - ❍ Primary Fuel Filters
- **OPTIONAL EXHAUST ACCESSORIES**
  - ❍ Critical Exhaust Silencer (Standard on enclosed gensets)
- **OPTIONAL ELECTRICAL ACCESSORIES**
  - ❍ Battery, 12 Volt, 135 A.H., 4D (2 req'd)
  - ❍ Battery, 12 Volt, 225 A.H., 8D (2 req'd)
  - ❍ 2A Battery Charger
  - ❍ 10A Dual Rate Battery Charger
  - ❍ Battery Heater
- **OPTIONAL ALTERNATOR ACCESSORIES**
  - ❍ Alternator Upsizing
  - ❍ Alternator Strip Heater
  - ❍ Alternator Tropicalization
  - ❍ Main Line Circuit Breaker
- **CONTROL CONSOLE OPTIONS**
  - ❍ Digital Controller H-100 (Bulletin 0172110SBY)
- **ADDITIONAL OPTIONAL EQUIPMENT**
  - ❍ Automatic Transfer Switch
  - ❍ 20 Light Remote Annunciator
  - ❍ Remote Relay Panels
  - ❍ Unit Vibration Isolators
  - ❍ Oil Make-Up System
  - ❍ Oil Heater
  - ❍ 5 Year Warranties
  - ❍ Export Boxing
  - ❍ GenLink® Communications Software
- **OPTIONAL ENCLOSURES**
  - ❍ Weather Protective
  - ❍ Sound Attenuated
  - ❍ Aluminum and Stainless Steel
  - ❍ Enclosed Muffler

**Distributed by:**

Design and specifications subject to change without notice. Dimensions shown are approximate. Contact your Generac dealer for certified drawings. DO NOT USE THESE DIMENSIONS FOR INSTALLATION PURPOSES.




mm [in]

OAKLAND ZOO VISITOR CENTER 3/2/10
RESTAURANT

TRANE

# General Data

IEA

*Table GD-2: General Data — 12 1/2, 15 and 20 Ton Condensing Units*

| | 12 1/2 Ton | 15 Ton | 15 Ton | 20 Ton | 20 Ton |
|---|---|---|---|---|---|
| | Dual Compressor TTA150B3,B4,BW | Dual Compressor TTA180B3,B4,BW | Manifolded Compressor TTA180C3,C4,CW | Dual Compressor TTA240B3,B4,BW | Manifolded Compressor TTA240F3, F4, FW |
| **Cooling Performance**[1] | | | | | |
| Gross Cooling Capacity | | | | | |
| Matched Air Handler | 148,000 | 182,000 | 182,000 | 246,000 | 246,000 |
| Condensing Unit Only[2] | 148,000 | 182000 | 182,000 | 246,000 | 246,000 |
| ARI Net Cooling Capacity[3] | 144,000 | 176,000 | 176,000 | 238,000 | 247,000 |
| EER[4] | | | | | |
| Matched Air Handler | 9.8 | 9.7 | 9.7 | 9.7 | 10.1 |
| Condensing Unit Only | 11.0 | 11.1 | 11.1 | 11.1 | 12.0 |
| System Integrated Part Load Value[5] | 11.0 | 10.9 | 13.0 | 10.9 | 13.0 |
| Condensing Unit Only IPLV[5] | 13.7 | 14.0 | 15.0 | 14.0 | 15.0 |
| System kW/Condensing Unit kW | 14.70/13.43 | 18.18/16.43 | 18.16/16.35 | 24.61/22.17 | 24.36/20.5 |
| **Compressor No./Type** | 2/Trane Climatuff™ Scroll | 2/Trane 3-D™ Scroll | 2/Trane 3-D™ Scrolls | 2/Trane 3-D™ Scrolls | 2/Copeland™ Scrolls |
| No. Motors/HP | 2/6.25 | 2/7.50 | 2/7.50 | 2/10.0 | 2/10.1 |
| Motor RPM | 3450 | 3450 | 3450 | 3450 | 3500 |
| → **Sound Rating (BELS)**[6] | 8.6 | 8.9 | 8.9 | 8.9 | 9.2 |
| **System Data**[7] | | | | | |
| No. Refrigerant Circuits | 2 | 2 | 1 | 2 | 1 |
| Suction Line (in.) OD | 1 1/8 | 1 3/8 | 1 5/8 | 1 3/8 | 1 5/8 |
| Liquid Line (in.) OD | 3/8 | 1/2 | 5/8 | 1/2 | 5/8 |
| **Outdoor Coil - Type** | Plate Fin | Plate Fin | Plate Fin | Plate Fin | Plate Fin |
| Tube Size (in.) OD | .375 | .375 | .375 | .375 | .375 |
| Face Area (sq ft) | 24.0 | 33.3 | 30.7 | 50.2 | 52.9 |
| Rows/FPI | 2/18 | 2/20 | 2/20 | 2/18 | 2/18 |
| **Outdoor Fan - Type** | Propeller | Propeller | Propeller | Propeller | Propeller |
| No. Used/Diameter (in.) | 1/28 | 2/26 | 2/26 | 2/28 | 2/28 |
| Drive Type/No. Speeds | Direct/1 | Direct/1 | Direct/1 | Direct1 | Direct1 |
| CFM | 8120 | 10900 | 11340 | 16120 | 14600 |
| No. Motor/HP | 1/1.00 | 2/.50 | 2/.50 | 2/1.00 | 2/1.00 |
| Motor RPM | 1100 | 1100 | 1100 | 1100 | 1100 |
| **Refrigerant Charge (Field Supplied)** | | | | | |
| (lbs of R-22)[8] | 23.6 | 30.0 | 28.00 | 40.0 | - |
| (lbs of R410A)[8] | - | - | - | - | 41.3 |

Notes:

1 Cooling Performance is rated at 95° F ambient, 80° F entering dry bulb, 67° F entering wet bulb. Gross capacity does not include the effect of fan motor heat. ARI capacity is net and includes the effect of fan motor heat. Certified in accordance with the Unitary Large Equipment certification program, which is based on ARI Standard 340/360-00 or 365-00.

2 Condensing unit only gross cooling capacity rated at 45° F saturated suction temperature and at 95° F ambient.

3 ARI net cooling capacity is calculated with matched blower coil and 25 feet of 1 3/8" or 1/2" OD (1 5/8" and 5/8" on TTA240F) interconnecting tubing.

4 EER is rated at ARI conditions and in accordance with DOE test procedures.

5 Integrated part load value is based on ARI Standard 340/360-00 or 365-00. Units are rated at 80° F ambient, 80° F entering dry bulb (DB), and 67° F entering wet bulb (WB) at ARI rated cfm.

6 Sound rating shown is tested in accordance with ARI Standard 270.

7 Refer to refrigerant piping applications manual for line sizing and line length.

8 Refrigerant (operating) charge is for condensing unit (all circuits) with matching blower coils and 25 feet of interconnecting refrigerant lines. All units are supplied with a small nitrogen holding charge only.

| ost-it® Fax Note 7671 | Date 3/22/10 # of pages ▸ 6 |
|---|---|
| o KEVIN FOWLER | From DICK CHARLES |
| o./Dept. [illegible] | Co. |
| hone # | Phone # |
| ax # 619 291 5400 | Fax # |

OAKLAND ZOO VISITORCENTER 3/2/10
MIDDLE & LOWER FLOORS

TRANE

# General Data

2 EA | EA

**Table GD-1: General Data — 7 1/2, 10 Ton Condensing Units**

| | 7 1/2 Ton Single Compressor TTA090A3,A4,AW | 10 Ton Single Compressor TTA120A3,A4,AW | 10 Ton Dual Compressor TTA120B3,B4,BW | 10 Ton Manifolded Compressor TTA120C3,C4,CW |
|---|---|---|---|---|
| **Cooling Performance**[1] | | | | |
| Gross Cooling Capacity | | | | |
| Matched Air Handler | 92,000 | 128,000 | 126,000 | 126,000 |
| Condensing Unit Only[2] | 92,000 | 128,000 | 126,000 | 126,000 |
| ARI Net Cooling Capacity[3] | 89,000 | 124,000 | 122,000 | 122,000 |
| EER[4] | | | | |
| Matched Air Handler | 10.3 | 10.3 | 10.3 | 10.3 |
| Condensing Unit Only | 11.6 | 11.3 | 11.5 | 11.4 |
| System Integrated Part Load Value[5] | - | - | 11.2 | 12.8 |
| Condensing Unit Only IPLV[5] | - | - | 14.0 | 14.8 |
| System kW/Condensing Unit kW | 8.61/7.90 | 12.11/11.25 | 11.89/10.94 | 11.9/11.1 |
| **Compressor** | | | | |
| No./Type | 1/Trane 3-D™ Scroll | 1/Trane 3-D™ Scroll | 2/Trane Climatuff™ Scrolls | 2/Manifolded Scrolls |
| No. Motors/HP | 1/7.5 | 1/10 | 2/5.0 | 2/5.0 |
| Motor RPM | 3450 | 3450 | 3450 | 3450 |
| **Sound Rating** (BELS)[6] | 8.6 | 8.9 | 8.9 | 8.9 |
| **System Data**[7] | | | | |
| No. Refrigerant Circuits | 1 | 1 | 2 | 1 |
| Suction Line (in.) OD | 1 3/8 | 1 3/8 | 1 1/8 | 1 3/8 |
| Liquid Line (in.) OD | 1/2 | 1/2 | 3/8 | 1/2 |
| **Outdoor Coil - Type** | Plate Fin | Plate Fin | Plate Fin | Plate Fin |
| Tube Size (in.) OD | .375 | .375 | .375 | .375 |
| Face Area (sq ft) | 19.26 | 24.0 | 24.0 | 18.4 |
| Rows/FPI | 2/18 | 2/20 | 2/20 | 2/20 |
| **Outdoor Fan - Type** | Propeller | Propeller | Propeller | Propeller |
| No. Used/Diameter (in.) | 1/26 | 1/28 | 1/28 | 1/28 |
| Drive Type/No. Speeds | Direct/1 | Direct/1 | Direct/1 | Direct1 |
| CFM | 5670 | 8120 | 8120 | 8120 |
| No. Motor/HP | 1/.50 | 1/1.00 | 1/1.00 | 1/1.00 |
| Motor RPM | 1100 | 1100 | 1100 | 1100 |
| **Refrigerant Charge (Field Supplied)** | | | | |
| (lbs of R-22)[8] | 16.00 | 19.0 | 21.00 | 20.50 |

Notes:

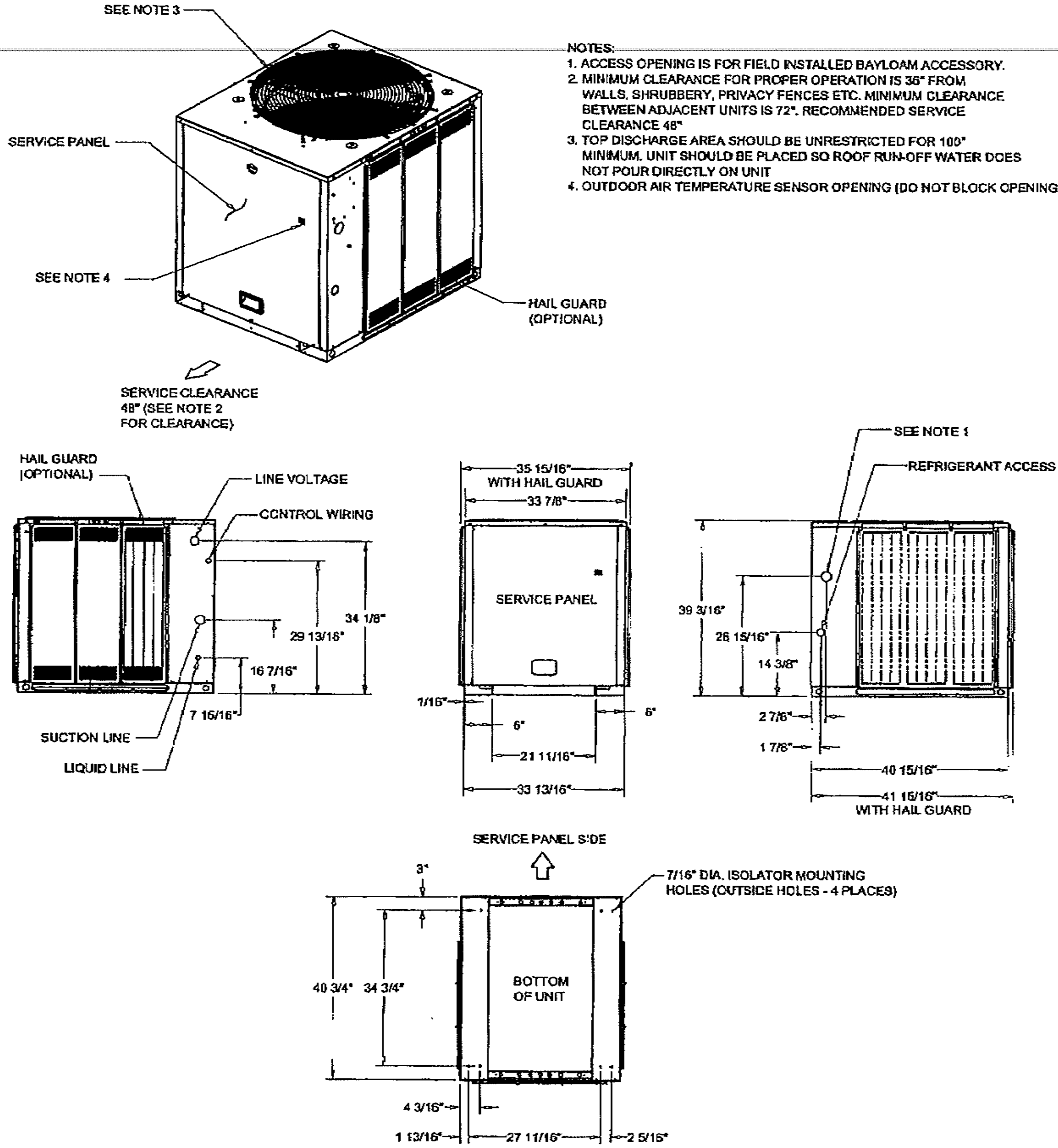
1. Cooling Performance is rated at 95° F ambient, 80° F entering dry bulb, 67° F entering wet bulb. Gross capacity does not include the effect of fan motor heat. ARI capacity is net and includes the effect of fan motor heat. Certified in accordance with the Unitary Large Equipment certification program, which is based on ARI Standard 340/360-00 or 365-00.
2. Condensing unit only gross cooling capacity rated at 45° F saturated suction temperature and at 95° F ambient.
3. ARI net cooling capacity is calculated with matched blower coil and 25 feet of 1 3/8" or 1/2" OD interconnecting tubing.
4. EER is rated at ARI conditions and in accordance with DOE test procedures.
5. Integrated part load value is based on ARI Standard 340/360-00 or 365-00. Units are rated at 80° F ambient, 80° F entering dry bulb (DB), and 67° F entering wet bulb (WB) at ARI rated cfm.
6. Sound rating shown is tested in accordance with ARI Standard 270 or 370.
7. Refer to refrigerant piping applications manual for line sizing and line length.
8. Refrigerant (operating) charge is for condensing unit (all circuits) with matching blower coils and 25 feet of interconnecting refrigerant lines. All units are supplied with a small nitrogen holding charge only.

OAKLAND ZOO VISITOR CENTER
MIDDLE & LOWER FLOORS
3/22/10

TRANE

# Dimensional Data

**Figure 22. 6-7 1/2 Ton Condensing Unit, Single Compressor**



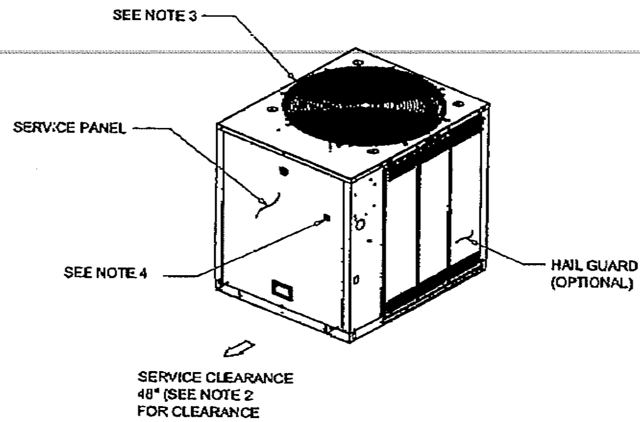

NOTES:
1. ACCESS OPENING IS FOR FIELD INSTALLED BAYLOAM ACCESSORY.
2. MINIMUM CLEARANCE FOR PROPER OPERATION IS 36" FROM WALLS, SHRUBBERY, PRIVACY FENCES ETC. MINIMUM CLEARANCE BETWEEN ADJACENT UNITS IS 72". RECOMMENDED SERVICE CLEARANCE 48"
3. TOP DISCHARGE AREA SHOULD BE UNRESTRICTED FOR 100" MINIMUM. UNIT SHOULD BE PLACED SO ROOF RUN-OFF WATER DOES NOT POUR DIRECTLY ON UNIT
4. OUTDOOR AIR TEMPERATURE SENSOR OPENING (DO NOT BLOCK OPENING)

3/22/10

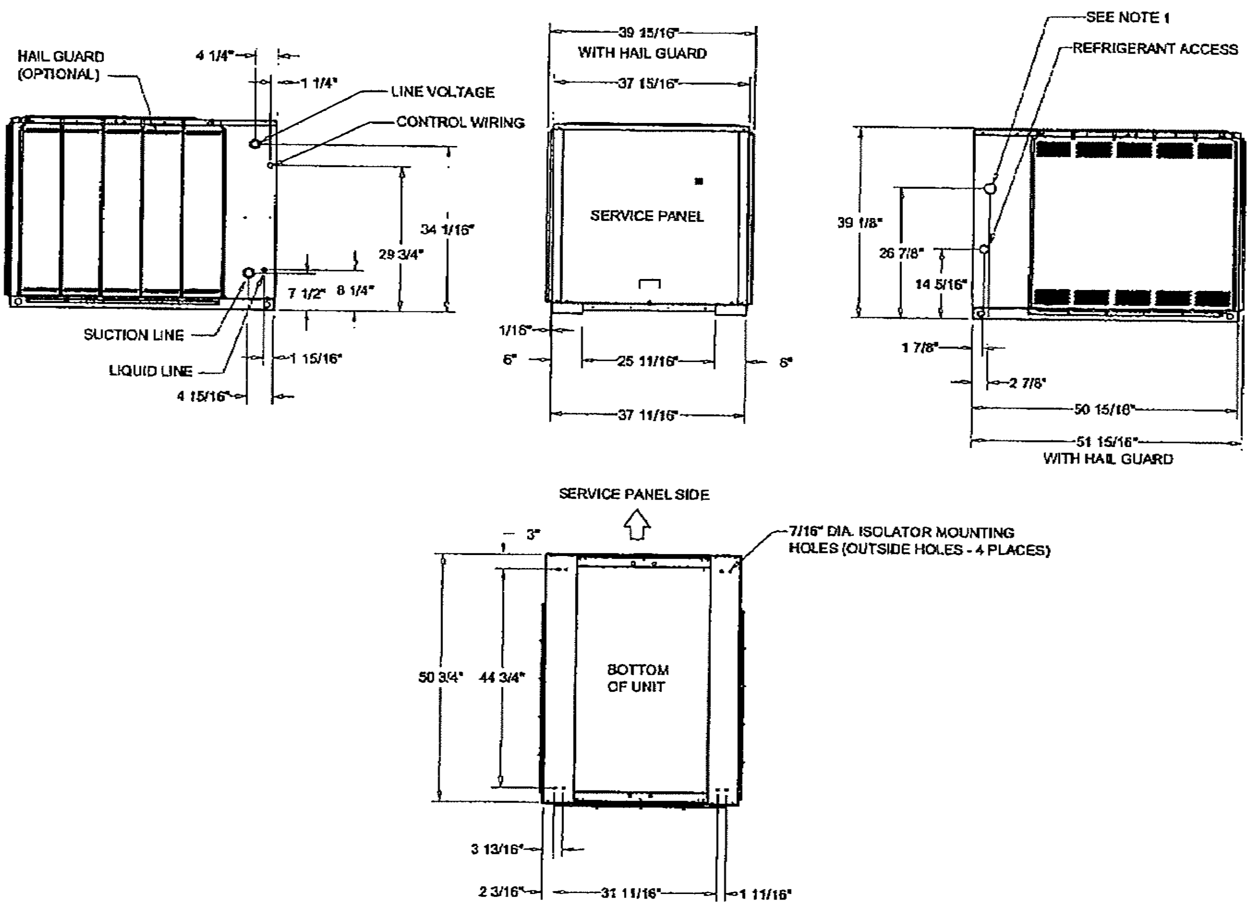
OAKLAND ZOO
VISITOR CENTRE
INTERPRETIVE CENTRE



**Figure 23. 10 Ton Condensing Unit, Single Compressor**




NOTES:
1. ACCESS OPENING IS FOR FIELD INSTALLED BAYLOAM ACCESSORY.
2. MINIMUM CLEARANCE FOR PROPER OPERATION IS 36" FROM WALLS, SHRUBBERY, PRIVACY FENCES ETC. MINIMUM CLEARANCE BETWEEN ADJACENT UNITS IS 72". RECOMMENDED SERVICE CLEARANCE 48"
3. TOP DISCHARGE AREA SHOULD BE UNRESTRICTED FOR 100" MINIMUM. UNIT SHOULD BE PLACED SO ROOF RUN-OFF WATER DOES NOT POUR DIRECTLY ON UNIT
4. OUTDOOR AIR TEMPERATURE SENSOR OPENING (DO NOT BLOCK OPENING)

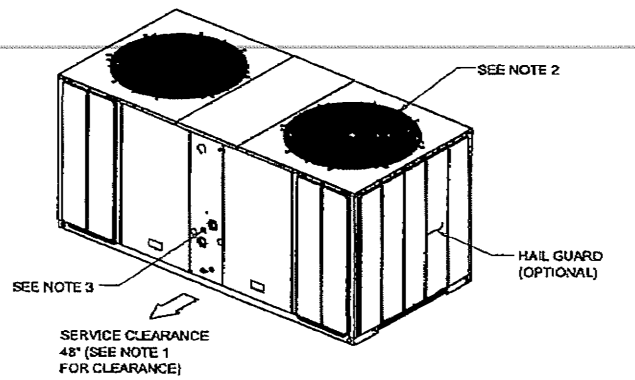


OAKLAND ZOO VISITOR CENTER RESTAURANT.

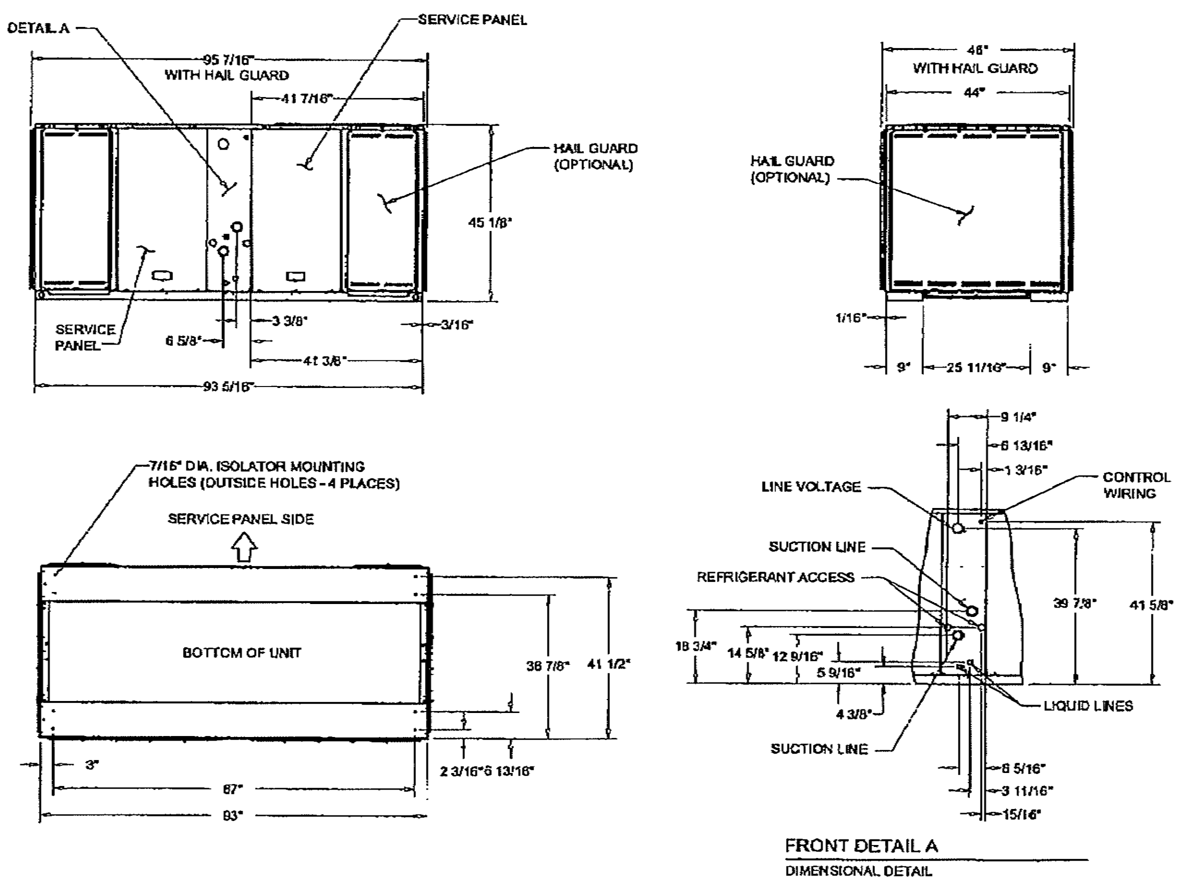
TRANE

## Dimensional Data

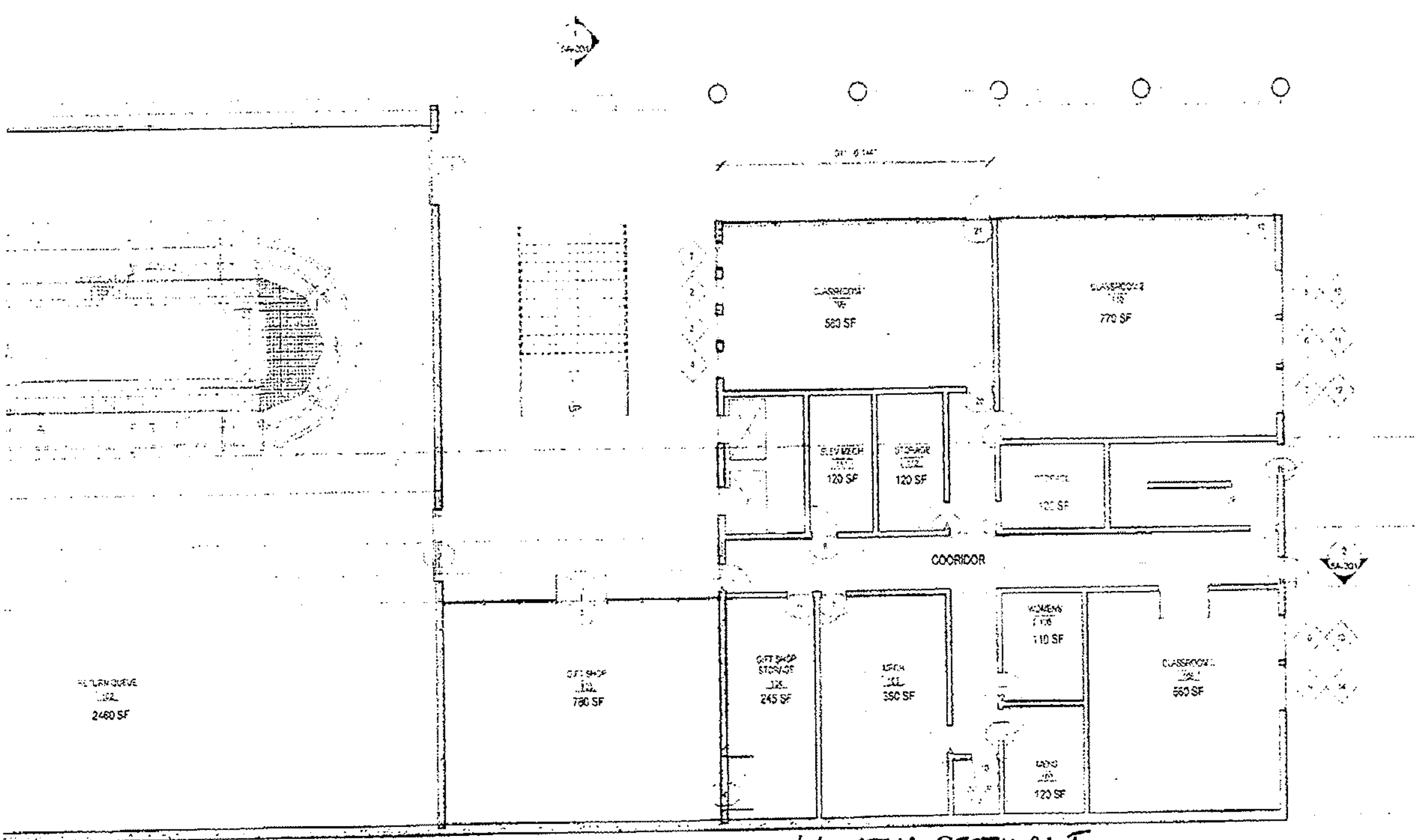
**Figure 27. 15-20 Ton Condensing Unit, Dual Compressor**




NOTES:
1. MINIMUM CLEARANCE FOR PROPER OPERATION IS 36" FROM WALLS, SHRUBBERY, PRIVACY FENCES ETC. MINIMUM CLEARANCE BETWEEN ADJACENT UNITS IS 72". RECOMMENDED SERVICE CLEARANCE 48"
2. TOP DISCHARGE AREA SHOULD BE UNRESTRICTED FOR 100" MINIMUM. UNIT SHOULD BE PLACED SO ROOF RUN-OFF WATER DOES NOT POUR DIRECTLY ON UNIT
3. OUTDOOR AIR TEMPERATURE SENSOR OPENING (DO NOT BLOCK OPENING)



| Post-it® Fax Note 7671 | Date 3/23/10 # of pages ▸ 1 |
| --- | --- |
| To KEVIN FOWLER | From DICK CHARLES |
| Co./Dept. [struck out] | Co. |
| Phone # | Phone # |
| Fax # 619 291 5400 | Fax # |




15 73 73 10
#1 2 3 4

#1 15TON RESTAURANT
#2 7.5TON MIDDLE & LOWER FLOOR
#3 " " " "
#4 10 TON INTERPERTIVE CENTER

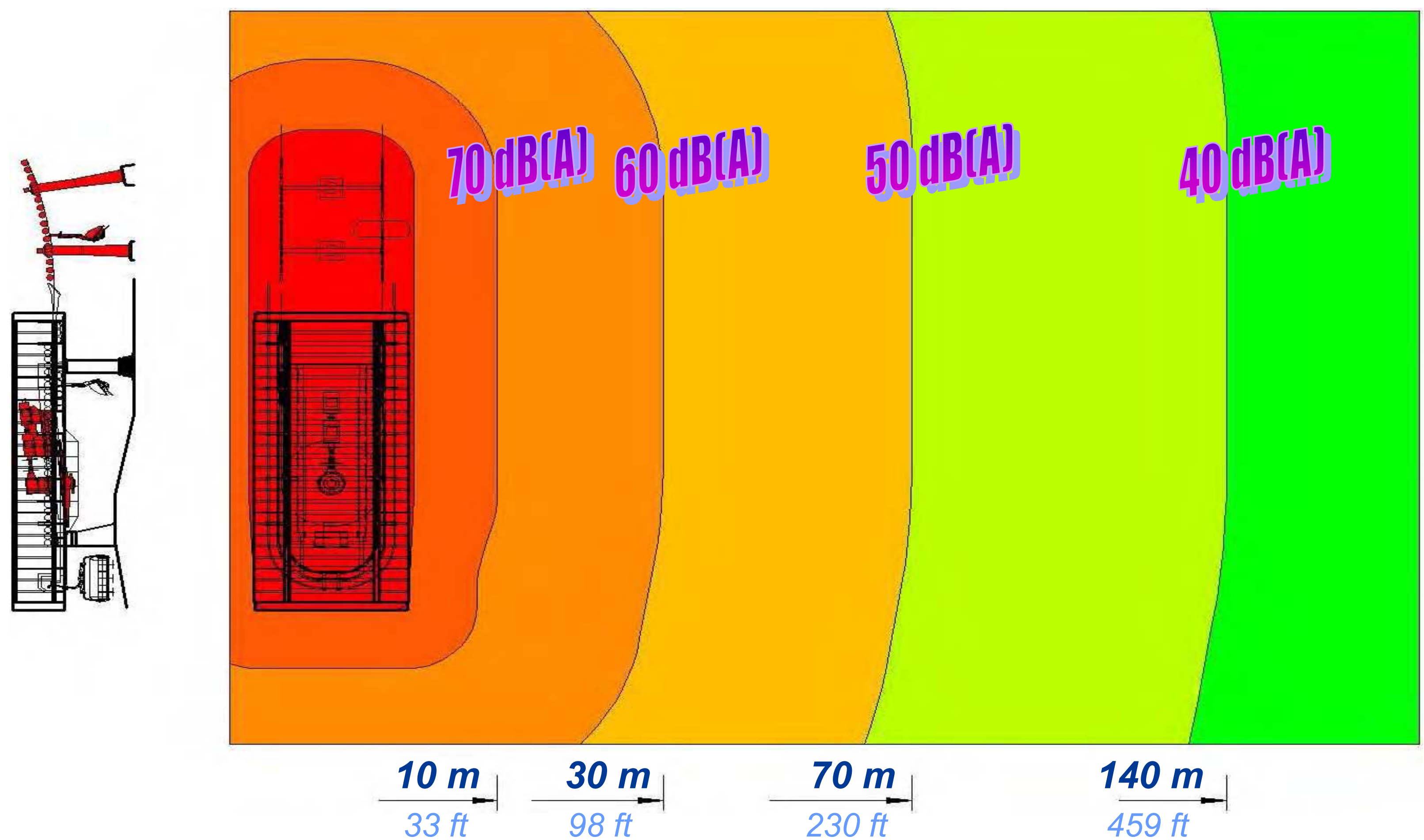
1/16" = 1'

OAKLAND ZOO VISITOR CENTER

3/22/10

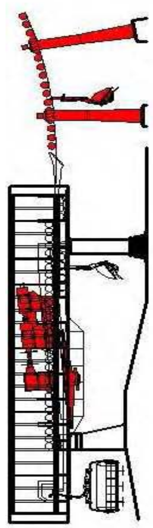
# Schallausbreitung Beispiel 6-CLD:

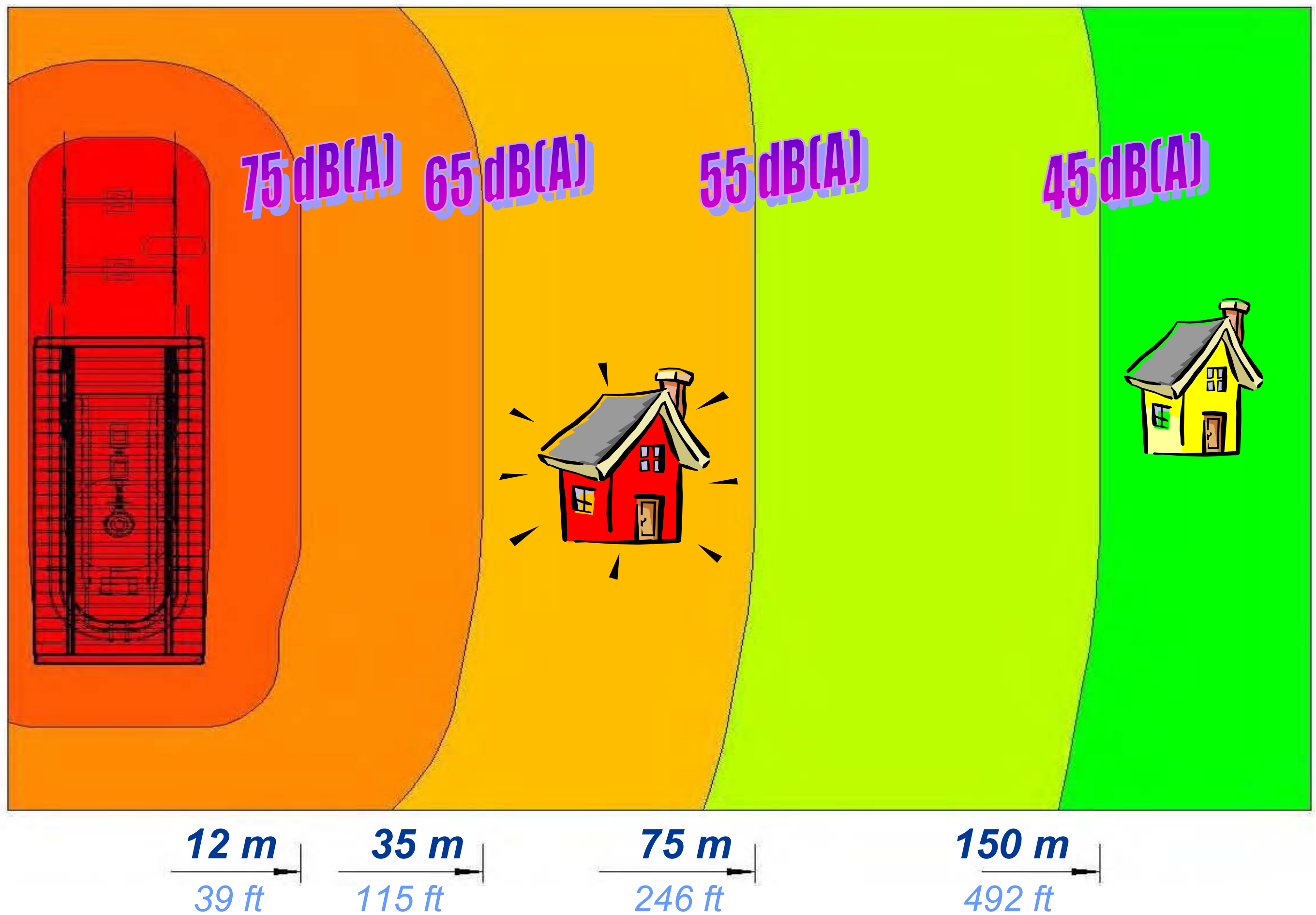
*Sound propagation*



# Beurteilungspegel für Anrainer:

*Asessment level for neighbours*





# APPENDIX J-2

## Construction Noise Data

# 9.0 CONSTRUCTION EQUIPMENT NOISE LEVELS AND RANGES

## 9.1 Equipment Type Inventory and Related Emission Levels

Noise levels generated by individual pieces of construction equipment and specific construction operations form the basis for the prediction of construction-related noise levels. A variety of information exists related to sound emissions related to such equipment and operations. This data transcends the period beginning in the 1970s thru 2006. This information exists for both stationary and mobile sources and for steady, intermittent, and impulse type generators of noise.

### 9.1.1 Stationary Equipment

Stationary equipment consists of equipment that generates noise from one general area and includes items such as pumps, generators, compressors, etc. These types of equipment operate at a constant noise level under normal operation and are classified as non-impact equipment. Other types of stationary equipment such as pile drivers, jackhammers, pavement breakers, blasting operations, etc., produce variable and sporadic noise levels and often produce impact-type noises. Impact equipment is equipment that generates impulsive noise, where impulsive noise is defined as noise of short duration (generally less than one second), high intensity, abrupt onset, rapid decay, and often rapidly changing spectral composition. For impact equipment, the noise is produced by the impact of a mass on a surface, typically repeating over time.

### 9.1.2 Mobile Equipment

Mobile equipment such as dozers, scrapers, graders, etc., may operate in a cyclic fashion in which a period of full power is followed by a period of reduced power. Other equipment such as compressors, although generally considered to be stationary when operating, can be readily relocated to another location for the next operation.

## 9.2 Sources of Information

Construction-related equipment and operation noise level data may be provided by numerous sources, including suppliers, manufacturers, agencies, organizations, etc. Some information is included in this document, and many web-based links are given for equipment manufacturers.

## 9.3 Specifics of Construction Equipment and Operation Noise Inventories

Details included in each specific inventory of construction equipment and operation noise emission levels are often variable in terms of how data is represented. Some inventories include ranges of noise levels while others present single numbers for each equipment type. Others provide levels for specific models of each type of construction equipment. Often, different noise descriptors are used, such as $L_{Aeq}$, $L_{max}$, $L_{10}$, sound power level, etc. As such, the array of data does not readily lend itself to being combined into a single table or easily compared. As such, this Handbook attempts to summarize a variety of such inventories and provide links to each, thereby providing the reader with a variety of sources from which to choose the appropriate levels for use in his or her respective analysis.

## 9.4 Summaries of Referenced Inventories

Included below are examples of several inventories of construction-related noise emission values. These and additional inventories are included on the companion CD-ROM.

### 9.4.1 RCNM Inventory

Equipment and operation noise levels in this inventory are expressed in terms of $L_{max}$ noise levels and are accompanied by a usage factor value. They have been recently updated and are based on extensive measurements taken in conjunction with the Central Artery/Tunnel (CA/T) Project. Table 9.1 summarizes the equipment noise emissions database used by the CA/T Project. While these values represent the "default" values for use in the RCNM, user-defined equipment and corresponding noise levels can be added.

**Table 9.1 RCNM Default Noise Emission Reference Levels and Usage Factors.**

| Equipment Description | Impact Device? | Acoustical Usage Factor (%) | Spec. 721.560 $L_{max}$ @ 50 feet (dBA, slow) | Actual Measured $L_{max}$ @ 50 feet (dBA, slow) (Samples Averaged) | Number of Actual Data Samples (Count) |
|---|---|---|---|---|---|
| All Other Equipment > 5 HP | No | 50 | 85 | N/A | 0 |
| Auger Drill Rig | No | 20 | 85 | 84 | 36 |
| Backhoe | No | 40 | 80 | 78 | 372 |
| Bar Bender | No | 20 | 80 | N/A | 0 |
| Blasting | Yes | N/A | 94 | N/A | 0 |
| Boring Jack Power Unit | No | 50 | 80 | 83 | 1 |
| Chain Saw | No | 20 | 85 | 84 | 46 |
| Clam Shovel (dropping) | Yes | 20 | 93 | 87 | 4 |
| Compactor (ground) | No | 20 | 80 | 83 | 57 |
| Compressor (air) | No | 40 | 80 | 78 | 18 |
| Concrete Batch Plant | No | 15 | 83 | N/A | 0 |
| Concrete Mixer Truck | No | 40 | 85 | 79 | 40 |
| Concrete Pump Truck | No | 20 | 82 | 81 | 30 |
| Concrete Saw | No | 20 | 90 | 90 | 55 |
| Crane | No | 16 | 85 | 81 | 405 |
| Dozer | No | 40 | 85 | 82 | 55 |
| Drill Rig Truck | No | 20 | 84 | 79 | 22 |
| Drum Mixer | No | 50 | 80 | 80 | 1 |
| Dump Truck | No | 40 | 84 | 76 | 31 |
| Excavator | No | 40 | 85 | 81 | 170 |
| Flat Bed Truck | No | 40 | 84 | 74 | 4 |
| Front End Loader | No | 40 | 80 | 79 | 96 |
| Generator | No | 50 | 82 | 81 | 19 |
| Generator (<25KVA, VMS Signs) | No | 50 | 70 | 73 | 74 |
| Gradall | No | 40 | 85 | 83 | 70 |

| | | | | | |
|---|---|---|---|---|---|
| Grader | No | 40 | 85 | N/A | 0 |
| Grapple (on backhoe) | No | 40 | 85 | 87 | 1 |
| Horizontal Boring Hydraulic Jack | No | 25 | 80 | 82 | 6 |
| Hydra Break Ram | Yes | 10 | 90 | N/A | 0 |
| Impact Pile Driver | Yes | 20 | 95 | 101 | 11 |
| Jackhammer | Yes | 20 | 85 | 89 | 133 |
| Man Lift | No | 20 | 85 | 75 | 23 |
| Mounted Impact Hammer (hoe ram) | Yes | 20 | 90 | 90 | 212 |
| Pavement Scarifier | No | 20 | 85 | 90 | 2 |
| Paver | No | 50 | 85 | 77 | 9 |
| Pickup Truck | No | 40 | 55 | 75 | 1 |
| Pneumatic Tools | No | 50 | 85 | 85 | 90 |
| Pumps | No | 50 | 77 | 81 | 17 |
| Refrigerator Unit | No | 100 | 82 | 73 | 3 |
| Rivit Buster/Chipping Gun | Yes | 20 | 85 | 79 | 19 |
| Rock Drill | No | 20 | 85 | 81 | 3 |
| Roller | No | 20 | 85 | 80 | 16 |
| Sand Blasting (single nozzle) | No | 20 | 85 | 96 | 9 |
| Scraper | No | 40 | 85 | 84 | 12 |
| Sheers (on backhoe) | No | 40 | 85 | 96 | 5 |
| Slurry Plant | No | 100 | 78 | 78 | 1 |
| Slurry Trenching Machine | No | 50 | 82 | 80 | 75 |
| Soil Mix Drill Rig | No | 50 | 80 | N/A | 0 |
| Tractor | No | 40 | 84 | N/A | 0 |
| Vacuum Excavator (Vac-Truck) | No | 40 | 85 | 85 | 149 |
| Vacuum Street Sweeper | No | 10 | 80 | 82 | 19 |
| Ventilation Fan | No | 100 | 85 | 79 | 13 |
| Vibrating Hopper | No | 50 | 85 | 87 | 1 |
| Vibratory Concrete Mixer | No | 20 | 80 | 80 | 1 |
| Vibratory Pile Driver | No | 20 | 95 | 101 | 44 |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Warning Horn | No | 5 | 85 | 83 | 12 |
| Welder/Torch | No | 40 | 73 | 74 | 5 |

For each generic type of equipment listed in Table 9.1, the following information is provided:

- an indication as to whether or not the equipment is an impact device;
- the acoustical usage factor to assume for modeling purposes;
- the specification "Spec" limit for each piece of equipment expressed as an $L_{max}$ level in dBA "slow" at a reference distance of 50 foot from the loudest side of the equipment;
- the measured "Actual" emission level at 50 feet for each piece of equipment based on hundreds of emission measurements performed on CA/T work sites; and
- the number of samples that were averaged together to compute the "Actual" emission level.

A comparison of the "Spec" emission limits against the "Actual" emission levels reveals that the Spec limits were set, in general, to realistically obtainable noise levels based on the equipment used by contractors on the CA/T Project. When measured in the field, some equipment such as pile drivers, sand blasting, demolition shears, and pumps tended to exceed their applicable emission limit. As such, these noisy devices needed to have some form of noise mitigation in place in order to comply with the Spec emission limits. Other equipment, such as clamshell shovels, concrete mixer trucks, truck-mounted drill rigs, man-lifts, chipping guns, ventilation fans, pavers, dump trucks, and flatbed trucks, easily complied. Therefore, the Spec emission limits for these devices could have been reduced somewhat further. It is recommended that the user review the RCNM User's Guide contained in Appendix A for detailed guidance regarding application of values contained in Table 9.1.

### 9.4.2 FHWA Special Report Inventories

Appendix A of the 1977 Handbook provides tables of construction equipment noise levels and ranges. The majority of the data were provided by the American Road Builders Association. These data were taken during a 1973 survey in which member contractors were asked to secure readings of noise exposure to operators of various types of equipment. Additionally, the contractors were asked to take readings at 50 feet from the machinery. These 50-foot peak readings are provided in Tables 9.2 through 9.8. Though the data were produced under varying conditions and degrees of expertise, the values are relatively consistent.

**Table 9.2 Construction Equipment Noise Levels Based on Limited Data Samples - Cranes.**

| Manufacturer | Type or Model | Peak Noise Level (dBA) | Remarks |
|---|---|---|---|
| Northwestern | 80D | 77 | Within 15m 1958 mod |
| Northwestern | 8 | 84 | Within 15m 1940 mod |
| Northwestern | 6 | 72 | Within 15m 1965 mod |
| American | 7260 | 82 | Within 15m 1967 mod |
| American | 599 | 76 | Within 15m 1969 mod |
| American | 5299 | 70 | Within 15m 1972 mod |
| American | 4210 | 82 | Within 15m 1968 mod |
| Buck Eye | 45C | 79 | Within 15m 1972 mod |
| Buck Eye | 308 | 74 | Within 15m 1968 mod |
| Buck Eye | 30B | 73 | Within 15m 1965 mod |
| Buck Eye | 30B | 70 | Within 15m 1959 mod |
| Link Belt | LS98 | 76 | Within 15m 1956 mod |
| Manitowoc | 4000 | 94 | Within 15m 1956 mod |

# APPENDIX J-3

## Sound Barrier Examples


REFRESHMENTS


REFRESHMENTS

APPENDIX

# K TRANSPORTATION STUDY TECHNICAL APPENDICES

# Oakland Zoo
# Transportation Study

## Technical Appendix X

1: Intersection Turning Movement Counts and Pneumatic Hose Counts
2: Intersection Level of Service Calculation Worksheets
3: Peak Hour Signal Warrant Worksheets
4: ACCMA Model Outputs
5: Oakland Zoo Traffic Volumes
6: Seasonal Variation and Attendance Growth Adjustment Factors

# Appendix X-1

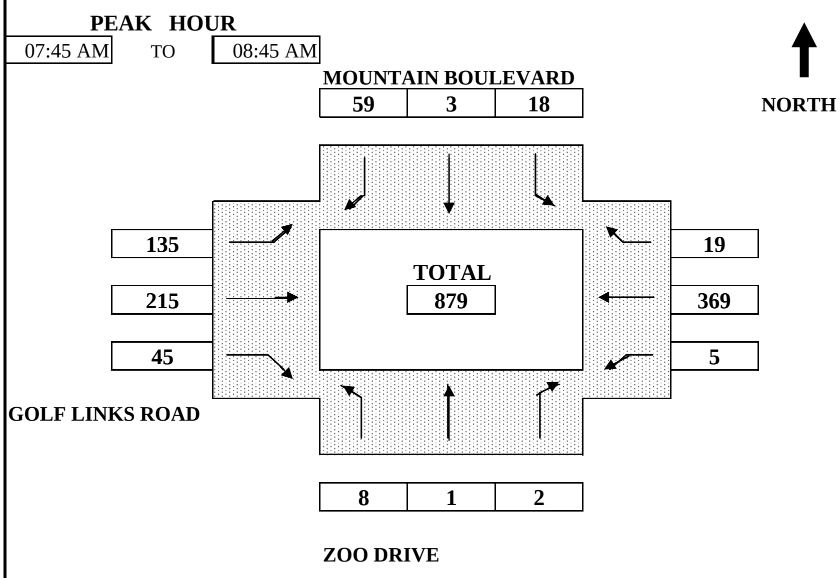
## Intersection Turning Movement Counts

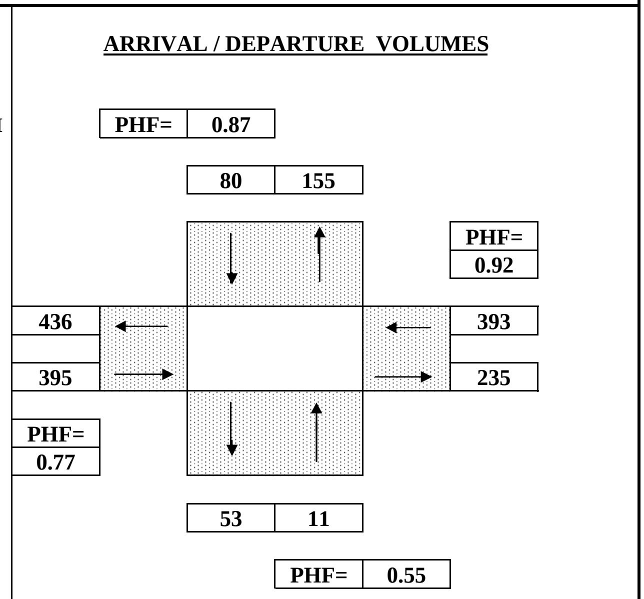
# Weekday Peak Periods
# (April 16, 2009)

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY |
| N-S Approach: | MOUNTAIN BOULEVARD / ZOO DRIVE | SURVEY TIME: | 7:00 AM | TO | 9:00 AM |
| E-W Approach: | GOLF LINKS ROAD | CITY: | OAKLAND | FILE: | 2904025-1AM |




| TIME PERIOD From | | To | NORTHBOUND Left | NB Thru | NB Right | SOUTHBOUND Left | SB Thru | SB Right | EASTBOUND Left | EB Thru | EB Right | WESTBOUND Left | WB Thru | WB Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 0 | 0 | 1 | 0 | 0 | 12 | 12 | 48 | 3 | 0 | 61 | 3 | ***140*** |
| 7:15 AM | --- | 7:30 AM | 0 | 0 | 1 | 0 | 0 | 24 | 31 | 87 | 10 | 0 | 126 | 4 | ***283*** |
| 7:30 AM | --- | 7:45 AM | 1 | 0 | 2 | 0 | 1 | 30 | 58 | 134 | 17 | 0 | 201 | 6 | ***450*** |
| 7:45 AM | --- | 8:00 AM | 3 | 1 | 2 | 1 | 1 | 45 | 97 | 174 | 37 | 1 | 282 | 7 | ***651*** |
| 8:00 AM | --- | 8:15 AM | 7 | 1 | 3 | 4 | 2 | 60 | 123 | 222 | 44 | 2 | 375 | 10 | ***853*** |
| 8:15 AM | --- | 8:30 AM | 8 | 1 | 3 | 13 | 3 | 72 | 162 | 299 | 56 | 3 | 474 | 16 | ***1,110*** |
| 8:30 AM | --- | 8:45 AM | 9 | 1 | 4 | 18 | 4 | 89 | 193 | 349 | 62 | 5 | 570 | 25 | ***1,329*** |
| 8:45 AM | --- | 9:00 AM | 12 | 2 | 4 | 19 | 4 | 109 | 217 | 389 | 77 | 5 | 638 | 27 | ***1,503*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 0 | 0 | 1 | 0 | 0 | 12 | 12 | 48 | 3 | 0 | 61 | 3 | ***140*** |
| 7:15 AM | --- | 7:30 AM | 0 | 0 | 0 | 0 | 0 | 12 | 19 | 39 | 7 | 0 | 65 | 1 | ***143*** |
| 7:30 AM | --- | 7:45 AM | 1 | 0 | 1 | 0 | 1 | 6 | 27 | 47 | 7 | 0 | 75 | 2 | ***167*** |
| 7:45 AM | --- | 8:00 AM | 2 | 1 | 0 | 1 | 0 | 15 | 39 | 40 | 20 | 1 | 81 | 1 | ***201*** |
| 8:00 AM | --- | 8:15 AM | 4 | 0 | 1 | 3 | 1 | 15 | 26 | 48 | 7 | 1 | 93 | 3 | ***202*** |
| 8:15 AM | --- | 8:30 AM | 1 | 0 | 0 | 9 | 1 | 12 | 39 | 77 | 12 | 1 | 99 | 6 | ***257*** |
| 8:30 AM | --- | 8:45 AM | 1 | 0 | 1 | 5 | 1 | 17 | 31 | 50 | 6 | 2 | 96 | 9 | ***219*** |
| 8:45 AM | --- | 9:00 AM | 3 | 1 | 0 | 1 | 0 | 20 | 24 | 40 | 15 | 0 | 68 | 2 | ***174*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 8:00 AM | 3 | 1 | 2 | 1 | 1 | 45 | 97 | 174 | 37 | 1 | 282 | 7 | ***651*** |
| 7:15 AM | --- | 8:15 AM | 7 | 1 | 2 | 4 | 2 | 48 | 111 | 174 | 41 | 2 | 314 | 7 | ***713*** |
| 7:30 AM | --- | 8:30 AM | 8 | 1 | 2 | 13 | 3 | 48 | 131 | 212 | 46 | 3 | 348 | 12 | ***827*** |
| 7:45 AM | --- | 8:45 AM | 8 | 1 | 2 | 18 | 3 | 59 | 135 | 215 | 45 | 5 | 369 | 19 | ***879*** |
| 8:00 AM | --- | 9:00 AM | 9 | 1 | 2 | 18 | 3 | 64 | 120 | 215 | 40 | 4 | 356 | 20 | ***852*** |

**Telephone: (510)232-1271** **Fax: (510)232-1272**

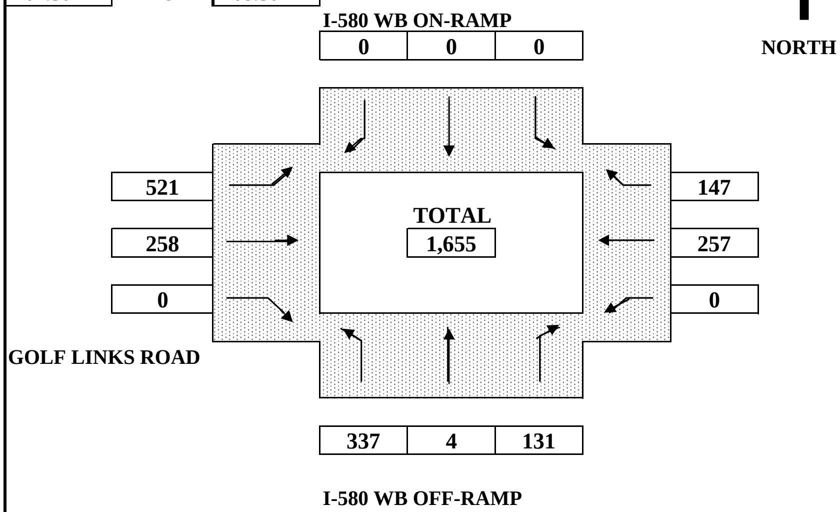
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

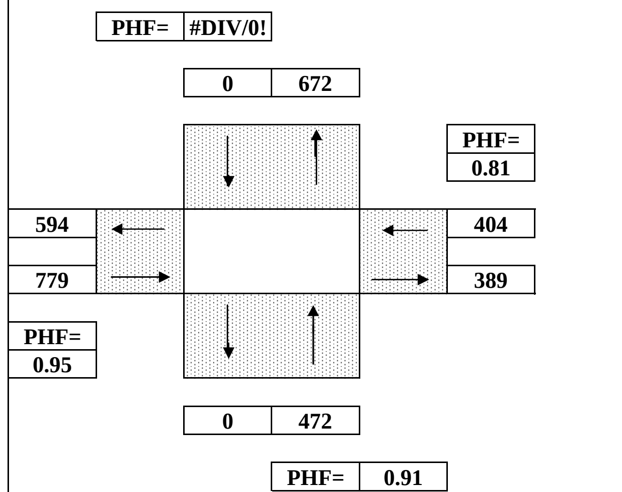
| | | | | | |
|---|---|---|---|---|---|
| **PROJECT:** | **OAKLAND ZOO TRAFFIC STUDY** | **SURVEY DATE:** | **4/16/2009** | **DAY:** | **THURSDAY** |
| **N-S Approach:** | **I-580 WB OFF-RAMP / I-580 WB ON-RAMP** | **SURVEY TIME:** | **7:00 AM** | **TO** | **9:00 AM** |
| **E-W Approach:** | **GOLF LINKS ROAD** | **CITY:** | **OAKLAND** | **FILE:** | **2904025-2AM** |

**PEAK HOUR**

07:30 AM TO 08:30 AM




**ARRIVAL / DEPARTURE VOLUMES**



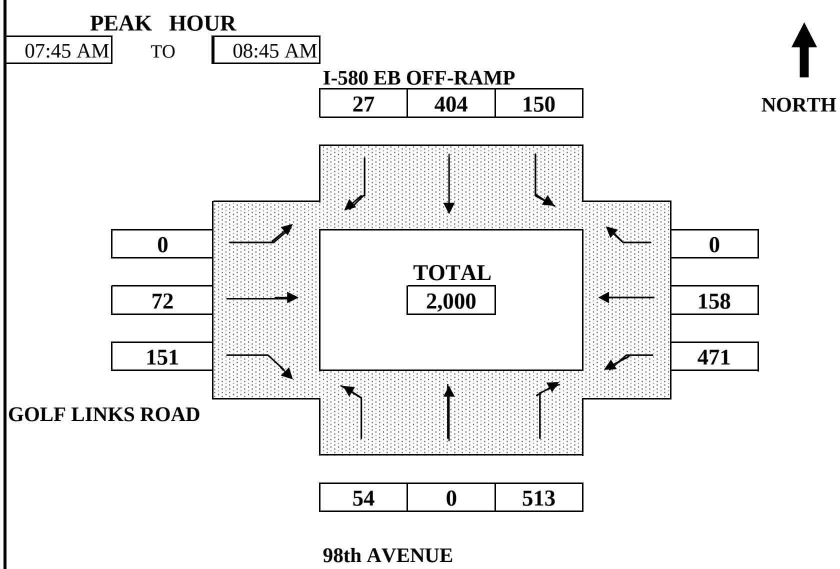

| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 49 | 1 | 14 | 0 | 0 | 0 | 106 | 49 | 0 | 0 | 47 | 26 | ***292*** |
| 7:15 AM | --- | 7:30 AM | 123 | 1 | 41 | 0 | 0 | 0 | 235 | 87 | 0 | 0 | 96 | 54 | ***637*** |
| 7:30 AM | --- | 7:45 AM | 215 | 1 | 65 | 0 | 0 | 0 | 380 | 144 | 0 | 0 | 150 | 87 | ***1,042*** |
| 7:45 AM | --- | 8:00 AM | 304 | 1 | 106 | 0 | 0 | 0 | 526 | 202 | 0 | 0 | 215 | 125 | ***1,479*** |
| 8:00 AM | --- | 8:15 AM | 395 | 2 | 136 | 0 | 0 | 0 | 655 | 263 | 0 | 0 | 287 | 155 | ***1,893*** |
| 8:15 AM | --- | 8:30 AM | 460 | 5 | 172 | 0 | 0 | 0 | 756 | 345 | 0 | 0 | 353 | 201 | ***2,292*** |
| 8:30 AM | --- | 8:45 AM | 556 | 5 | 190 | 0 | 0 | 0 | 845 | 414 | 0 | 0 | 433 | 245 | ***2,688*** |
| 8:45 AM | --- | 9:00 AM | 651 | 5 | 207 | 0 | 0 | 0 | 958 | 476 | 0 | 0 | 490 | 269 | ***3,056*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 49 | 1 | 14 | 0 | 0 | 0 | 106 | 49 | 0 | 0 | 47 | 26 | ***292*** |
| 7:15 AM | --- | 7:30 AM | 74 | 0 | 27 | 0 | 0 | 0 | 129 | 38 | 0 | 0 | 49 | 28 | ***345*** |
| 7:30 AM | --- | 7:45 AM | 92 | 0 | 24 | 0 | 0 | 0 | 145 | 57 | 0 | 0 | 54 | 33 | ***405*** |
| 7:45 AM | --- | 8:00 AM | 89 | 0 | 41 | 0 | 0 | 0 | 146 | 58 | 0 | 0 | 65 | 38 | ***437*** |
| 8:00 AM | --- | 8:15 AM | 91 | 1 | 30 | 0 | 0 | 0 | 129 | 61 | 0 | 0 | 72 | 30 | ***414*** |
| 8:15 AM | --- | 8:30 AM | 65 | 3 | 36 | 0 | 0 | 0 | 101 | 82 | 0 | 0 | 66 | 46 | ***399*** |
| 8:30 AM | --- | 8:45 AM | 96 | 0 | 18 | 0 | 0 | 0 | 89 | 69 | 0 | 0 | 80 | 44 | ***396*** |
| 8:45 AM | --- | 9:00 AM | 95 | 0 | 17 | 0 | 0 | 0 | 113 | 62 | 0 | 0 | 57 | 24 | ***368*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 8:00 AM | 304 | 1 | 106 | 0 | 0 | 0 | 526 | 202 | 0 | 0 | 215 | 125 | ***1,479*** |
| 7:15 AM | --- | 8:15 AM | 346 | 1 | 122 | 0 | 0 | 0 | 549 | 214 | 0 | 0 | 240 | 129 | ***1,601*** |
| 7:30 AM | --- | 8:30 AM | 337 | 4 | 131 | 0 | 0 | 0 | 521 | 258 | 0 | 0 | 257 | 147 | ***1,655*** |
| 7:45 AM | --- | 8:45 AM | 341 | 4 | 125 | 0 | 0 | 0 | 465 | 270 | 0 | 0 | 283 | 158 | ***1,646*** |
| 8:00 AM | --- | 9:00 AM | 347 | 4 | 101 | 0 | 0 | 0 | 432 | 274 | 0 | 0 | 275 | 144 | ***1,577*** |

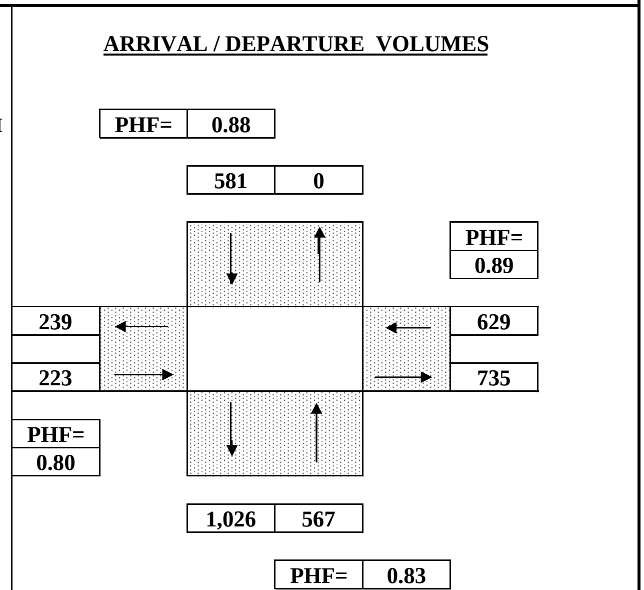
**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| **PROJECT:** | **OAKLAND ZOO TRAFFIC STUDY** | **SURVEY DATE:** | **4/16/2009** | **DAY:** | **THURSDAY** |
| **N-S Approach:** | **98th AVENUE / I-580 EB OFF-RAMP** | **SURVEY TIME:** | **7:00 AM** | **TO** | **9:00 AM** |
| **E-W Approach:** | **GOLF LINKS ROAD** | **CITY:** | **OAKLAND** | **FILE:** | **2904025-3AM** |




| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 3 | 0 | 134 | 14 | 58 | 2 | 0 | 7 | 26 | 82 | 14 | 0 | ***340*** |
| 7:15 AM | --- | 7:30 AM | 8 | 0 | 274 | 29 | 120 | 2 | 0 | 19 | 60 | 177 | 42 | 0 | ***731*** |
| 7:30 AM | --- | 7:45 AM | 16 | 0 | 437 | 50 | 194 | 6 | 0 | 37 | 99 | 295 | 65 | 0 | ***1,199*** |
| 7:45 AM | --- | 8:00 AM | 29 | 0 | 586 | 77 | 296 | 14 | 0 | 55 | 138 | 406 | 103 | 0 | ***1,704*** |
| 8:00 AM | --- | 8:15 AM | 41 | 0 | 718 | 104 | 393 | 21 | 0 | 76 | 172 | 531 | 151 | 0 | ***2,207*** |
| 8:15 AM | --- | 8:30 AM | 64 | 0 | 848 | 152 | 488 | 26 | 0 | 101 | 217 | 632 | 181 | 0 | ***2,709*** |
| 8:30 AM | --- | 8:45 AM | 70 | 0 | 950 | 200 | 598 | 33 | 0 | 109 | 250 | 766 | 223 | 0 | ***3,199*** |
| 8:45 AM | --- | 9:00 AM | 80 | 0 | 1,086 | 231 | 710 | 40 | 0 | 117 | 293 | 884 | 257 | 0 | ***3,698*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 3 | 0 | 134 | 14 | 58 | 2 | 0 | 7 | 26 | 82 | 14 | 0 | ***340*** |
| 7:15 AM | --- | 7:30 AM | 5 | 0 | 140 | 15 | 62 | 0 | 0 | 12 | 34 | 95 | 28 | 0 | ***391*** |
| 7:30 AM | --- | 7:45 AM | 8 | 0 | 163 | 21 | 74 | 4 | 0 | 18 | 39 | 118 | 23 | 0 | ***468*** |
| 7:45 AM | --- | 8:00 AM | 13 | 0 | 149 | 27 | 102 | 8 | 0 | 18 | 39 | 111 | 38 | 0 | ***505*** |
| 8:00 AM | --- | 8:15 AM | 12 | 0 | 132 | 27 | 97 | 7 | 0 | 21 | 34 | 125 | 48 | 0 | ***503*** |
| 8:15 AM | --- | 8:30 AM | 23 | 0 | 130 | 48 | 95 | 5 | 0 | 25 | 45 | 101 | 30 | 0 | ***502*** |
| 8:30 AM | --- | 8:45 AM | 6 | 0 | 102 | 48 | 110 | 7 | 0 | 8 | 33 | 134 | 42 | 0 | ***490*** |
| 8:45 AM | --- | 9:00 AM | 10 | 0 | 136 | 31 | 112 | 7 | 0 | 8 | 43 | 118 | 34 | 0 | ***499*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 8:00 AM | 29 | 0 | 586 | 77 | 296 | 14 | 0 | 55 | 138 | 406 | 103 | 0 | ***1,704*** |
| 7:15 AM | --- | 8:15 AM | 38 | 0 | 584 | 90 | 335 | 19 | 0 | 69 | 146 | 449 | 137 | 0 | ***1,867*** |
| 7:30 AM | --- | 8:30 AM | 56 | 0 | 574 | 123 | 368 | 24 | 0 | 82 | 157 | 455 | 139 | 0 | ***1,978*** |
| 7:45 AM | --- | 8:45 AM | 54 | 0 | 513 | 150 | 404 | 27 | 0 | 72 | 151 | 471 | 158 | 0 | ***2,000*** |
| 8:00 AM | --- | 9:00 AM | 51 | 0 | 500 | 154 | 414 | 26 | 0 | 62 | 155 | 478 | 154 | 0 | ***1,994*** |

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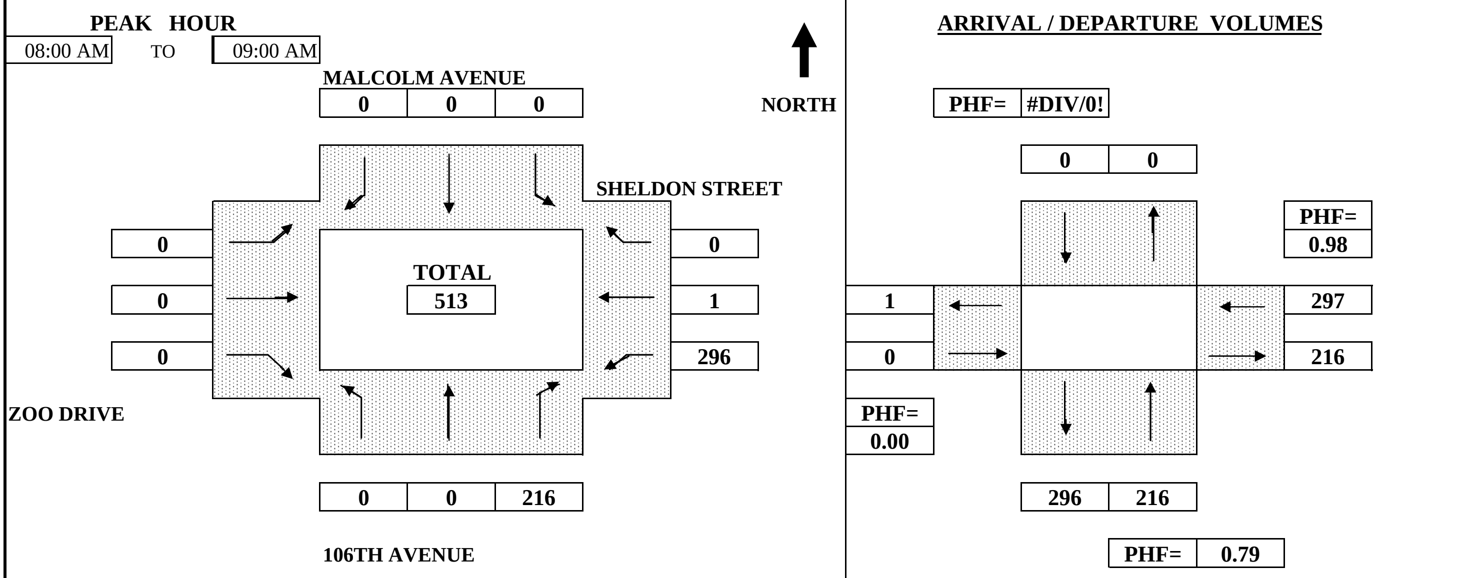
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| **PROJECT:** | **OAKLAND ZOO TRAFFIC STUDY** | **SURVEY DATE:** | **4/16/2009** | **DAY:** | **THURSDAY** |
| **N-S Approach:** | **106TH AVENUE / MALCOLM AVENUE** | **SURVEY TIME:** | **7:00 AM** | **TO** | **9:00 AM** |
| **E-W Approach:** | **ZOO DRIVE / SHELDON STREET** | **CITY:** | **OAKLAND** | **FILE:** | **2904025-4AM** |




| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **From** | | **To** | **Left** | **Thru** | **Right** | **Left** | **Thru** | **Right** | **Left** | **Thru** | **Right** | **Left** | **Thru** | **Right** | **TOTAL** |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 0 | ***47*** |
| 7:15 AM | --- | 7:30 AM | 0 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 1 | 79 | 0 | 0 | ***108*** |
| 7:30 AM | --- | 7:45 AM | 0 | 0 | 49 | 0 | 0 | 0 | 0 | 0 | 2 | 137 | 0 | 0 | ***188*** |
| 7:45 AM | --- | 8:00 AM | 1 | 0 | 77 | 0 | 0 | 0 | 0 | 0 | 2 | 193 | 0 | 0 | ***273*** |
| 8:00 AM | --- | 8:15 AM | 1 | 0 | 130 | 0 | 0 | 0 | 0 | 0 | 2 | 266 | 0 | 0 | ***399*** |
| 8:15 AM | --- | 8:30 AM | 1 | 0 | 198 | 0 | 0 | 0 | 0 | 0 | 2 | 342 | 0 | 0 | ***543*** |
| 8:30 AM | --- | 8:45 AM | 1 | 0 | 262 | 0 | 0 | 0 | 0 | 0 | 2 | 415 | 0 | 0 | ***680*** |
| 8:45 AM | --- | 9:00 AM | 1 | 0 | 293 | 0 | 0 | 0 | 0 | 0 | 2 | 489 | 1 | 0 | ***786*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 0 | ***47*** |
| 7:15 AM | --- | 7:30 AM | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 1 | 45 | 0 | 0 | ***61*** |
| 7:30 AM | --- | 7:45 AM | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 1 | 58 | 0 | 0 | ***80*** |
| 7:45 AM | --- | 8:00 AM | 1 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 0 | ***85*** |
| 8:00 AM | --- | 8:15 AM | 0 | 0 | 53 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 0 | 0 | ***126*** |
| 8:15 AM | --- | 8:30 AM | 0 | 0 | 68 | 0 | 0 | 0 | 0 | 0 | 0 | 76 | 0 | 0 | ***144*** |
| 8:30 AM | --- | 8:45 AM | 0 | 0 | 64 | 0 | 0 | 0 | 0 | 0 | 0 | 73 | 0 | 0 | ***137*** |
| 8:45 AM | --- | 9:00 AM | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | 1 | 0 | ***106*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 8:00 AM | 1 | 0 | 77 | 0 | 0 | 0 | 0 | 0 | 2 | 193 | 0 | 0 | ***273*** |
| 7:15 AM | --- | 8:15 AM | 1 | 0 | 117 | 0 | 0 | 0 | 0 | 0 | 2 | 232 | 0 | 0 | ***352*** |
| 7:30 AM | --- | 8:30 AM | 1 | 0 | 170 | 0 | 0 | 0 | 0 | 0 | 1 | 263 | 0 | 0 | ***435*** |
| 7:45 AM | --- | 8:45 AM | 1 | 0 | 213 | 0 | 0 | 0 | 0 | 0 | 0 | 278 | 0 | 0 | ***492*** |
| 8:00 AM | --- | 9:00 AM | 0 | 0 | 216 | 0 | 0 | 0 | 0 | 0 | 0 | 296 | 1 | 0 | ***513*** |

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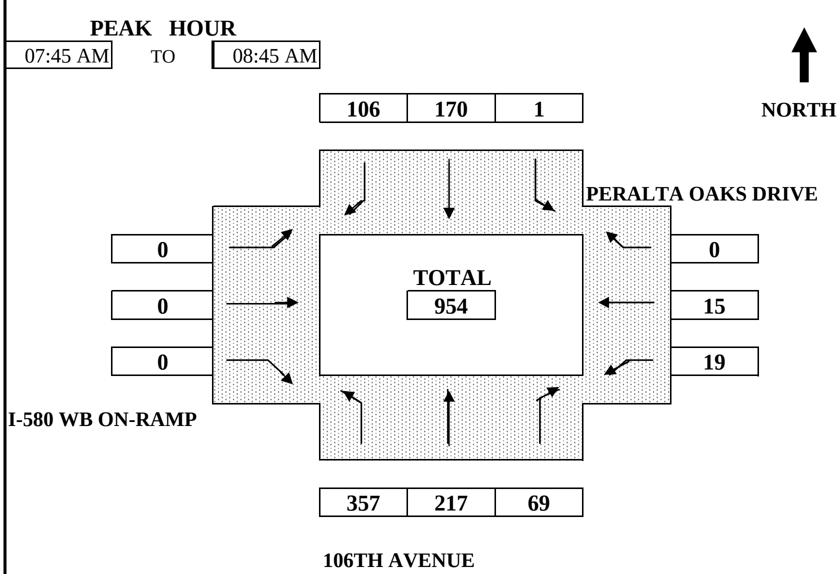
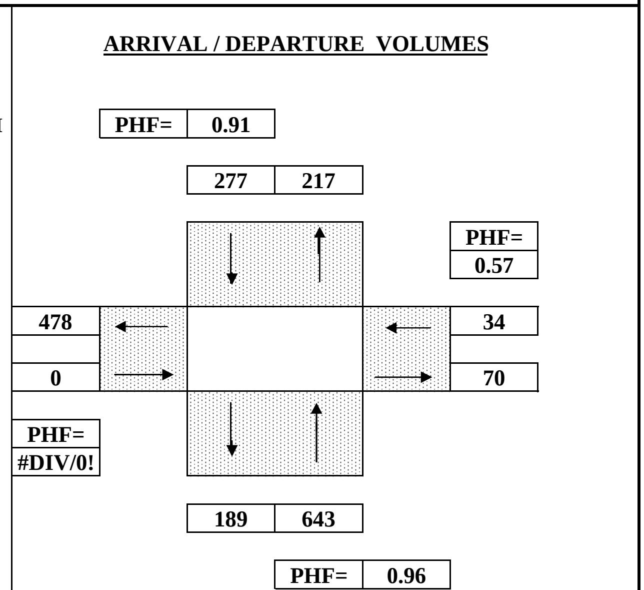
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY | |
| N-S Approach: | 106TH AVENUE | SURVEY TIME: | 7:00 AM | TO | 9:00 AM | |
| E-W Approach: | I-580 WB ON-RAMP / PERALTA OAKS DR | CITY: | OAKLAND | FILE: | 2904025-5AM | |




| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 72 | 12 | 9 | 0 | 16 | 17 | 0 | 0 | 0 | 1 | 1 | 0 | *128* |
| 7:15 AM | --- | 7:30 AM | 142 | 27 | 19 | 0 | 37 | 42 | 0 | 0 | 0 | 1 | 3 | 0 | *271* |
| 7:30 AM | --- | 7:45 AM | 245 | 47 | 36 | 0 | 67 | 72 | 0 | 0 | 0 | 5 | 3 | 0 | *475* |
| 7:45 AM | --- | 8:00 AM | 358 | 76 | 48 | 0 | 98 | 97 | 0 | 0 | 0 | 10 | 4 | 0 | *691* |
| 8:00 AM | --- | 8:15 AM | 457 | 129 | 59 | 0 | 137 | 130 | 0 | 0 | 0 | 16 | 7 | 0 | *935* |
| 8:15 AM | --- | 8:30 AM | 526 | 200 | 87 | 0 | 189 | 154 | 0 | 0 | 0 | 17 | 10 | 0 | *1,183* |
| 8:30 AM | --- | 8:45 AM | 602 | 264 | 105 | 1 | 237 | 178 | 0 | 0 | 0 | 24 | 18 | 0 | *1,429* |
| 8:45 AM | --- | 9:00 AM | 665 | 294 | 124 | 1 | 290 | 200 | 0 | 0 | 0 | 25 | 21 | 0 | *1,620* |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 72 | 12 | 9 | 0 | 16 | 17 | 0 | 0 | 0 | 1 | 1 | 0 | *128* |
| 7:15 AM | --- | 7:30 AM | 70 | 15 | 10 | 0 | 21 | 25 | 0 | 0 | 0 | 0 | 2 | 0 | *143* |
| 7:30 AM | --- | 7:45 AM | 103 | 20 | 17 | 0 | 30 | 30 | 0 | 0 | 0 | 4 | 0 | 0 | *204* |
| 7:45 AM | --- | 8:00 AM | 113 | 29 | 12 | 0 | 31 | 25 | 0 | 0 | 0 | 5 | 1 | 0 | *216* |
| 8:00 AM | --- | 8:15 AM | 99 | 53 | 11 | 0 | 39 | 33 | 0 | 0 | 0 | 6 | 3 | 0 | *244* |
| 8:15 AM | --- | 8:30 AM | 69 | 71 | 28 | 0 | 52 | 24 | 0 | 0 | 0 | 1 | 3 | 0 | *248* |
| 8:30 AM | --- | 8:45 AM | 76 | 64 | 18 | 1 | 48 | 24 | 0 | 0 | 0 | 7 | 8 | 0 | *246* |
| 8:45 AM | --- | 9:00 AM | 63 | 30 | 19 | 0 | 53 | 22 | 0 | 0 | 0 | 1 | 3 | 0 | *191* |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 8:00 AM | 358 | 76 | 48 | 0 | 98 | 97 | 0 | 0 | 0 | 10 | 4 | 0 | *691* |
| 7:15 AM | --- | 8:15 AM | 385 | 117 | 50 | 0 | 121 | 113 | 0 | 0 | 0 | 15 | 6 | 0 | *807* |
| 7:30 AM | --- | 8:30 AM | 384 | 173 | 68 | 0 | 152 | 112 | 0 | 0 | 0 | 16 | 7 | 0 | *912* |
| 7:45 AM | --- | 8:45 AM | 357 | 217 | 69 | 1 | 170 | 106 | 0 | 0 | 0 | 19 | 15 | 0 | *954* |
| 8:00 AM | --- | 9:00 AM | 307 | 218 | 76 | 1 | 192 | 103 | 0 | 0 | 0 | 15 | 17 | 0 | *929* |

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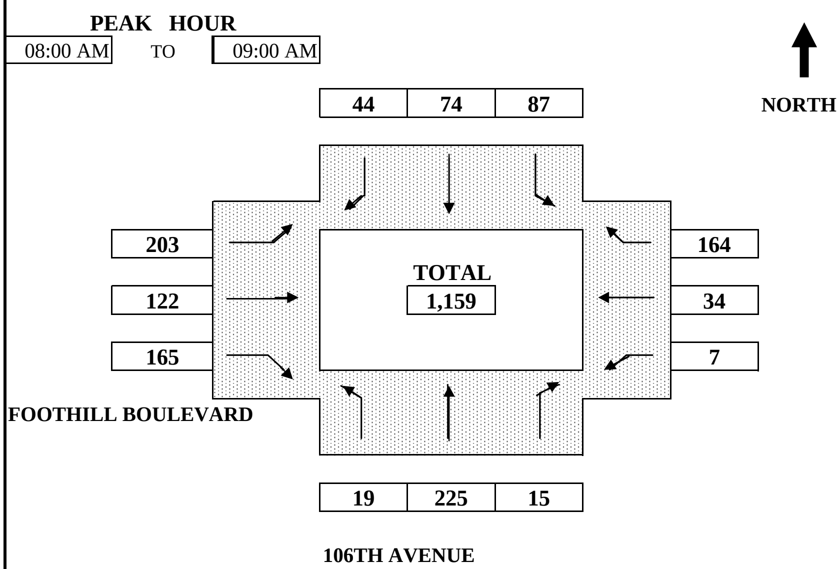
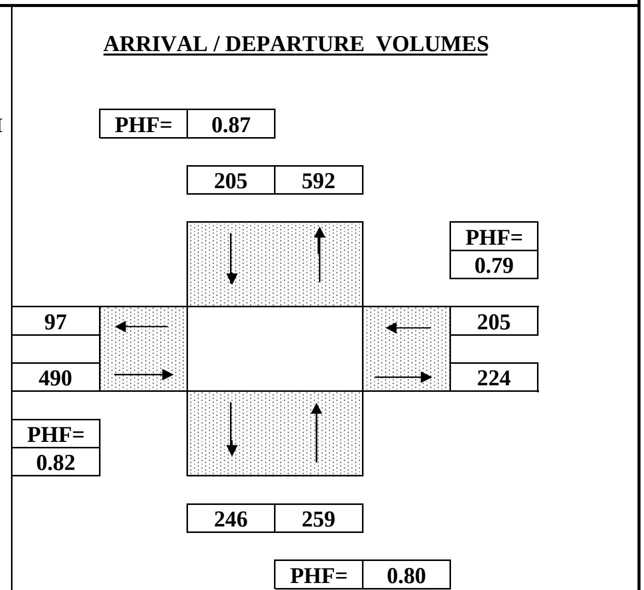
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | | DAY: | THURSDAY |
| N-S Approach: | 106TH AVENUE | SURVEY TIME: | 7:00 AM | | TO | 9:00 AM |
| E-W Approach: | FOOTHILL BOULEVARD | CITY: | OAKLAND | | FILE: | 2904025-6AM |



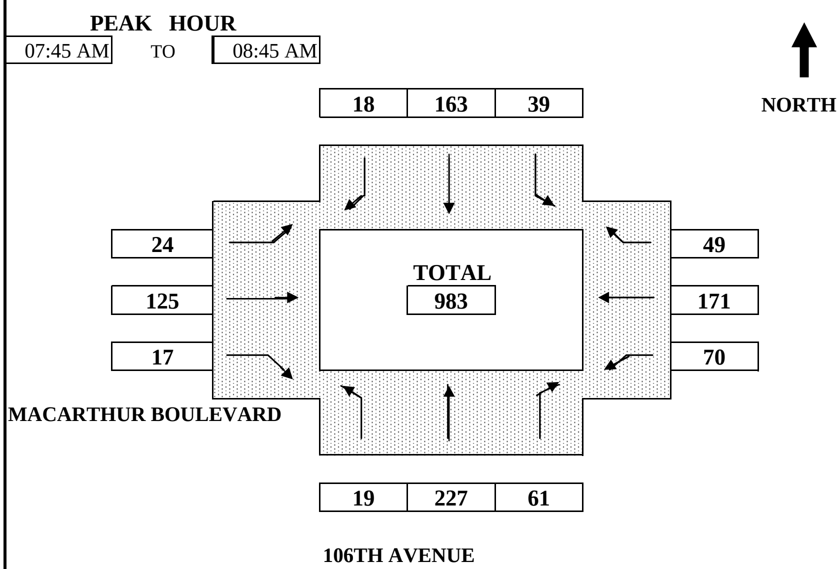

| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 3 | 47 | 1 | 6 | 8 | 4 | 18 | 13 | 17 | 1 | 4 | 32 | ***154*** |
| 7:15 AM | --- | 7:30 AM | 4 | 88 | 3 | 20 | 13 | 9 | 47 | 27 | 39 | 1 | 10 | 60 | ***321*** |
| 7:30 AM | --- | 7:45 AM | 6 | 150 | 4 | 42 | 17 | 17 | 87 | 40 | 70 | 2 | 21 | 93 | ***549*** |
| 7:45 AM | --- | 8:00 AM | 10 | 224 | 7 | 57 | 27 | 30 | 134 | 60 | 90 | 4 | 27 | 124 | ***794*** |
| 8:00 AM | --- | 8:15 AM | 18 | 294 | 10 | 70 | 44 | 44 | 186 | 87 | 119 | 5 | 33 | 182 | ***1,092*** |
| 8:15 AM | --- | 8:30 AM | 24 | 347 | 13 | 88 | 64 | 60 | 260 | 117 | 164 | 8 | 42 | 227 | ***1,414*** |
| 8:30 AM | --- | 8:45 AM | 26 | 404 | 16 | 115 | 87 | 69 | 300 | 148 | 213 | 10 | 53 | 264 | ***1,705*** |
| 8:45 AM | --- | 9:00 AM | 29 | 449 | 22 | 144 | 101 | 74 | 337 | 182 | 255 | 11 | 61 | 288 | ***1,953*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 3 | 47 | 1 | 6 | 8 | 4 | 18 | 13 | 17 | 1 | 4 | 32 | ***154*** |
| 7:15 AM | --- | 7:30 AM | 1 | 41 | 2 | 14 | 5 | 5 | 29 | 14 | 22 | 0 | 6 | 28 | ***167*** |
| 7:30 AM | --- | 7:45 AM | 2 | 62 | 1 | 22 | 4 | 8 | 40 | 13 | 31 | 1 | 11 | 33 | ***228*** |
| 7:45 AM | --- | 8:00 AM | 4 | 74 | 3 | 15 | 10 | 13 | 47 | 20 | 20 | 2 | 6 | 31 | ***245*** |
| 8:00 AM | --- | 8:15 AM | 8 | 70 | 3 | 13 | 17 | 14 | 52 | 27 | 29 | 1 | 6 | 58 | ***298*** |
| 8:15 AM | --- | 8:30 AM | 6 | 53 | 3 | 18 | 20 | 16 | 74 | 30 | 45 | 3 | 9 | 45 | ***322*** |
| 8:30 AM | --- | 8:45 AM | 2 | 57 | 3 | 27 | 23 | 9 | 40 | 31 | 49 | 2 | 11 | 37 | ***291*** |
| 8:45 AM | --- | 9:00 AM | 3 | 45 | 6 | 29 | 14 | 5 | 37 | 34 | 42 | 1 | 8 | 24 | ***248*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 8:00 AM | 10 | 224 | 7 | 57 | 27 | 30 | 134 | 60 | 90 | 4 | 27 | 124 | ***794*** |
| 7:15 AM | --- | 8:15 AM | 15 | 247 | 9 | 64 | 36 | 40 | 168 | 74 | 102 | 4 | 29 | 150 | ***938*** |
| 7:30 AM | --- | 8:30 AM | 20 | 259 | 10 | 68 | 51 | 51 | 213 | 90 | 125 | 7 | 32 | 167 | ***1,093*** |
| 7:45 AM | --- | 8:45 AM | 20 | 254 | 12 | 73 | 70 | 52 | 213 | 108 | 143 | 8 | 32 | 171 | ***1,156*** |
| 8:00 AM | --- | 9:00 AM | 19 | 225 | 15 | 87 | 74 | 44 | 203 | 122 | 165 | 7 | 34 | 164 | ***1,159*** |

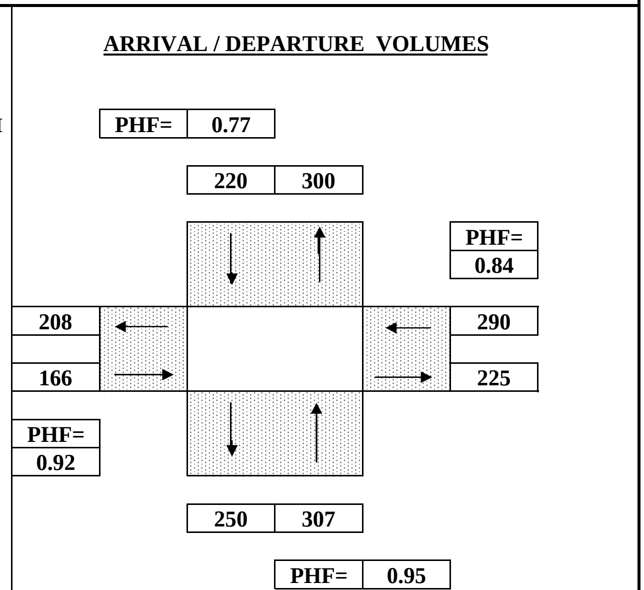
**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| **PROJECT:** | **OAKLAND ZOO TRAFFIC STUDY** | **SURVEY DATE:** | **4/16/2009** | **DAY:** | **THURSDAY** |
| **N-S Approach:** | **106TH AVENUE** | **SURVEY TIME:** | **7:00 AM** | **TO** | **9:00 AM** |
| **E-W Approach:** | **MACARTHUR BOULEVARD** | **CITY:** | **OAKLAND** | **FILE:** | **2904025-7AM** |




| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 1 | 38 | 10 | 3 | 17 | 0 | 2 | 17 | 1 | 8 | 19 | 10 | ***126*** |
| 7:15 AM | --- | 7:30 AM | 5 | 74 | 25 | 9 | 40 | 0 | 5 | 32 | 3 | 16 | 49 | 17 | ***275*** |
| 7:30 AM | --- | 7:45 AM | 10 | 120 | 40 | 13 | 68 | 1 | 9 | 48 | 5 | 32 | 78 | 30 | ***454*** |
| 7:45 AM | --- | 8:00 AM | 17 | 180 | 54 | 17 | 99 | 4 | 10 | 81 | 10 | 50 | 132 | 44 | ***698*** |
| 8:00 AM | --- | 8:15 AM | 23 | 241 | 67 | 25 | 132 | 8 | 25 | 106 | 15 | 66 | 172 | 57 | ***937*** |
| 8:15 AM | --- | 8:30 AM | 27 | 296 | 85 | 38 | 180 | 13 | 28 | 138 | 20 | 82 | 204 | 70 | ***1,181*** |
| 8:30 AM | --- | 8:45 AM | 29 | 347 | 101 | 52 | 231 | 19 | 33 | 173 | 22 | 102 | 249 | 79 | ***1,437*** |
| 8:45 AM | --- | 9:00 AM | 32 | 389 | 111 | 69 | 272 | 21 | 39 | 203 | 26 | 121 | 274 | 89 | ***1,646*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 7:15 AM | 1 | 38 | 10 | 3 | 17 | 0 | 2 | 17 | 1 | 8 | 19 | 10 | ***126*** |
| 7:15 AM | --- | 7:30 AM | 4 | 36 | 15 | 6 | 23 | 0 | 3 | 15 | 2 | 8 | 30 | 7 | ***149*** |
| 7:30 AM | --- | 7:45 AM | 5 | 46 | 15 | 4 | 28 | 1 | 4 | 16 | 2 | 16 | 29 | 13 | ***179*** |
| 7:45 AM | --- | 8:00 AM | 7 | 60 | 14 | 4 | 31 | 3 | 1 | 33 | 5 | 18 | 54 | 14 | ***244*** |
| 8:00 AM | --- | 8:15 AM | 6 | 61 | 13 | 8 | 33 | 4 | 15 | 25 | 5 | 16 | 40 | 13 | ***239*** |
| 8:15 AM | --- | 8:30 AM | 4 | 55 | 18 | 13 | 48 | 5 | 3 | 32 | 5 | 16 | 32 | 13 | ***244*** |
| 8:30 AM | --- | 8:45 AM | 2 | 51 | 16 | 14 | 51 | 6 | 5 | 35 | 2 | 20 | 45 | 9 | ***256*** |
| 8:45 AM | --- | 9:00 AM | 3 | 42 | 10 | 17 | 41 | 2 | 6 | 30 | 4 | 19 | 25 | 10 | ***209*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 7:00 AM | --- | 8:00 AM | 17 | 180 | 54 | 17 | 99 | 4 | 10 | 81 | 10 | 50 | 132 | 44 | ***698*** |
| 7:15 AM | --- | 8:15 AM | 22 | 203 | 57 | 22 | 115 | 8 | 23 | 89 | 14 | 58 | 153 | 47 | ***811*** |
| 7:30 AM | --- | 8:30 AM | 22 | 222 | 60 | 29 | 140 | 13 | 23 | 106 | 17 | 66 | 155 | 53 | ***906*** |
| 7:45 AM | --- | 8:45 AM | 19 | 227 | 61 | 39 | 163 | 18 | 24 | 125 | 17 | 70 | 171 | 49 | ***983*** |
| 8:00 AM | --- | 9:00 AM | 15 | 209 | 57 | 52 | 173 | 17 | 29 | 122 | 16 | 71 | 142 | 45 | ***948*** |

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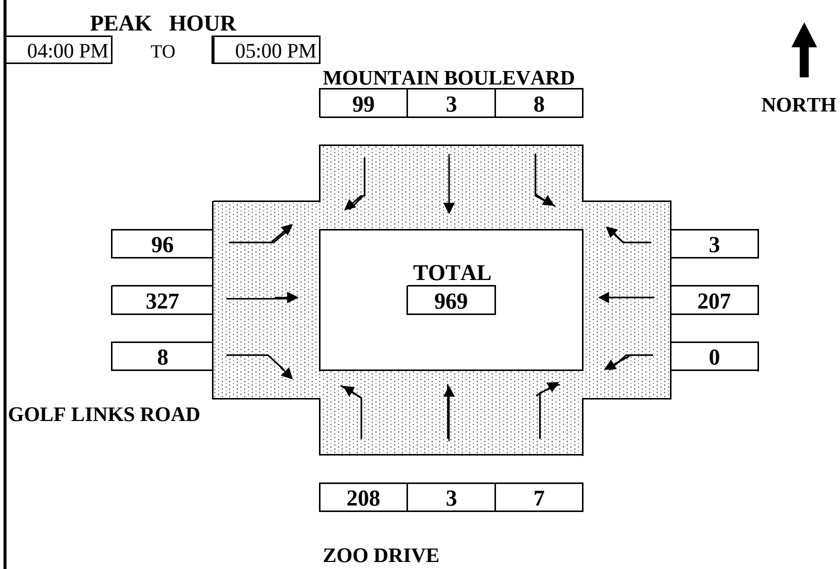
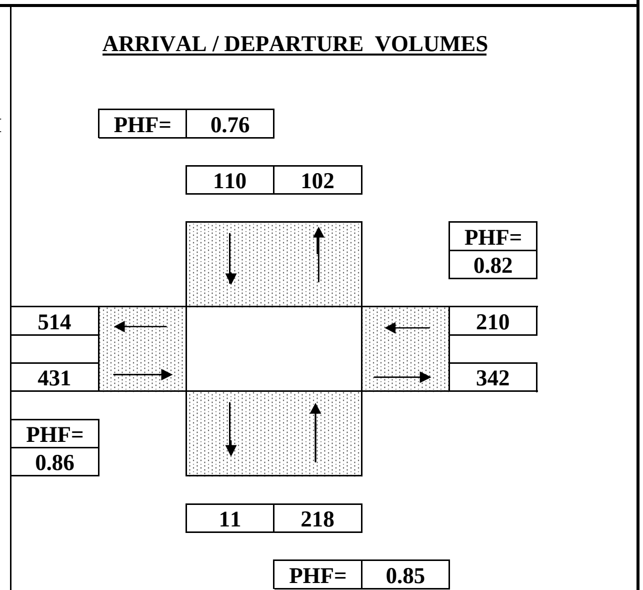
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY |
| N-S Approach: | MOUNTAIN BOULEVARD / ZOO DRIVE | SURVEY TIME: | 4:00 PM | TO | 6:00 PM |
| E-W Approach: | GOLF LINKS ROAD | CITY: | OAKLAND | FILE: | 2904025-1PM |



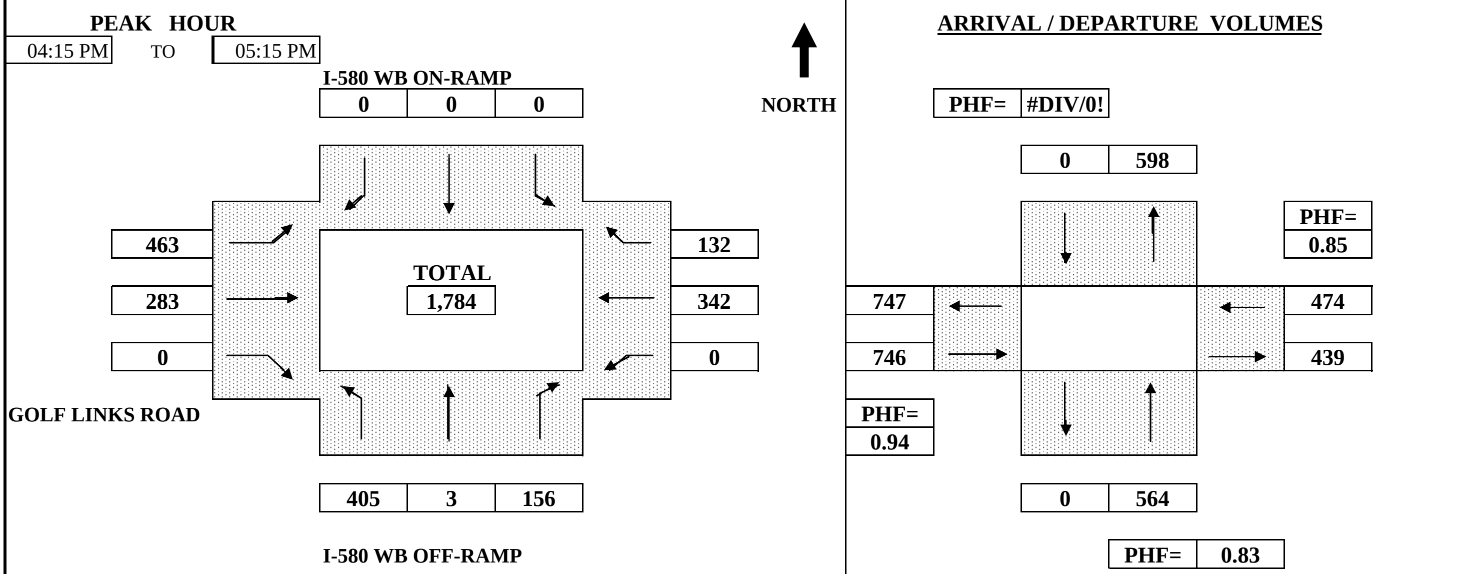

| TIME PERIOD From | | To | NORTHBOUND Left | NB Thru | NB Right | SOUTHBOUND Left | SB Thru | SB Right | EASTBOUND Left | EB Thru | EB Right | WESTBOUND Left | WB Thru | WB Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 52 | 0 | 1 | 2 | 0 | 29 | 25 | 65 | 3 | 0 | 57 | 1 | ***235*** |
| 4:15 PM | --- | 4:30 PM | 99 | 2 | 4 | 4 | 2 | 54 | 57 | 155 | 7 | 0 | 94 | 1 | ***479*** |
| 4:30 PM | --- | 4:45 PM | 159 | 3 | 7 | 7 | 2 | 87 | 82 | 248 | 7 | 0 | 149 | 3 | ***754*** |
| 4:45 PM | --- | 5:00 PM | 208 | 3 | 7 | 8 | 3 | 99 | 96 | 327 | 8 | 0 | 207 | 3 | ***969*** |
| 5:00 PM | --- | 5:15 PM | 249 | 3 | 12 | 9 | 4 | 119 | 113 | 405 | 14 | 0 | 246 | 4 | ***1,178*** |
| 5:15 PM | --- | 5:30 PM | 260 | 4 | 16 | 10 | 6 | 136 | 141 | 482 | 15 | 0 | 309 | 5 | ***1,384*** |
| 5:30 PM | --- | 5:45 PM | 267 | 4 | 17 | 12 | 7 | 158 | 157 | 578 | 17 | 0 | 348 | 5 | ***1,570*** |
| 5:45 PM | --- | 6:00 PM | 277 | 4 | 20 | 16 | 7 | 174 | 186 | 668 | 17 | 0 | 404 | 5 | ***1,778*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 52 | 0 | 1 | 2 | 0 | 29 | 25 | 65 | 3 | 0 | 57 | 1 | ***235*** |
| 4:15 PM | --- | 4:30 PM | 47 | 2 | 3 | 2 | 2 | 25 | 32 | 90 | 4 | 0 | 37 | 0 | ***244*** |
| 4:30 PM | --- | 4:45 PM | 60 | 1 | 3 | 3 | 0 | 33 | 25 | 93 | 0 | 0 | 55 | 2 | ***275*** |
| 4:45 PM | --- | 5:00 PM | 49 | 0 | 0 | 1 | 1 | 12 | 14 | 79 | 1 | 0 | 58 | 0 | ***215*** |
| 5:00 PM | --- | 5:15 PM | 41 | 0 | 5 | 1 | 1 | 20 | 17 | 78 | 6 | 0 | 39 | 1 | ***209*** |
| 5:15 PM | --- | 5:30 PM | 11 | 1 | 4 | 1 | 2 | 17 | 28 | 77 | 1 | 0 | 63 | 1 | ***206*** |
| 5:30 PM | --- | 5:45 PM | 7 | 0 | 1 | 2 | 1 | 22 | 16 | 96 | 2 | 0 | 39 | 0 | ***186*** |
| 5:45 PM | --- | 6:00 PM | 10 | 0 | 3 | 4 | 0 | 16 | 29 | 90 | 0 | 0 | 56 | 0 | ***208*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 5:00 PM | 208 | 3 | 7 | 8 | 3 | 99 | 96 | 327 | 8 | 0 | 207 | 3 | ***969*** |
| 4:15 PM | --- | 5:15 PM | 197 | 3 | 11 | 7 | 4 | 90 | 88 | 340 | 11 | 0 | 189 | 3 | ***943*** |
| 4:30 PM | --- | 5:30 PM | 161 | 2 | 12 | 6 | 4 | 82 | 84 | 327 | 8 | 0 | 215 | 4 | ***905*** |
| 4:45 PM | --- | 5:45 PM | 108 | 1 | 10 | 5 | 5 | 71 | 75 | 330 | 10 | 0 | 199 | 2 | ***816*** |
| 5:00 PM | --- | 6:00 PM | 69 | 1 | 13 | 8 | 4 | 75 | 90 | 341 | 9 | 0 | 197 | 2 | ***809*** |

**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY |
| N-S Approach: | I-580 WB OFF-RAMP / I-580 WB ON-RAMP | SURVEY TIME: | 4:00 PM | TO | 6:00 PM |
| E-W Approach: | GOLF LINKS ROAD | CITY: | OAKLAND | FILE: | 2904025-2PM |



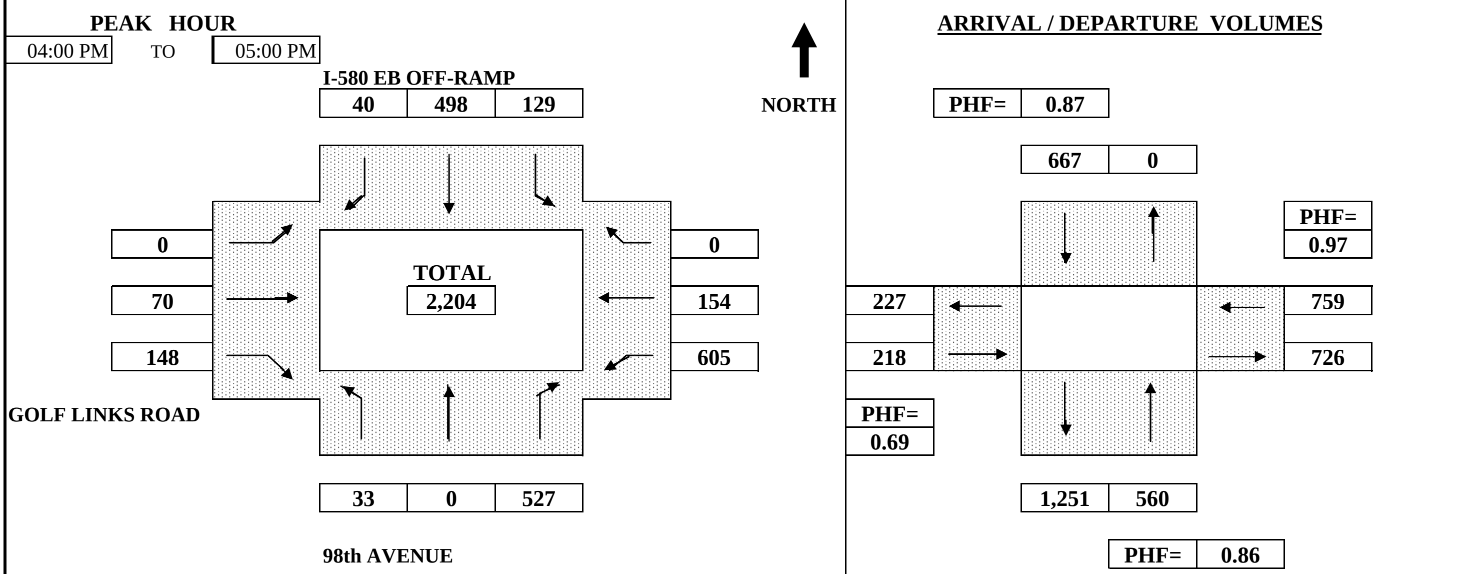

| TIME PERIOD From | | To | NORTHBOUND Left | Thru | Right | SOUTHBOUND Left | Thru | Right | EASTBOUND Left | Thru | Right | WESTBOUND Left | Thru | Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 69 | 0 | 26 | 0 | 0 | 0 | 98 | 62 | 0 | 0 | 110 | 30 | ***395*** |
| 4:15 PM | --- | 4:30 PM | 176 | 1 | 71 | 0 | 0 | 0 | 215 | 143 | 0 | 0 | 203 | 54 | ***863*** |
| 4:30 PM | --- | 4:45 PM | 256 | 1 | 104 | 0 | 0 | 0 | 321 | 228 | 0 | 0 | 309 | 86 | ***1,305*** |
| 4:45 PM | --- | 5:00 PM | 353 | 2 | 139 | 0 | 0 | 0 | 439 | 287 | 0 | 0 | 406 | 128 | ***1,754*** |
| 5:00 PM | --- | 5:15 PM | 474 | 3 | 182 | 0 | 0 | 0 | 561 | 345 | 0 | 0 | 452 | 162 | ***2,179*** |
| 5:15 PM | --- | 5:30 PM | 596 | 3 | 229 | 0 | 0 | 0 | 695 | 404 | 0 | 0 | 520 | 187 | ***2,634*** |
| 5:30 PM | --- | 5:45 PM | 715 | 3 | 277 | 0 | 0 | 0 | 808 | 480 | 0 | 0 | 564 | 209 | ***3,056*** |
| 5:45 PM | --- | 6:00 PM | 831 | 3 | 321 | 0 | 0 | 0 | 911 | 550 | 0 | 0 | 625 | 230 | ***3,471*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 69 | 0 | 26 | 0 | 0 | 0 | 98 | 62 | 0 | 0 | 110 | 30 | ***395*** |
| 4:15 PM | --- | 4:30 PM | 107 | 1 | 45 | 0 | 0 | 0 | 117 | 81 | 0 | 0 | 93 | 24 | ***468*** |
| 4:30 PM | --- | 4:45 PM | 80 | 0 | 33 | 0 | 0 | 0 | 106 | 85 | 0 | 0 | 106 | 32 | ***442*** |
| 4:45 PM | --- | 5:00 PM | 97 | 1 | 35 | 0 | 0 | 0 | 118 | 59 | 0 | 0 | 97 | 42 | ***449*** |
| 5:00 PM | --- | 5:15 PM | 121 | 1 | 43 | 0 | 0 | 0 | 122 | 58 | 0 | 0 | 46 | 34 | ***425*** |
| 5:15 PM | --- | 5:30 PM | 122 | 0 | 47 | 0 | 0 | 0 | 134 | 59 | 0 | 0 | 68 | 25 | ***455*** |
| 5:30 PM | --- | 5:45 PM | 119 | 0 | 48 | 0 | 0 | 0 | 113 | 76 | 0 | 0 | 44 | 22 | ***422*** |
| 5:45 PM | --- | 6:00 PM | 116 | 0 | 44 | 0 | 0 | 0 | 103 | 70 | 0 | 0 | 61 | 21 | ***415*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 5:00 PM | 353 | 2 | 139 | 0 | 0 | 0 | 439 | 287 | 0 | 0 | 406 | 128 | ***1,754*** |
| 4:15 PM | --- | 5:15 PM | 405 | 3 | 156 | 0 | 0 | 0 | 463 | 283 | 0 | 0 | 342 | 132 | ***1,784*** |
| 4:30 PM | --- | 5:30 PM | 420 | 2 | 158 | 0 | 0 | 0 | 480 | 261 | 0 | 0 | 317 | 133 | ***1,771*** |
| 4:45 PM | --- | 5:45 PM | 459 | 2 | 173 | 0 | 0 | 0 | 487 | 252 | 0 | 0 | 255 | 123 | ***1,751*** |
| 5:00 PM | --- | 6:00 PM | 478 | 1 | 182 | 0 | 0 | 0 | 472 | 263 | 0 | 0 | 219 | 102 | ***1,717*** |

**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | | DAY: | THURSDAY |
| N-S Approach: | 98th AVENUE / I-580 EB OFF-RAMP | SURVEY TIME: | 4:00 PM | | TO | 6:00 PM |
| E-W Approach: | GOLF LINKS ROAD | CITY: | OAKLAND | | FILE: | 2904025-3PM |



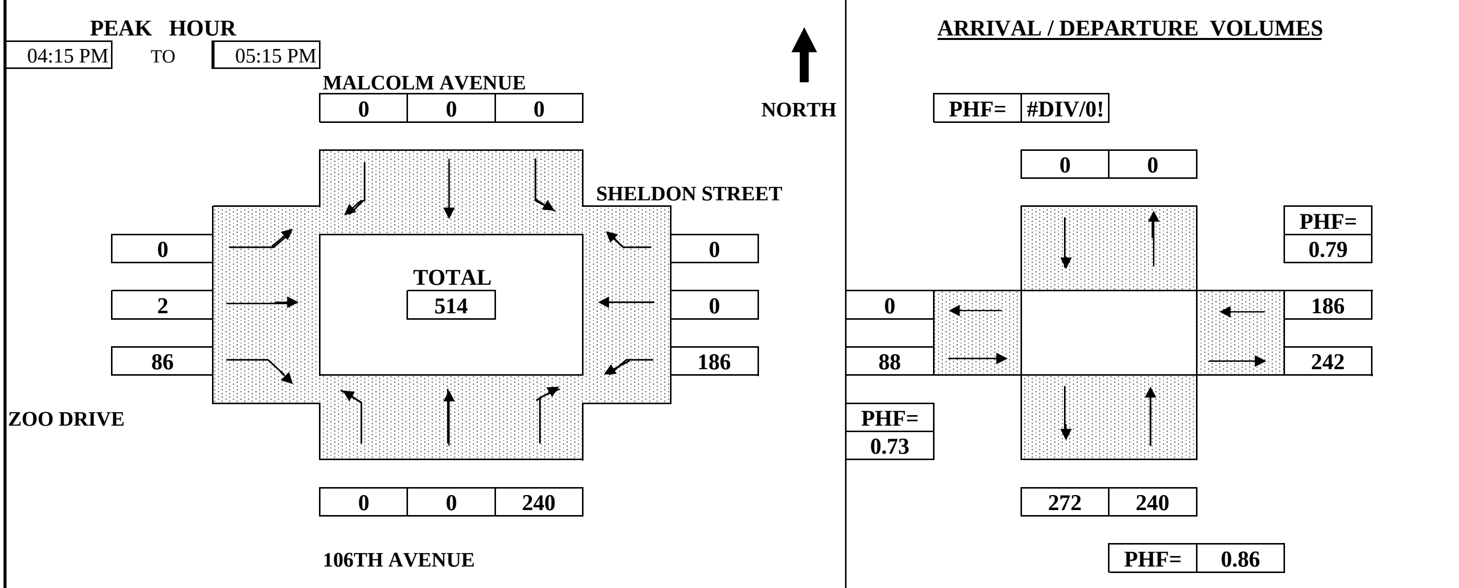

| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 7 | 0 | 114 | 30 | 151 | 11 | 0 | 16 | 44 | 141 | 38 | 0 | ***552*** |
| 4:15 PM | --- | 4:30 PM | 16 | 0 | 262 | 59 | 295 | 25 | 0 | 37 | 74 | 295 | 74 | 0 | ***1,137*** |
| 4:30 PM | --- | 4:45 PM | 26 | 0 | 403 | 92 | 410 | 32 | 0 | 54 | 115 | 453 | 112 | 0 | ***1,697*** |
| 4:45 PM | --- | 5:00 PM | 33 | 0 | 527 | 129 | 498 | 40 | 0 | 70 | 148 | 605 | 154 | 0 | ***2,204*** |
| 5:00 PM | --- | 5:15 PM | 46 | 0 | 648 | 160 | 629 | 52 | 0 | 88 | 185 | 725 | 201 | 0 | ***2,734*** |
| 5:15 PM | --- | 5:30 PM | 58 | 0 | 772 | 199 | 743 | 60 | 0 | 108 | 231 | 855 | 261 | 0 | ***3,287*** |
| 5:30 PM | --- | 5:45 PM | 77 | 0 | 916 | 241 | 867 | 66 | 0 | 131 | 287 | 970 | 309 | 0 | ***3,864*** |
| 5:45 PM | --- | 6:00 PM | 86 | 0 | 1,038 | 276 | 976 | 79 | 0 | 147 | 327 | 1,097 | 359 | 0 | ***4,385*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 7 | 0 | 114 | 30 | 151 | 11 | 0 | 16 | 44 | 141 | 38 | 0 | ***552*** |
| 4:15 PM | --- | 4:30 PM | 9 | 0 | 148 | 29 | 144 | 14 | 0 | 21 | 30 | 154 | 36 | 0 | ***585*** |
| 4:30 PM | --- | 4:45 PM | 10 | 0 | 141 | 33 | 115 | 7 | 0 | 17 | 41 | 158 | 38 | 0 | ***560*** |
| 4:45 PM | --- | 5:00 PM | 7 | 0 | 124 | 37 | 88 | 8 | 0 | 16 | 33 | 152 | 42 | 0 | ***507*** |
| 5:00 PM | --- | 5:15 PM | 13 | 0 | 121 | 31 | 131 | 12 | 0 | 18 | 37 | 120 | 47 | 0 | ***530*** |
| 5:15 PM | --- | 5:30 PM | 12 | 0 | 124 | 39 | 114 | 8 | 0 | 20 | 46 | 130 | 60 | 0 | ***553*** |
| 5:30 PM | --- | 5:45 PM | 19 | 0 | 144 | 42 | 124 | 6 | 0 | 23 | 56 | 115 | 48 | 0 | ***577*** |
| 5:45 PM | --- | 6:00 PM | 9 | 0 | 122 | 35 | 109 | 13 | 0 | 16 | 40 | 127 | 50 | 0 | ***521*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 5:00 PM | 33 | 0 | 527 | 129 | 498 | 40 | 0 | 70 | 148 | 605 | 154 | 0 | ***2,204*** |
| 4:15 PM | --- | 5:15 PM | 39 | 0 | 534 | 130 | 478 | 41 | 0 | 72 | 141 | 584 | 163 | 0 | ***2,182*** |
| 4:30 PM | --- | 5:30 PM | 42 | 0 | 510 | 140 | 448 | 35 | 0 | 71 | 157 | 560 | 187 | 0 | ***2,150*** |
| 4:45 PM | --- | 5:45 PM | 51 | 0 | 513 | 149 | 457 | 34 | 0 | 77 | 172 | 517 | 197 | 0 | ***2,167*** |
| 5:00 PM | --- | 6:00 PM | 53 | 0 | 511 | 147 | 478 | 39 | 0 | 77 | 179 | 492 | 205 | 0 | ***2,181*** |

**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY |
| N-S Approach: | 106TH AVENUE / MALCOLM AVENUE | SURVEY TIME: | 4:00 PM | TO | 6:00 PM |
| E-W Approach: | ZOO DRIVE / SHELDON STREET | CITY: | OAKLAND | FILE: | 2904025-4PM |




| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 0 | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 22 | 46 | 0 | 0 | ***104*** |
| 4:15 PM | --- | 4:30 PM | 0 | 0 | 92 | 0 | 0 | 0 | 0 | 1 | 42 | 105 | 0 | 0 | ***240*** |
| 4:30 PM | --- | 4:45 PM | 0 | 0 | 146 | 0 | 0 | 0 | 0 | 2 | 64 | 142 | 0 | 0 | ***354*** |
| 4:45 PM | --- | 5:00 PM | 0 | 0 | 208 | 0 | 0 | 0 | 0 | 2 | 94 | 184 | 0 | 0 | ***488*** |
| 5:00 PM | --- | 5:15 PM | 0 | 0 | 276 | 0 | 0 | 0 | 0 | 2 | 108 | 232 | 0 | 0 | ***618*** |
| 5:15 PM | --- | 5:30 PM | 0 | 0 | 332 | 0 | 0 | 0 | 0 | 2 | 114 | 285 | 0 | 0 | ***733*** |
| 5:30 PM | --- | 5:45 PM | 0 | 0 | 402 | 0 | 0 | 0 | 0 | 2 | 118 | 337 | 0 | 0 | ***859*** |
| 5:45 PM | --- | 6:00 PM | 0 | 0 | 466 | 0 | 0 | 0 | 0 | 2 | 120 | 383 | 1 | 0 | ***972*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 0 | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 22 | 46 | 0 | 0 | ***104*** |
| 4:15 PM | --- | 4:30 PM | 0 | 0 | 56 | 0 | 0 | 0 | 0 | 1 | 20 | 59 | 0 | 0 | ***136*** |
| 4:30 PM | --- | 4:45 PM | 0 | 0 | 54 | 0 | 0 | 0 | 0 | 1 | 22 | 37 | 0 | 0 | ***114*** |
| 4:45 PM | --- | 5:00 PM | 0 | 0 | 62 | 0 | 0 | 0 | 0 | 0 | 30 | 42 | 0 | 0 | ***134*** |
| 5:00 PM | --- | 5:15 PM | 0 | 0 | 68 | 0 | 0 | 0 | 0 | 0 | 14 | 48 | 0 | 0 | ***130*** |
| 5:15 PM | --- | 5:30 PM | 0 | 0 | 56 | 0 | 0 | 0 | 0 | 0 | 6 | 53 | 0 | 0 | ***115*** |
| 5:30 PM | --- | 5:45 PM | 0 | 0 | 70 | 0 | 0 | 0 | 0 | 0 | 4 | 52 | 0 | 0 | ***126*** |
| 5:45 PM | --- | 6:00 PM | 0 | 0 | 64 | 0 | 0 | 0 | 0 | 0 | 2 | 46 | 1 | 0 | ***113*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 5:00 PM | 0 | 0 | 208 | 0 | 0 | 0 | 0 | 2 | 94 | 184 | 0 | 0 | ***488*** |
| 4:15 PM | --- | 5:15 PM | 0 | 0 | 240 | 0 | 0 | 0 | 0 | 2 | 86 | 186 | 0 | 0 | ***514*** |
| 4:30 PM | --- | 5:30 PM | 0 | 0 | 240 | 0 | 0 | 0 | 0 | 1 | 72 | 180 | 0 | 0 | ***493*** |
| 4:45 PM | --- | 5:45 PM | 0 | 0 | 256 | 0 | 0 | 0 | 0 | 0 | 54 | 195 | 0 | 0 | ***505*** |
| 5:00 PM | --- | 6:00 PM | 0 | 0 | 258 | 0 | 0 | 0 | 0 | 0 | 26 | 199 | 1 | 0 | ***484*** |

**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

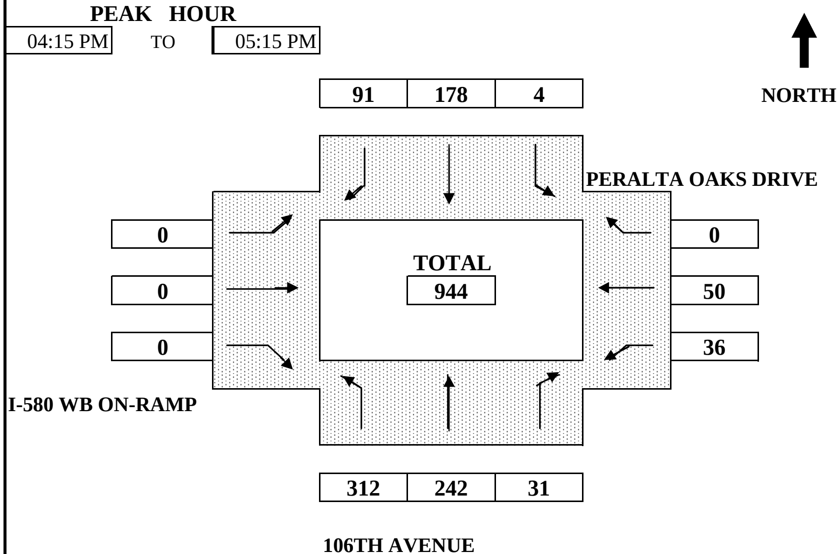
## INTERSECTION TURNING MOVEMENT SUMMARY

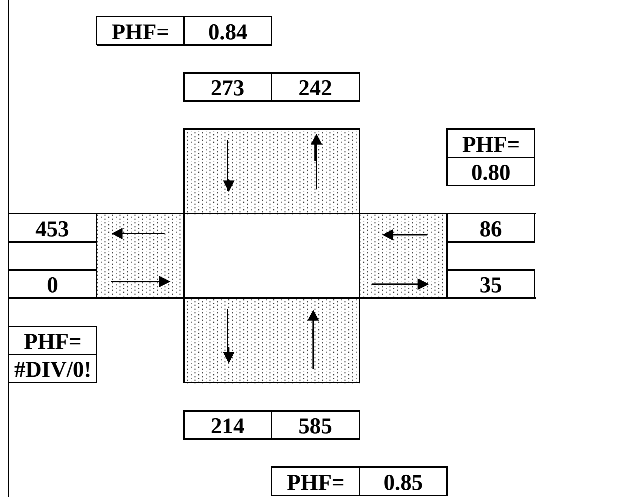
| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY |
| N-S Approach: | 106TH AVENUE | SURVEY TIME: | 4:00 PM | TO | 6:00 PM |
| E-W Approach: | I-580 WB ON-RAMP / PERALTA OAKS DR | CITY: | OAKLAND | FILE: | 2904025-5PM |

**PEAK HOUR**

04:15 PM TO 05:15 PM

**ARRIVAL / DEPARTURE VOLUMES**



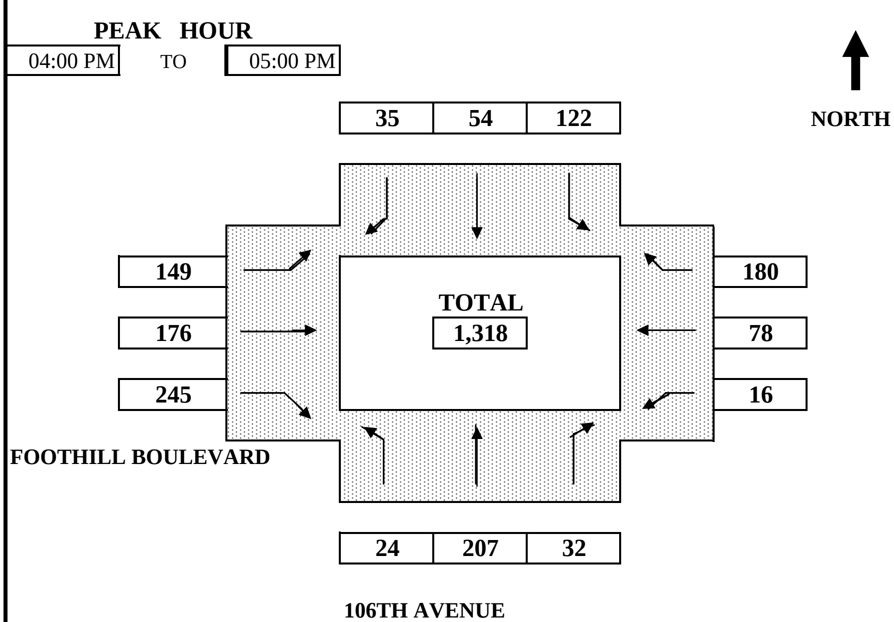

| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 91 | 34 | 6 | 0 | 46 | 22 | 0 | 0 | 0 | 5 | 6 | 1 | ***211*** |
| 4:15 PM | --- | 4:30 PM | 161 | 90 | 12 | 1 | 100 | 48 | 0 | 0 | 0 | 11 | 19 | 1 | ***443*** |
| 4:30 PM | --- | 4:45 PM | 239 | 144 | 20 | 2 | 139 | 67 | 0 | 0 | 0 | 24 | 33 | 1 | ***669*** |
| 4:45 PM | --- | 5:00 PM | 311 | 207 | 26 | 4 | 185 | 90 | 0 | 0 | 0 | 30 | 42 | 1 | ***896*** |
| 5:00 PM | --- | 5:15 PM | 403 | 276 | 37 | 4 | 224 | 113 | 0 | 0 | 0 | 41 | 56 | 1 | ***1,155*** |
| 5:15 PM | --- | 5:30 PM | 473 | 331 | 39 | 4 | 266 | 130 | 0 | 0 | 0 | 49 | 70 | 1 | ***1,363*** |
| 5:30 PM | --- | 5:45 PM | 558 | 402 | 44 | 4 | 304 | 148 | 0 | 0 | 0 | 60 | 80 | 1 | ***1,601*** |
| 5:45 PM | --- | 6:00 PM | 645 | 465 | 49 | 4 | 332 | 167 | 0 | 0 | 0 | 65 | 84 | 1 | ***1,812*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 91 | 34 | 6 | 0 | 46 | 22 | 0 | 0 | 0 | 5 | 6 | 1 | ***211*** |
| 4:15 PM | --- | 4:30 PM | 70 | 56 | 6 | 1 | 54 | 26 | 0 | 0 | 0 | 6 | 13 | 0 | ***232*** |
| 4:30 PM | --- | 4:45 PM | 78 | 54 | 8 | 1 | 39 | 19 | 0 | 0 | 0 | 13 | 14 | 0 | ***226*** |
| 4:45 PM | --- | 5:00 PM | 72 | 63 | 6 | 2 | 46 | 23 | 0 | 0 | 0 | 6 | 9 | 0 | ***227*** |
| 5:00 PM | --- | 5:15 PM | 92 | 69 | 11 | 0 | 39 | 23 | 0 | 0 | 0 | 11 | 14 | 0 | ***259*** |
| 5:15 PM | --- | 5:30 PM | 70 | 55 | 2 | 0 | 42 | 17 | 0 | 0 | 0 | 8 | 14 | 0 | ***208*** |
| 5:30 PM | --- | 5:45 PM | 85 | 71 | 5 | 0 | 38 | 18 | 0 | 0 | 0 | 11 | 10 | 0 | ***238*** |
| 5:45 PM | --- | 6:00 PM | 87 | 63 | 5 | 0 | 28 | 19 | 0 | 0 | 0 | 5 | 4 | 0 | ***211*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 5:00 PM | 311 | 207 | 26 | 4 | 185 | 90 | 0 | 0 | 0 | 30 | 42 | 1 | ***896*** |
| 4:15 PM | --- | 5:15 PM | 312 | 242 | 31 | 4 | 178 | 91 | 0 | 0 | 0 | 36 | 50 | 0 | ***944*** |
| 4:30 PM | --- | 5:30 PM | 312 | 241 | 27 | 3 | 166 | 82 | 0 | 0 | 0 | 38 | 51 | 0 | ***920*** |
| 4:45 PM | --- | 5:45 PM | 319 | 258 | 24 | 2 | 165 | 81 | 0 | 0 | 0 | 36 | 47 | 0 | ***932*** |
| 5:00 PM | --- | 6:00 PM | 334 | 258 | 23 | 0 | 147 | 77 | 0 | 0 | 0 | 35 | 42 | 0 | ***916*** |

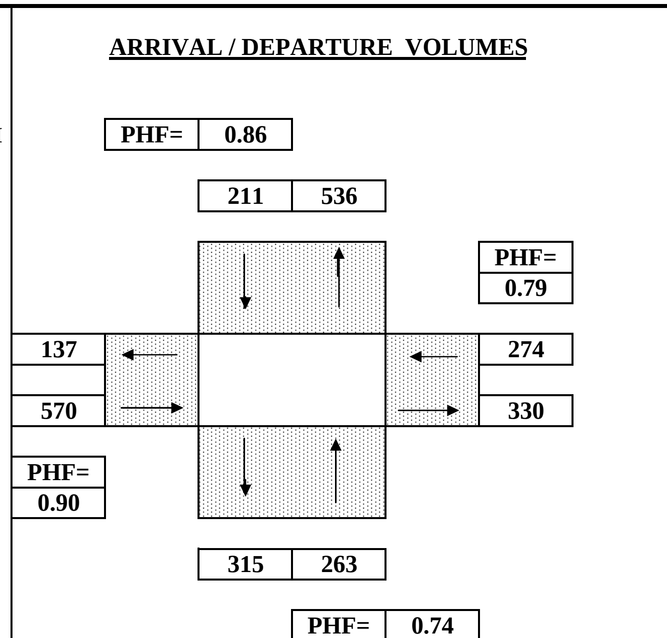

**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY |
| N-S Approach: | 106TH AVENUE | SURVEY TIME: | 4:00 PM | TO | 6:00 PM |
| E-W Approach: | FOOTHILL BOULEVARD | CITY: OAKLAND | | FILE: | 2904025-6PM |




| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 6 | 60 | 10 | 35 | 11 | 9 | 36 | 56 | 67 | 4 | 26 | 53 | ***373*** |
| 4:15 PM | --- | 4:30 PM | 12 | 108 | 18 | 70 | 25 | 21 | 75 | 101 | 135 | 8 | 40 | 93 | ***706*** |
| 4:30 PM | --- | 4:45 PM | 19 | 159 | 26 | 91 | 38 | 32 | 111 | 138 | 188 | 14 | 57 | 133 | ***1,006*** |
| 4:45 PM | --- | 5:00 PM | 24 | 207 | 32 | 122 | 54 | 35 | 149 | 176 | 245 | 16 | 78 | 180 | ***1,318*** |
| 5:00 PM | --- | 5:15 PM | 37 | 276 | 39 | 152 | 66 | 49 | 196 | 210 | 294 | 19 | 92 | 234 | ***1,664*** |
| 5:15 PM | --- | 5:30 PM | 38 | 335 | 44 | 172 | 82 | 57 | 229 | 242 | 361 | 22 | 108 | 280 | ***1,970*** |
| 5:30 PM | --- | 5:45 PM | 40 | 392 | 48 | 204 | 94 | 62 | 266 | 277 | 420 | 24 | 127 | 346 | ***2,300*** |
| 5:45 PM | --- | 6:00 PM | 50 | 459 | 59 | 222 | 103 | 67 | 307 | 319 | 463 | 28 | 153 | 385 | ***2,615*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 6 | 60 | 10 | 35 | 11 | 9 | 36 | 56 | 67 | 4 | 26 | 53 | ***373*** |
| 4:15 PM | --- | 4:30 PM | 6 | 48 | 8 | 35 | 14 | 12 | 39 | 45 | 68 | 4 | 14 | 40 | ***333*** |
| 4:30 PM | --- | 4:45 PM | 7 | 51 | 8 | 21 | 13 | 11 | 36 | 37 | 53 | 6 | 17 | 40 | ***300*** |
| 4:45 PM | --- | 5:00 PM | 5 | 48 | 6 | 31 | 16 | 3 | 38 | 38 | 57 | 2 | 21 | 47 | ***312*** |
| 5:00 PM | --- | 5:15 PM | 13 | 69 | 7 | 30 | 12 | 14 | 47 | 34 | 49 | 3 | 14 | 54 | ***346*** |
| 5:15 PM | --- | 5:30 PM | 1 | 59 | 5 | 20 | 16 | 8 | 33 | 32 | 67 | 3 | 16 | 46 | ***306*** |
| 5:30 PM | --- | 5:45 PM | 2 | 57 | 4 | 32 | 12 | 5 | 37 | 35 | 59 | 2 | 19 | 66 | ***330*** |
| 5:45 PM | --- | 6:00 PM | 10 | 67 | 11 | 18 | 9 | 5 | 41 | 42 | 43 | 4 | 26 | 39 | ***315*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 5:00 PM | 24 | 207 | 32 | 122 | 54 | 35 | 149 | 176 | 245 | 16 | 78 | 180 | ***1,318*** |
| 4:15 PM | --- | 5:15 PM | 31 | 216 | 29 | 117 | 55 | 40 | 160 | 154 | 227 | 15 | 66 | 181 | ***1,291*** |
| 4:30 PM | --- | 5:30 PM | 26 | 227 | 26 | 102 | 57 | 36 | 154 | 141 | 226 | 14 | 68 | 187 | ***1,264*** |
| 4:45 PM | --- | 5:45 PM | 21 | 233 | 22 | 113 | 56 | 30 | 155 | 139 | 232 | 10 | 70 | 213 | ***1,294*** |
| 5:00 PM | --- | 6:00 PM | 26 | 252 | 27 | 100 | 49 | 32 | 158 | 143 | 218 | 12 | 75 | 205 | ***1,297*** |

Telephone: (510)232-1271 Fax: (510)232-1272

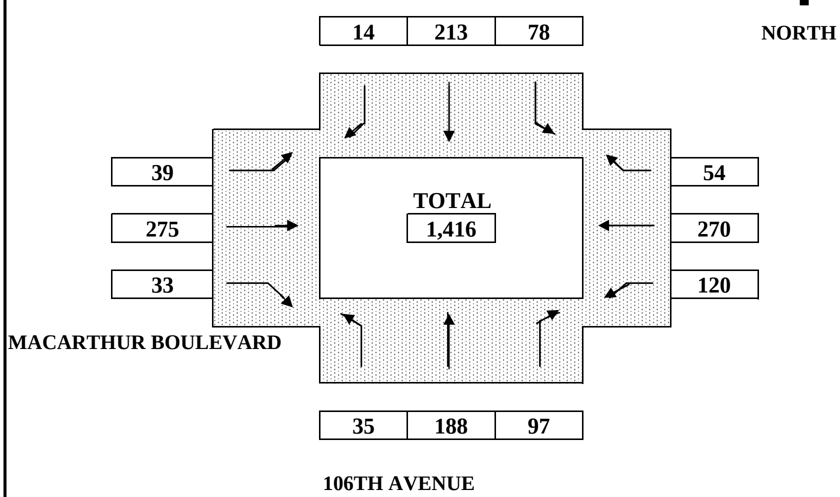
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

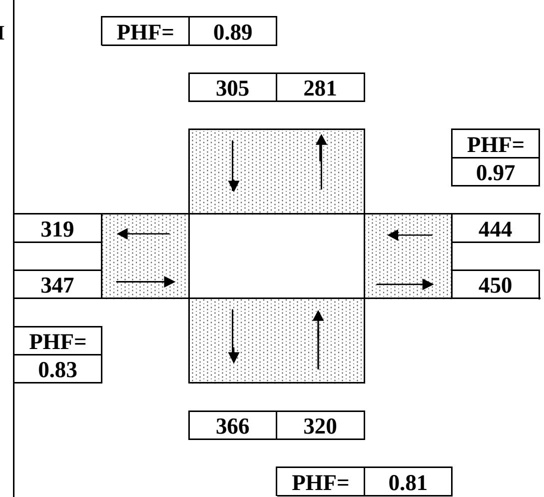
| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO TRAFFIC STUDY | SURVEY DATE: | 4/16/2009 | DAY: | THURSDAY |
| N-S Approach: | 106TH AVENUE | SURVEY TIME: | 4:00 PM | TO | 6:00 PM |
| E-W Approach: | MACARTHUR BOULEVARD | CITY: | OAKLAND | FILE: | 2904025-7PM |

**PEAK HOUR**

04:00 PM TO 05:00 PM




**ARRIVAL / DEPARTURE VOLUMES**




| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 9 | 59 | 22 | 12 | 51 | 3 | 9 | 47 | 6 | 26 | 78 | 8 | ***330*** |
| 4:15 PM | --- | 4:30 PM | 10 | 92 | 49 | 33 | 107 | 5 | 23 | 115 | 13 | 50 | 154 | 23 | ***674*** |
| 4:30 PM | --- | 4:45 PM | 27 | 141 | 71 | 57 | 165 | 9 | 31 | 189 | 22 | 85 | 216 | 40 | ***1,053*** |
| 4:45 PM | --- | 5:00 PM | 35 | 188 | 97 | 78 | 213 | 14 | 39 | 275 | 33 | 120 | 270 | 54 | ***1,416*** |
| 5:00 PM | --- | 5:15 PM | 44 | 248 | 120 | 97 | 250 | 19 | 47 | 314 | 39 | 156 | 324 | 71 | ***1,729*** |
| 5:15 PM | --- | 5:30 PM | 49 | 301 | 148 | 121 | 306 | 21 | 52 | 388 | 51 | 174 | 373 | 83 | ***2,067*** |
| 5:30 PM | --- | 5:45 PM | 62 | 347 | 177 | 135 | 365 | 25 | 58 | 443 | 57 | 190 | 428 | 96 | ***2,383*** |
| 5:45 PM | --- | 6:00 PM | 74 | 410 | 201 | 147 | 409 | 27 | 63 | 528 | 66 | 206 | 485 | 114 | ***2,730*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 4:15 PM | 9 | 59 | 22 | 12 | 51 | 3 | 9 | 47 | 6 | 26 | 78 | 8 | ***330*** |
| 4:15 PM | --- | 4:30 PM | 1 | 33 | 27 | 21 | 56 | 2 | 14 | 68 | 7 | 24 | 76 | 15 | ***344*** |
| 4:30 PM | --- | 4:45 PM | 17 | 49 | 22 | 24 | 58 | 4 | 8 | 74 | 9 | 35 | 62 | 17 | ***379*** |
| 4:45 PM | --- | 5:00 PM | 8 | 47 | 26 | 21 | 48 | 5 | 8 | 86 | 11 | 35 | 54 | 14 | ***363*** |
| 5:00 PM | --- | 5:15 PM | 9 | 60 | 23 | 19 | 37 | 5 | 8 | 39 | 6 | 36 | 54 | 17 | ***313*** |
| 5:15 PM | --- | 5:30 PM | 5 | 53 | 28 | 24 | 56 | 2 | 5 | 74 | 12 | 18 | 49 | 12 | ***338*** |
| 5:30 PM | --- | 5:45 PM | 13 | 46 | 29 | 14 | 59 | 4 | 6 | 55 | 6 | 16 | 55 | 13 | ***316*** |
| 5:45 PM | --- | 6:00 PM | 12 | 63 | 24 | 12 | 44 | 2 | 5 | 85 | 9 | 16 | 57 | 18 | ***347*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 4:00 PM | --- | 5:00 PM | 35 | 188 | 97 | 78 | 213 | 14 | 39 | 275 | 33 | 120 | 270 | 54 | ***1,416*** |
| 4:15 PM | --- | 5:15 PM | 35 | 189 | 98 | 85 | 199 | 16 | 38 | 267 | 33 | 130 | 246 | 63 | ***1,399*** |
| 4:30 PM | --- | 5:30 PM | 39 | 209 | 99 | 88 | 199 | 16 | 29 | 273 | 38 | 124 | 219 | 60 | ***1,393*** |
| 4:45 PM | --- | 5:45 PM | 35 | 206 | 106 | 78 | 200 | 16 | 27 | 254 | 35 | 105 | 212 | 56 | ***1,330*** |
| 5:00 PM | --- | 6:00 PM | 39 | 222 | 104 | 69 | 196 | 13 | 24 | 253 | 33 | 86 | 215 | 60 | ***1,314*** |


**Telephone: (510)232-1271** **Fax: (510)232-1272**

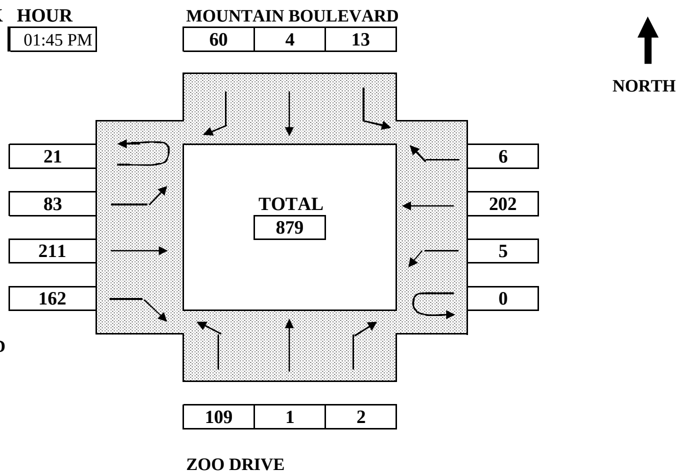
# Weekend Peak Periods
# (January 30, 2010)

# B.A.Y.M.E.T.R.I.C.S.

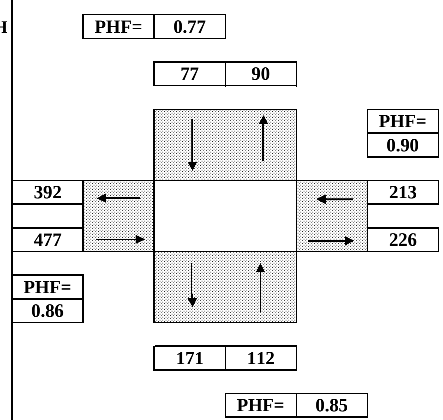
## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO (SATURDAY) MID-DAY TS | SURVEY DATE: | 1/30/2010 | DAY: | SATURDAY |
| N-S APPROACH: | ZOO DRIVE / MOUNTAIN BOULEVARD | SURVEY TIME: | 12:00 PM | TO | 2:00 PM |
| E-W APPROACH: | GOLF LINKS ROAD | CITY: OAKLAND | | FILE: | 3001006-1MD |

PEAK HOUR 12:45 PM TO 01:45 PM




ARRIVAL / DEPARTURE VOLUMES



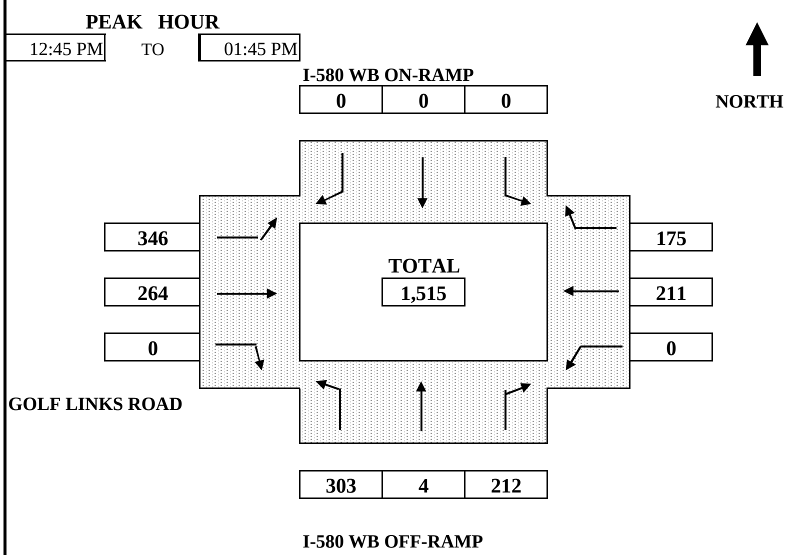

| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND U-Turn | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND U-Turn | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 11 | 1 | 0 | 3 | 1 | 16 | 6 | 15 | 46 | 46 | 0 | 0 | 57 | 0 | *202* |
| 12:15 PM | --- | 12:30 PM | 31 | 1 | 0 | 4 | 2 | 26 | 10 | 36 | 99 | 83 | 0 | 2 | 105 | 2 | *401* |
| 12:30 PM | --- | 12:45 PM | 52 | 1 | 1 | 6 | 2 | 41 | 12 | 64 | 147 | 114 | 0 | 3 | 160 | 4 | *607* |
| 12:45 PM | --- | 1:00 PM | 74 | 1 | 2 | 10 | 4 | 60 | 18 | 86 | 214 | 158 | 0 | 6 | 216 | 4 | *853* |
| 1:00 PM | --- | 1:15 PM | 106 | 1 | 3 | 12 | 4 | 75 | 21 | 103 | 256 | 202 | 0 | 6 | 265 | 6 | *1,060* |
| 1:15 PM | --- | 1:30 PM | 134 | 2 | 3 | 13 | 4 | 88 | 26 | 121 | 300 | 238 | 0 | 6 | 318 | 9 | *1,262* |
| 1:30 PM | --- | 1:45 PM | 161 | 2 | 3 | 19 | 6 | 101 | 33 | 147 | 358 | 276 | 0 | 8 | 362 | 10 | *1,486* |
| 1:45 PM | --- | 2:00 PM | 188 | 2 | 3 | 21 | 7 | 117 | 36 | 176 | 409 | 309 | 0 | 8 | 415 | 11 | *1,702* |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 11 | 1 | 0 | 3 | 1 | 16 | 6 | 15 | 46 | 46 | 0 | 0 | 57 | 0 | *202* |
| 12:15 PM | --- | 12:30 PM | 20 | 0 | 0 | 1 | 1 | 10 | 4 | 21 | 53 | 37 | 0 | 2 | 48 | 2 | *199* |
| 12:30 PM | --- | 12:45 PM | 21 | 0 | 1 | 2 | 0 | 15 | 2 | 28 | 48 | 31 | 0 | 1 | 55 | 2 | *206* |
| 12:45 PM | --- | 1:00 PM | 22 | 0 | 1 | 4 | 2 | 19 | 6 | 22 | 67 | 44 | 0 | 3 | 56 | 0 | *246* |
| 1:00 PM | --- | 1:15 PM | 32 | 0 | 1 | 2 | 0 | 15 | 3 | 17 | 42 | 44 | 0 | 0 | 49 | 2 | *207* |
| 1:15 PM | --- | 1:30 PM | 28 | 1 | 0 | 1 | 0 | 13 | 5 | 18 | 44 | 36 | 0 | 0 | 53 | 3 | *202* |
| 1:30 PM | --- | 1:45 PM | 27 | 0 | 0 | 6 | 2 | 13 | 7 | 26 | 58 | 38 | 0 | 2 | 44 | 1 | *224* |
| 1:45 PM | --- | 2:00 PM | 27 | 0 | 0 | 2 | 1 | 16 | 3 | 29 | 51 | 33 | 0 | 0 | 53 | 1 | *216* |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 1:00 PM | 74 | 1 | 2 | 10 | 4 | 60 | 18 | 86 | 214 | 158 | 0 | 6 | 216 | 4 | *853* |
| 12:15 PM | --- | 1:15 PM | 95 | 0 | 3 | 9 | 3 | 59 | 15 | 88 | 210 | 156 | 0 | 6 | 208 | 6 | *858* |
| 12:30 PM | --- | 1:30 PM | 103 | 1 | 3 | 9 | 2 | 62 | 16 | 85 | 201 | 155 | 0 | 4 | 213 | 7 | *861* |
| 12:45 PM | --- | 1:45 PM | 109 | 1 | 2 | 13 | 4 | 60 | 21 | 83 | 211 | 162 | 0 | 5 | 202 | 6 | *879* |
| 1:00 PM | --- | 2:00 PM | 114 | 1 | 1 | 11 | 3 | 57 | 18 | 90 | 195 | 151 | 0 | 2 | 199 | 7 | *849* |

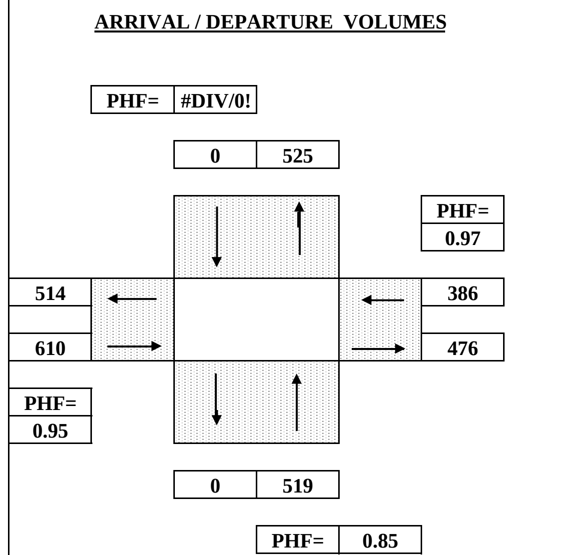
**Telephone: (510)232-1271** **Fax: (510)232-1272**

# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO (SATURDAY) MID-DAY TS | SURVEY DATE: | 1/30/2010 | DAY: | SATURDAY |
| N-S APPROACH: | I-580 WB RAMPS | SURVEY TIME: | 12:00 PM | TO | 2:00 PM |
| E-W APPROACH: | GOLF LINKS ROAD | CITY: | OAKLAND | FILE: | 3001006-2MD |




| TIME PERIOD From | | To | NORTHBOUND Left | Thru | Right | SOUTHBOUND Left | Thru | Right | EASTBOUND Left | Thru | Right | WESTBOUND Left | Thru | Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 73 | 4 | 56 | 0 | 0 | 0 | 88 | 66 | 0 | 0 | 50 | 39 | *376* |
| 12:15 PM | --- | 12:30 PM | 140 | 4 | 108 | 0 | 0 | 0 | 165 | 126 | 0 | 0 | 93 | 77 | *713* |
| 12:30 PM | --- | 12:45 PM | 195 | 4 | 151 | 0 | 0 | 0 | 219 | 197 | 0 | 0 | 143 | 122 | *1,031* |
| 12:45 PM | --- | 1:00 PM | 269 | 5 | 215 | 0 | 0 | 0 | 293 | 270 | 0 | 0 | 201 | 163 | *1,416* |
| 1:00 PM | --- | 1:15 PM | 348 | 6 | 256 | 0 | 0 | 0 | 391 | 332 | 0 | 0 | 255 | 207 | *1,795* |
| 1:15 PM | --- | 1:30 PM | 410 | 7 | 299 | 0 | 0 | 0 | 479 | 390 | 0 | 0 | 305 | 250 | *2,140* |
| 1:30 PM | --- | 1:45 PM | 498 | 8 | 363 | 0 | 0 | 0 | 565 | 461 | 0 | 0 | 354 | 297 | *2,546* |
| 1:45 PM | --- | 2:00 PM | 576 | 9 | 416 | 0 | 0 | 0 | 646 | 522 | 0 | 0 | 408 | 335 | *2,912* |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 73 | 4 | 56 | 0 | 0 | 0 | 88 | 66 | 0 | 0 | 50 | 39 | *376* |
| 12:15 PM | --- | 12:30 PM | 67 | 0 | 52 | 0 | 0 | 0 | 77 | 60 | 0 | 0 | 43 | 38 | *337* |
| 12:30 PM | --- | 12:45 PM | 55 | 0 | 43 | 0 | 0 | 0 | 54 | 71 | 0 | 0 | 50 | 45 | *318* |
| 12:45 PM | --- | 1:00 PM | 74 | 1 | 64 | 0 | 0 | 0 | 74 | 73 | 0 | 0 | 58 | 41 | *385* |
| 1:00 PM | --- | 1:15 PM | 79 | 1 | 41 | 0 | 0 | 0 | 98 | 62 | 0 | 0 | 54 | 44 | *379* |
| 1:15 PM | --- | 1:30 PM | 62 | 1 | 43 | 0 | 0 | 0 | 88 | 58 | 0 | 0 | 50 | 43 | *345* |
| 1:30 PM | --- | 1:45 PM | 88 | 1 | 64 | 0 | 0 | 0 | 86 | 71 | 0 | 0 | 49 | 47 | *406* |
| 1:45 PM | --- | 2:00 PM | 78 | 1 | 53 | 0 | 0 | 0 | 81 | 61 | 0 | 0 | 54 | 38 | *366* |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 1:00 PM | 269 | 5 | 215 | 0 | 0 | 0 | 293 | 270 | 0 | 0 | 201 | 163 | *1,416* |
| 12:15 PM | --- | 1:15 PM | 275 | 2 | 200 | 0 | 0 | 0 | 303 | 266 | 0 | 0 | 205 | 168 | *1,419* |
| 12:30 PM | --- | 1:30 PM | 270 | 3 | 191 | 0 | 0 | 0 | 314 | 264 | 0 | 0 | 212 | 173 | *1,427* |
| 12:45 PM | --- | 1:45 PM | 303 | 4 | 212 | 0 | 0 | 0 | 346 | 264 | 0 | 0 | 211 | 175 | *1,515* |
| 1:00 PM | --- | 2:00 PM | 307 | 4 | 201 | 0 | 0 | 0 | 353 | 252 | 0 | 0 | 207 | 172 | *1,496* |

**Telephone: (510)232-1271** **Fax: (510)232-1272**

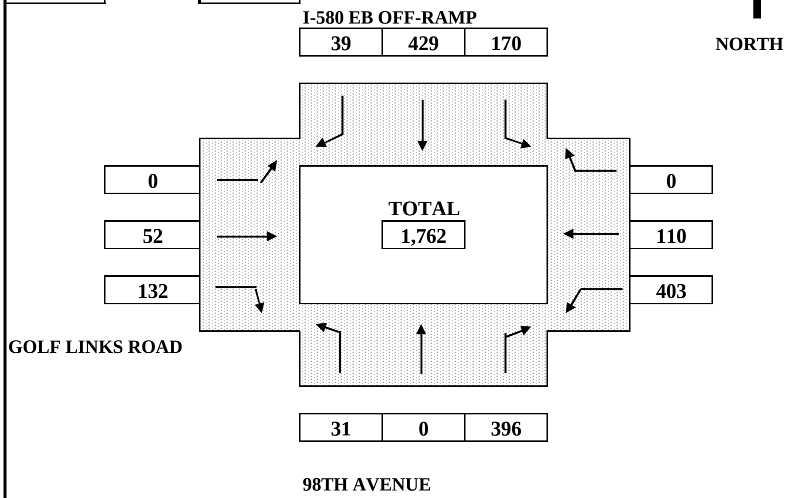
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

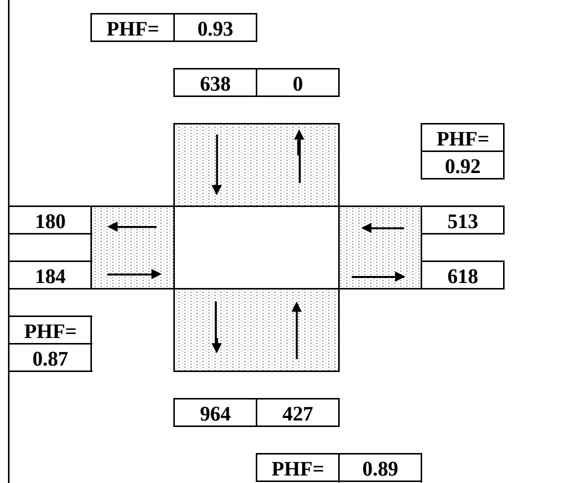
| | | | | | |
|---|---|---|---|---|---|
| **PROJECT:** | **OAKLAND ZOO (SATURDAY) MID-DAY TS** | **SURVEY DATE:** | **1/30/2010** | **DAY:** | **SATURDAY** |
| **N-S APPROACH:** | **98TH AVENUE / I-580 EB OFF-RAMP** | **SURVEY TIME:** | **12:00 PM** | **TO** | **2:00 PM** |
| **E-W APPROACH:** | **GOLF LINKS ROAD** | **CITY:** | **OAKLAND** | **FILE:** | **3001006-3MD** |

**PEAK HOUR**

01:00 PM TO 02:00 PM




**ARRIVAL / DEPARTURE VOLUMES**



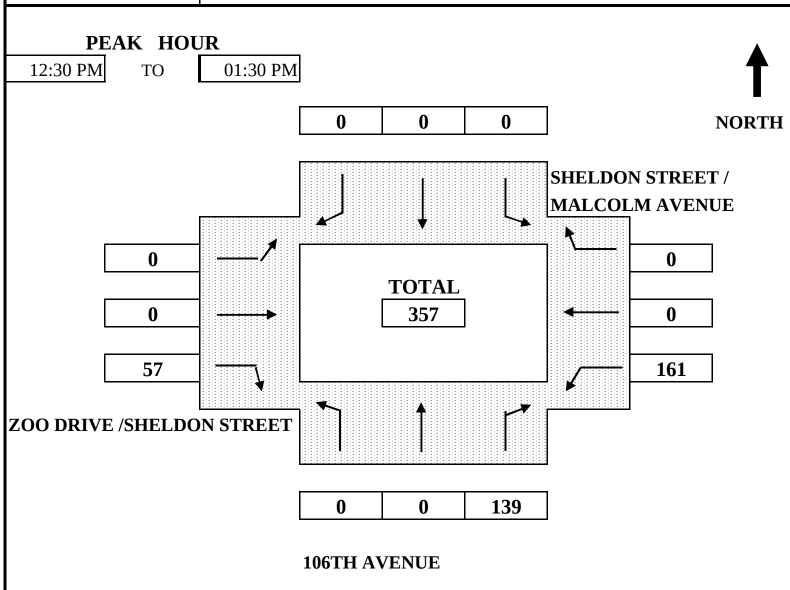

| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 5 | 0 | 101 | 42 | 77 | 5 | 0 | 10 | 25 | 89 | 32 | 0 | *386* |
| 12:15 PM | --- | 12:30 PM | 8 | 0 | 193 | 81 | 138 | 14 | 0 | 19 | 54 | 178 | 57 | 0 | *742* |
| 12:30 PM | --- | 12:45 PM | 17 | 0 | 259 | 131 | 225 | 26 | 0 | 31 | 88 | 248 | 81 | 0 | *1,106* |
| 12:45 PM | --- | 1:00 PM | 22 | 0 | 358 | 179 | 333 | 38 | 0 | 47 | 124 | 359 | 107 | 0 | *1,567* |
| 1:00 PM | --- | 1:15 PM | 33 | 0 | 467 | 219 | 445 | 42 | 0 | 59 | 157 | 455 | 134 | 0 | *2,011* |
| 1:15 PM | --- | 1:30 PM | 37 | 0 | 564 | 266 | 555 | 56 | 0 | 67 | 189 | 549 | 158 | 0 | *2,441* |
| 1:30 PM | --- | 1:45 PM | 43 | 0 | 654 | 309 | 652 | 66 | 0 | 82 | 220 | 655 | 185 | 0 | *2,866* |
| 1:45 PM | --- | 2:00 PM | 53 | 0 | 754 | 349 | 762 | 77 | 0 | 99 | 256 | 762 | 217 | 0 | *3,329* |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 5 | 0 | 101 | 42 | 77 | 5 | 0 | 10 | 25 | 89 | 32 | 0 | *386* |
| 12:15 PM | --- | 12:30 PM | 3 | 0 | 92 | 39 | 61 | 9 | 0 | 9 | 29 | 89 | 25 | 0 | *356* |
| 12:30 PM | --- | 12:45 PM | 9 | 0 | 66 | 50 | 87 | 12 | 0 | 12 | 34 | 70 | 24 | 0 | *364* |
| 12:45 PM | --- | 1:00 PM | 5 | 0 | 99 | 48 | 108 | 12 | 0 | 16 | 36 | 111 | 26 | 0 | *461* |
| 1:00 PM | --- | 1:15 PM | 11 | 0 | 109 | 40 | 112 | 4 | 0 | 12 | 33 | 96 | 27 | 0 | *444* |
| 1:15 PM | --- | 1:30 PM | 4 | 0 | 97 | 47 | 110 | 14 | 0 | 8 | 32 | 94 | 24 | 0 | *430* |
| 1:30 PM | --- | 1:45 PM | 6 | 0 | 90 | 43 | 97 | 10 | 0 | 15 | 31 | 106 | 27 | 0 | *425* |
| 1:45 PM | --- | 2:00 PM | 10 | 0 | 100 | 40 | 110 | 11 | 0 | 17 | 36 | 107 | 32 | 0 | *463* |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 1:00 PM | 22 | 0 | 358 | 179 | 333 | 38 | 0 | 47 | 124 | 359 | 107 | 0 | *1,567* |
| 12:15 PM | --- | 1:15 PM | 28 | 0 | 366 | 177 | 368 | 37 | 0 | 49 | 132 | 366 | 102 | 0 | *1,625* |
| 12:30 PM | --- | 1:30 PM | 29 | 0 | 371 | 185 | 417 | 42 | 0 | 48 | 135 | 371 | 101 | 0 | *1,699* |
| 12:45 PM | --- | 1:45 PM | 26 | 0 | 395 | 178 | 427 | 40 | 0 | 51 | 132 | 407 | 104 | 0 | *1,760* |
| 1:00 PM | --- | 2:00 PM | 31 | 0 | 396 | 170 | 429 | 39 | 0 | 52 | 132 | 403 | 110 | 0 | *1,762* |

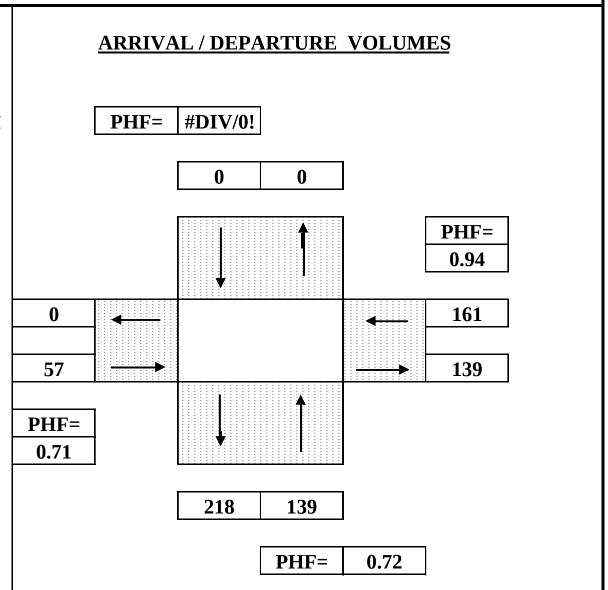
**Telephone: (510)232-1271** **Fax: (510)232-1272**

# *B.A.Y.M.E.T.R.I.C.S.*

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| **PROJECT:** | **OAKLAND ZOO (SATURDAY) MID-DAY TS** | **SURVEY DATE:** | **1/30/2010** | **DAY:** | **SATURDAY** |
| **N-S APPROACH:** | **106TH AVENUE** | **SURVEY TIME:** | **12:00 PM** | **TO** | **2:00 PM** |
| **E-W APPROACH:** | **ZOO DRIVE /SHELDON STREET** | **CITY:** | **OAKLAND** | **FILE:** | **3001006-4MD** |




| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 0 | 0 | 43 | 0 | 0 | 0 | 0 | 0 | 7 | 43 | 0 | 0 | ***93*** |
| 12:15 PM | --- | 12:30 PM | 0 | 0 | 70 | 0 | 0 | 0 | 0 | 0 | 17 | 76 | 0 | 0 | ***163*** |
| 12:30 PM | --- | 12:45 PM | 0 | 0 | 102 | 0 | 0 | 0 | 0 | 0 | 29 | 117 | 0 | 0 | ***248*** |
| 12:45 PM | --- | 1:00 PM | 0 | 0 | 129 | 0 | 0 | 0 | 0 | 0 | 42 | 156 | 0 | 0 | ***327*** |
| 1:00 PM | --- | 1:15 PM | 0 | 0 | 177 | 0 | 0 | 0 | 0 | 0 | 62 | 197 | 0 | 0 | ***436*** |
| 1:15 PM | --- | 1:30 PM | 0 | 0 | 209 | 0 | 0 | 0 | 0 | 0 | 74 | 237 | 0 | 0 | ***520*** |
| 1:30 PM | --- | 1:45 PM | 0 | 0 | 245 | 0 | 0 | 0 | 0 | 0 | 87 | 270 | 0 | 0 | ***602*** |
| 1:45 PM | --- | 2:00 PM | 0 | 0 | 276 | 0 | 0 | 0 | 0 | 0 | 94 | 302 | 0 | 0 | ***672*** |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 0 | 0 | 43 | 0 | 0 | 0 | 0 | 0 | 7 | 43 | 0 | 0 | ***93*** |
| 12:15 PM | --- | 12:30 PM | 0 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 10 | 33 | 0 | 0 | ***70*** |
| 12:30 PM | --- | 12:45 PM | 0 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 12 | 41 | 0 | 0 | ***85*** |
| 12:45 PM | --- | 1:00 PM | 0 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 13 | 39 | 0 | 0 | ***79*** |
| 1:00 PM | --- | 1:15 PM | 0 | 0 | 48 | 0 | 0 | 0 | 0 | 0 | 20 | 41 | 0 | 0 | ***109*** |
| 1:15 PM | --- | 1:30 PM | 0 | 0 | 32 | 0 | 0 | 0 | 0 | 0 | 12 | 40 | 0 | 0 | ***84*** |
| 1:30 PM | --- | 1:45 PM | 0 | 0 | 36 | 0 | 0 | 0 | 0 | 0 | 13 | 33 | 0 | 0 | ***82*** |
| 1:45 PM | --- | 2:00 PM | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 0 | 7 | 32 | 0 | 0 | ***70*** |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 1:00 PM | 0 | 0 | 129 | 0 | 0 | 0 | 0 | 0 | 42 | 156 | 0 | 0 | ***327*** |
| 12:15 PM | --- | 1:15 PM | 0 | 0 | 134 | 0 | 0 | 0 | 0 | 0 | 55 | 154 | 0 | 0 | ***343*** |
| 12:30 PM | --- | 1:30 PM | 0 | 0 | 139 | 0 | 0 | 0 | 0 | 0 | 57 | 161 | 0 | 0 | ***357*** |
| 12:45 PM | --- | 1:45 PM | 0 | 0 | 143 | 0 | 0 | 0 | 0 | 0 | 58 | 153 | 0 | 0 | ***354*** |
| 1:00 PM | --- | 2:00 PM | 0 | 0 | 147 | 0 | 0 | 0 | 0 | 0 | 52 | 146 | 0 | 0 | ***345*** |

**Telephone: (510)232-1271** **Fax: (510)232-1272**

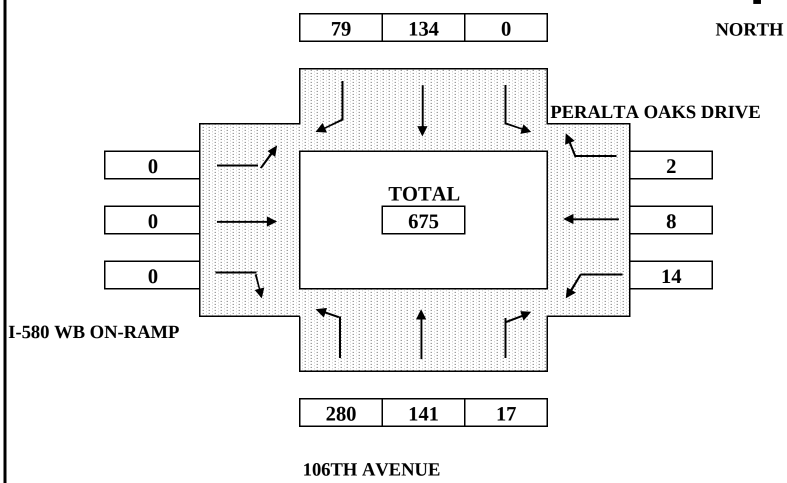
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

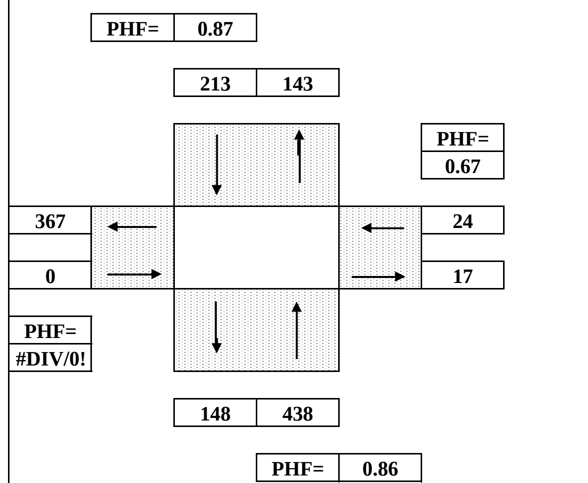
| PROJECT: | OAKLAND ZOO (SATURDAY) MID-DAY TS | SURVEY DATE: | 1/30/2010 | DAY: | SATURDAY |
|---|---|---|---|---|---|
| N-S APPROACH: | 106TH AVENUE | SURVEY TIME: | 12:00 PM | TO | 2:00 PM |
| E-W APPROACH: | I-580 WB ON-RAMP / PERALTA OAKS DR | CITY: | OAKLAND | FILE: | 3001006-5MD |

**PEAK HOUR**

12:45 PM TO 01:45 PM




**ARRIVAL / DEPARTURE VOLUMES**



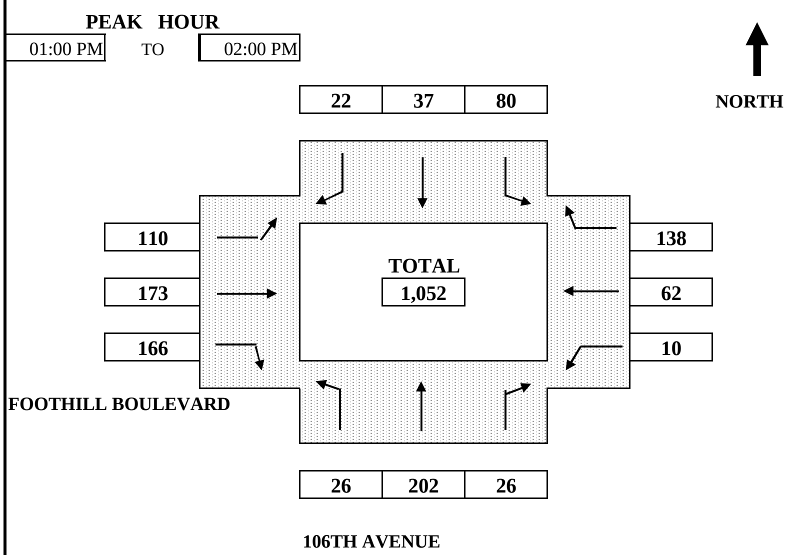

| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 59 | 44 | 3 | 0 | 35 | 17 | 0 | 0 | 0 | 2 | 0 | 0 | *160* |
| 12:15 PM | --- | 12:30 PM | 132 | 69 | 8 | 0 | 61 | 33 | 0 | 0 | 0 | 5 | 0 | 0 | *308* |
| 12:30 PM | --- | 12:45 PM | 189 | 101 | 12 | 1 | 88 | 58 | 0 | 0 | 0 | 9 | 0 | 0 | *458* |
| 12:45 PM | --- | 1:00 PM | 253 | 128 | 15 | 1 | 120 | 80 | 0 | 0 | 0 | 13 | 5 | 0 | *615* |
| 1:00 PM | --- | 1:15 PM | 325 | 177 | 21 | 1 | 162 | 99 | 0 | 0 | 0 | 15 | 6 | 0 | *806* |
| 1:15 PM | --- | 1:30 PM | 396 | 206 | 26 | 1 | 191 | 123 | 0 | 0 | 0 | 19 | 6 | 1 | *969* |
| 1:30 PM | --- | 1:45 PM | 469 | 242 | 29 | 1 | 222 | 137 | 0 | 0 | 0 | 23 | 8 | 2 | *1,133* |
| 1:45 PM | --- | 2:00 PM | 542 | 272 | 33 | 1 | 245 | 154 | 0 | 0 | 0 | 28 | 8 | 2 | *1,285* |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 59 | 44 | 3 | 0 | 35 | 17 | 0 | 0 | 0 | 2 | 0 | 0 | *160* |
| 12:15 PM | --- | 12:30 PM | 73 | 25 | 5 | 0 | 26 | 16 | 0 | 0 | 0 | 3 | 0 | 0 | *148* |
| 12:30 PM | --- | 12:45 PM | 57 | 32 | 4 | 1 | 27 | 25 | 0 | 0 | 0 | 4 | 0 | 0 | *150* |
| 12:45 PM | --- | 1:00 PM | 64 | 27 | 3 | 0 | 32 | 22 | 0 | 0 | 0 | 4 | 5 | 0 | *157* |
| 1:00 PM | --- | 1:15 PM | 72 | 49 | 6 | 0 | 42 | 19 | 0 | 0 | 0 | 2 | 1 | 0 | *191* |
| 1:15 PM | --- | 1:30 PM | 71 | 29 | 5 | 0 | 29 | 24 | 0 | 0 | 0 | 4 | 0 | 1 | *163* |
| 1:30 PM | --- | 1:45 PM | 73 | 36 | 3 | 0 | 31 | 14 | 0 | 0 | 0 | 4 | 2 | 1 | *164* |
| 1:45 PM | --- | 2:00 PM | 73 | 30 | 4 | 0 | 23 | 17 | 0 | 0 | 0 | 5 | 0 | 0 | *152* |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 1:00 PM | 253 | 128 | 15 | 1 | 120 | 80 | 0 | 0 | 0 | 13 | 5 | 0 | *615* |
| 12:15 PM | --- | 1:15 PM | 266 | 133 | 18 | 1 | 127 | 82 | 0 | 0 | 0 | 13 | 6 | 0 | *646* |
| 12:30 PM | --- | 1:30 PM | 264 | 137 | 18 | 1 | 130 | 90 | 0 | 0 | 0 | 14 | 6 | 1 | *661* |
| 12:45 PM | --- | 1:45 PM | 280 | 141 | 17 | 0 | 134 | 79 | 0 | 0 | 0 | 14 | 8 | 2 | *675* |
| 1:00 PM | --- | 2:00 PM | 289 | 144 | 18 | 0 | 125 | 74 | 0 | 0 | 0 | 15 | 3 | 2 | *670* |

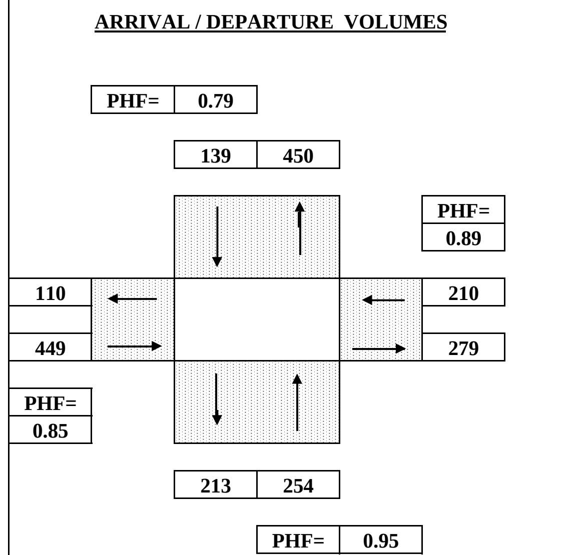
Telephone: (510)232-1271 Fax: (510)232-1272

# B . A . Y . M . E . T . R . I . C . S .

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO (SATURDAY) MID-DAY TS | SURVEY DATE: | 1/30/2010 | DAY: | SATURDAY |
| N-S APPROACH: | 106TH AVENUE | SURVEY TIME: | 12:00 PM | TO | 2:00 PM |
| E-W APPROACH: | FOOTHILL BOULEVARD | CITY: | OAKLAND | FILE: | 3001006-6MD |




| TIME PERIOD | | | NORTHBOUND | | | SOUTHBOUND | | | EASTBOUND | | | WESTBOUND | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From | | To | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | Left | Thru | Right | TOTAL |
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 7 | 37 | 5 | 20 | 11 | 7 | 31 | 36 | 27 | 0 | 14 | 38 | *233* |
| 12:15 PM | --- | 12:30 PM | 10 | 87 | 8 | 36 | 17 | 14 | 53 | 73 | 67 | 4 | 27 | 68 | *464* |
| 12:30 PM | --- | 12:45 PM | 16 | 127 | 17 | 55 | 25 | 15 | 84 | 110 | 111 | 5 | 49 | 90 | *704* |
| 12:45 PM | --- | 1:00 PM | 27 | 166 | 21 | 73 | 38 | 20 | 103 | 142 | 148 | 6 | 65 | 125 | *934* |
| 1:00 PM | --- | 1:15 PM | 30 | 222 | 27 | 95 | 53 | 27 | 135 | 201 | 189 | 7 | 84 | 164 | *1,234* |
| 1:15 PM | --- | 1:30 PM | 38 | 263 | 34 | 114 | 61 | 33 | 166 | 249 | 229 | 10 | 98 | 196 | *1,491* |
| 1:30 PM | --- | 1:45 PM | 46 | 315 | 40 | 139 | 67 | 37 | 186 | 288 | 270 | 12 | 113 | 236 | *1,749* |
| 1:45 PM | --- | 2:00 PM | 53 | 368 | 47 | 153 | 75 | 42 | 213 | 315 | 314 | 16 | 127 | 263 | *1,986* |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 7 | 37 | 5 | 20 | 11 | 7 | 31 | 36 | 27 | 0 | 14 | 38 | *233* |
| 12:15 PM | --- | 12:30 PM | 3 | 50 | 3 | 16 | 6 | 7 | 22 | 37 | 40 | 4 | 13 | 30 | *231* |
| 12:30 PM | --- | 12:45 PM | 6 | 40 | 9 | 19 | 8 | 1 | 31 | 37 | 44 | 1 | 22 | 22 | *240* |
| 12:45 PM | --- | 1:00 PM | 11 | 39 | 4 | 18 | 13 | 5 | 19 | 32 | 37 | 1 | 16 | 35 | *230* |
| 1:00 PM | --- | 1:15 PM | 3 | 56 | 6 | 22 | 15 | 7 | 32 | 59 | 41 | 1 | 19 | 39 | *300* |
| 1:15 PM | --- | 1:30 PM | 8 | 41 | 7 | 19 | 8 | 6 | 31 | 48 | 40 | 3 | 14 | 32 | *257* |
| 1:30 PM | --- | 1:45 PM | 8 | 52 | 6 | 25 | 6 | 4 | 20 | 39 | 41 | 2 | 15 | 40 | *258* |
| 1:45 PM | --- | 2:00 PM | 7 | 53 | 7 | 14 | 8 | 5 | 27 | 27 | 44 | 4 | 14 | 27 | *237* |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 1:00 PM | 27 | 166 | 21 | 73 | 38 | 20 | 103 | 142 | 148 | 6 | 65 | 125 | *934* |
| 12:15 PM | --- | 1:15 PM | 23 | 185 | 22 | 75 | 42 | 20 | 104 | 165 | 162 | 7 | 70 | 126 | *1,001* |
| 12:30 PM | --- | 1:30 PM | 28 | 176 | 26 | 78 | 44 | 19 | 113 | 176 | 162 | 6 | 71 | 128 | *1,027* |
| 12:45 PM | --- | 1:45 PM | 30 | 188 | 23 | 84 | 42 | 22 | 102 | 178 | 159 | 7 | 64 | 146 | *1,045* |
| 1:00 PM | --- | 2:00 PM | 26 | 202 | 26 | 80 | 37 | 22 | 110 | 173 | 166 | 10 | 62 | 138 | *1,052* |

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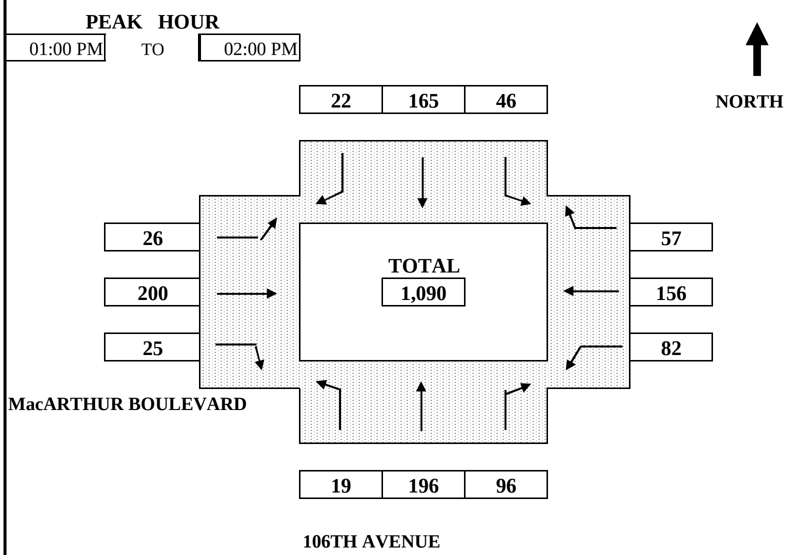
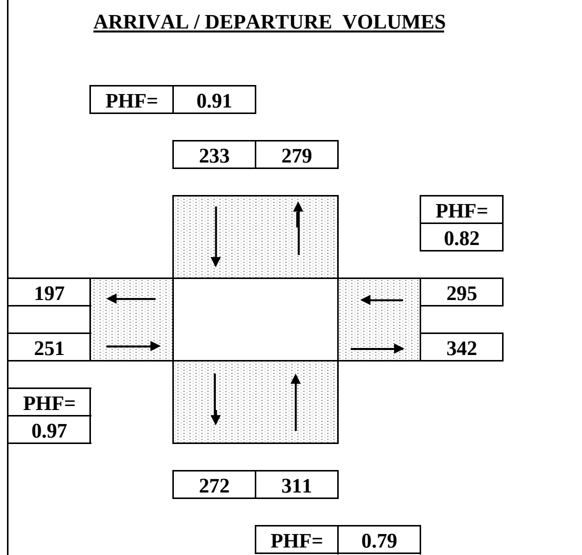
# B.A.Y.M.E.T.R.I.C.S.

## INTERSECTION TURNING MOVEMENT SUMMARY

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | OAKLAND ZOO (SATURDAY) MID-DAY TS | SURVEY DATE: | 1/30/2010 | DAY: | SATURDAY |
| N-S APPROACH: | 106TH AVENUE | SURVEY TIME: | 12:00 PM | TO | 2:00 PM |
| E-W APPROACH: | MacARTHUR BOULEVARD | CITY: | OAKLAND | FILE: | 3001006-7MD |




| TIME PERIOD From | | To | NORTHBOUND Left | NORTHBOUND Thru | NORTHBOUND Right | SOUTHBOUND Left | SOUTHBOUND Thru | SOUTHBOUND Right | EASTBOUND Left | EASTBOUND Thru | EASTBOUND Right | WESTBOUND Left | WESTBOUND Thru | WESTBOUND Right | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SURVEY DATA** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 9 | 32 | 22 | 17 | 19 | 1 | 4 | 42 | 6 | 15 | 40 | 10 | *217* |
| 12:15 PM | --- | 12:30 PM | 10 | 66 | 42 | 31 | 51 | 6 | 10 | 86 | 10 | 38 | 80 | 30 | *460* |
| 12:30 PM | --- | 12:45 PM | 22 | 114 | 80 | 50 | 87 | 12 | 21 | 132 | 15 | 57 | 125 | 47 | *762* |
| 12:45 PM | --- | 1:00 PM | 29 | 146 | 95 | 55 | 133 | 18 | 30 | 162 | 24 | 76 | 168 | 58 | *994* |
| 1:00 PM | --- | 1:15 PM | 32 | 195 | 120 | 61 | 184 | 24 | 36 | 216 | 29 | 92 | 202 | 71 | *1,262* |
| 1:15 PM | --- | 1:30 PM | 37 | 241 | 146 | 73 | 215 | 31 | 43 | 261 | 41 | 111 | 235 | 80 | *1,514* |
| 1:30 PM | --- | 1:45 PM | 45 | 293 | 166 | 91 | 256 | 36 | 51 | 306 | 48 | 135 | 288 | 93 | *1,808* |
| 1:45 PM | --- | 2:00 PM | 48 | 342 | 191 | 101 | 298 | 40 | 56 | 362 | 49 | 158 | 324 | 115 | *2,084* |
| **TOTAL BY PERIOD** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 12:15 PM | 9 | 32 | 22 | 17 | 19 | 1 | 4 | 42 | 6 | 15 | 40 | 10 | *217* |
| 12:15 PM | --- | 12:30 PM | 1 | 34 | 20 | 14 | 32 | 5 | 6 | 44 | 4 | 23 | 40 | 20 | *243* |
| 12:30 PM | --- | 12:45 PM | 12 | 48 | 38 | 19 | 36 | 6 | 11 | 46 | 5 | 19 | 45 | 17 | *302* |
| 12:45 PM | --- | 1:00 PM | 7 | 32 | 15 | 5 | 46 | 6 | 9 | 30 | 9 | 19 | 43 | 11 | *232* |
| 1:00 PM | --- | 1:15 PM | 3 | 49 | 25 | 6 | 51 | 6 | 6 | 54 | 5 | 16 | 34 | 13 | *268* |
| 1:15 PM | --- | 1:30 PM | 5 | 46 | 26 | 12 | 31 | 7 | 7 | 45 | 12 | 19 | 33 | 9 | *252* |
| 1:30 PM | --- | 1:45 PM | 8 | 52 | 20 | 18 | 41 | 5 | 8 | 45 | 7 | 24 | 53 | 13 | *294* |
| 1:45 PM | --- | 2:00 PM | 3 | 49 | 25 | 10 | 42 | 4 | 5 | 56 | 1 | 23 | 36 | 22 | *276* |
| **HOURLY TOTALS** | | | | | | | | | | | | | | | |
| 12:00 PM | --- | 1:00 PM | 29 | 146 | 95 | 55 | 133 | 18 | 30 | 162 | 24 | 76 | 168 | 58 | *994* |
| 12:15 PM | --- | 1:15 PM | 23 | 163 | 98 | 44 | 165 | 23 | 32 | 174 | 23 | 77 | 162 | 61 | *1,045* |
| 12:30 PM | --- | 1:30 PM | 27 | 175 | 104 | 42 | 164 | 25 | 33 | 175 | 31 | 73 | 155 | 50 | *1,054* |
| 12:45 PM | --- | 1:45 PM | 23 | 179 | 86 | 41 | 169 | 24 | 30 | 174 | 33 | 78 | 163 | 46 | *1,046* |
| 1:00 PM | --- | 2:00 PM | 19 | 196 | 96 | 46 | 165 | 22 | 26 | 200 | 25 | 82 | 156 | 57 | *1,090* |

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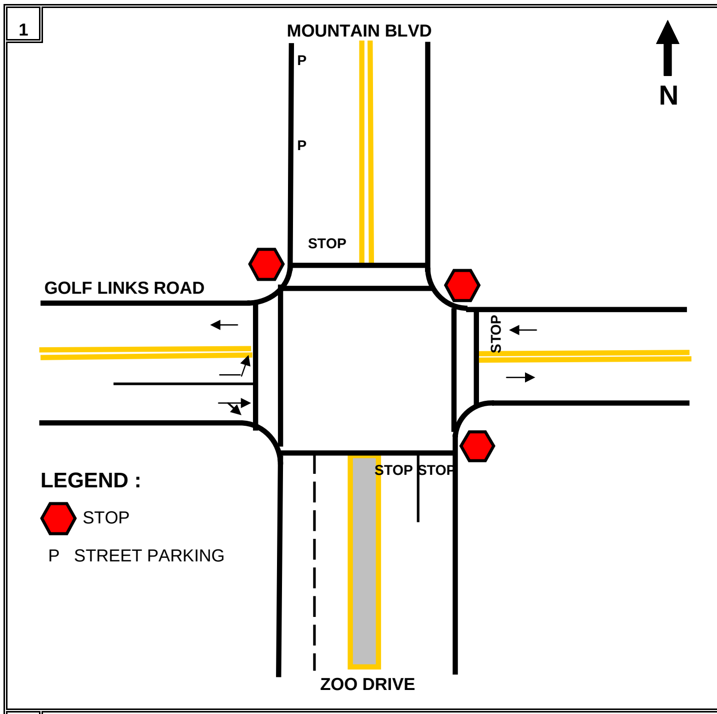
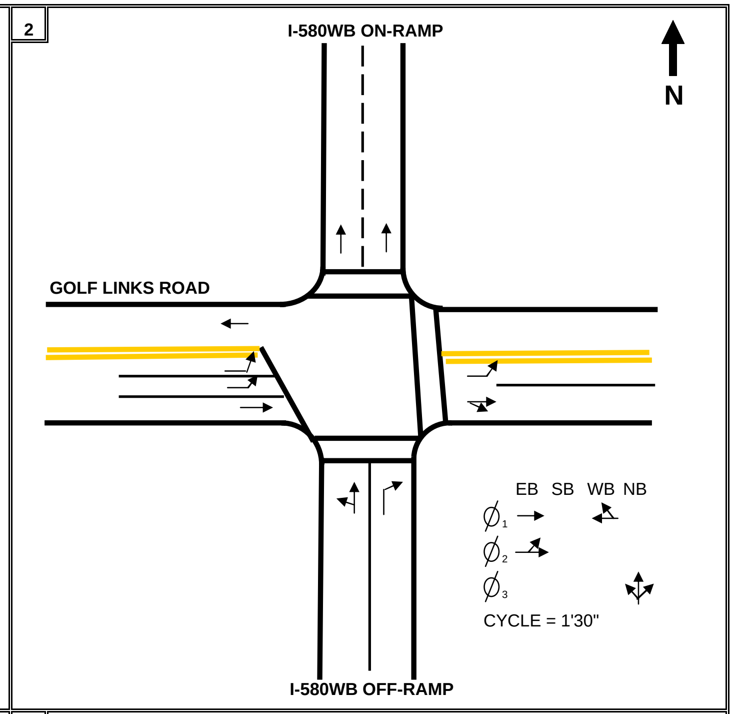
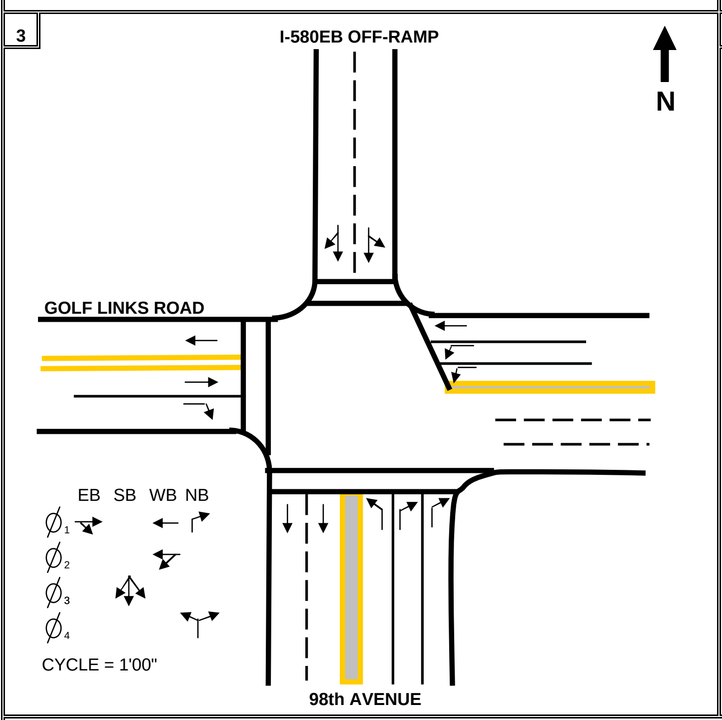
# BAYMETRICS

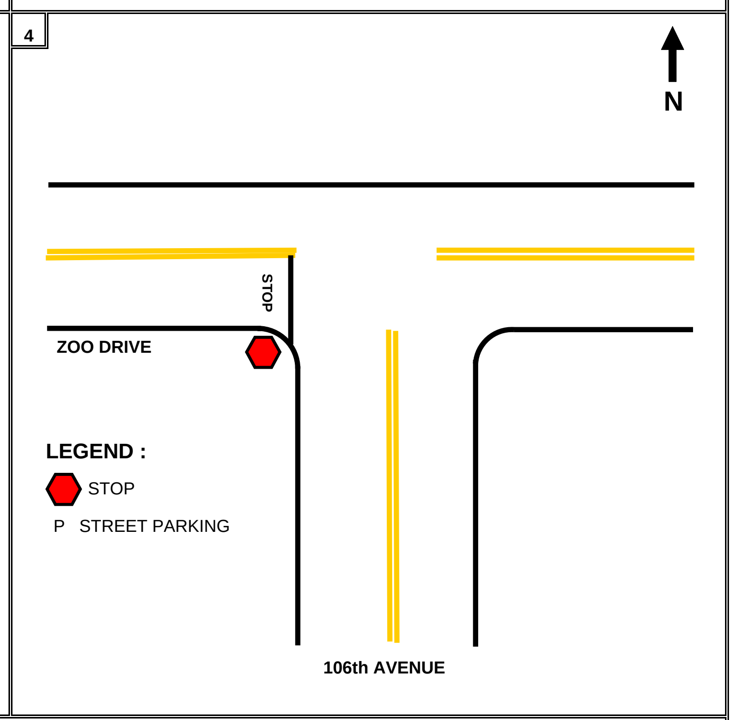
INTERSECTION GEOMETRY & TRAFFIC CONTROL PLAN

**PROJECT: OAKLAND ZOO TRAFFIC STUDY** **JURISDICTION: OAKLAND** **DATE: 4/16/2009 THURSDAY**



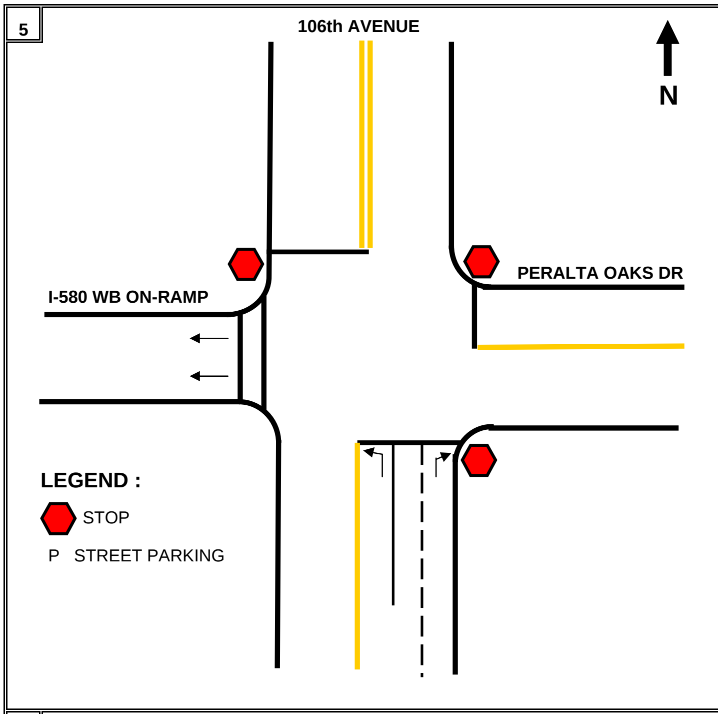



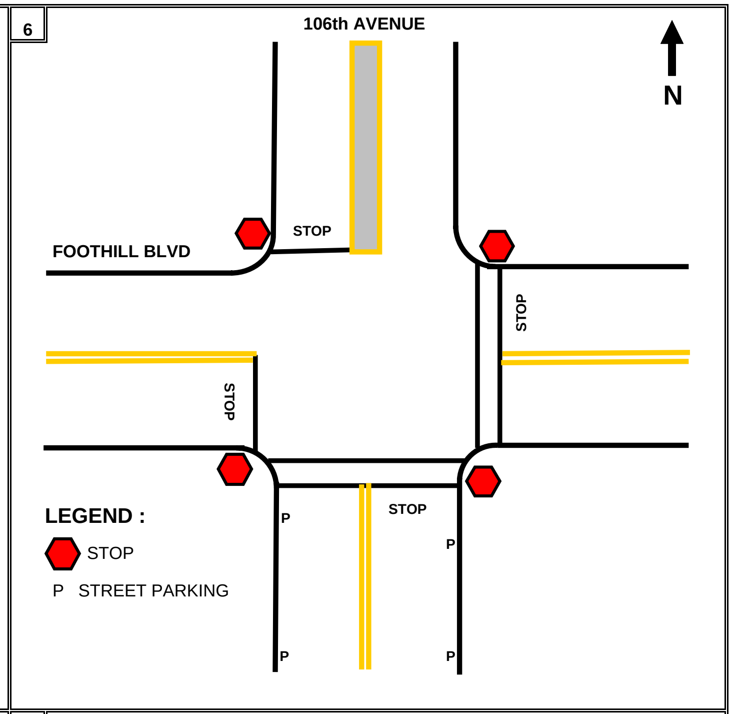

TELEPHONE: (510) 232 - 1271 FAX: (510) 232 - 1272

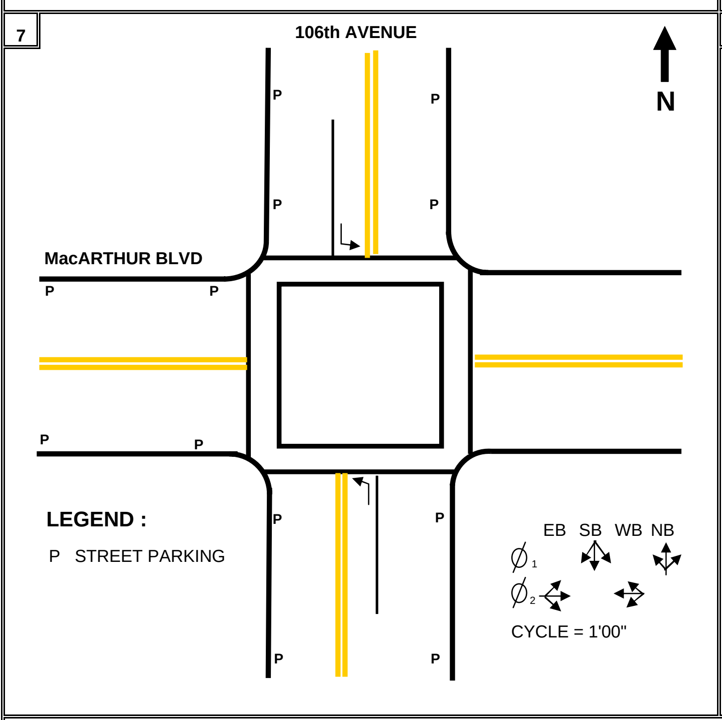
# B A Y M E T R I C S

INTERSECTION GEOMETRY & TRAFFIC CONTROL PLAN

**PROJECT: OAKLAND ZOO TRAFFIC STUDY** **JURISDICTION: OAKLAND** **DATE: 4/16/2009 THURSDAY**




TELEPHONE: (510) 232 - 1271 FAX: (510) 232 - 1272

# Pneumatic Hose Counts
# (April 16, 2009 – April 22, 2009)

# ***B A Y M E T R I C S***

## *Oakland Zoo Traffic Study*

| Date | 16-Apr-09 Thursday | | | | 17-Apr-09 Friday | | | | 18-Apr-09 Saturday | | | | 19-Apr-09 Sunday | | | | 20-Apr-09 Monday | | | | 21-Apr-09 Tuesday | | | | 22-Apr-09 Wednesday | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **A. On Zoo Drive, just inboard of the main Golf Links Road intersections** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | NB(Outlet) | | SB(Inlet) | | NB(Outlet) | | SB(Inlet) | | NB(Outlet) | | SB(Inlet) | | NB(Outlet) | | SB(Inlet) | | NB(Outlet) | | SB(Inlet) | | NB(Outlet) | | SB(Inlet) | | NB(Outlet) | | SB(Inlet) | |
| TIME | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN |
| 1200 | **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 1215 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***2*** | ***0*** | ***2*** | ***0*** |
| 1230 | *0* | *0-Jan-00* | *0* | *0* | | *0-Jan-00* | *0* | *0* | | *0-Jan-00* | *0* | *0* | | *0-Jan-00* | *0* | *0* | | *0-Jan-00* | *0* | *0* | | *0-Jan-00* | *0* | *3* | | *0-Jan-00* | *0* | |
| 1245 | 0 | | | | | | | | | | | | | | **0** | | | | | | | | | | | | | |
| 100 | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *1* | *0* | *0* | *1* | *1* | *0* | *1* | *0* | *1* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *5* | *0* | *2* |
| 115 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| 130 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 145 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 215 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 230 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 245 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 315 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 330 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 345 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 415 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 430 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 445 | 0 | 1 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 500 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 515 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 530 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 545 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 600 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 615 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 630 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 3 | 3 | 0 | 0 | 1 | 1 |
| 645 | 0 | 0 | 1 | 2 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 3 | 0 | 0 | 6 | 9 | 0 | 0 | 1 | 2 |
| 700 | 1 | 1 | 2 | 4 | 3 | 3 | 3 | 7 | 0 | 0 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 3 | 2 | 5 | 1 | 1 | 17 | 26 | 0 | 0 | 1 | 3 |
| 715 | 1 | 2 | 3 | 7 | 0 | 3 | 4 | 11 | 2 | 2 | 3 | 5 | 0 | 1 | 5 | 7 | 2 | 5 | 2 | 7 | 0 | 1 | 3 | 29 | 0 | 0 | 0 | 3 |
| 730 | 0 | 2 | 7 | 13 | 1 | 4 | 9 | 20 | 0 | 2 | 7 | 11 | 0 | 1 | 7 | 14 | 1 | 6 | 8 | 13 | 0 | 1 | 5 | 31 | 0 | 0 | 4 | 6 |
| 745 | 2 | 4 | 8 | 20 | 2 | 6 | 18 | 34 | 2 | 4 | 15 | 26 | 1 | 2 | 6 | 19 | 0 | 4 | 8 | 20 | 3 | 4 | 13 | 38 | 0 | 0 | 8 | 13 |
| 800 | 3 | 6 | 20 | 38 | 2 | 5 | 15 | 46 | 2 | 6 | 12 | 37 | 1 | 2 | 23 | 41 | 2 | 5 | 13 | 31 | 2 | 5 | 17 | 38 | 1 | 1 | 16 | 28 |
| 815 | 5 | 10 | 9 | 44 | 7 | 12 | 17 | 59 | 2 | 6 | 11 | 45 | 3 | 5 | 8 | 44 | 2 | 5 | 9 | 38 | 3 | 8 | 16 | 51 | 0 | 1 | 8 | 36 |
| 830 | 2 | 12 | 14 | 51 | 4 | 15 | 39 | 89 | 1 | 7 | 16 | 54 | 0 | 5 | 9 | 46 | 2 | 6 | 12 | 42 | 1 | 9 | 13 | 59 | 1 | 2 | 11 | 43 |
| 845 | 2 | 12 | 9 | 52 | 3 | 16 | 47 | 118 | 6 | 11 | 11 | 50 | 1 | 5 | 20 | 60 | 0 | 6 | 17 | 51 | 1 | 7 | 20 | 66 | 4 | 6 | 19 | 54 |
| 900 | 4 | 13 | 15 | 47 | 6 | 20 | 60 | 163 | 3 | 12 | 18 | 56 | 2 | 6 | 37 | 74 | 1 | 5 | 13 | 51 | 6 | 11 | 8 | 57 | 2 | 7 | 12 | 50 |
| 915 | 4 | 12 | 15 | 53 | 10 | 23 | 71 | 217 | 5 | 15 | 19 | 64 | 5 | 8 | 39 | 105 | 5 | 8 | 16 | 58 | 2 | 10 | 5 | 46 | 2 | 9 | 15 | 57 |
| 930 | 7 | 17 | 30 | 69 | 9 | 28 | 96 | 274 | 3 | 17 | 13 | 61 | 11 | 19 | 40 | 136 | 3 | 9 | 18 | 64 | 0 | 9 | 20 | 53 | 2 | 10 | 15 | 61 |
| 945 | 0 | 15 | 32 | 92 | 30 | 55 | 139 | 366 | 5 | 16 | 35 | 85 | 14 | 32 | 42 | 158 | 0 | 9 | 9 | 56 | 1 | 9 | 12 | 45 | 0 | 6 | 20 | 62 |
| 1000 | 16 | 27 | 83 | 160 | 17 | 66 | 111 | 417 | 3 | 16 | 66 | 133 | 7 | 37 | 89 | 210 | 0 | 8 | 21 | 64 | 8 | 11 | 34 | 71 | 2 | 6 | 84 | 134 |
| 1015 | 2 | 25 | 147 | 292 | 7 | 63 | 239 | 585 | 9 | 20 | 84 | 198 | 7 | 39 | 108 | 279 | 2 | 5 | 26 | 74 | 0 | 9 | 30 | 96 | 7 | 11 | 63 | 182 |
| 1030 | 3 | 21 | 127 | 389 | 6 | 60 | 143 | 632 | 2 | 19 | 77 | 262 | 5 | 33 | 113 | 352 | 2 | 4 | 21 | 77 | 9 | 18 | 35 | 111 | 13 | 22 | 51 | 218 |
| 1045 | 1 | 22 | 166 | 523 | 12 | 42 | 217 | 710 | 4 | 18 | 84 | 311 | 2 | 21 | 122 | 432 | 1 | 5 | 18 | 86 | 16 | 33 | 26 | 125 | 1 | 23 | 33 | 231 |
| 1100 | 3 | 9 | 141 | 581 | 16 | 41 | 206 | 805 | 8 | 23 | 89 | 334 | 8 | 22 | 117 | 460 | 4 | 9 | 21 | 86 | 5 | 30 | 17 | 108 | 9 | 30 | 35 | 182 |
| 1115 | 6 | 13 | 98 | 532 | 6 | 40 | 187 | 753 | 9 | 23 | 114 | 364 | 7 | 22 | 85 | 437 | 8 | 15 | 15 | 75 | 5 | 35 | 11 | 89 | 6 | 29 | 20 | 139 |
| 1130 | 4 | 14 | 76 | 481 | 31 | 65 | 206 | 816 | 17 | 38 | 93 | 380 | 11 | 28 | 102 | 426 | 2 | 15 | 15 | 69 | 7 | 33 | 15 | 69 | 8 | 24 | 23 | 111 |
| 1145 | 13 | 26 | 75 | 390 | 19 | 72 | 226 | 825 | 13 | 47 | 132 | 428 | 19 | 45 | 127 | 431 | 6 | 20 | 15 | 66 | 5 | 22 | 19 | 62 | 3 | 26 | 19 | 97 |
| 1200 | 18 | 41 | 74 | 323 | 21 | 77 | 147 | 766 | 19 | 58 | 143 | 482 | 22 | 59 | 137 | 451 | 3 | 19 | 13 | 58 | 11 | 28 | 13 | 58 | 12 | 29 | 29 | 91 |
| 1215 | 24 | 59 | 81 | 306 | 50 | 121 | 126 | 705 | 28 | 77 | 121 | 489 | 34 | 86 | 126 | 492 | 9 | 20 | 8 | 51 | 7 | 30 | 5 | 52 | 25 | 48 | 15 | 86 |
| 1230 | 44 | 99 | 69 | 299 | 39 | 129 | 128 | 627 | 37 | 97 | 124 | 520 | 32 | 107 | 137 | 527 | 16 | 34 | 19 | 55 | 16 | 39 | 21 | 58 | 22 | 62 | 23 | 86 |
| 1245 | 33 | 119 | 59 | 283 | 38 | 148 | 114 | 515 | 40 | 124 | 112 | 500 | 46 | 134 | 124 | 524 | 13 | 41 | 12 | 52 | 17 | 51 | 4 | 43 | 24 | 83 | 18 | 85 |
| 1300 | 48 | 149 | 65 | 274 | 49 | 176 | 73 | 441 | 37 | 142 | 104 | 461 | 44 | 156 | 69 | 456 | 9 | 47 | 13 | 52 | 27 | 67 | 13 | 43 | 7 | 78 | 13 | 69 |
| 1315 | 68 | 193 | 54 | 247 | 40 | 166 | 89 | 404 | 38 | 152 | 106 | 446 | 26 | 148 | 71 | 401 | 16 | 54 | 10 | 54 | 14 | 74 | 13 | 51 | 26 | 79 | 15 | 69 |
| 1330 | 47 | 196 | 56 | 234 | 61 | 188 | 60 | 336 | 43 | 158 | 67 | 389 | 29 | 145 | 119 | 383 | 13 | 51 | 19 | 54 | 16 | 74 | 10 | 40 | 14 | 71 | 11 | 57 |
| 1345 | 50 | 213 | 45 | 220 | 76 | 226 | 67 | 289 | 47 | 165 | 109 | 386 | 21 | 120 | 77 | 336 | 18 | 56 | 19 | 61 | 15 | 72 | 12 | 48 | 17 | 64 | 16 | 55 |
| 1400 | 86 | 251 | 21 | 176 | 52 | 229 | 39 | 255 | 39 | 167 | 98 | 380 | 32 | 108 | 63 | 330 | 9 | 56 | 13 | 61 | 10 | 55 | 12 | 47 | 28 | 85 | 22 | 64 |
| 1415 | 46 | 229 | 23 | 145 | 69 | 258 | 45 | 211 | 47 | 176 | 87 | 361 | 43 | 125 | 57 | 316 | 12 | 52 | 10 | 61 | 10 | 51 | 8 | 42 | 12 | 71 | 4 | 53 |
| 1430 | 47 | 229 | 32 | 121 | 73 | 270 | 37 | 188 | 44 | 177 | 74 | 368 | 50 | 146 | 52 | 249 | 4 | 43 | 8 | 50 | 18 | 53 | 11 | 43 | 14 | 71 | 7 | 49 |
| 1445 | 64 | 243 | 28 | 104 | 77 | 271 | 31 | 152 | 61 | 191 | 87 | 346 | 37 | 162 | 45 | 217 | 9 | 34 | 6 | 37 | 8 | 46 | 6 | 37 | 17 | 71 | 17 | 50 |
| 1500 | 66 | 223 | 13 | 96 | 43 | 262 | 19 | 132 | 62 | 214 | 39 | 287 | 33 | 163 | 43 | 197 | 11 | 36 | 13 | 37 | 8 | 44 | 4 | 29 | 30 | 73 | 7 | 35 |
| 1515 | 39 | 216 | 12 | 85 | 41 | 234 | 20 | 107 | 91 | 258 | 32 | 232 | 40 | 160 | 38 | 178 | 6 | 30 | 6 | 33 | 10 | 44 | 8 | 29 | 17 | 78 | 9 | 40 |
| 1530 | 47 | 216 | 19 | 72 | 44 | 205 | 20 | 90 | 92 | 306 | 33 | 191 | 54 | 164 | 17 | 143 | 11 | 37 | 6 | 31 | 4 | 30 | 4 | 22 | 16 | 80 | 9 | 42 |
| 1545 | 55 | 207 | 10 | 54 | 32 | 160 | 10 | 69 | 93 | 338 | 22 | 126 | 51 | 178 | 23 | 121 | 5 | 33 | 3 | 28 | 9 | 31 | 2 | 18 | 13 | 76 | 5 | 30 |
| 1600 | 82 | 223 | 8 | 49 | 17 | 134 | 10 | 60 | 77 | 353 | 18 | 105 | 43 | 188 | 22 | 100 | 11 | 33 | 5 | 20 | 12 | 35 | 8 | 22 | 12 | 58 | 10 | 33 |
| 1615 | 53 | 237 | 3 | 40 | 33 | 126 | 11 | 51 | 87 | 349 | 13 | 86 | 30 | 178 | 11 | 73 | 13 | 40 | 8 | 22 | 16 | 41 | 5 | 19 | 21 | 62 | 4 | 28 |
| 1630 | 52 | 242 | 6 | 27 | 31 | 113 | 8 | 39 | 125 | 382 | 10 | 63 | 26 | 150 | 6 | 62 | 20 | 49 | 1 | 17 | 15 | 52 | 2 | 17 | 15 | 61 | 7 | 26 |
| 1645 | 65 | 252 | 0 | 17 | 36 | 117 | 7 | 36 | 73 | 362 | 7 | 48 | 35 | 134 | 7 | 46 | 14 | 58 | 4 | 18 | 18 | 61 | 4 | 19 | 12 | 60 | 1 | 22 |
| 1700 | 49 | 219 | 2 | 11 | 28 | 128 | 5 | 31 | 77 | 362 | 9 | 39 | 20 | 111 | 6 | 30 | 9 | 56 | 3 | 16 | 10 | 59 | 2 | 13 | 23 | 71 | 1 | 13 |
| 1715 | 46 | 212 | 6 | 14 | 24 | 119 | 7 | 27 | 52 | 327 | 6 | 32 | 34 | 115 | 7 | 26 | 9 | 52 | 2 | 10 | 11 | 54 | 1 | 9 | 12 | 62 | 3 | 12 |
| 1730 | 16 | 176 | 3 | 11 | 18 | 106 | 2 | 21 | 45 | 247 | 7 | 29 | 24 | 113 | 4 | 24 | 8 | 40 | 1 | 10 | 7 | 46 | 0 | 7 | 4 | 51 | 6 | 11 |
| 1745 | 9 | 120 | 3 | 14 | 17 | 87 | 1 | 15 | 48 | 222 | 3 | 25 | 32 | 110 | 4 | 21 | 3 | 29 | 0 | 6 | 1 | 29 | 0 | 3 | 2 | 41 | 1 | 11 |
| 1800 | 14 | 85 | 1 | 13 | 9 | 68 | 1 | 11 | 35 | 180 | 5 | 21 | 25 | 115 | 4 | 19 | 2 | 22 | 2 | 5 | 1 | 20 | 3 | 4 | 1 | 19 | 2 | 12 |
| 1815 | 6 | 45 | 3 | 10 | 7 | 51 | 2 | 6 | 19 | 147 | 2 | 17 | 9 | 90 | 5 | 17 | 7 | 20 | 0 | 3 | 8 | 17 | 2 | 5 | 6 | 13 | 0 | 9 |
| 1830 | 14 | 43 | 3 | 10 | 7 | 40 | 1 | 5 | 13 | 115 | 4 | 14 | 13 | 79 | 4 | 17 | 2 | 14 | 1 | 3 | 4 | 14 | 0 | 5 | 5 | 14 | 5 | 8 |
| 1845 | 5 | 39 | 1 | 8 | 2 | 25 | 1 | 5 | 8 | 75 | 2 | 13 | 9 | 56 | 3 | 16 | 0 | 11 | 0 | 3 | 1 | 14 | 0 | 5 | 2 | 14 | 10 | 17 |
| 1900 | 4 | 29 | 0 | 7 | 1 | 17 | 0 | 4 | 3 | 43 | 4 | 12 | 3 | 34 | 1 | 13 | 1 | 10 | 1 | 2 | 1 | 14 | 0 | 2 | 0 | 13 | 8 | 23 |
| 1915 | 0 | 23 | 0 | 4 | 3 | 13 | 0 | 2 | 6 | 30 | 2 | 12 | 1 | 26 | 2 | 10 | 0 | 3 | 1 | 3 | 1 | 7 | 1 | 1 | 0 | 7 | 2 | 25 |
| 1930 | 6 | 15 | 2 | 3 | 2 | 8 | 1 | 2 | 2 | 19 | 2 | 10 | 1 | 14 | 0 | 6 | 1 | 2 | 0 | 2 | 2 | 5 | 2 | 3 | 2 | 4 | 1 | 21 |
| 1945 | 0 | 10 | 1 | 3 | 1 | 7 | 1 | 2 | 2 | 13 | 2 | 10 | 0 | 5 | 0 | 3 | 1 | 3 | 1 | 3 | 0 | 4 | 0 | 3 | 1 | 3 | 2 | 13 |
| 2000 | 0 | 6 | 0 | 3 | 0 | 6 | 0 | 2 | 2 | 12 | 0 | 6 | 0 | 2 | 1 | 3 | 1 | 3 | 1 | 3 | 0 | 3 | 0 | 3 | 1 | 4 | 0 | 5 |
| 2015 | 0 | 6 | 0 | 3 | 0 | 3 | 1 | 3 | 1 | 7 | 1 | 5 | 0 | 1 | 1 | 2 | 1 | 4 | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 5 | 3 | 6 |
| 2030 | 1 | 1 | 1 | 2 | 1 | 2 | 0 | 2 | 1 | 6 | 2 | 5 | 1 | 1 | 1 | 3 | 2 | 5 | 1 | 4 | 1 | 2 | 1 | 2 | 2 | 5 | 1 | 6 |
| 2045 | 1 | 2 | 0 | 1 | 0 | 1 | 1 | 2 | 2 | 6 | 0 | 3 | 2 | 3 | 0 | 3 | 2 | 6 | 0 | 3 | 0 | 2 | 0 | 2 | 0 | 4 | 0 | 4 |
| 2100 | 0 | 2 | 0 | 1 | 3 | 4 | 0 | 2 | 0 | 4 | 0 | 3 | 0 | 3 | 0 | 2 | 2 | 7 | 4 | 6 | 0 | 2 | 0 | 2 | 8 | 11 | 0 | 4 |
| 2115 | 1 | 3 | 3 | 4 | 0 | 4 | 2 | 3 | 1 | 4 | 3 | 5 | 0 | 3 | 0 | 1 | 5 | 11 | 4 | 9 | 0 | 1 | 2 | 3 | 10 | 20 | 0 | 1 |
| 2130 | 0 | 2 | 2 | 5 | 4 | 7 | 0 | 3 | 3 | 6 | 3 | 6 | 0 | 2 | 2 | 2 | 5 | 14 | 0 | 8 | 1 | 1 | 1 | 3 | 9 | 27 | 1 | 1 |
| 2145 | 2 | 3 | 0 | 5 | 0 | 7 | 1 | 3 | 3 | 7 | 3 | 9 | 0 | 0 | 0 | 2 | 0 | 12 | 1 | 9 | 0 | 1 | 0 | 3 | 0 | 27 | 0 | 1 |
| 2200 | 0 | 3 | 1 | 6 | 0 | 4 | 0 | 3 | 3 | 10 | 2 | 11 | 0 | 0 | 0 | 2 | 1 | 11 | 0 | 5 | 0 | 1 | 0 | 3 | 0 | 19 | 0 | 1 |
| 2215 | 0 | 2 | 0 | 3 | 0 | 4 | 0 | 1 | 1 | 10 | 1 | 9 | 0 | 0 | 0 | 2 | 0 | 6 | 0 | 1 | 0 | 1 | 1 | 2 | 0 | 9 | 0 | 1 |
| 2230 | 3 | 5 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 9 | 0 | 6 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |
| 2245 | 0 | 3 | 0 | 1 | 2 | 2 | 2 | 2 | 0 | 6 | 0 | 3 | 0 | 0 | 1 | 3 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 0 | 0 | 0 |
| 2300 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 | 5 | 0 | 2 | 1 | 1 | 1 | 1 |
| 2315 | 0 | 3 | 1 | 1 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 2330 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 2345 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 1 |
| TOTAL | 1291 | N/A | 1792 | N/A | 1249 | N/A | 3149 | N/A | 1614 | N/A | 2373 | N/A | 1008 | N/A | 2394 | N/A | 332 | N/A | 502 | N/A | 392 | N/A | 528 | N/A | 511 | N/A | 751 | N/A |
| AM | | 12 | | 52 | | 16 | | 118 | | 11 | | 50 | | 5 | | 60 | | 6 | | 51 | | 7 | | 66 | | 10 | | 161 |
| NOON | | 119 | | 283 | | 148 | | 515 | | 124 | | 500 | | 134 | | 524 | | 41 | | 52 | | 51 | | 43 | | 83 | | 85 |
| PM | | 252 | | 17 | | 117 | | 36 | | 362 | | 48 | | 134 | | 46 | | 58 | | 18 | | 61 | | 19 | | 60 | | 22 |
| EVEN | | 6 | | 6 | | 7 | | 3 | | 12 | | 11 | | 3 | | 3 | | 14 | | 9 | | 5 | | 3 | | 27 | | 6 |



Fax: (510) 232-1272

# ***B A Y M E T R I C S***

## *Oakland Zoo Traffic Study*

| Date | 16-Apr-09 Thursday | | | | 17-Apr-09 Friday | | | | 18-Apr-09 Saturday | | | | 19-Apr-09 Sunday | | | | 20-Apr-09 Monday | | | | 21-Apr-09 Tuesday | | | | 22-Apr-09 Wednesday | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **B. On Zoo Drive, just inboard of the Malcolm Avenue exit** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | EB(Outlet) | | WB | | EB(Outlet) | | WB | | EB(Outlet) | | WB | | EB(Outlet) | | WB | | EB(Outlet) | | WB | | EB(Outlet) | | WB | | EB(Outlet) | | WB | |
| TIME | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN |
| 1200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1215 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1230 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1245 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 100 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 115 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 130 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 145 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 215 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 230 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 245 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 315 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 330 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 345 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 415 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 430 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 445 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 500 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 515 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 |
| 530 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 | 0 | 0 |
| 545 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 600 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 615 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 630 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 645 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 700 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 715 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 730 | 1 | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 745 | 1 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 800 | 0 | 2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 815 | 0 | 2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 4 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 0 |
| 830 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 |
| 845 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 3 | 7 | 0 | 0 | 1 | 2 | 0 | 0 | 2 | 4 | 0 | 0 |
| 900 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 7 | 0 | 0 | 1 | 7 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 4 | 0 | 0 |
| 915 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 7 | 0 | 0 | 1 | 5 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 4 | 0 | 0 |
| 930 | 2 | 2 | 0 | 0 | 1 | 5 | 0 | 0 | 1 | 2 | 0 | 0 | 3 | 10 | 0 | 0 | 1 | 6 | 0 | 0 | 2 | 5 | 0 | 0 | 4 | 8 | 0 | 0 |
| 945 | 0 | 2 | 0 | 0 | 2 | 7 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 8 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 6 | 0 | 0 |
| 1000 | 1 | 3 | 0 | 0 | 0 | 6 | 0 | 0 | 2 | 4 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 4 | 0 | 0 | 2 | 7 | 0 | 0 |
| 1015 | 3 | 6 | 0 | 0 | 7 | 10 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 6 | 0 | 0 | 2 | 4 | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 7 | 0 | 0 |
| 1030 | 2 | 6 | 0 | 0 | 1 | 10 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 4 | 0 | 0 | 2 | 4 | 0 | 0 | 1 | 4 | 0 | 0 |
| 1045 | 2 | 8 | 0 | 0 | 1 | 9 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 5 | 0 | 0 | 3 | 6 | 0 | 0 | 2 | 6 | 0 | 0 | 2 | 6 | 0 | 0 |
| 1100 | 1 | 8 | 0 | 0 | 6 | 15 | 0 | 0 | 2 | 3 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 4 | 0 | 0 |
| 1115 | 1 | 6 | 0 | 0 | 9 | 17 | 0 | 0 | 4 | 7 | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 5 | 0 | 0 | 2 | 5 | 0 | 0 |
| 1130 | 1 | 5 | 0 | 0 | 15 | 31 | 0 | 0 | 4 | 10 | 0 | 0 | 3 | 8 | 0 | 0 | 2 | 5 | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 5 | 0 | 0 |
| 1145 | 3 | 6 | 0 | 0 | 15 | 45 | 0 | 0 | 6 | 16 | 0 | 0 | 8 | 14 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 5 | 0 | 0 |
| 1200 | 4 | 9 | 0 | 0 | 53 | 92 | 0 | 0 | 11 | 25 | 0 | 0 | 6 | 19 | 0 | 0 | 5 | 8 | 0 | 0 | 5 | 7 | 0 | 0 | 3 | 8 | 0 | 0 |
| 1215 | 17 | 25 | 0 | 0 | 87 | 170 | 0 | 0 | 19 | 40 | 0 | 0 | 12 | 29 | 0 | 0 | 9 | 17 | 0 | 0 | 5 | 11 | 0 | 0 | 12 | 18 | 0 | 0 |
| 1230 | 9 | 33 | 0 | 0 | 52 | 207 | 0 | 0 | 21 | 57 | 0 | 0 | 20 | 46 | 0 | 0 | 2 | 17 | 0 | 0 | 7 | 17 | 0 | 0 | 10 | 27 | 0 | 0 |
| 1245 | 19 | 49 | 0 | 0 | 62 | 254 | 0 | 0 | 22 | 73 | 0 | 0 | 28 | 66 | 0 | 0 | 6 | 22 | 0 | 0 | 5 | 22 | 0 | 0 | 2 | 27 | 0 | 0 |
| 1300 | 29 | 74 | 0 | 0 | 67 | 268 | 0 | 0 | 17 | 79 | 0 | 0 | 32 | 92 | 0 | 0 | 2 | 19 | 0 | 0 | 4 | 21 | 0 | 0 | 6 | 30 | 0 | 0 |
| 1315 | 32 | 89 | 0 | 0 | 106 | 287 | 0 | 0 | 27 | 87 | 0 | 0 | 72 | 152 | 0 | 0 | 6 | 16 | 0 | 0 | 4 | 20 | 0 | 0 | 10 | 28 | 0 | 0 |
| 1330 | 22 | 102 | 0 | 0 | 79 | 314 | 0 | 0 | 29 | 95 | 0 | 0 | 64 | 196 | 0 | 0 | 10 | 24 | 0 | 0 | 15 | 28 | 0 | 0 | 8 | 26 | 0 | 0 |
| 1345 | 14 | 97 | 0 | 0 | 93 | 345 | 0 | 0 | 26 | 99 | 0 | 0 | 59 | 227 | 0 | 0 | 4 | 22 | 0 | 0 | 2 | 25 | 0 | 0 | 5 | 29 | 0 | 0 |
| 1400 | 21 | 89 | 0 | 0 | 98 | 376 | 0 | 0 | 30 | 112 | 0 | 0 | 88 | 283 | 0 | 0 | 8 | 28 | 0 | 0 | 8 | 29 | 0 | 0 | 16 | 39 | 0 | 0 |
| 1415 | 27 | 84 | 0 | 0 | 80 | 350 | 0 | 0 | 12 | 97 | 0 | 0 | 70 | 281 | 0 | 0 | 16 | 38 | 0 | 0 | 9 | 34 | 0 | 0 | 10 | 39 | 0 | 0 |
| 1430 | 22 | 84 | 0 | 0 | 73 | 344 | 0 | 0 | 20 | 88 | 0 | 0 | 56 | 273 | 0 | 0 | 6 | 34 | 0 | 0 | 3 | 22 | 0 | 0 | 5 | 36 | 0 | 0 |
| 1445 | 22 | 92 | 0 | 0 | 99 | 350 | 0 | 0 | 35 | 97 | 0 | 0 | 38 | 252 | 0 | 0 | 5 | 35 | 0 | 0 | 2 | 22 | 0 | 0 | 16 | 47 | 0 | 0 |
| 1500 | 21 | 92 | 0 | 0 | 83 | 335 | 0 | 0 | 24 | 91 | 0 | 0 | 72 | 236 | 0 | 0 | 7 | 34 | 0 | 0 | 0 | 14 | 0 | 0 | 7 | 38 | 0 | 0 |
| 1515 | 16 | 81 | 0 | 0 | 93 | 348 | 0 | 0 | 34 | 113 | 0 | 0 | 67 | 233 | 0 | 0 | 3 | 21 | 0 | 0 | 3 | 8 | 0 | 0 | 8 | 36 | 0 | 0 |
| 1530 | 13 | 72 | 0 | 0 | 83 | 358 | 0 | 0 | 28 | 121 | 0 | 0 | 80 | 257 | 0 | 0 | 9 | 24 | 0 | 0 | 4 | 9 | 0 | 0 | 10 | 41 | 0 | 0 |
| 1545 | 21 | 71 | 0 | 0 | 76 | 335 | 0 | 0 | 27 | 113 | 0 | 0 | 78 | 297 | 0 | 0 | 8 | 27 | 0 | 0 | 5 | 12 | 0 | 0 | 11 | 36 | 0 | 0 |
| 1600 | 11 | 61 | 0 | 0 | 53 | 305 | 0 | 0 | 32 | 121 | 0 | 0 | 66 | 291 | 0 | 0 | 6 | 26 | 0 | 0 | 10 | 22 | 0 | 0 | 7 | 36 | 0 | 0 |
| 1615 | 22 | 67 | 0 | 0 | 75 | 287 | 0 | 0 | 50 | 137 | 0 | 0 | 94 | 318 | 0 | 0 | 12 | 35 | 0 | 0 | 14 | 33 | 0 | 0 | 11 | 39 | 0 | 0 |
| 1630 | 21 | 75 | 0 | 0 | 74 | 278 | 0 | 0 | 33 | 142 | 0 | 0 | 61 | 299 | 0 | 0 | 14 | 40 | 0 | 0 | 8 | 37 | 0 | 0 | 11 | 40 | 0 | 0 |
| 1645 | 23 | 77 | 0 | 0 | 82 | 284 | 0 | 0 | 37 | 152 | 0 | 0 | 59 | 280 | 0 | 0 | 3 | 35 | 0 | 0 | 5 | 37 | 0 | 0 | 4 | 33 | 0 | 0 |
| 1700 | 30 | 96 | 0 | 0 | 68 | 299 | 0 | 0 | 38 | 158 | 0 | 0 | 70 | 284 | 0 | 0 | 5 | 34 | 0 | 0 | 5 | 32 | 0 | 0 | 8 | 34 | 0 | 0 |
| 1715 | 15 | 89 | 0 | 0 | 62 | 286 | 0 | 0 | 39 | 147 | 0 | 0 | 53 | 243 | 0 | 0 | 12 | 34 | 0 | 0 | 2 | 20 | 0 | 0 | 4 | 27 | 0 | 0 |
| 1730 | 6 | 74 | 0 | 0 | 44 | 256 | 0 | 0 | 36 | 150 | 0 | 0 | 30 | 212 | 0 | 0 | 3 | 23 | 0 | 0 | 6 | 18 | 0 | 0 | 5 | 21 | 0 | 0 |
| 1745 | 4 | 55 | 0 | 0 | 42 | 216 | 0 | 0 | 26 | 139 | 0 | 0 | 20 | 173 | 0 | 0 | 0 | 20 | 0 | 0 | 1 | 14 | 0 | 0 | 2 | 19 | 0 | 0 |
| 1800 | 3 | 28 | 0 | 0 | 22 | 170 | 0 | 0 | 20 | 121 | 0 | 0 | 14 | 117 | 0 | 0 | 1 | 16 | 0 | 0 | 1 | 10 | 0 | 0 | 3 | 14 | 0 | 0 |
| 1815 | 1 | 14 | 0 | 0 | 2 | 110 | 0 | 0 | 7 | 89 | 0 | 0 | 2 | 66 | 0 | 0 | 1 | 5 | 0 | 0 | 5 | 13 | 0 | 0 | 4 | 14 | 0 | 0 |
| 1830 | 4 | 12 | 0 | 0 | 4 | 70 | 0 | 0 | 5 | 58 | 0 | 0 | 1 | 37 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 8 | 0 | 0 | 0 | 9 | 0 | 0 |
| 1845 | 3 | 11 | 0 | 0 | 0 | 28 | 0 | 0 | 3 | 35 | 0 | 0 | 1 | 18 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 8 | 0 | 0 | 1 | 8 | 0 | 0 |
| 1900 | 0 | 8 | 0 | 0 | 1 | 7 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 5 | 0 | 0 |
| 1915 | 0 | 7 | 0 | 0 | 0 | 5 | 0 | 0 | 2 | 10 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 0 |
| 1930 | 1 | 4 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 |
| 1945 | 2 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2000 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2015 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2030 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2045 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 2 | 0 | 0 |
| 2100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 2 | 0 | 0 |
| 2115 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 2 | 0 | 0 |
| 2130 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 |
| 2145 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2200 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 2215 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2230 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2245 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2300 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2315 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2330 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2345 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 480 | N/A | 0 | N/A | 1,885 | N/A | 0 | N/A | 739 | N/A | 0 | N/A | 1,350 | N/A | 0 | N/A | 192 | N/A | 0 | N/A | 162 | N/A | 0 | N/A | 227 | N/A | 0 | N/A |
| AM | | 2 | | 0 | | 7 | | 0 | | 3 | | 0 | | 10 | | 0 | | 7 | | 0 | | 5 | | 0 | | 8 | | 0 |
| NOON | | 102 | | 0 | | 376 | | 0 | | 112 | | 0 | | 283 | | 0 | | 38 | | 0 | | 34 | | 0 | | 47 | | 0 |
| PM | | 96 | | 0 | | 358 | | 0 | | 158 | | 0 | | 318 | | 0 | | 40 | | 0 | | 37 | | 0 | | 41 | | 0 |
| EVEN | | 3 | | 0 | | 2 | | 0 | | 3 | | 0 | | 2 | | 0 | | 3 | | 0 | | 3 | | 0 | | 2 | | 0 |

# *B A Y M E T R I C S*

## *Oakland Zoo Traffic Study*

| Date | *16-Apr-09 Thursday* | | | | *17-Apr-09 Friday* | | | | *18-Apr-09 Saturday* | | | | *19-Apr-09 Sunday* | | | | *20-Apr-09 Monday* | | | | *21-Apr-09 Tuesday* | | | | *22-Apr-09 Wednesday* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **C. On 106th Avenue, between Malcolm Avenue and I-580 Westbound Ramp** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | *NB* | | *SB* | | *NB* | | *SB* | | *NB* | | *SB* | | *NB* | | *SB* | | *NB* | | *SB* | | *NB* | | *SB* | | *NB* | | *SB* | |
| TIME | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN | 15 MIN | 60 MIN |
| 1200 | 6 | 0 | 5 | 0 | 7 | 0 | 3 | 0 | 15 | 0 | 3 | 0 | 8 | 0 | 11 | 0 | 10 | 0 | 4 | 0 | 6 | 0 | 6 | 0 | 10 | 0 | 6 | 0 |
| 1215 | 4 | 0 | 2 | 0 | 6 | 0 | 0 | 0 | 11 | 0 | 6 | 0 | 12 | 0 | 5 | 0 | 10 | 0 | 9 | 0 | 5 | 0 | 3 | 0 | 6 | 0 | 4 | 0 |
| 1230 | 6 | 0 | 2 | 0 | 7 | 0 | 0 | 0 | 5 | 0 | 6 | 0 | 15 | 0 | 10 | 0 | 1 | 0 | 0 | 0 | 5 | 0 | 3 | 0 | 6 | 0 | 2 | 0 |
| 1245 | 7 | 23 | 3 | 12 | 2 | 22 | 3 | 6 | 13 | 44 | 4 | 19 | 10 | 45 | 11 | 37 | 1 | 22 | 2 | 15 | 5 | 21 | 1 | 13 | 3 | 25 | 2 | 14 |
| 100 | 3 | 20 | 3 | 10 | 3 | 18 | 2 | 5 | 9 | 38 | 9 | 25 | 10 | 47 | 3 | 29 | 4 | 16 | 2 | 13 | 1 | 16 | 3 | 10 | 3 | 18 | 8 | 16 |
| 115 | 4 | 20 | 0 | 8 | 4 | 16 | 1 | 6 | 5 | 32 | 7 | 26 | 4 | 39 | 9 | 33 | 2 | 8 | 1 | 5 | 6 | 17 | 1 | 8 | 4 | 16 | 3 | 15 |
| 130 | 2 | 16 | 2 | 8 | 2 | 11 | 0 | 6 | 6 | 33 | 6 | 26 | 9 | 33 | 2 | 25 | 4 | 11 | 3 | 8 | 3 | 15 | 2 | 7 | 4 | 14 | 1 | 14 |
| 145 | 3 | 12 | 1 | 6 | 2 | 11 | 3 | 6 | 4 | 24 | 7 | 29 | 4 | 27 | 8 | 22 | 1 | 11 | 5 | 11 | 1 | 11 | 1 | 7 | 0 | 11 | 1 | 13 |
| 200 | 1 | 10 | 0 | 3 | 1 | 9 | 2 | 6 | 8 | 23 | 9 | 29 | 2 | 19 | 5 | 24 | 3 | 10 | 1 | 10 | 1 | 11 | 0 | 4 | 1 | 9 | 0 | 5 |
| 215 | 0 | 6 | 1 | 4 | 2 | 7 | 0 | 5 | 2 | 20 | 3 | 25 | 12 | 27 | 5 | 20 | 1 | 9 | 0 | 9 | 0 | 5 | 1 | 4 | 3 | 8 | 2 | 4 |
| 230 | 1 | 5 | 2 | 4 | 2 | 7 | 2 | 7 | 3 | 17 | 5 | 24 | 5 | 23 | 4 | 22 | 2 | 7 | 4 | 10 | 1 | 3 | 5 | 7 | 0 | 4 | 8 | 11 |
| 245 | 1 | 3 | 3 | 6 | 0 | 5 | 0 | 4 | 7 | 20 | 2 | 19 | 2 | 21 | 2 | 16 | 0 | 6 | 2 | 7 | 2 | 4 | 1 | 7 | 1 | 5 | 6 | 16 |
| 300 | 2 | 4 | 2 | 8 | 1 | 5 | 0 | 2 | 4 | 16 | 3 | 13 | 2 | 21 | 3 | 14 | 2 | 5 | 1 | 7 | 3 | 6 | 0 | 7 | 1 | 5 | 0 | 16 |
| 315 | 1 | 5 | 1 | 8 | 0 | 3 | 1 | 3 | 1 | 15 | 1 | 11 | 5 | 14 | 6 | 15 | 0 | 4 | 1 | 8 | 0 | 6 | 4 | 10 | 3 | 5 | 2 | 16 |
| 330 | 2 | 6 | 0 | 6 | 1 | 2 | 0 | 1 | 2 | 14 | 0 | 6 | 3 | 12 | 0 | 11 | 0 | 2 | 3 | 7 | 0 | 5 | 1 | 6 | 1 | 6 | 3 | 11 |
| 345 | 3 | 8 | 3 | 6 | 3 | 5 | 5 | 6 | 0 | 7 | 2 | 6 | 2 | 12 | 2 | 11 | 1 | 3 | 6 | 11 | 4 | 7 | 2 | 7 | 2 | 7 | 0 | 5 |
| 400 | 0 | 6 | 4 | 8 | 0 | 4 | 0 | 6 | 3 | 6 | 0 | 3 | 4 | 14 | 1 | 9 | 2 | 3 | 0 | 10 | 1 | 5 | 3 | 10 | 1 | 7 | 3 | 8 |
| 415 | 1 | 6 | 3 | 10 | 0 | 4 | 3 | 8 | 1 | 6 | 0 | 2 | 0 | 9 | 1 | 4 | 3 | 6 | 4 | 13 | 0 | 5 | 2 | 8 | 2 | 6 | 4 | 10 |
| 430 | 2 | 6 | 3 | 13 | 0 | 3 | 4 | 12 | 3 | 7 | 1 | 3 | 1 | 7 | 1 | 5 | 0 | 6 | 8 | 18 | 1 | 6 | 3 | 10 | 1 | 6 | 3 | 10 |
| 445 | 1 | 4 | 2 | 12 | 0 | 0 | 4 | 11 | 0 | 7 | 1 | 2 | 0 | 5 | 2 | 5 | 0 | 5 | 3 | 15 | 0 | 2 | 5 | 13 | 0 | 4 | 5 | 15 |
| 500 | 0 | 4 | 8 | 16 | 7 | 7 | 8 | 19 | 1 | 5 | 1 | 3 | 1 | 2 | 1 | 5 | 3 | 6 | 4 | 19 | 1 | 2 | 9 | 19 | 2 | 5 | 7 | 19 |
| 515 | 4 | 7 | 7 | 20 | 2 | 9 | 4 | 20 | 0 | 4 | 3 | 6 | 0 | 2 | 3 | 7 | 2 | 5 | 10 | 25 | 3 | 5 | 8 | 25 | 3 | 6 | 4 | 19 |
| 530 | 1 | 6 | 11 | 28 | 1 | 10 | 11 | 27 | 1 | 2 | 6 | 11 | 1 | 2 | 3 | 9 | 1 | 6 | 11 | 28 | 2 | 6 | 8 | 30 | 2 | 7 | 11 | 27 |
| 545 | 2 | 7 | 8 | 34 | 2 | 12 | 9 | 32 | 1 | 3 | 6 | 16 | 0 | 2 | 2 | 9 | 1 | 7 | 7 | 32 | 2 | 8 | 10 | 35 | 3 | 10 | 10 | 32 |
| 600 | 3 | 10 | 10 | 36 | 1 | 6 | 9 | 33 | 0 | 2 | 2 | 17 | 0 | 1 | 2 | 10 | 0 | 4 | 6 | 34 | 2 | 9 | 13 | 39 | 3 | 11 | 3 | 28 |
| 615 | 1 | 7 | 15 | 44 | 3 | 7 | 12 | 41 | 3 | 5 | 4 | 18 | 1 | 2 | 2 | 9 | 1 | 3 | 19 | 43 | 2 | 8 | 13 | 44 | 4 | 12 | 12 | 36 |
| 630 | 7 | 13 | 14 | 47 | 7 | 13 | 15 | 45 | 2 | 6 | 1 | 13 | 1 | 2 | 3 | 9 | 3 | 5 | 18 | 50 | 6 | 12 | 15 | 51 | 3 | 13 | 15 | 40 |
| 645 | 3 | 14 | 28 | 67 | 0 | 11 | 24 | 60 | 3 | 8 | 12 | 19 | 0 | 2 | 8 | 15 | 3 | 7 | 32 | 75 | 6 | 16 | 28 | 69 | 4 | 14 | 26 | 56 |
| 700 | 6 | 17 | 34 | 91 | 13 | 23 | 25 | 76 | 10 | 18 | 15 | 32 | 1 | 3 | 5 | 18 | 11 | 18 | 28 | 97 | 12 | 26 | 35 | 91 | 8 | 19 | 40 | 93 |
| 715 | 12 | 28 | 33 | 109 | 11 | 31 | 29 | 93 | 5 | 20 | 13 | 41 | 3 | 5 | 9 | 25 | 11 | 28 | 33 | 111 | 16 | 40 | 46 | 124 | 14 | 29 | 38 | 119 |
| 730 | 15 | 36 | 46 | 141 | 11 | 35 | 40 | 118 | 6 | 24 | 15 | 55 | 6 | 10 | 12 | 34 | 23 | 48 | 60 | 153 | 15 | 49 | 54 | 163 | 13 | 39 | 58 | 162 |
| 745 | 20 | 53 | 61 | 174 | 22 | 57 | 62 | 156 | 5 | 26 | 17 | 60 | 6 | 16 | 17 | 43 | 23 | 68 | 61 | 182 | 22 | 65 | 63 | 198 | 28 | 63 | 59 | 195 |
| 800 | 29 | 76 | 56 | 196 | 26 | 70 | 51 | 182 | 8 | 24 | 27 | 72 | 5 | 20 | 15 | 53 | 33 | 90 | 69 | 223 | 31 | 84 | 73 | 236 | 24 | 79 | 58 | 213 |
| 815 | 53 | 117 | 72 | 235 | 47 | 106 | 83 | 236 | 15 | 34 | 30 | 89 | 3 | 20 | 19 | 63 | 45 | 124 | 87 | 277 | 52 | 120 | 81 | 271 | 58 | 123 | 85 | 260 |
| 830 | 71 | 173 | 76 | 265 | 67 | 162 | 90 | 286 | 17 | 45 | 28 | 102 | 8 | 22 | 21 | 72 | 70 | 171 | 83 | 300 | 81 | 186 | 87 | 304 | 74 | 184 | 83 | 285 |
| 845 | 64 | 217 | 73 | 277 | 49 | 189 | 82 | 306 | 29 | 69 | 37 | 122 | 5 | 21 | 26 | 81 | 40 | 188 | 84 | 323 | 46 | 210 | 89 | 330 | 36 | 192 | 99 | 325 |
| 900 | 31 | 219 | 75 | 296 | 29 | 192 | 45 | 300 | 30 | 91 | 37 | 132 | 14 | 30 | 30 | 96 | 23 | 178 | 63 | 317 | 29 | 208 | 55 | 312 | 18 | 186 | 51 | 318 |
| 915 | 26 | 192 | 40 | 264 | 19 | 164 | 50 | 267 | 20 | 96 | 38 | 140 | 13 | 40 | 29 | 106 | 16 | 149 | 42 | 272 | 28 | 184 | 39 | 270 | 16 | 144 | 43 | 276 |
| 930 | 25 | 146 | 38 | 226 | 16 | 113 | 48 | 225 | 13 | 92 | 45 | 157 | 10 | 42 | 40 | 125 | 23 | 102 | 35 | 224 | 12 | 115 | 50 | 233 | 24 | 94 | 43 | 236 |
| 945 | 13 | 95 | 30 | 183 | 19 | 83 | 40 | 183 | 17 | 80 | 37 | 157 | 11 | 48 | 35 | 134 | 21 | 83 | 38 | 178 | 18 | 87 | 40 | 184 | 15 | 73 | 33 | 170 |
| 1000 | 27 | 91 | 33 | 141 | 28 | 82 | 39 | 177 | 32 | 82 | 52 | 172 | 13 | 47 | 27 | 131 | 23 | 83 | 33 | 148 | 21 | 79 | 35 | 164 | 20 | 75 | 36 | 155 |
| 1015 | 25 | 90 | 41 | 142 | 28 | 91 | 49 | 176 | 21 | 83 | 44 | 178 | 14 | 48 | 30 | 132 | 16 | 83 | 40 | 146 | 15 | 66 | 32 | 157 | 24 | 83 | 37 | 149 |
| 1030 | 25 | 90 | 32 | 136 | 28 | 103 | 40 | 168 | 31 | 101 | 32 | 165 | 19 | 57 | 39 | 131 | 24 | 84 | 31 | 142 | 25 | 79 | 47 | 154 | 16 | 75 | 33 | 139 |
| 1045 | 17 | 94 | 33 | 139 | 28 | 112 | 46 | 174 | 40 | 124 | 49 | 177 | 23 | 69 | 38 | 134 | 30 | 93 | 33 | 137 | 23 | 84 | 28 | 142 | 13 | 73 | 30 | 136 |
| 1100 | 21 | 88 | 26 | 132 | 33 | 117 | 41 | 176 | 31 | 123 | 49 | 174 | 28 | 84 | 38 | 145 | 21 | 91 | 37 | 141 | 20 | 83 | 34 | 141 | 22 | 75 | 32 | 132 |
| 1115 | 18 | 81 | 43 | 134 | 35 | 124 | 37 | 164 | 30 | 132 | 49 | 179 | 34 | 104 | 33 | 148 | 18 | 93 | 31 | 132 | 17 | 85 | 32 | 141 | 19 | 70 | 34 | 129 |
| 1130 | 27 | 83 | 31 | 133 | 31 | 127 | 53 | 177 | 29 | 130 | 58 | 205 | 25 | 110 | 39 | 148 | 32 | 101 | 34 | 135 | 37 | 97 | 33 | 127 | 26 | 80 | 27 | 123 |
| 1145 | 40 | 106 | 30 | 130 | 40 | 139 | 55 | 186 | 27 | 117 | 42 | 198 | 22 | 109 | 37 | 147 | 17 | 88 | 45 | 147 | 28 | 102 | 35 | 134 | 23 | 90 | 28 | 121 |
| 1200 | 33 | 118 | 36 | 140 | 32 | 138 | 75 | 220 | 28 | 114 | 47 | 196 | 29 | 110 | 45 | 154 | 25 | 92 | 39 | 149 | 24 | 106 | 24 | 124 | 23 | 91 | 32 | 121 |
| 1215 | 25 | 125 | 56 | 153 | 31 | 134 | 86 | 269 | 35 | 119 | 61 | 208 | 19 | 95 | 49 | 170 | 25 | 99 | 57 | 175 | 18 | 107 | 34 | 126 | 23 | 95 | 44 | 131 |
| 1230 | 26 | 124 | 46 | 168 | 28 | 131 | 83 | 299 | 39 | 129 | 62 | 212 | 30 | 100 | 44 | 175 | 24 | 91 | 31 | 172 | 34 | 104 | 44 | 137 | 35 | 104 | 54 | 158 |
| 1245 | 35 | 119 | 48 | 186 | 22 | 113 | 95 | 339 | 44 | 146 | 69 | 239 | 24 | 102 | 63 | 201 | 31 | 105 | 35 | 162 | 45 | 121 | 30 | 132 | 29 | 110 | 34 | 164 |
| 1300 | 22 | 108 | 56 | 206 | 23 | 104 | 92 | 356 | 39 | 157 | 68 | 260 | 38 | 111 | 62 | 218 | 30 | 110 | 43 | 166 | 35 | 132 | 31 | 139 | 27 | 114 | 41 | 173 |
| 1315 | 26 | 109 | 66 | 216 | 27 | 100 | 109 | 379 | 32 | 154 | 65 | 264 | 39 | 131 | 94 | 263 | 33 | 118 | 34 | 143 | 27 | 141 | 32 | 137 | 26 | 117 | 37 | 166 |
| 1330 | 25 | 108 | 46 | 216 | 33 | 105 | 117 | 413 | 35 | 150 | 61 | 263 | 43 | 144 | 85 | 304 | 28 | 122 | 25 | 137 | 28 | 135 | 44 | 137 | 28 | 110 | 54 | 166 |
| 1345 | 31 | 104 | 44 | 212 | 26 | 109 | 104 | 422 | 34 | 140 | 64 | 258 | 36 | 156 | 91 | 332 | 42 | 133 | 33 | 135 | 16 | 106 | 37 | 144 | 27 | 108 | 61 | 193 |
| 1400 | 36 | 118 | 50 | 206 | 30 | 116 | 104 | 434 | 38 | 139 | 69 | 259 | 41 | 159 | 108 | 378 | 27 | 130 | 41 | 133 | 38 | 109 | 31 | 144 | 31 | 112 | 68 | 220 |
| 1415 | 31 | 123 | 56 | 196 | 42 | 131 | 89 | 414 | 38 | 145 | 41 | 235 | 41 | 161 | 91 | 375 | 33 | 130 | 37 | 136 | 31 | 113 | 44 | 156 | 32 | 118 | 56 | 239 |
| 1430 | 47 | 145 | 53 | 203 | 34 | 132 | 102 | 399 | 33 | 143 | 54 | 228 | 34 | 152 | 90 | 380 | 43 | 145 | 43 | 154 | 50 | 135 | 40 | 152 | 49 | 139 | 38 | 223 |
| 1445 | 56 | 170 | 70 | 229 | 62 | 168 | 114 | 409 | 40 | 149 | 63 | 227 | 44 | 160 | 68 | 357 | 50 | 153 | 54 | 175 | 54 | 173 | 42 | 157 | 55 | 167 | 47 | 209 |
| 1500 | 52 | 186 | 77 | 256 | 53 | 191 | 144 | 449 | 33 | 144 | 61 | 219 | 30 | 149 | 85 | 334 | 39 | 165 | 64 | 198 | 38 | 173 | 65 | 191 | 49 | 185 | 56 | 197 |
| 1515 | 47 | 202 | 66 | 266 | 37 | 186 | 123 | 483 | 36 | 142 | 66 | 244 | 27 | 135 | 91 | 334 | 50 | 182 | 51 | 212 | 46 | 188 | 40 | 187 | 48 | 201 | 39 | 180 |
| 1530 | 36 | 191 | 53 | 266 | 44 | 196 | 93 | 474 | 30 | 139 | 61 | 251 | 35 | 136 | 96 | 340 | 48 | 187 | 43 | 212 | 45 | 183 | 42 | 189 | 37 | 189 | 39 | 181 |
| 1545 | 47 | 182 | 50 | 246 | 52 | 186 | 105 | 465 | 38 | 137 | 59 | 247 | 27 | 119 | 96 | 368 | 51 | 188 | 45 | 203 | 50 | 179 | 49 | 196 | 51 | 185 | 45 | 179 |
| 1600 | 48 | 178 | 50 | 219 | 55 | 188 | 86 | 407 | 44 | 148 | 59 | 245 | 39 | 128 | 93 | 376 | 51 | 200 | 47 | 186 | 45 | 186 | 53 | 184 | 47 | 183 | 50 | 173 |
| 1615 | 35 | 166 | 68 | 221 | 47 | 198 | 105 | 389 | 42 | 154 | 70 | 249 | 25 | 126 | 107 | 392 | 35 | 185 | 65 | 200 | 38 | 178 | 67 | 211 | 36 | 171 | 54 | 188 |
| 1630 | 56 | 186 | 81 | 249 | 53 | 207 | 99 | 395 | 40 | 164 | 66 | 254 | 35 | 126 | 82 | 378 | 46 | 183 | 53 | 210 | 41 | 174 | 53 | 222 | 56 | 190 | 53 | 202 |
| 1645 | 55 | 194 | 59 | 258 | 63 | 218 | 93 | 383 | 47 | 173 | 65 | 260 | 48 | 147 | 79 | 361 | 50 | 182 | 35 | 200 | 41 | 165 | 42 | 215 | 54 | 193 | 41 | 198 |
| 1700 | 63 | 209 | 71 | 279 | 50 | 213 | 97 | 394 | 40 | 169 | 63 | 264 | 27 | 135 | 92 | 360 | 39 | 170 | 42 | 195 | 56 | 176 | 38 | 200 | 63 | 209 | 61 | 209 |
| 1715 | 69 | 243 | 62 | 273 | 40 | 206 | 98 | 387 | 38 | 165 | 74 | 268 | 34 | 144 | 75 | 328 | 47 | 182 | 59 | 189 | 58 | 196 | 48 | 181 | 67 | 240 | 53 | 208 |
| 1730 | 55 | 242 | 59 | 251 | 62 | 215 | 79 | 367 | 34 | 159 | 62 | 264 | 30 | 139 | 54 | 300 | 67 | 203 | 45 | 181 | 61 | 216 | 50 | 178 | 57 | 241 | 60 | 215 |
| 1745 | 72 | 259 | 56 | 248 | 72 | 224 | 82 | 356 | 32 | 144 | 53 | 252 | 34 | 125 | 42 | 263 | 67 | 220 | 55 | 201 | 55 | 230 | 50 | 186 | 68 | 255 | 64 | 238 |
| 1800 | 63 | 259 | 48 | 225 | 62 | 236 | 77 | 336 | 38 | 142 | 56 | 245 | 30 | 128 | 45 | 216 | 55 | 236 | 55 | 214 | 61 | 235 | 54 | 202 | 66 | 258 | 57 | 234 |
| 1815 | 62 | 252 | 53 | 216 | 49 | 245 | 46 | 284 | 37 | 141 | 42 | 213 | 32 | 126 | 26 | 167 | 57 | 246 | 39 | 194 | 62 | 239 | 62 | 216 | 61 | 252 | 49 | 230 |
| 1830 | 47 | 244 | 35 | 192 | 55 | 238 | 42 | 247 | 31 | 138 | 38 | 189 | 28 | 124 | 35 | 148 | 51 | 230 | 28 | 177 | 30 | 208 | 35 | 201 | 53 | 248 | 34 | 204 |
| 1845 | 47 | 219 | 48 | 184 | 44 | 210 | 46 | 211 | 38 | 144 | 30 | 166 | 30 | 120 | 16 | 122 | 28 | 191 | 36 | 158 | 41 | 194 | 35 | 186 | 45 | 225 | 41 | 181 |
| 1900 | 45 | 201 | 35 | 171 | 49 | 197 | 45 | 179 | 38 | 144 | 39 | 149 | 35 | 125 | 28 | 105 | 37 | 173 | 34 | 137 | 42 | 175 | 29 | 161 | 47 | 206 | 23 | 147 |
| 1915 | 38 | 177 | 28 | 146 | 36 | 184 | 32 | 165 | 30 | 137 | 34 | 141 | 35 | 128 | 28 | 107 | 34 | 150 | 33 | 131 | 46 | 159 | 38 | 137 | 41 | 186 | 33 | 131 |
| 1930 | 40 | 170 | 33 | 144 | 45 | 174 | 29 | 152 | 35 | 141 | 26 | 129 | 30 | 130 | 30 | 102 | 39 | 138 | 33 | 136 | 41 | 170 | 22 | 124 | 39 | 172 | 25 | 122 |
| 1945 | 33 | 156 | 32 | 128 | 39 | 169 | 29 | 135 | 35 | 138 | 28 | 127 | 36 | 136 | 28 | 114 | 29 | 139 | 28 | 128 | 33 | 162 | 18 | 107 | 35 | 162 | 27 | 108 |
| 2000 | 39 | 150 | 18 | 111 | 45 | 165 | 27 | 117 | 39 | 139 | 31 | 119 | 26 | 127 | 27 | 113 | 34 | 136 | 24 | 118 | 35 | 155 | 27 | 105 | 41 | 156 | 14 | 99 |
| 2015 | 31 | 143 | 25 | 108 | 31 | 160 | 38 | 123 | 34 | 143 | 25 | 110 | 24 | 116 | 25 | 110 | 41 | 143 | 27 | 112 | 29 | 138 | 19 | 86 | 32 | 147 | 21 | 87 |
| 2030 | 29 | 132 | 17 | 92 | 25 | 140 | 29 | 123 | 33 | 141 | 32 | 116 | 33 | 119 | 19 | 99 | 26 | 130 | 23 | 102 | 32 | 129 | 26 | 90 | 30 | 138 | 25 | 87 |
| 2045 | 35 | 134 | 12 | 72 | 31 | 132 | 30 | 124 | 26 | 132 | 22 | 110 | 29 | 112 | 29 | 100 | 21 | 122 | 19 | 93 | 33 | 129 | 18 | 90 | 34 | 137 | 19 | 79 |
| 2100 | 33 | 128 | 18 | 72 | 19 | 106 | 21 | 118 | 32 | 125 | 22 | 101 | 25 | 111 | 24 | 97 | 29 | 117 | 20 | 89 | 30 | 124 | 11 | 74 | 31 | 127 | 9 | 74 |
| 2115 | 28 | 125 | 12 | 59 | 32 | 107 | 23 | 103 | 28 | 119 | 19 | 95 | 18 | 105 | 27 | 99 | 19 | 95 | 12 | 74 | 27 | 122 | 14 | 69 | 27 | 122 | 21 | 74 |
| 2130 | 26 | 122 | 16 | 58 | 29 | 111 | 19 | 93 | 32 | 118 | 16 | 79 | 30 | 102 | 17 | 97 | 20 | 89 | 14 | 65 | 18 | 108 | 15 | 58 | 28 | 120 | 14 | 63 |
| 2145 | 27 | 114 | 24 | 70 | 24 | 104 | 20 | 83 | 23 | 115 | 17 | 74 | 24 | 97 | 18 | 86 | 21 | 89 | 16 | 62 | 23 | 98 | 16 | 56 | 24 | 110 | 13 | 57 |
| 2200 | 18 | 99 | 9 | 61 | 31 | 116 | 17 | 79 | 20 | 103 | 19 | 71 | 23 | 95 | 11 | 73 | 14 | 74 | 11 | 53 | 21 | 89 | 11 | 56 | 21 | 100 | 13 | 61 |
| 2215 | 13 | 84 | 17 | 66 | 28 | 112 | 26 | 82 | 18 | 93 | 23 | 75 | 16 | 93 | 15 | 61 | 14 | 69 | 18 | 59 | 30 | 92 | 10 | 52 | 19 | 92 | 9 | 49 |
| 2230 | 5 | 63 | 5 | 55 | 25 | 108 | 34 | 97 | 15 | 76 | 15 | 74 | 19 | 82 | 14 | 58 | 16 | 65 | 11 | 56 | 20 | 94 | 7 | 44 | 14 | 78 | 13 | 48 |
| 2245 | 12 | 48 | 5 | 36 | 23 | 107 | 15 | 92 | 17 | 70 | 13 | 70 | 8 | 66 | 16 | 56 | 14 | 58 | 9 | 49 | 14 | 85 | 11 | 39 | 11 | 65 | 10 | 45 |
| 2300 | 17 | 47 | 6 | 33 | 15 | 91 | 12 | 87 | 12 | 62 | 12 | 63 | 15 | 58 | 6 | 51 | 12 | 56 | 8 | 46 | 8 | 72 | 6 | 34 | 16 | 60 | 8 | 40 |
| 2315 | 14 | 48 | 5 | 21 | 18 | 81 | 12 | 73 | 18 | 62 | 8 | 48 | 12 | 54 | 10 | 46 | 11 | 53 | 8 | 36 | 13 | 55 | 8 | 32 | 15 | 56 | 12 | 43 |
| 2330 | 12 | 55 | 4 | 20 | 6 | 62 | 8 | 47 | 20 | 67 | 19 | 52 | 12 | 47 | 8 | 40 | 6 | 43 | 4 | 29 | 11 | 46 | 6 | 31 | 12 | 54 | 4 | 34 |
| 2345 | 9 | 52 | 10 | 25 | 14 | 53 | 9 | 41 | 15 | 65 | 9 | 48 | 7 | 46 | 8 | 32 | 4 | 33 | 4 | 24 | 4 | 36 | 3 | 23 | 8 | 51 | 5 | 29 |
| TOTAL | 2,387 | N/A | 2,940 | N/A | 2,439 | N/A | 4,190 | N/A | 2,082 | N/A | 2,902 | N/A | 1,763 | N/A | 3,046 | N/A | 2,194 | N/A | 2,723 | N/A | 2,295 | N/A | 2,670 | N/A | 2,335 | N/A | 2,778 | N/A |
| AM | | 219 | | 296 | | 192 | | 306 | | 96 | | 157 | | 48 | | 134 | | 188 | | 323 | | 210 | | 330 | | 192 | | 325 |
| NOON | | 170 | | 229 | | 168 | | 434 | | 157 | | 264 | | 161 | | 380 | | 153 | | 175 | | 173 | | 164 | | 167 | | 239 |
| PM | | 259 | | 279 | | 245 | | 483 | | 173 | | 268 | | 149 | | 392 | | 246 | | 214 | | 239 | | 222 | | 258 | | 238 |
| EVEN | | 150 | | 111 | | 165 | | 124 | | 143 | | 119 | | 127 | | 113 | | 143 | | 118 | | 155 | | 105 | | 156 | | 99 |

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# Appendix X-2

## Intersection Level of Service Calculation Worksheets

# Existing Conditions
# Weekday AM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 135 | 215 | 44 | 5 | 369 | 19 | 8 | 1 | 2 | 18 | 3 | 59 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 147 | 234 | 48 | 5 | 401 | 21 | 9 | 1 | 2 | 20 | 3 | 66 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 147 | 282 | 427 | 9 | 3 | 88 |
| Volume Left (vph) | 147 | 0 | 5 | 9 | 0 | 20 |
| Volume Right (vph) | 0 | 48 | 21 | 0 | 2 | 66 |
| Hadj (s) | 0.53 | -0.08 | 0.01 | 0.53 | -0.43 | -0.37 |
| Departure Headway (s) | 5.8 | 5.2 | 5.3 | 7.3 | 6.3 | 6.2 |
| Degree Utilization, x | 0.24 | 0.40 | 0.63 | 0.02 | 0.01 | 0.15 |
| Capacity (veh/h) | 610 | 681 | 666 | 426 | 492 | 525 |
| Control Delay (s) | 9.4 | 10.4 | 16.9 | 9.2 | 8.2 | 10.3 |
| Approach Delay (s) | 10.0 | | 16.9 | 9.0 | | 10.3 |
| Approach LOS | B | | C | A | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 13.1 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 56.3% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 521 | 262 | 0 | 0 | 258 | 148 | 337 | 4 | 134 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 548 | 276 | 0 | 0 | 287 | 164 | 370 | 4 | 147 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 0 | 103 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 548 | 276 | 0 | 0 | 413 | 0 | 0 | 374 | 44 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 10.8 | 29.8 | | | 15.0 | | | 16.0 | 16.0 | | | |
| Effective Green, g (s) | 10.8 | 29.8 | | | 15.0 | | | 16.0 | 16.0 | | | |
| Actuated g/C Ratio | 0.20 | 0.55 | | | 0.28 | | | 0.30 | 0.30 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 689 | 1032 | | | 494 | | | 528 | 471 | | | |
| v/s Ratio Prot | c0.16 | 0.15 | | | c0.23 | | | c0.21 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.03 | | | |
| v/c Ratio | 0.80 | 0.27 | | | 0.84 | | | 0.71 | 0.09 | | | |
| Uniform Delay, d1 | 20.4 | 6.3 | | | 18.2 | | | 16.8 | 13.7 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 6.3 | 0.1 | | | 11.6 | | | 7.8 | 0.4 | | | |
| Delay (s) | 26.8 | 6.4 | | | 29.9 | | | 24.6 | 14.0 | | | |
| Level of Service | C | A | | | C | | | C | B | | | |
| Approach Delay (s) | | 20.0 | | | 29.9 | | | 21.6 | | | 0.0 | |
| Approach LOS | | B | | | C | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 22.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.78 | | |
| Actuated Cycle Length (s) | 53.8 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 66.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 73 | 151 | 472 | 158 | 0 | 54 | 0 | 514 | 153 | 404 | 27 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3469 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.41 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 755 | | 2787 | | 3469 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 81 | 168 | 524 | 176 | 0 | 60 | 0 | 571 | 170 | 449 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 132 | 0 | 0 | 0 | 0 | 0 | 340 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 81 | 36 | 524 | 176 | 0 | 60 | 0 | 231 | 0 | 645 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.5 | 18.5 | 18.8 | 41.3 | | 12.2 | | 35.0 | | 21.2 | |
| Effective Green, g (s) | | 18.5 | 18.5 | 18.8 | 41.3 | | 12.2 | | 35.0 | | 21.2 | |
| Actuated g/C Ratio | | 0.21 | 0.21 | 0.22 | 0.48 | | 0.14 | | 0.40 | | 0.24 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 398 | 338 | 744 | 887 | | 106 | | 1125 | | 848 | |
| v/s Ratio Prot | | 0.04 | | c0.15 | c0.09 | | | | 0.08 | | c0.19 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.08 | | | | | |
| v/c Ratio | | 0.20 | 0.11 | 0.70 | 0.20 | | 0.57 | | 0.20 | | 0.76 | |
| Uniform Delay, d1 | | 28.0 | 27.4 | 31.4 | 13.1 | | 34.8 | | 16.8 | | 30.4 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.2 | 0.6 | 3.0 | 0.1 | | 6.8 | | 0.1 | | 4.1 | |
| Delay (s) | | 29.2 | 28.1 | 34.4 | 13.2 | | 41.5 | | 16.9 | | 34.5 | |
| Level of Service | | C | C | C | B | | D | | B | | C | |
| Approach Delay (s) | | 28.4 | | | 29.1 | | | 19.2 | | | 34.5 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 27.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.54 | | |
| Actuated Cycle Length (s) | 86.7 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 49.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 216 | 296 | 1 | 0 | 0 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 240 | 302 | 1 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 303 | | | | 543 | 303 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 303 | | | | 543 | 303 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1258 | | | | 501 | 737 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 240 | 303 | 0 | 0 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 1 | 0 | 0 |
| cSH | 1258 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.18 | 0.00 | 0.00 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 0.0 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 19.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 357 | 217 | 69 | 1 | 170 | 106 | 19 | 15 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 372 | 226 | 72 | 1 | 187 | 116 | 21 | 17 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 372 | 298 | 304 | 38 |
| Volume Left (vph) | 372 | 0 | 1 | 21 |
| Volume Right (vph) | 0 | 72 | 116 | 0 |
| Hadj (s) | 0.53 | -0.13 | -0.19 | 0.15 |
| Departure Headway (s) | 5.4 | 4.7 | 4.5 | 6.0 |
| Degree Utilization, x | 0.56 | 0.39 | 0.38 | 0.06 |
| Capacity (veh/h) | 663 | 754 | 778 | 546 |
| Control Delay (s) | 13.7 | 9.5 | 10.3 | 9.4 |
| Approach Delay (s) | 11.8 | | 10.3 | 9.4 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.3 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 48.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 19 | 225 | 15 | 87 | 74 | 44 | 203 | 122 | 165 | 7 | 34 | 164 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 21 | 250 | 17 | 97 | 82 | 49 | 226 | 136 | 183 | 8 | 38 | 182 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 288 | 228 | 361 | 183 | 228 |
| Volume Left (vph) | 21 | 97 | 226 | 0 | 8 |
| Volume Right (vph) | 17 | 49 | 0 | 183 | 182 |
| Hadj (s) | 0.01 | -0.01 | 0.35 | -0.67 | -0.44 |
| Departure Headway (s) | 6.7 | 6.9 | 7.1 | 6.1 | 6.4 |
| Degree Utilization, x | 0.54 | 0.43 | 0.71 | 0.31 | 0.41 |
| Capacity (veh/h) | 492 | 467 | 492 | 570 | 498 |
| Control Delay (s) | 17.2 | 15.0 | 24.6 | 10.6 | 13.8 |
| Approach Delay (s) | 17.2 | 15.0 | 19.8 | | 13.8 |
| Approach LOS | C | C | C | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 17.3 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 227 | 61 | 39 | 163 | 18 | 24 | 125 | 17 | 70 | 171 | 49 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 1.00 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1807 | | | 1826 | | 1770 | 1830 | | 1770 | 1801 | |
| Flt Permitted | | 0.98 | | | 0.91 | | 0.61 | 1.00 | | 0.66 | 1.00 | |
| Satd. Flow (perm) | | 1768 | | | 1670 | | 1131 | 1830 | | 1228 | 1801 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 20 | 239 | 64 | 43 | 181 | 20 | 26 | 136 | 18 | 78 | 190 | 54 |
| RTOR Reduction (vph) | 0 | 22 | 0 | 0 | 8 | 0 | 0 | 11 | 0 | 0 | 26 | 0 |
| Lane Group Flow (vph) | 0 | 301 | 0 | 0 | 236 | 0 | 26 | 143 | 0 | 78 | 218 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 707 | | | 668 | | 452 | 732 | | 491 | 720 | |
| v/s Ratio Prot | | | | | | | | 0.08 | | | c0.12 | |
| v/s Ratio Perm | | c0.17 | | | 0.14 | | 0.02 | | | 0.06 | | |
| v/c Ratio | | 0.43 | | | 0.35 | | 0.06 | 0.20 | | 0.16 | 0.30 | |
| Uniform Delay, d1 | | 8.7 | | | 8.4 | | 7.4 | 7.8 | | 7.7 | 8.2 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.9 | | | 1.5 | | 0.2 | 0.6 | | 0.7 | 1.1 | |
| Delay (s) | | 10.5 | | | 9.9 | | 7.6 | 8.4 | | 8.4 | 9.3 | |
| Level of Service | | B | | | A | | A | A | | A | A | |
| Approach Delay (s) | | 10.5 | | | 9.9 | | | 8.3 | | | 9.1 | |
| Approach LOS | | B | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.36 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 48.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Existing Conditions
# Weekday PM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 96 | 327 | 8 | 0 | 207 | 3 | 213 | 3 | 7 | 8 | 3 | 99 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 104 | 355 | 9 | 0 | 225 | 3 | 237 | 3 | 8 | 9 | 3 | 110 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 104 | 364 | 228 | 237 | 11 | 122 |
| Volume Left (vph) | 104 | 0 | 0 | 237 | 0 | 9 |
| Volume Right (vph) | 0 | 9 | 3 | 0 | 8 | 110 |
| Hadj (s) | 0.53 | 0.02 | 0.03 | 0.53 | -0.45 | -0.49 |
| Departure Headway (s) | 6.8 | 6.3 | 6.7 | 7.4 | 6.4 | 6.7 |
| Degree Utilization, x | 0.20 | 0.64 | 0.42 | 0.48 | 0.02 | 0.23 |
| Capacity (veh/h) | 504 | 549 | 497 | 456 | 522 | 475 |
| Control Delay (s) | 10.3 | 18.4 | 14.5 | 15.9 | 8.3 | 11.7 |
| Approach Delay (s) | 16.6 | | 14.5 | 15.6 | | 11.7 |
| Approach LOS | C | | B | C | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 15.3 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 57.2% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 463 | 284 | 0 | 0 | 363 | 147 | 405 | 3 | 157 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.96 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1790 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1790 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 487 | 299 | 0 | 0 | 403 | 163 | 445 | 3 | 173 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 112 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 487 | 299 | 0 | 0 | 542 | 0 | 0 | 448 | 61 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 9.0 | 31.0 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Effective Green, g (s) | 9.0 | 31.0 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Actuated g/C Ratio | 0.15 | 0.52 | | | 0.30 | | | 0.35 | 0.35 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 515 | 963 | | | 537 | | | 621 | 554 | | | |
| v/s Ratio Prot | c0.14 | 0.16 | | | c0.30 | | | c0.25 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.04 | | | |
| v/c Ratio | 0.95 | 0.31 | | | 1.01 | | | 0.72 | 0.11 | | | |
| Uniform Delay, d1 | 25.3 | 8.3 | | | 21.0 | | | 17.0 | 13.2 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 26.4 | 0.2 | | | 40.9 | | | 7.1 | 0.4 | | | |
| Delay (s) | 51.7 | 8.5 | | | 61.9 | | | 24.1 | 13.6 | | | |
| Level of Service | D | A | | | E | | | C | B | | | |
| Approach Delay (s) | | 35.3 | | | 61.9 | | | 21.1 | | | 0.0 | |
| Approach LOS | | D | | | E | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 38.5 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.87 | | |
| Actuated Cycle Length (s) | 60.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 75.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 70 | 148 | 624 | 157 | 0 | 33 | 0 | 527 | 130 | 498 | 40 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3474 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.38 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 710 | | 2787 | | 3474 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 78 | 164 | 693 | 174 | 0 | 37 | 0 | 586 | 144 | 553 | 44 |
| RTOR Reduction (vph) | 0 | 0 | 133 | 0 | 0 | 0 | 0 | 0 | 344 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 78 | 31 | 693 | 174 | 0 | 37 | 0 | 242 | 0 | 737 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.3 | 17.3 | 22.8 | 44.1 | | 10.5 | | 37.3 | | 23.8 | |
| Effective Green, g (s) | | 17.3 | 17.3 | 22.8 | 44.1 | | 10.5 | | 37.3 | | 23.8 | |
| Actuated g/C Ratio | | 0.19 | 0.19 | 0.25 | 0.49 | | 0.12 | | 0.41 | | 0.26 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 357 | 303 | 866 | 909 | | 82 | | 1150 | | 915 | |
| v/s Ratio Prot | | 0.04 | | c0.20 | c0.09 | | | | 0.09 | | c0.21 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.22 | 0.10 | 0.80 | 0.19 | | 0.45 | | 0.21 | | 0.81 | |
| Uniform Delay, d1 | | 30.8 | 30.2 | 31.7 | 13.1 | | 37.3 | | 17.1 | | 31.1 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.4 | 0.7 | 5.3 | 0.1 | | 3.9 | | 0.1 | | 5.2 | |
| Delay (s) | | 32.2 | 30.8 | 37.0 | 13.2 | | 41.2 | | 17.2 | | 36.3 | |
| Level of Service | | C | C | D | B | | D | | B | | D | |
| Approach Delay (s) | | 31.3 | | | 32.2 | | | 18.6 | | | 36.3 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.59 | | |
| Actuated Cycle Length (s) | 90.4 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 56.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 240 | 186 | 1 | 2 | 101 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 267 | 190 | 1 | 2 | 112 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 191 | | | | 457 | 190 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 191 | | | | 457 | 190 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 87 |
| cM capacity (veh/h) | 1383 | | | | 562 | 851 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 267 | 191 | 2 | 112 |
| Volume Left | 0 | 0 | 2 | 0 |
| Volume Right | 0 | 1 | 0 | 112 |
| cSH | 1383 | 1700 | 562 | 851 |
| Volume to Capacity | 0.00 | 0.11 | 0.00 | 0.13 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 11 |
| Control Delay (s) | 0.0 | 0.0 | 11.4 | 9.9 |
| Lane LOS | | | B | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.9 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.0 | | |
| Intersection Capacity Utilization | 22.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 312 | 242 | 31 | 4 | 188 | 96 | 36 | 50 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 325 | 252 | 32 | 4 | 207 | 105 | 40 | 56 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 325 | 284 | 316 | 96 |
| Volume Left (vph) | 325 | 0 | 4 | 40 |
| Volume Right (vph) | 0 | 32 | 105 | 0 |
| Hadj (s) | 0.53 | -0.05 | -0.16 | 0.12 |
| Departure Headway (s) | 5.6 | 5.0 | 4.8 | 5.9 |
| Degree Utilization, x | 0.51 | 0.40 | 0.42 | 0.16 |
| Capacity (veh/h) | 624 | 703 | 736 | 552 |
| Control Delay (s) | 13.0 | 10.1 | 11.1 | 10.0 |
| Approach Delay (s) | 11.7 | | 11.1 | 10.0 |
| Approach LOS | B | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.3 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 47.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 24 | 207 | 32 | 122 | 63 | 35 | 149 | 176 | 245 | 16 | 78 | 180 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 27 | 230 | 36 | 136 | 70 | 39 | 166 | 196 | 272 | 18 | 87 | 200 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 292 | 244 | 361 | 272 | 304 |
| Volume Left (vph) | 27 | 136 | 166 | 0 | 18 |
| Volume Right (vph) | 36 | 39 | 0 | 272 | 200 |
| Hadj (s) | -0.02 | 0.05 | 0.26 | -0.67 | -0.35 |
| Departure Headway (s) | 7.4 | 7.6 | 7.6 | 6.6 | 7.0 |
| Degree Utilization, x | 0.60 | 0.52 | 0.76 | 0.50 | 0.59 |
| Capacity (veh/h) | 451 | 426 | 456 | 532 | 475 |
| Control Delay (s) | 20.7 | 18.4 | 29.4 | 14.8 | 19.7 |
| Approach Delay (s) | 20.7 | 18.4 | 23.1 | | 19.7 |
| Approach LOS | C | C | C | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.2 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 73.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 35 | 188 | 97 | 84 | 216 | 14 | 39 | 275 | 33 | 120 | 270 | 54 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.96 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.98 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1777 | | | 1827 | | 1770 | 1833 | | 1770 | 1816 | |
| Flt Permitted | | 0.94 | | | 0.85 | | 0.48 | 1.00 | | 0.51 | 1.00 | |
| Satd. Flow (perm) | | 1676 | | | 1582 | | 890 | 1833 | | 944 | 1816 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 37 | 198 | 102 | 93 | 240 | 16 | 42 | 299 | 36 | 133 | 300 | 60 |
| RTOR Reduction (vph) | 0 | 39 | 0 | 0 | 4 | 0 | 0 | 11 | 0 | 0 | 18 | 0 |
| Lane Group Flow (vph) | 0 | 298 | 0 | 0 | 345 | 0 | 42 | 324 | 0 | 133 | 342 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 670 | | | 633 | | 356 | 733 | | 378 | 726 | |
| v/s Ratio Prot | | | | | | | | 0.18 | | | c0.19 | |
| v/s Ratio Perm | | 0.18 | | | c0.22 | | 0.05 | | | 0.14 | | |
| v/c Ratio | | 0.44 | | | 0.54 | | 0.12 | 0.44 | | 0.35 | 0.47 | |
| Uniform Delay, d1 | | 8.8 | | | 9.2 | | 7.6 | 8.7 | | 8.4 | 8.9 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.1 | | | 3.3 | | 0.7 | 1.9 | | 2.6 | 2.2 | |
| Delay (s) | | 10.9 | | | 12.6 | | 8.2 | 10.7 | | 10.9 | 11.1 | |
| Level of Service | | B | | | B | | A | B | | B | B | |
| Approach Delay (s) | | 10.9 | | | 12.6 | | | 10.4 | | | 11.0 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.51 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 66.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Existing Conditions
# Weekend Midday Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 104 | 211 | 259 | 8 | 202 | 6 | 118 | 2 | 3 | 13 | 6 | 60 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 113 | 229 | 282 | 9 | 220 | 7 | 131 | 2 | 3 | 14 | 7 | 67 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 113 | 511 | 235 | 131 | 5 | 87 |
| Volume Left (vph) | 113 | 0 | 9 | 131 | 0 | 14 |
| Volume Right (vph) | 0 | 282 | 7 | 0 | 3 | 67 |
| Hadj (s) | 0.53 | -0.35 | 0.02 | 0.53 | -0.38 | -0.39 |
| Departure Headway (s) | 6.2 | 5.3 | 6.1 | 7.4 | 6.5 | 6.6 |
| Degree Utilization, x | 0.19 | 0.75 | 0.40 | 0.27 | 0.01 | 0.16 |
| Capacity (veh/h) | 562 | 664 | 560 | 437 | 504 | 490 |
| Control Delay (s) | 9.5 | 21.2 | 13.2 | 11.9 | 8.3 | 10.9 |
| Approach Delay (s) | 19.1 | | 13.2 | 11.8 | | 10.9 |
| Approach LOS | C | | B | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 16.2 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 61.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 346 | 360 | 0 | 0 | 278 | 220 | 303 | 4 | 279 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.94 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1752 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1752 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 379 | 0 | 0 | 309 | 244 | 333 | 4 | 307 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 48 | 0 | 0 | 0 | 199 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 364 | 379 | 0 | 0 | 505 | 0 | 0 | 337 | 108 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 8.9 | 30.9 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Effective Green, g (s) | 8.9 | 30.9 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Actuated g/C Ratio | 0.15 | 0.52 | | | 0.30 | | | 0.35 | 0.35 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 510 | 961 | | | 526 | | | 622 | 555 | | | |
| v/s Ratio Prot | c0.11 | 0.20 | | | c0.29 | | | c0.19 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.07 | | | |
| v/c Ratio | 0.71 | 0.39 | | | 0.96 | | | 0.54 | 0.19 | | | |
| Uniform Delay, d1 | 24.3 | 8.8 | | | 20.6 | | | 15.6 | 13.6 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 4.7 | 0.3 | | | 29.4 | | | 3.4 | 0.8 | | | |
| Delay (s) | 29.0 | 9.1 | | | 50.0 | | | 19.0 | 14.3 | | | |
| Level of Service | C | A | | | D | | | B | B | | | |
| Approach Delay (s) | | 18.8 | | | 50.0 | | | 16.8 | | | 0.0 | |
| Approach LOS | | B | | | D | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 27.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.73 | | |
| Actuated Cycle Length (s) | 59.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 74.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 66 | 132 | 462 | 118 | 0 | 31 | 0 | 411 | 237 | 429 | 39 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.98 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3452 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.40 | | 1.00 | | 0.98 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 745 | | 2787 | | 3452 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 73 | 147 | 513 | 131 | 0 | 34 | 0 | 457 | 263 | 477 | 43 |
| RTOR Reduction (vph) | 0 | 0 | 117 | 0 | 0 | 0 | 0 | 0 | 283 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 73 | 30 | 513 | 131 | 0 | 34 | 0 | 174 | 0 | 779 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.4 | 17.4 | 18.9 | 40.3 | | 10.0 | | 32.9 | | 23.9 | |
| Effective Green, g (s) | | 17.4 | 17.4 | 18.9 | 40.3 | | 10.0 | | 32.9 | | 23.9 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.22 | 0.47 | | 0.12 | | 0.38 | | 0.28 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 376 | 320 | 753 | 871 | | 86 | | 1064 | | 957 | |
| v/s Ratio Prot | | c0.04 | | c0.15 | 0.07 | | | | 0.06 | | c0.23 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.19 | 0.09 | 0.68 | 0.15 | | 0.40 | | 0.16 | | 0.81 | |
| Uniform Delay, d1 | | 28.6 | 28.0 | 30.9 | 13.1 | | 35.3 | | 17.6 | | 29.1 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.1 | 0.6 | 2.6 | 0.1 | | 3.0 | | 0.1 | | 5.4 | |
| Delay (s) | | 29.7 | 28.6 | 33.4 | 13.2 | | 38.3 | | 17.7 | | 34.4 | |
| Level of Service | | C | C | C | B | | D | | B | | C | |
| Approach Delay (s) | | 28.9 | | | 29.3 | | | 19.1 | | | 34.4 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 28.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.56 | | |
| Actuated Cycle Length (s) | 86.2 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 52.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 57 | 161 | 0 | 0 | 59 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 63 | 164 | 0 | 0 | 66 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 164 | | | | 228 | 164 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 164 | | | | 228 | 164 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 93 |
| cM capacity (veh/h) | 1414 | | | | 761 | 880 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 63 | 164 | 0 | 66 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 66 |
| cSH | 1414 | 1700 | 1700 | 880 |
| Volume to Capacity | 0.00 | 0.10 | 0.00 | 0.07 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 6 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 9.4 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.4 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.1 | | |
| Intersection Capacity Utilization | 18.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 280 | 141 | 17 | 0 | 172 | 100 | 10 | 14 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 292 | 147 | 18 | 0 | 189 | 110 | 11 | 16 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 292 | 165 | 299 | 27 |
| Volume Left (vph) | 292 | 0 | 0 | 11 |
| Volume Right (vph) | 0 | 18 | 110 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.19 | 0.12 |
| Departure Headway (s) | 5.3 | 4.7 | 4.3 | 5.6 |
| Degree Utilization, x | 0.43 | 0.22 | 0.36 | 0.04 |
| Capacity (veh/h) | 670 | 746 | 811 | 576 |
| Control Delay (s) | 11.1 | 7.8 | 9.8 | 8.9 |
| Approach Delay (s) | 9.9 | | 9.8 | 8.9 |
| Approach LOS | A | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 9.8 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 44.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 110 | 173 | 166 | 12 | 96 | 140 | 26 | 202 | 26 | 80 | 37 | 22 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 122 | 192 | 184 | 13 | 107 | 156 | 29 | 224 | 29 | 89 | 41 | 24 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 499 | 276 | 253 | 29 | 154 |
| Volume Left (vph) | 122 | 13 | 29 | 0 | 89 |
| Volume Right (vph) | 184 | 156 | 0 | 29 | 24 |
| Hadj (s) | -0.14 | -0.30 | 0.09 | -0.67 | 0.05 |
| Departure Headway (s) | 5.9 | 6.2 | 7.3 | 6.5 | 7.3 |
| Degree Utilization, x | 0.82 | 0.47 | 0.51 | 0.05 | 0.31 |
| Capacity (veh/h) | 499 | 518 | 444 | 497 | 442 |
| Control Delay (s) | 29.9 | 14.7 | 16.6 | 8.7 | 13.5 |
| Approach Delay (s) | 29.9 | 14.7 | 15.8 | | 13.5 |
| Approach LOS | D | B | C | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.1 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 72.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 26 | 200 | 25 | 104 | 167 | 58 | 19 | 196 | 96 | 46 | 165 | 22 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.98 | | 1.00 | 0.95 | | 1.00 | 0.98 | |
| Flt Protected | | 0.99 | | | 0.98 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1829 | | | 1790 | | 1770 | 1771 | | 1770 | 1830 | |
| Flt Permitted | | 0.95 | | | 0.84 | | 0.63 | 1.00 | | 0.53 | 1.00 | |
| Satd. Flow (perm) | | 1738 | | | 1525 | | 1170 | 1771 | | 984 | 1830 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 27 | 211 | 26 | 116 | 186 | 64 | 21 | 213 | 104 | 51 | 183 | 24 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 19 | 0 | 0 | 44 | 0 | 0 | 12 | 0 |
| Lane Group Flow (vph) | 0 | 254 | 0 | 0 | 347 | 0 | 21 | 273 | 0 | 51 | 195 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 695 | | | 610 | | 468 | 708 | | 394 | 732 | |
| v/s Ratio Prot | | | | | | | | c0.15 | | | 0.11 | |
| v/s Ratio Perm | | 0.15 | | | c0.23 | | 0.02 | | | 0.05 | | |
| v/c Ratio | | 0.37 | | | 0.57 | | 0.04 | 0.39 | | 0.13 | 0.27 | |
| Uniform Delay, d1 | | 8.4 | | | 9.3 | | 7.3 | 8.5 | | 7.6 | 8.1 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.5 | | | 3.8 | | 0.2 | 1.6 | | 0.7 | 0.9 | |
| Delay (s) | | 9.9 | | | 13.1 | | 7.5 | 10.1 | | 8.3 | 8.9 | |
| Level of Service | | A | | | B | | A | B | | A | A | |
| Approach Delay (s) | | 9.9 | | | 13.1 | | | 9.9 | | | 8.8 | |
| Approach LOS | | A | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 64.4% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Year 2015 Baseline Conditions
# Weekday AM Peak Hour

# HCM Unsignalized Intersection Capacity Analysis
## 1: Golf Links Road & Mountain Blvd

11/9/2010

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 267 | 216 | 40 | 4 | 370 | 23 | 8 | 1 | 2 | 21 | 3 | 228 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 290 | 235 | 43 | 4 | 402 | 25 | 9 | 1 | 2 | 23 | 3 | 253 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 290 | 278 | 432 | 9 | 3 | 279 |
| Volume Left (vph) | 290 | 0 | 4 | 9 | 0 | 23 |
| Volume Right (vph) | 0 | 43 | 25 | 0 | 2 | 253 |
| Hadj (s) | 0.53 | -0.08 | 0.00 | 0.53 | -0.43 | -0.49 |
| Departure Headway (s) | 6.8 | 6.1 | 6.3 | 8.5 | 7.5 | 6.6 |
| Degree Utilization, x | 0.54 | 0.47 | 0.76 | 0.02 | 0.01 | 0.51 |
| Capacity (veh/h) | 518 | 572 | 554 | 378 | 419 | 518 |
| Control Delay (s) | 16.3 | 13.3 | 26.2 | 10.5 | 9.4 | 16.1 |
| Approach Delay (s) | 14.9 | | 26.2 | 10.2 | | 16.1 |
| Approach LOS | B | | D | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 18.9 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.0% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 521 | 255 | 0 | 0 | 333 | 190 | 368 | 4 | 140 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 548 | 268 | 0 | 0 | 370 | 211 | 404 | 4 | 154 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 34 | 0 | 0 | 0 | 110 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 548 | 268 | 0 | 0 | 547 | 0 | 0 | 408 | 44 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 11.8 | 34.8 | | | 19.0 | | | 17.0 | 17.0 | | | |
| Effective Green, g (s) | 11.8 | 34.8 | | | 19.0 | | | 17.0 | 17.0 | | | |
| Actuated g/C Ratio | 0.20 | 0.58 | | | 0.32 | | | 0.28 | 0.28 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 677 | 1084 | | | 563 | | | 505 | 450 | | | |
| v/s Ratio Prot | c0.16 | 0.14 | | | c0.31 | | | c0.23 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.03 | | | |
| v/c Ratio | 0.81 | 0.25 | | | 0.97 | | | 0.81 | 0.10 | | | |
| Uniform Delay, d1 | 22.9 | 6.1 | | | 20.1 | | | 19.9 | 15.8 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 7.1 | 0.1 | | | 30.6 | | | 13.0 | 0.4 | | | |
| Delay (s) | 30.0 | 6.2 | | | 50.7 | | | 32.9 | 16.2 | | | |
| Level of Service | C | A | | | D | | | C | B | | | |
| Approach Delay (s) | | 22.2 | | | 50.7 | | | 28.3 | | | 0.0 | |
| Approach LOS | | C | | | D | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 32.4 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.87 | | |
| Actuated Cycle Length (s) | 59.8 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 74.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 90 | 191 | 514 | 173 | 0 | 54 | 0 | 512 | 161 | 442 | 30 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3470 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.38 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 716 | | 2787 | | 3470 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 100 | 212 | 571 | 192 | 0 | 60 | 0 | 569 | 179 | 491 | 33 |
| RTOR Reduction (vph) | 0 | 0 | 170 | 0 | 0 | 0 | 0 | 0 | 334 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 100 | 42 | 571 | 192 | 0 | 60 | 0 | 235 | 0 | 699 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.5 | 17.5 | 20.1 | 41.6 | | 12.5 | | 36.6 | | 22.4 | |
| Effective Green, g (s) | | 17.5 | 17.5 | 20.1 | 41.6 | | 12.5 | | 36.6 | | 22.4 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.23 | 0.47 | | 0.14 | | 0.41 | | 0.25 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 368 | 313 | 780 | 876 | | 101 | | 1153 | | 878 | |
| v/s Ratio Prot | | c0.05 | | c0.17 | 0.10 | | | | 0.08 | | c0.20 | |
| v/s Ratio Perm | | | 0.03 | | | | c0.08 | | | | | |
| v/c Ratio | | 0.27 | 0.13 | 0.73 | 0.22 | | 0.59 | | 0.20 | | 0.80 | |
| Uniform Delay, d1 | | 30.1 | 29.3 | 31.7 | 13.9 | | 35.6 | | 16.6 | | 30.9 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.8 | 0.9 | 3.6 | 0.1 | | 9.0 | | 0.1 | | 5.1 | |
| Delay (s) | | 31.9 | 30.1 | 35.3 | 14.0 | | 44.7 | | 16.7 | | 36.0 | |
| Level of Service | | C | C | D | B | | D | | B | | D | |
| Approach Delay (s) | | 30.7 | | | 29.9 | | | 19.4 | | | 36.0 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 88.5 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 54.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 221 | 316 | 1 | 0 | 0 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 246 | 322 | 1 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 323 | | | | 569 | 323 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 323 | | | | 569 | 323 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1236 | | | | 484 | 718 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 246 | 323 | 0 | 0 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 1 | 0 | 0 |
| cSH | 1236 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.19 | 0.00 | 0.00 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 0.0 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 20.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 368 | 224 | 71 | 1 | 182 | 113 | 19 | 15 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 383 | 233 | 74 | 1 | 200 | 124 | 21 | 17 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 383 | 307 | 325 | 38 |
| Volume Left (vph) | 383 | 0 | 1 | 21 |
| Volume Right (vph) | 0 | 74 | 124 | 0 |
| Hadj (s) | 0.53 | -0.13 | -0.19 | 0.15 |
| Departure Headway (s) | 5.4 | 4.7 | 4.5 | 6.0 |
| Degree Utilization, x | 0.57 | 0.40 | 0.41 | 0.06 |
| Capacity (veh/h) | 651 | 752 | 776 | 539 |
| Control Delay (s) | 14.2 | 9.7 | 10.7 | 9.4 |
| Approach Delay (s) | 12.2 | | 10.7 | 9.4 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.6 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 50.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 20 | 238 | 16 | 95 | 81 | 48 | 222 | 133 | 180 | 7 | 36 | 174 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 22 | 264 | 18 | 106 | 90 | 53 | 247 | 148 | 200 | 8 | 40 | 193 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 304 | 249 | 394 | 200 | 241 |
| Volume Left (vph) | 22 | 106 | 247 | 0 | 8 |
| Volume Right (vph) | 18 | 53 | 0 | 200 | 193 |
| Hadj (s) | 0.01 | -0.01 | 0.35 | -0.67 | -0.44 |
| Departure Headway (s) | 7.1 | 7.2 | 7.4 | 6.4 | 6.9 |
| Degree Utilization, x | 0.60 | 0.50 | 0.81 | 0.35 | 0.46 |
| Capacity (veh/h) | 471 | 445 | 465 | 547 | 468 |
| Control Delay (s) | 20.1 | 17.2 | 34.0 | 11.6 | 15.6 |
| Approach Delay (s) | 20.1 | 17.2 | 26.4 | | 15.6 |
| Approach LOS | C | C | D | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.5 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 72.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 234 | 63 | 49 | 205 | 23 | 27 | 142 | 19 | 74 | 180 | 52 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 1.00 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1807 | | | 1826 | | 1770 | 1829 | | 1770 | 1800 | |
| Flt Permitted | | 0.97 | | | 0.90 | | 0.60 | 1.00 | | 0.65 | 1.00 | |
| Satd. Flow (perm) | | 1760 | | | 1655 | | 1116 | 1829 | | 1205 | 1800 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 21 | 246 | 66 | 54 | 228 | 26 | 29 | 154 | 21 | 82 | 200 | 58 |
| RTOR Reduction (vph) | 0 | 22 | 0 | 0 | 8 | 0 | 0 | 12 | 0 | 0 | 26 | 0 |
| Lane Group Flow (vph) | 0 | 311 | 0 | 0 | 300 | 0 | 29 | 163 | 0 | 82 | 232 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 704 | | | 662 | | 446 | 732 | | 482 | 720 | |
| v/s Ratio Prot | | | | | | | | 0.09 | | | c0.13 | |
| v/s Ratio Perm | | 0.18 | | | c0.18 | | 0.03 | | | 0.07 | | |
| v/c Ratio | | 0.44 | | | 0.45 | | 0.07 | 0.22 | | 0.17 | 0.32 | |
| Uniform Delay, d1 | | 8.7 | | | 8.8 | | 7.4 | 7.9 | | 7.7 | 8.3 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.0 | | | 2.2 | | 0.3 | 0.7 | | 0.8 | 1.2 | |
| Delay (s) | | 10.7 | | | 11.0 | | 7.7 | 8.6 | | 8.5 | 9.4 | |
| Level of Service | | B | | | B | | A | A | | A | A | |
| Approach Delay (s) | | 10.7 | | | 11.0 | | | 8.5 | | | 9.2 | |
| Approach LOS | | B | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.0 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 54.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Year 2015 Baseline Conditions
# Weekday PM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 290 | 328 | 7 | 0 | 208 | 12 | 191 | 3 | 6 | 17 | 3 | 330 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 315 | 357 | 8 | 0 | 226 | 13 | 212 | 3 | 7 | 18 | 3 | 367 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 315 | 364 | 239 | 212 | 10 | 388 |
| Volume Left (vph) | 315 | 0 | 0 | 212 | 0 | 18 |
| Volume Right (vph) | 0 | 8 | 13 | 0 | 7 | 367 |
| Hadj (s) | 0.53 | 0.02 | 0.00 | 0.53 | -0.43 | -0.52 |
| Departure Headway (s) | 8.3 | 7.7 | 8.5 | 9.1 | 8.1 | 7.5 |
| Degree Utilization, x | 0.72 | 0.78 | 0.57 | 0.54 | 0.02 | 0.81 |
| Capacity (veh/h) | 421 | 455 | 395 | 369 | 411 | 457 |
| Control Delay (s) | 29.0 | 32.3 | 22.0 | 21.0 | 10.1 | 35.9 |
| Approach Delay (s) | 30.7 | | 22.0 | 20.5 | | 35.9 |
| Approach LOS | D | | C | C | | E |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 29.2 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 74.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 499 | 304 | 0 | 0 | 398 | 139 | 443 | 3 | 170 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.97 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1798 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1798 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 525 | 320 | 0 | 0 | 442 | 154 | 487 | 3 | 187 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 123 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 525 | 320 | 0 | 0 | 580 | 0 | 0 | 490 | 64 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 13.0 | 44.1 | | | 27.1 | | | 27.0 | 27.0 | | | |
| Effective Green, g (s) | 13.0 | 44.1 | | | 27.1 | | | 27.0 | 27.0 | | | |
| Actuated g/C Ratio | 0.16 | 0.56 | | | 0.34 | | | 0.34 | 0.34 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 564 | 1039 | | | 616 | | | 606 | 540 | | | |
| v/s Ratio Prot | c0.15 | 0.17 | | | c0.32 | | | c0.28 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.04 | | | |
| v/c Ratio | 0.93 | 0.31 | | | 0.94 | | | 0.81 | 0.12 | | | |
| Uniform Delay, d1 | 32.6 | 9.3 | | | 25.2 | | | 23.7 | 17.9 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 22.2 | 0.2 | | | 22.9 | | | 11.1 | 0.4 | | | |
| Delay (s) | 54.9 | 9.5 | | | 48.1 | | | 34.8 | 18.3 | | | |
| Level of Service | D | A | | | D | | | C | B | | | |
| Approach Delay (s) | | 37.7 | | | 48.1 | | | 30.3 | | | 0.0 | |
| Approach LOS | | D | | | D | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 38.2 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.89 | | |
| Actuated Cycle Length (s) | 79.1 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 80.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 87 | 184 | 643 | 166 | 0 | 34 | 0 | 538 | 141 | 545 | 44 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3474 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.37 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 690 | | 2787 | | 3474 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 97 | 204 | 714 | 184 | 0 | 38 | 0 | 598 | 157 | 606 | 49 |
| RTOR Reduction (vph) | 0 | 0 | 164 | 0 | 0 | 0 | 0 | 0 | 349 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 97 | 40 | 714 | 184 | 0 | 38 | 0 | 249 | 0 | 808 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.2 | 18.2 | 23.7 | 45.9 | | 10.8 | | 38.5 | | 23.9 | |
| Effective Green, g (s) | | 18.2 | 18.2 | 23.7 | 45.9 | | 10.8 | | 38.5 | | 23.9 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.26 | 0.50 | | 0.12 | | 0.42 | | 0.26 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 366 | 311 | 879 | 923 | | 80 | | 1159 | | 897 | |
| v/s Ratio Prot | | c0.05 | | c0.21 | 0.10 | | | | 0.09 | | c0.23 | |
| v/s Ratio Perm | | | 0.03 | | | | c0.06 | | | | | |
| v/c Ratio | | 0.27 | 0.13 | 0.81 | 0.20 | | 0.48 | | 0.21 | | 0.90 | |
| Uniform Delay, d1 | | 31.5 | 30.7 | 32.4 | 13.1 | | 38.2 | | 17.4 | | 33.2 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.8 | 0.9 | 5.8 | 0.1 | | 4.4 | | 0.1 | | 12.0 | |
| Delay (s) | | 33.3 | 31.5 | 38.1 | 13.2 | | 42.6 | | 17.4 | | 45.2 | |
| Level of Service | | C | C | D | B | | D | | B | | D | |
| Approach Delay (s) | | 32.1 | | | 33.0 | | | 19.0 | | | 45.2 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 33.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.66 | | |
| Actuated Cycle Length (s) | 92.6 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 60.3% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 258 | 194 | 1 | 2 | 79 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 287 | 198 | 1 | 2 | 88 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 199 | | | | 485 | 198 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 199 | | | | 485 | 198 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 90 |
| cM capacity (veh/h) | 1373 | | | | 541 | 843 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 287 | 199 | 2 | 88 |
| Volume Left | 0 | 0 | 2 | 0 |
| Volume Right | 0 | 1 | 0 | 88 |
| cSH | 1373 | 1700 | 541 | 843 |
| Volume to Capacity | 0.00 | 0.12 | 0.00 | 0.10 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 9 |
| Control Delay (s) | 0.0 | 0.0 | 11.7 | 9.8 |
| Lane LOS | | | B | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.8 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.5 | | |
| Intersection Capacity Utilization | 23.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 324 | 251 | 32 | 4 | 180 | 92 | 36 | 51 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 338 | 261 | 33 | 4 | 198 | 101 | 40 | 57 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 338 | 295 | 303 | 97 |
| Volume Left (vph) | 338 | 0 | 4 | 40 |
| Volume Right (vph) | 0 | 33 | 101 | 0 |
| Hadj (s) | 0.53 | -0.05 | -0.16 | 0.12 |
| Departure Headway (s) | 5.6 | 5.0 | 4.8 | 5.9 |
| Degree Utilization, x | 0.53 | 0.41 | 0.40 | 0.16 |
| Capacity (veh/h) | 626 | 704 | 732 | 553 |
| Control Delay (s) | 13.4 | 10.3 | 10.9 | 10.1 |
| Approach Delay (s) | 12.0 | | 10.9 | 10.1 |
| Approach LOS | B | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.5 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 47.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 26 | 226 | 35 | 130 | 50 | 37 | 157 | 186 | 258 | 17 | 84 | 194 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 29 | 251 | 39 | 144 | 56 | 41 | 174 | 207 | 287 | 19 | 93 | 216 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 319 | 241 | 381 | 287 | 328 |
| Volume Left (vph) | 29 | 144 | 174 | 0 | 19 |
| Volume Right (vph) | 39 | 41 | 0 | 287 | 216 |
| Hadj (s) | -0.02 | 0.05 | 0.26 | -0.67 | -0.35 |
| Departure Headway (s) | 7.6 | 8.0 | 7.9 | 6.9 | 7.3 |
| Degree Utilization, x | 0.68 | 0.54 | 0.83 | 0.55 | 0.67 |
| Capacity (veh/h) | 441 | 404 | 443 | 499 | 450 |
| Control Delay (s) | 25.2 | 19.9 | 38.2 | 16.9 | 23.8 |
| Approach Delay (s) | 25.2 | 19.9 | 29.1 | | 23.8 |
| Approach LOS | D | C | D | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 25.8 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 76.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 38 | 204 | 105 | 82 | 245 | 16 | 44 | 313 | 38 | 134 | 301 | 60 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.96 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1777 | | | 1829 | | 1770 | 1833 | | 1770 | 1816 | |
| Flt Permitted | | 0.93 | | | 0.86 | | 0.43 | 1.00 | | 0.45 | 1.00 | |
| Satd. Flow (perm) | | 1667 | | | 1597 | | 803 | 1833 | | 846 | 1816 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 40 | 215 | 111 | 91 | 272 | 18 | 48 | 340 | 41 | 149 | 334 | 67 |
| RTOR Reduction (vph) | 0 | 39 | 0 | 0 | 4 | 0 | 0 | 11 | 0 | 0 | 18 | 0 |
| Lane Group Flow (vph) | 0 | 327 | 0 | 0 | 377 | 0 | 48 | 370 | 0 | 149 | 383 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 667 | | | 639 | | 321 | 733 | | 338 | 726 | |
| v/s Ratio Prot | | | | | | | | 0.20 | | | c0.21 | |
| v/s Ratio Perm | | 0.20 | | | c0.24 | | 0.06 | | | 0.18 | | |
| v/c Ratio | | 0.49 | | | 0.59 | | 0.15 | 0.51 | | 0.44 | 0.53 | |
| Uniform Delay, d1 | | 9.0 | | | 9.4 | | 7.7 | 9.0 | | 8.7 | 9.1 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.6 | | | 4.0 | | 1.0 | 2.5 | | 4.1 | 2.7 | |
| Delay (s) | | 11.5 | | | 13.4 | | 8.6 | 11.5 | | 12.9 | 11.9 | |
| Level of Service | | B | | | B | | A | B | | B | B | |
| Approach Delay (s) | | 11.5 | | | 13.4 | | | 11.2 | | | 12.1 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.0 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.56 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 69.9% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Year 2015 Baseline Conditions
# Weekend Midday Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 104 | 212 | 247 | 8 | 203 | 6 | 112 | 2 | 3 | 13 | 6 | 60 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 113 | 230 | 268 | 9 | 221 | 7 | 124 | 2 | 3 | 14 | 7 | 67 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 113 | 499 | 236 | 124 | 5 | 87 |
| Volume Left (vph) | 113 | 0 | 9 | 124 | 0 | 14 |
| Volume Right (vph) | 0 | 268 | 7 | 0 | 3 | 67 |
| Hadj (s) | 0.53 | -0.34 | 0.02 | 0.53 | -0.38 | -0.39 |
| Departure Headway (s) | 6.1 | 5.3 | 6.1 | 7.4 | 6.4 | 6.6 |
| Degree Utilization, x | 0.19 | 0.73 | 0.40 | 0.25 | 0.01 | 0.16 |
| Capacity (veh/h) | 565 | 666 | 565 | 439 | 499 | 495 |
| Control Delay (s) | 9.4 | 19.9 | 13.1 | 11.7 | 8.3 | 10.8 |
| Approach Delay (s) | 17.9 | | 13.1 | 11.5 | | 10.8 |
| Approach LOS | C | | B | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 15.5 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 60.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 346 | 310 | 0 | 0 | 254 | 201 | 326 | 4 | 255 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.94 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1752 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1752 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 326 | 0 | 0 | 282 | 223 | 358 | 4 | 280 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 0 | 178 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 364 | 326 | 0 | 0 | 467 | 0 | 0 | 362 | 102 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 11.8 | 39.5 | | | 23.7 | | | 27.2 | 27.2 | | | |
| Effective Green, g (s) | 11.8 | 39.5 | | | 23.7 | | | 27.2 | 27.2 | | | |
| Actuated g/C Ratio | 0.16 | 0.53 | | | 0.32 | | | 0.36 | 0.36 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 542 | 985 | | | 556 | | | 646 | 576 | | | |
| v/s Ratio Prot | c0.11 | 0.18 | | | c0.27 | | | c0.20 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.06 | | | |
| v/c Ratio | 0.67 | 0.33 | | | 0.84 | | | 0.56 | 0.18 | | | |
| Uniform Delay, d1 | 29.6 | 10.1 | | | 23.7 | | | 19.0 | 16.1 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 3.3 | 0.2 | | | 11.0 | | | 3.5 | 0.7 | | | |
| Delay (s) | 32.9 | 10.3 | | | 34.8 | | | 22.5 | 16.8 | | | |
| Level of Service | C | B | | | C | | | C | B | | | |
| Approach Delay (s) | | 22.2 | | | 34.8 | | | 20.0 | | | 0.0 | |
| Approach LOS | | C | | | C | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.69 | | |
| Actuated Cycle Length (s) | 74.7 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 70.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 67 | 160 | 433 | 122 | 0 | 31 | 0 | 403 | 210 | 462 | 42 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3457 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.40 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 745 | | 2787 | | 3457 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 74 | 178 | 481 | 136 | 0 | 34 | 0 | 448 | 233 | 513 | 47 |
| RTOR Reduction (vph) | 0 | 0 | 140 | 0 | 0 | 0 | 0 | 0 | 280 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 74 | 38 | 481 | 136 | 0 | 34 | 0 | 168 | 0 | 789 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.3 | 18.3 | 18.3 | 40.6 | | 10.0 | | 32.3 | | 23.5 | |
| Effective Green, g (s) | | 18.3 | 18.3 | 18.3 | 40.6 | | 10.0 | | 32.3 | | 23.5 | |
| Actuated g/C Ratio | | 0.21 | 0.21 | 0.21 | 0.47 | | 0.12 | | 0.38 | | 0.27 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 396 | 336 | 730 | 878 | | 87 | | 1046 | | 944 | |
| v/s Ratio Prot | | c0.04 | | c0.14 | 0.07 | | | | 0.06 | | c0.23 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.19 | 0.11 | 0.66 | 0.15 | | 0.39 | | 0.16 | | 0.84 | |
| Uniform Delay, d1 | | 27.8 | 27.3 | 31.0 | 13.0 | | 35.2 | | 17.9 | | 29.5 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.0 | 0.7 | 2.2 | 0.1 | | 2.9 | | 0.1 | | 6.5 | |
| Delay (s) | | 28.8 | 28.0 | 33.2 | 13.1 | | 38.1 | | 18.0 | | 36.0 | |
| Level of Service | | C | C | C | B | | D | | B | | D | |
| Approach Delay (s) | | 28.3 | | | 28.8 | | | 19.4 | | | 36.0 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.3 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.56 | | |
| Actuated Cycle Length (s) | 86.1 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 52.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 53 | 168 | 0 | 0 | 59 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 59 | 171 | 0 | 0 | 66 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 171 | | | | 230 | 171 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 171 | | | | 230 | 171 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 92 |
| cM capacity (veh/h) | 1406 | | | | 758 | 872 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 59 | 171 | 0 | 66 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 66 |
| cSH | 1406 | 1700 | 1700 | 872 |
| Volume to Capacity | 0.00 | 0.10 | 0.00 | 0.08 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 6 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 9.5 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.5 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.1 | | |
| Intersection Capacity Utilization | 19.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 288 | 145 | 17 | 0 | 175 | 102 | 10 | 14 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 300 | 151 | 18 | 0 | 192 | 112 | 11 | 16 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 300 | 169 | 304 | 27 |
| Volume Left (vph) | 300 | 0 | 0 | 11 |
| Volume Right (vph) | 0 | 18 | 112 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.19 | 0.12 |
| Departure Headway (s) | 5.3 | 4.7 | 4.4 | 5.6 |
| Degree Utilization, x | 0.44 | 0.22 | 0.37 | 0.04 |
| Capacity (veh/h) | 669 | 745 | 809 | 572 |
| Control Delay (s) | 11.3 | 7.9 | 9.9 | 8.9 |
| Approach Delay (s) | 10.1 | | 9.9 | 8.9 |
| Approach LOS | B | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.0 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 44.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 119 | 186 | 179 | 15 | 92 | 153 | 85 | 40 | 23 | 28 | 214 | 28 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 132 | 207 | 199 | 17 | 102 | 170 | 94 | 44 | 26 | 31 | 238 | 31 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 538 | 289 | 139 | 26 | 300 |
| Volume Left (vph) | 132 | 17 | 94 | 0 | 31 |
| Volume Right (vph) | 199 | 170 | 0 | 26 | 31 |
| Hadj (s) | -0.14 | -0.31 | 0.37 | -0.67 | -0.01 |
| Departure Headway (s) | 6.2 | 6.6 | 8.4 | 7.3 | 7.2 |
| Degree Utilization, x | 0.93 | 0.53 | 0.32 | 0.05 | 0.60 |
| Capacity (veh/h) | 573 | 512 | 402 | 455 | 480 |
| Control Delay (s) | 46.2 | 16.8 | 14.2 | 9.5 | 20.4 |
| Approach Delay (s) | 46.2 | 16.8 | 13.5 | | 20.4 |
| Approach LOS | E | C | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 29.4 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 77.0% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 27 | 209 | 26 | 113 | 191 | 67 | 51 | 184 | 25 | 20 | 209 | 102 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.98 | | 1.00 | 0.98 | | 1.00 | 0.95 | |
| Flt Protected | | 0.99 | | | 0.98 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1829 | | | 1790 | | 1770 | 1830 | | 1770 | 1771 | |
| Flt Permitted | | 0.94 | | | 0.84 | | 0.50 | 1.00 | | 0.62 | 1.00 | |
| Satd. Flow (perm) | | 1729 | | | 1529 | | 922 | 1830 | | 1149 | 1771 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 28 | 220 | 27 | 126 | 212 | 74 | 55 | 200 | 27 | 22 | 232 | 113 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 12 | 0 | 0 | 44 | 0 |
| Lane Group Flow (vph) | 0 | 265 | 0 | 0 | 392 | 0 | 55 | 215 | 0 | 22 | 301 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 692 | | | 612 | | 369 | 732 | | 460 | 708 | |
| v/s Ratio Prot | | | | | | | | 0.12 | | | c0.17 | |
| v/s Ratio Perm | | 0.15 | | | c0.26 | | 0.06 | | | 0.02 | | |
| v/c Ratio | | 0.38 | | | 0.64 | | 0.15 | 0.29 | | 0.05 | 0.43 | |
| Uniform Delay, d1 | | 8.5 | | | 9.7 | | 7.7 | 8.2 | | 7.3 | 8.7 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.6 | | | 5.1 | | 0.9 | 1.0 | | 0.2 | 1.9 | |
| Delay (s) | | 10.1 | | | 14.8 | | 8.5 | 9.2 | | 7.5 | 10.5 | |
| Level of Service | | B | | | B | | A | A | | A | B | |
| Approach Delay (s) | | 10.1 | | | 14.8 | | | 9.0 | | | 10.4 | |
| Approach LOS | | B | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.4 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.53 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 68.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Cumulative Year 2035 Baseline Conditions
# Weekday AM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 267 | 219 | 40 | 4 | 375 | 23 | 7 | 1 | 2 | 21 | 3 | 228 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 290 | 238 | 43 | 4 | 408 | 25 | 8 | 1 | 2 | 23 | 3 | 253 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 290 | 282 | 437 | 8 | 3 | 279 |
| Volume Left (vph) | 290 | 0 | 4 | 8 | 0 | 23 |
| Volume Right (vph) | 0 | 43 | 25 | 0 | 2 | 253 |
| Hadj (s) | 0.53 | -0.07 | 0.00 | 0.53 | -0.43 | -0.49 |
| Departure Headway (s) | 6.8 | 6.1 | 6.3 | 8.6 | 7.6 | 6.6 |
| Degree Utilization, x | 0.54 | 0.48 | 0.76 | 0.02 | 0.01 | 0.51 |
| Capacity (veh/h) | 518 | 572 | 554 | 378 | 419 | 517 |
| Control Delay (s) | 16.4 | 13.5 | 26.9 | 10.5 | 9.4 | 16.2 |
| Approach Delay (s) | 14.9 | | 26.9 | 10.2 | | 16.2 |
| Approach LOS | B | | D | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 19.2 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 521 | 255 | 0 | 0 | 796 | 455 | 496 | 6 | 182 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 548 | 268 | 0 | 0 | 884 | 506 | 545 | 7 | 200 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 147 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 548 | 268 | 0 | 0 | 1365 | 0 | 0 | 552 | 53 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 15.9 | 49.9 | | | 30.0 | | | 21.0 | 21.0 | | | |
| Effective Green, g (s) | 15.9 | 49.9 | | | 30.0 | | | 21.0 | 21.0 | | | |
| Actuated g/C Ratio | 0.20 | 0.63 | | | 0.38 | | | 0.27 | 0.27 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 692 | 1178 | | | 673 | | | 472 | 421 | | | |
| v/s Ratio Prot | c0.16 | 0.14 | | | c0.77 | | | c0.31 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.03 | | | |
| v/c Ratio | 0.79 | 0.23 | | | 2.03 | | | 1.17 | 0.13 | | | |
| Uniform Delay, d1 | 29.9 | 6.2 | | | 24.5 | | | 29.0 | 22.0 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 6.2 | 0.1 | | | 467.6 | | | 97.0 | 0.6 | | | |
| Delay (s) | 36.1 | 6.3 | | | 492.1 | | | 125.9 | 22.6 | | | |
| Level of Service | D | A | | | F | | | F | C | | | |
| Approach Delay (s) | | 26.3 | | | 492.1 | | | 98.4 | | | 0.0 | |
| Approach LOS | | C | | | F | | | F | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 263.5 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.46 | | |
| Actuated Cycle Length (s) | 78.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 122.3% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 192 | 419 | 691 | 232 | 0 | 54 | 0 | 512 | 211 | 595 | 40 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3471 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.30 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 567 | | 2787 | | 3471 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 213 | 466 | 768 | 258 | 0 | 60 | 0 | 569 | 234 | 661 | 44 |
| RTOR Reduction (vph) | 0 | 0 | 229 | 0 | 0 | 0 | 0 | 0 | 287 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 213 | 237 | 768 | 258 | 0 | 60 | 0 | 282 | 0 | 935 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.1 | 18.1 | 24.2 | 46.3 | | 13.3 | | 41.5 | | 25.1 | |
| Effective Green, g (s) | | 18.1 | 18.1 | 24.2 | 46.3 | | 13.3 | | 41.5 | | 25.1 | |
| Actuated g/C Ratio | | 0.19 | 0.19 | 0.25 | 0.48 | | 0.14 | | 0.43 | | 0.26 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 349 | 296 | 859 | 892 | | 78 | | 1196 | | 901 | |
| v/s Ratio Prot | | 0.11 | | c0.22 | 0.14 | | | | 0.10 | | c0.27 | |
| v/s Ratio Perm | | | c0.15 | | | | c0.11 | | | | | |
| v/c Ratio | | 0.61 | 0.80 | 0.89 | 0.29 | | 0.77 | | 0.24 | | 1.04 | |
| Uniform Delay, d1 | | 36.1 | 37.6 | 35.0 | 15.2 | | 40.2 | | 17.5 | | 35.8 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 7.7 | 19.9 | 11.7 | 0.2 | | 35.7 | | 0.1 | | 40.3 | |
| Delay (s) | | 43.8 | 57.5 | 46.7 | 15.4 | | 75.9 | | 17.6 | | 76.1 | |
| Level of Service | | D | E | D | B | | E | | B | | E | |
| Approach Delay (s) | | 53.2 | | | 38.8 | | | 23.2 | | | 76.1 | |
| Approach LOS | | D | | | D | | | C | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 49.5 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.90 | | |
| Actuated Cycle Length (s) | 96.7 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 79.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 237 | 390 | 1 | 0 | 0 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 263 | 398 | 1 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 399 | | | | 662 | 398 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 399 | | | | 662 | 398 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1160 | | | | 427 | 651 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 263 | 399 | 0 | 0 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 1 | 0 | 0 |
| cSH | 1160 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.23 | 0.00 | 0.00 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 0.0 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 23.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 408 | 248 | 79 | 1 | 226 | 141 | 20 | 16 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 425 | 258 | 82 | 1 | 248 | 155 | 22 | 18 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 425 | 341 | 404 | 40 |
| Volume Left (vph) | 425 | 0 | 1 | 22 |
| Volume Right (vph) | 0 | 82 | 155 | 0 |
| Hadj (s) | 0.53 | -0.14 | -0.20 | 0.15 |
| Departure Headway (s) | 5.5 | 4.8 | 4.6 | 6.3 |
| Degree Utilization, x | 0.65 | 0.45 | 0.52 | 0.07 |
| Capacity (veh/h) | 643 | 741 | 768 | 516 |
| Control Delay (s) | 16.7 | 10.5 | 12.4 | 9.8 |
| Approach Delay (s) | 14.0 | | 12.4 | 9.8 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 13.3 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 56.5% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 24 | 289 | 19 | 128 | 109 | 65 | 299 | 180 | 243 | 9 | 44 | 211 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 27 | 321 | 21 | 142 | 121 | 72 | 332 | 200 | 270 | 10 | 49 | 234 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 369 | 336 | 532 | 270 | 293 |
| Volume Left (vph) | 27 | 142 | 332 | 0 | 10 |
| Volume Right (vph) | 21 | 72 | 0 | 270 | 234 |
| Hadj (s) | 0.01 | -0.01 | 0.35 | -0.67 | -0.44 |
| Departure Headway (s) | 8.2 | 8.4 | 8.8 | 7.8 | 8.3 |
| Degree Utilization, x | 0.84 | 0.78 | 1.30 | 0.58 | 0.68 |
| Capacity (veh/h) | 420 | 414 | 409 | 450 | 399 |
| Control Delay (s) | 42.3 | 35.2 | 178.7 | 19.9 | 26.9 |
| Approach Delay (s) | 42.3 | 35.2 | 125.2 | | 26.9 |
| Approach LOS | E | E | F | | D |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 75.4 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 89.6% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 22 | 258 | 69 | 105 | 441 | 49 | 42 | 220 | 30 | 88 | 216 | 62 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 1.00 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1807 | | | 1826 | | 1770 | 1829 | | 1770 | 1800 | |
| Flt Permitted | | 0.96 | | | 0.88 | | 0.54 | 1.00 | | 0.58 | 1.00 | |
| Satd. Flow (perm) | | 1738 | | | 1624 | | 1001 | 1829 | | 1084 | 1800 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 23 | 272 | 73 | 117 | 490 | 54 | 46 | 239 | 33 | 98 | 240 | 69 |
| RTOR Reduction (vph) | 0 | 22 | 0 | 0 | 8 | 0 | 0 | 13 | 0 | 0 | 26 | 0 |
| Lane Group Flow (vph) | 0 | 346 | 0 | 0 | 653 | 0 | 46 | 259 | 0 | 98 | 283 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 695 | | | 650 | | 400 | 732 | | 434 | 720 | |
| v/s Ratio Prot | | | | | | | | 0.14 | | | c0.16 | |
| v/s Ratio Perm | | 0.20 | | | c0.40 | | 0.05 | | | 0.09 | | |
| v/c Ratio | | 0.50 | | | 1.00 | | 0.12 | 0.35 | | 0.23 | 0.39 | |
| Uniform Delay, d1 | | 9.0 | | | 12.0 | | 7.5 | 8.4 | | 7.9 | 8.5 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.5 | | | 36.5 | | 0.6 | 1.3 | | 1.2 | 1.6 | |
| Delay (s) | | 11.5 | | | 48.5 | | 8.1 | 9.7 | | 9.1 | 10.2 | |
| Level of Service | | B | | | D | | A | A | | A | B | |
| Approach Delay (s) | | 11.5 | | | 48.5 | | | 9.5 | | | 9.9 | |
| Approach LOS | | B | | | D | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 82.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Cumulative Year 2035 Baseline Conditions
# Weekday PM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 290 | 333 | 7 | 0 | 211 | 12 | 191 | 3 | 6 | 17 | 3 | 330 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 315 | 362 | 8 | 0 | 229 | 13 | 212 | 3 | 7 | 18 | 3 | 367 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 315 | 370 | 242 | 212 | 10 | 388 |
| Volume Left (vph) | 315 | 0 | 0 | 212 | 0 | 18 |
| Volume Right (vph) | 0 | 8 | 13 | 0 | 7 | 367 |
| Hadj (s) | 0.53 | 0.02 | 0.00 | 0.53 | -0.43 | -0.52 |
| Departure Headway (s) | 8.3 | 7.8 | 8.5 | 9.1 | 8.1 | 7.6 |
| Degree Utilization, x | 0.73 | 0.80 | 0.57 | 0.54 | 0.02 | 0.82 |
| Capacity (veh/h) | 420 | 454 | 394 | 367 | 409 | 455 |
| Control Delay (s) | 29.2 | 33.8 | 22.4 | 21.1 | 10.1 | 36.4 |
| Approach Delay (s) | 31.7 | | 22.4 | 20.6 | | 36.4 |
| Approach LOS | D | | C | C | | E |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 29.8 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 75.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 641 | 389 | 0 | 0 | 801 | 226 | 596 | 4 | 228 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.97 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1807 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1807 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 675 | 409 | 0 | 0 | 890 | 251 | 655 | 4 | 251 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 137 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 675 | 409 | 0 | 0 | 1132 | 0 | 0 | 659 | 114 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 19.0 | 69.0 | | | 46.0 | | | 33.0 | 33.0 | | | |
| Effective Green, g (s) | 19.0 | 69.0 | | | 46.0 | | | 33.0 | 33.0 | | | |
| Actuated g/C Ratio | 0.17 | 0.63 | | | 0.42 | | | 0.30 | 0.30 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 593 | 1169 | | | 756 | | | 533 | 475 | | | |
| v/s Ratio Prot | c0.20 | 0.22 | | | c0.63 | | | c0.37 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.07 | | | |
| v/c Ratio | 1.14 | 0.35 | | | 1.50 | | | 1.24 | 0.24 | | | |
| Uniform Delay, d1 | 45.5 | 9.8 | | | 32.0 | | | 38.5 | 29.0 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 81.3 | 0.2 | | | 230.6 | | | 121.8 | 1.2 | | | |
| Delay (s) | 126.8 | 10.0 | | | 262.6 | | | 160.3 | 30.2 | | | |
| Level of Service | F | A | | | F | | | F | C | | | |
| Approach Delay (s) | | 82.7 | | | 262.6 | | | 124.4 | | | 0.0 | |
| Approach LOS | | F | | | F | | | F | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 160.3 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.34 | | |
| Actuated Cycle Length (s) | 110.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 119.6% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 177 | 378 | 831 | 219 | 0 | 36 | 0 | 577 | 188 | 733 | 59 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3474 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.33 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 616 | | 2787 | | 3474 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 197 | 420 | 923 | 243 | 0 | 40 | 0 | 641 | 209 | 814 | 66 |
| RTOR Reduction (vph) | 0 | 0 | 221 | 0 | 0 | 0 | 0 | 0 | 254 | 0 | 5 | 0 |
| Lane Group Flow (vph) | 0 | 197 | 199 | 923 | 243 | 0 | 40 | 0 | 387 | 0 | 1084 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.1 | 17.1 | 28.9 | 50.0 | | 12.1 | | 45.0 | | 21.1 | |
| Effective Green, g (s) | | 17.1 | 17.1 | 28.9 | 50.0 | | 12.1 | | 45.0 | | 21.1 | |
| Actuated g/C Ratio | | 0.18 | 0.18 | 0.30 | 0.53 | | 0.13 | | 0.47 | | 0.22 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 335 | 284 | 1042 | 978 | | 78 | | 1317 | | 770 | |
| v/s Ratio Prot | | 0.11 | | c0.27 | 0.13 | | | | 0.14 | | c0.31 | |
| v/s Ratio Perm | | | c0.13 | | | | c0.06 | | | | | |
| v/c Ratio | | 0.59 | 0.70 | 0.89 | 0.25 | | 0.51 | | 0.29 | | 1.41 | |
| Uniform Delay, d1 | | 35.8 | 36.7 | 31.6 | 12.3 | | 38.8 | | 15.4 | | 37.1 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 7.4 | 13.5 | 9.2 | 0.1 | | 5.6 | | 0.1 | | 191.4 | |
| Delay (s) | | 43.2 | 50.2 | 40.8 | 12.5 | | 44.4 | | 15.5 | | 228.5 | |
| Level of Service | | D | D | D | B | | D | | B | | F | |
| Approach Delay (s) | | 48.0 | | | 34.9 | | | 17.2 | | | 228.5 | |
| Approach LOS | | D | | | C | | | B | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 93.1 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 0.93 | | |
| Actuated Cycle Length (s) | 95.2 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 84.7% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 328 | 222 | 1 | 2 | 79 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 364 | 227 | 1 | 2 | 88 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 228 | | | | 591 | 227 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 228 | | | | 591 | 227 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 89 |
| cM capacity (veh/h) | 1341 | | | | 469 | 812 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 364 | 228 | 2 | 88 |
| Volume Left | 0 | 0 | 2 | 0 |
| Volume Right | 0 | 1 | 0 | 88 |
| cSH | 1341 | 1700 | 469 | 812 |
| Volume to Capacity | 0.00 | 0.13 | 0.00 | 0.11 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 9 |
| Control Delay (s) | 0.0 | 0.0 | 12.7 | 10.0 |
| Lane LOS | | | B | A |
| Approach Delay (s) | 0.0 | 0.0 | 10.0 | |
| Approach LOS | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.3 | | |
| Intersection Capacity Utilization | 27.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 366 | 284 | 36 | 5 | 205 | 104 | 38 | 53 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 381 | 296 | 38 | 5 | 225 | 114 | 42 | 59 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 381 | 333 | 345 | 101 |
| Volume Left (vph) | 381 | 0 | 5 | 42 |
| Volume Right (vph) | 0 | 38 | 114 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.16 | 0.12 |
| Departure Headway (s) | 5.7 | 5.1 | 4.9 | 6.2 |
| Degree Utilization, x | 0.60 | 0.47 | 0.47 | 0.17 |
| Capacity (veh/h) | 619 | 696 | 720 | 535 |
| Control Delay (s) | 15.7 | 11.4 | 12.0 | 10.4 |
| Approach Delay (s) | 13.7 | | 12.0 | 10.4 |
| Approach LOS | B | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 12.9 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 52.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 44 | 305 | 47 | 164 | 50 | 46 | 188 | 222 | 309 | 22 | 109 | 252 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 49 | 339 | 52 | 182 | 56 | 51 | 209 | 247 | 343 | 24 | 121 | 280 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 440 | 289 | 456 | 343 | 426 |
| Volume Left (vph) | 49 | 182 | 209 | 0 | 24 |
| Volume Right (vph) | 52 | 51 | 0 | 343 | 280 |
| Hadj (s) | -0.01 | 0.05 | 0.26 | -0.67 | -0.35 |
| Departure Headway (s) | 8.9 | 9.6 | 9.4 | 8.5 | 8.7 |
| Degree Utilization, x | 1.09 | 0.77 | 1.20 | 0.81 | 1.03 |
| Capacity (veh/h) | 413 | 370 | 386 | 418 | 426 |
| Control Delay (s) | 101.7 | 38.2 | 139.0 | 38.1 | 81.6 |
| Approach Delay (s) | 101.7 | 38.2 | 95.7 | | 81.6 |
| Approach LOS | F | E | F | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 85.5 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 93.7% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 50 | 267 | 138 | 117 | 399 | 25 | 69 | 484 | 58 | 191 | 429 | 86 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.96 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1777 | | | 1831 | | 1770 | 1833 | | 1770 | 1816 | |
| Flt Permitted | | 0.91 | | | 0.81 | | 0.25 | 1.00 | | 0.25 | 1.00 | |
| Satd. Flow (perm) | | 1634 | | | 1492 | | 466 | 1833 | | 466 | 1816 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 53 | 281 | 145 | 130 | 443 | 28 | 75 | 526 | 63 | 212 | 477 | 96 |
| RTOR Reduction (vph) | 0 | 39 | 0 | 0 | 4 | 0 | 0 | 11 | 0 | 0 | 18 | 0 |
| Lane Group Flow (vph) | 0 | 440 | 0 | 0 | 597 | 0 | 75 | 578 | 0 | 212 | 555 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 654 | | | 597 | | 186 | 733 | | 186 | 726 | |
| v/s Ratio Prot | | | | | | | | 0.32 | | | 0.31 | |
| v/s Ratio Perm | | 0.27 | | | c0.40 | | 0.16 | | | c0.46 | | |
| v/c Ratio | | 0.67 | | | 1.00 | | 0.40 | 0.79 | | 1.14 | 0.76 | |
| Uniform Delay, d1 | | 9.9 | | | 12.0 | | 8.6 | 10.5 | | 12.0 | 10.4 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 5.5 | | | 36.8 | | 6.4 | 8.4 | | 108.6 | 7.5 | |
| Delay (s) | | 15.3 | | | 48.8 | | 15.0 | 18.9 | | 120.6 | 17.9 | |
| Level of Service | | B | | | D | | B | B | | F | B | |
| Approach Delay (s) | | 15.3 | | | 48.8 | | | 18.5 | | | 45.6 | |
| Approach LOS | | B | | | D | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 33.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 1.07 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 99.8% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Cumulative Year 2035 Baseline Conditions
# Weekend Midday Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 104 | 215 | 247 | 8 | 205 | 6 | 112 | 2 | 3 | 13 | 6 | 60 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 113 | 234 | 268 | 9 | 223 | 7 | 124 | 2 | 3 | 14 | 7 | 67 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 113 | 502 | 238 | 124 | 5 | 87 |
| Volume Left (vph) | 113 | 0 | 9 | 124 | 0 | 14 |
| Volume Right (vph) | 0 | 268 | 7 | 0 | 3 | 67 |
| Hadj (s) | 0.53 | -0.34 | 0.02 | 0.53 | -0.38 | -0.39 |
| Departure Headway (s) | 6.1 | 5.3 | 6.1 | 7.4 | 6.5 | 6.6 |
| Degree Utilization, x | 0.19 | 0.73 | 0.40 | 0.26 | 0.01 | 0.16 |
| Capacity (veh/h) | 564 | 665 | 565 | 438 | 498 | 491 |
| Control Delay (s) | 9.4 | 20.2 | 13.1 | 11.7 | 8.3 | 10.8 |
| Approach Delay (s) | 18.2 | | 13.1 | 11.6 | | 10.8 |
| Approach LOS | C | | B | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 15.7 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 60.9% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 346 | 310 | 0 | 0 | 510 | 432 | 440 | 6 | 310 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.94 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1747 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1747 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 326 | 0 | 0 | 567 | 480 | 484 | 7 | 341 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 0 | 225 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 364 | 326 | 0 | 0 | 1009 | 0 | 0 | 491 | 116 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 12.1 | 44.1 | | | 28.0 | | | 27.0 | 27.0 | | | |
| Effective Green, g (s) | 12.1 | 44.1 | | | 28.0 | | | 27.0 | 27.0 | | | |
| Actuated g/C Ratio | 0.15 | 0.56 | | | 0.35 | | | 0.34 | 0.34 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 525 | 1039 | | | 618 | | | 606 | 540 | | | |
| v/s Ratio Prot | c0.11 | 0.18 | | | c0.58 | | | c0.28 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.07 | | | |
| v/c Ratio | 0.69 | 0.31 | | | 1.63 | | | 0.81 | 0.22 | | | |
| Uniform Delay, d1 | 31.7 | 9.4 | | | 25.5 | | | 23.7 | 18.5 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 3.9 | 0.2 | | | 292.0 | | | 11.2 | 0.9 | | | |
| Delay (s) | 35.7 | 9.6 | | | 317.5 | | | 34.9 | 19.4 | | | |
| Level of Service | D | A | | | F | | | C | B | | | |
| Approach Delay (s) | | 23.3 | | | 317.5 | | | 28.6 | | | 0.0 | |
| Approach LOS | | C | | | F | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 144.9 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.13 | | |
| Actuated Cycle Length (s) | 79.1 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 104.2% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 120 | 343 | 562 | 160 | 0 | 31 | 0 | 403 | 249 | 622 | 57 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3460 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.37 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 684 | | 2787 | | 3460 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 133 | 381 | 624 | 178 | 0 | 34 | 0 | 448 | 277 | 691 | 63 |
| RTOR Reduction (vph) | 0 | 0 | 231 | 0 | 0 | 0 | 0 | 0 | 267 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 133 | 150 | 624 | 178 | 0 | 34 | 0 | 181 | 0 | 1027 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.2 | 18.2 | 22.0 | 44.2 | | 10.9 | | 36.9 | | 24.2 | |
| Effective Green, g (s) | | 18.2 | 18.2 | 22.0 | 44.2 | | 10.9 | | 36.9 | | 24.2 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.24 | 0.48 | | 0.12 | | 0.40 | | 0.27 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 371 | 316 | 827 | 902 | | 82 | | 1126 | | 917 | |
| v/s Ratio Prot | | 0.07 | | c0.18 | 0.10 | | | | 0.06 | | c0.30 | |
| v/s Ratio Perm | | | c0.09 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.36 | 0.47 | 0.75 | 0.20 | | 0.41 | | 0.16 | | 1.12 | |
| Uniform Delay, d1 | | 31.5 | 32.3 | 32.1 | 13.4 | | 37.2 | | 17.3 | | 33.6 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 2.7 | 5.0 | 3.9 | 0.1 | | 3.4 | | 0.1 | | 68.3 | |
| Delay (s) | | 34.2 | 37.3 | 36.1 | 13.5 | | 40.6 | | 17.4 | | 101.8 | |
| Level of Service | | C | D | D | B | | D | | B | | F | |
| Approach Delay (s) | | 36.5 | | | 31.1 | | | 19.0 | | | 101.8 | |
| Approach LOS | | D | | | C | | | B | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 55.8 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 0.75 | | |
| Actuated Cycle Length (s) | 91.3 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 73.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 71 | 201 | 0 | 0 | 53 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 79 | 205 | 0 | 0 | 59 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 205 | | | | 284 | 205 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 205 | | | | 284 | 205 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 93 |
| cM capacity (veh/h) | 1366 | | | | 706 | 835 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 79 | 205 | 0 | 59 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 59 |
| cSH | 1366 | 1700 | 1700 | 835 |
| Volume to Capacity | 0.00 | 0.12 | 0.00 | 0.07 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 6 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 9.6 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.6 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.7 | | |
| Intersection Capacity Utilization | 20.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 322 | 162 | 20 | 0 | 205 | 120 | 11 | 15 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 335 | 169 | 21 | 0 | 225 | 132 | 12 | 17 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 335 | 190 | 357 | 29 |
| Volume Left (vph) | 335 | 0 | 0 | 12 |
| Volume Right (vph) | 0 | 21 | 132 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.19 | 0.12 |
| Departure Headway (s) | 5.4 | 4.8 | 4.4 | 5.9 |
| Degree Utilization, x | 0.50 | 0.25 | 0.44 | 0.05 |
| Capacity (veh/h) | 663 | 738 | 800 | 548 |
| Control Delay (s) | 12.4 | 8.2 | 10.8 | 9.1 |
| Approach Delay (s) | 10.9 | | 10.8 | 9.1 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.8 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 49.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 160 | 251 | 241 | 19 | 115 | 204 | 111 | 51 | 31 | 35 | 268 | 35 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 178 | 279 | 268 | 21 | 128 | 227 | 123 | 57 | 34 | 39 | 298 | 39 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 724 | 376 | 180 | 34 | 376 |
| Volume Left (vph) | 178 | 21 | 123 | 0 | 39 |
| Volume Right (vph) | 268 | 227 | 0 | 34 | 39 |
| Hadj (s) | -0.14 | -0.32 | 0.38 | -0.67 | -0.01 |
| Departure Headway (s) | 7.4 | 7.5 | 9.2 | 8.2 | 7.9 |
| Degree Utilization, x | 1.49 | 0.78 | 0.46 | 0.08 | 0.83 |
| Capacity (veh/h) | 467 | 464 | 357 | 402 | 435 |
| Control Delay (s) | 253.5 | 32.6 | 18.8 | 10.7 | 38.6 |
| Approach Delay (s) | 253.5 | 32.6 | 17.5 | | 38.6 |
| Approach LOS | F | D | C | | E |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 126.7 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 96.7% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 33 | 250 | 31 | 197 | 351 | 125 | 79 | 284 | 38 | 26 | 271 | 133 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.97 | | 1.00 | 0.98 | | 1.00 | 0.95 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1828 | | | 1790 | | 1770 | 1830 | | 1770 | 1771 | |
| Flt Permitted | | 0.92 | | | 0.79 | | 0.38 | 1.00 | | 0.49 | 1.00 | |
| Satd. Flow (perm) | | 1687 | | | 1436 | | 705 | 1830 | | 912 | 1771 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 35 | 263 | 33 | 219 | 390 | 139 | 86 | 309 | 41 | 29 | 301 | 148 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 12 | 0 | 0 | 44 | 0 |
| Lane Group Flow (vph) | 0 | 321 | 0 | 0 | 728 | 0 | 86 | 338 | 0 | 29 | 405 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 675 | | | 574 | | 282 | 732 | | 365 | 708 | |
| v/s Ratio Prot | | | | | | | | 0.18 | | | c0.23 | |
| v/s Ratio Perm | | 0.19 | | | c0.51 | | 0.12 | | | 0.03 | | |
| v/c Ratio | | 0.48 | | | 1.27 | | 0.30 | 0.46 | | 0.08 | 0.57 | |
| Uniform Delay, d1 | | 8.9 | | | 12.0 | | 8.2 | 8.8 | | 7.4 | 9.3 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.4 | | | 133.8 | | 2.8 | 2.1 | | 0.4 | 3.3 | |
| Delay (s) | | 11.3 | | | 145.8 | | 11.0 | 10.9 | | 7.9 | 12.7 | |
| Level of Service | | B | | | F | | B | B | | A | B | |
| Approach Delay (s) | | 11.3 | | | 145.8 | | | 10.9 | | | 12.4 | |
| Approach LOS | | B | | | F | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 61.9 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 93.9% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Existing plus Project Conditions
# Weekday AM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 135 | 215 | 52 | 6 | 369 | 19 | 9 | 1 | 2 | 18 | 4 | 59 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 147 | 234 | 57 | 7 | 401 | 21 | 10 | 1 | 2 | 20 | 4 | 66 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 147 | 290 | 428 | 10 | 3 | 90 |
| Volume Left (vph) | 147 | 0 | 7 | 10 | 0 | 20 |
| Volume Right (vph) | 0 | 57 | 21 | 0 | 2 | 66 |
| Hadj (s) | 0.53 | -0.10 | 0.01 | 0.53 | -0.43 | -0.36 |
| Departure Headway (s) | 5.8 | 5.2 | 5.3 | 7.3 | 6.4 | 6.2 |
| Degree Utilization, x | 0.24 | 0.42 | 0.63 | 0.02 | 0.01 | 0.15 |
| Capacity (veh/h) | 609 | 682 | 663 | 424 | 489 | 522 |
| Control Delay (s) | 9.4 | 10.6 | 17.1 | 9.3 | 8.2 | 10.3 |
| Approach Delay (s) | 10.2 | | 17.1 | 9.0 | | 10.3 |
| Approach LOS | B | | C | A | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 13.2 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 56.9% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 521 | 262 | 0 | 0 | 258 | 148 | 337 | 4 | 134 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 548 | 276 | 0 | 0 | 287 | 164 | 370 | 4 | 147 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 35 | 0 | 0 | 0 | 103 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 548 | 276 | 0 | 0 | 416 | 0 | 0 | 374 | 44 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 11.7 | 32.4 | | | 16.7 | | | 17.1 | 17.1 | | | |
| Effective Green, g (s) | 11.7 | 32.4 | | | 16.7 | | | 17.1 | 17.1 | | | |
| Actuated g/C Ratio | 0.20 | 0.56 | | | 0.29 | | | 0.30 | 0.30 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 699 | 1050 | | | 514 | | | 528 | 471 | | | |
| v/s Ratio Prot | c0.16 | 0.15 | | | c0.23 | | | c0.21 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.03 | | | |
| v/c Ratio | 0.78 | 0.26 | | | 0.81 | | | 0.71 | 0.09 | | | |
| Uniform Delay, d1 | 21.7 | 6.4 | | | 18.9 | | | 18.0 | 14.6 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 5.8 | 0.1 | | | 9.1 | | | 7.8 | 0.4 | | | |
| Delay (s) | 27.5 | 6.6 | | | 28.0 | | | 25.8 | 15.0 | | | |
| Level of Service | C | A | | | C | | | C | B | | | |
| Approach Delay (s) | | 20.5 | | | 28.0 | | | 22.7 | | | 0.0 | |
| Approach LOS | | C | | | C | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 23.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.76 | | |
| Actuated Cycle Length (s) | 57.5 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 66.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 73 | 151 | 472 | 158 | 0 | 54 | 0 | 514 | 153 | 404 | 27 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3469 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.41 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 755 | | 2787 | | 3469 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 81 | 168 | 524 | 176 | 0 | 60 | 0 | 571 | 170 | 449 | 30 |
| RTOR Reduction (vph) | 0 | 0 | 134 | 0 | 0 | 0 | 0 | 0 | 336 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 81 | 34 | 524 | 176 | 0 | 60 | 0 | 235 | 0 | 645 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.5 | 17.5 | 19.1 | 40.6 | | 12.2 | | 35.3 | | 21.0 | |
| Effective Green, g (s) | | 17.5 | 17.5 | 19.1 | 40.6 | | 12.2 | | 35.3 | | 21.0 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.22 | 0.47 | | 0.14 | | 0.41 | | 0.24 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 380 | 323 | 764 | 882 | | 107 | | 1147 | | 849 | |
| v/s Ratio Prot | | 0.04 | | c0.15 | c0.09 | | | | 0.08 | | c0.19 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.08 | | | | | |
| v/c Ratio | | 0.21 | 0.11 | 0.69 | 0.20 | | 0.56 | | 0.20 | | 0.76 | |
| Uniform Delay, d1 | | 28.4 | 27.8 | 30.6 | 13.1 | | 34.3 | | 16.2 | | 30.1 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.3 | 0.7 | 2.6 | 0.1 | | 6.6 | | 0.1 | | 4.0 | |
| Delay (s) | | 29.7 | 28.4 | 33.2 | 13.3 | | 40.9 | | 16.3 | | 34.0 | |
| Level of Service | | C | C | C | B | | D | | B | | C | |
| Approach Delay (s) | | 28.9 | | | 28.2 | | | 18.7 | | | 34.0 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 27.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.54 | | |
| Actuated Cycle Length (s) | 85.8 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 49.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 216 | 296 | 1 | 0 | 0 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 240 | 302 | 1 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 303 | | | | 543 | 303 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 303 | | | | 543 | 303 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1258 | | | | 501 | 737 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 240 | 303 | 0 | 0 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 1 | 0 | 0 |
| cSH | 1258 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.18 | 0.00 | 0.00 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 0.0 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 19.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 357 | 217 | 69 | 1 | 170 | 106 | 19 | 15 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 372 | 226 | 72 | 1 | 187 | 116 | 21 | 17 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 372 | 298 | 304 | 38 |
| Volume Left (vph) | 372 | 0 | 1 | 21 |
| Volume Right (vph) | 0 | 72 | 116 | 0 |
| Hadj (s) | 0.53 | -0.13 | -0.19 | 0.15 |
| Departure Headway (s) | 5.4 | 4.7 | 4.5 | 6.0 |
| Degree Utilization, x | 0.56 | 0.39 | 0.38 | 0.06 |
| Capacity (veh/h) | 663 | 754 | 778 | 546 |
| Control Delay (s) | 13.7 | 9.5 | 10.3 | 9.4 |
| Approach Delay (s) | 11.8 | | 10.3 | 9.4 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.3 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 48.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 19 | 225 | 15 | 87 | 74 | 44 | 203 | 122 | 165 | 7 | 34 | 164 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 21 | 250 | 17 | 97 | 82 | 49 | 226 | 136 | 183 | 8 | 38 | 182 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 288 | 228 | 361 | 183 | 228 |
| Volume Left (vph) | 21 | 97 | 226 | 0 | 8 |
| Volume Right (vph) | 17 | 49 | 0 | 183 | 182 |
| Hadj (s) | 0.01 | -0.01 | 0.35 | -0.67 | -0.44 |
| Departure Headway (s) | 6.7 | 6.9 | 7.1 | 6.1 | 6.4 |
| Degree Utilization, x | 0.54 | 0.43 | 0.71 | 0.31 | 0.41 |
| Capacity (veh/h) | 492 | 467 | 492 | 570 | 498 |
| Control Delay (s) | 17.2 | 15.0 | 24.6 | 10.6 | 13.8 |
| Approach Delay (s) | 17.2 | 15.0 | 19.8 | | 13.8 |
| Approach LOS | C | C | C | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 17.3 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.5% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 19 | 227 | 61 | 39 | 163 | 18 | 24 | 125 | 17 | 70 | 171 | 49 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 1.00 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1807 | | | 1826 | | 1770 | 1830 | | 1770 | 1801 | |
| Flt Permitted | | 0.98 | | | 0.91 | | 0.61 | 1.00 | | 0.66 | 1.00 | |
| Satd. Flow (perm) | | 1768 | | | 1670 | | 1131 | 1830 | | 1228 | 1801 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 20 | 239 | 64 | 43 | 181 | 20 | 26 | 136 | 18 | 78 | 190 | 54 |
| RTOR Reduction (vph) | 0 | 22 | 0 | 0 | 8 | 0 | 0 | 11 | 0 | 0 | 26 | 0 |
| Lane Group Flow (vph) | 0 | 301 | 0 | 0 | 236 | 0 | 26 | 143 | 0 | 78 | 218 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 707 | | | 668 | | 452 | 732 | | 491 | 720 | |
| v/s Ratio Prot | | | | | | | | 0.08 | | | c0.12 | |
| v/s Ratio Perm | | c0.17 | | | 0.14 | | 0.02 | | | 0.06 | | |
| v/c Ratio | | 0.43 | | | 0.35 | | 0.06 | 0.20 | | 0.16 | 0.30 | |
| Uniform Delay, d1 | | 8.7 | | | 8.4 | | 7.4 | 7.8 | | 7.7 | 8.2 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.9 | | | 1.5 | | 0.2 | 0.6 | | 0.7 | 1.1 | |
| Delay (s) | | 10.5 | | | 9.9 | | 7.6 | 8.4 | | 8.4 | 9.3 | |
| Level of Service | | B | | | A | | A | A | | A | A | |
| Approach Delay (s) | | 10.5 | | | 9.9 | | | 8.3 | | | 9.1 | |
| Approach LOS | | B | | | A | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 9.6 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.36 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 48.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Existing plus Project Conditions
# Weekday PM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 96 | 327 | 9 | 0 | 207 | 3 | 248 | 4 | 8 | 8 | 4 | 99 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 104 | 355 | 10 | 0 | 225 | 3 | 276 | 4 | 9 | 9 | 4 | 110 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 104 | 365 | 228 | 276 | 13 | 123 |
| Volume Left (vph) | 104 | 0 | 0 | 276 | 0 | 9 |
| Volume Right (vph) | 0 | 10 | 3 | 0 | 9 | 110 |
| Hadj (s) | 0.53 | 0.02 | 0.03 | 0.53 | -0.43 | -0.49 |
| Departure Headway (s) | 7.0 | 6.5 | 6.9 | 7.5 | 6.5 | 6.9 |
| Degree Utilization, x | 0.20 | 0.66 | 0.44 | 0.57 | 0.02 | 0.24 |
| Capacity (veh/h) | 489 | 531 | 479 | 456 | 519 | 449 |
| Control Delay (s) | 10.6 | 19.9 | 15.2 | 18.7 | 8.4 | 12.1 |
| Approach Delay (s) | 17.8 | | 15.2 | 18.2 | | 12.1 |
| Approach LOS | C | | C | C | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 16.8 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 59.2% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

# HCM Signalized Intersection Capacity Analysis
## 2: Golf Links Road & I-580 WB On Ramp

11/8/2010

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 463 | 284 | 0 | 0 | 366 | 148 | 405 | 3 | 157 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.96 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1791 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1791 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 487 | 299 | 0 | 0 | 407 | 164 | 445 | 3 | 173 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 112 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 487 | 299 | 0 | 0 | 547 | 0 | 0 | 448 | 61 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 9.0 | 31.0 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Effective Green, g (s) | 9.0 | 31.0 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Actuated g/C Ratio | 0.15 | 0.52 | | | 0.30 | | | 0.35 | 0.35 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 515 | 963 | | | 537 | | | 621 | 554 | | | |
| v/s Ratio Prot | c0.14 | 0.16 | | | c0.31 | | | c0.25 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.04 | | | |
| v/c Ratio | 0.95 | 0.31 | | | 1.02 | | | 0.72 | 0.11 | | | |
| Uniform Delay, d1 | 25.3 | 8.3 | | | 21.0 | | | 17.0 | 13.2 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 26.4 | 0.2 | | | 43.4 | | | 7.1 | 0.4 | | | |
| Delay (s) | 51.7 | 8.5 | | | 64.4 | | | 24.1 | 13.6 | | | |
| Level of Service | D | A | | | E | | | C | B | | | |
| Approach Delay (s) | | 35.3 | | | 64.4 | | | 21.1 | | | 0.0 | |
| Approach LOS | | D | | | E | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 39.2 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.87 | | |
| Actuated Cycle Length (s) | 60.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 75.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 70 | 148 | 626 | 156 | 0 | 33 | 0 | 527 | 130 | 498 | 40 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3474 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.38 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 710 | | 2787 | | 3474 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 78 | 164 | 696 | 173 | 0 | 37 | 0 | 586 | 144 | 553 | 44 |
| RTOR Reduction (vph) | 0 | 0 | 133 | 0 | 0 | 0 | 0 | 0 | 344 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 78 | 31 | 696 | 173 | 0 | 37 | 0 | 242 | 0 | 737 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.3 | 17.3 | 22.9 | 44.2 | | 10.5 | | 37.4 | | 23.8 | |
| Effective Green, g (s) | | 17.3 | 17.3 | 22.9 | 44.2 | | 10.5 | | 37.4 | | 23.8 | |
| Actuated g/C Ratio | | 0.19 | 0.19 | 0.25 | 0.49 | | 0.12 | | 0.41 | | 0.26 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 356 | 303 | 869 | 910 | | 82 | | 1152 | | 914 | |
| v/s Ratio Prot | | c0.04 | | c0.20 | 0.09 | | | | 0.09 | | c0.21 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.22 | 0.10 | 0.80 | 0.19 | | 0.45 | | 0.21 | | 0.81 | |
| Uniform Delay, d1 | | 30.9 | 30.2 | 31.7 | 13.1 | | 37.3 | | 17.1 | | 31.2 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.4 | 0.7 | 5.3 | 0.1 | | 3.9 | | 0.1 | | 5.2 | |
| Delay (s) | | 32.3 | 30.9 | 37.0 | 13.2 | | 41.2 | | 17.2 | | 36.4 | |
| Level of Service | | C | C | D | B | | D | | B | | D | |
| Approach Delay (s) | | 31.3 | | | 32.3 | | | 18.6 | | | 36.4 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 30.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 90.5 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 56.7% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 240 | 186 | 1 | 2 | 102 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 267 | 190 | 1 | 2 | 113 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 191 | | | | 457 | 190 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 191 | | | | 457 | 190 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 87 |
| cM capacity (veh/h) | 1383 | | | | 562 | 851 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 267 | 191 | 2 | 113 |
| Volume Left | 0 | 0 | 2 | 0 |
| Volume Right | 0 | 1 | 0 | 113 |
| cSH | 1383 | 1700 | 562 | 851 |
| Volume to Capacity | 0.00 | 0.11 | 0.00 | 0.13 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 11 |
| Control Delay (s) | 0.0 | 0.0 | 11.4 | 9.9 |
| Lane LOS | | | B | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.9 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.0 | | |
| Intersection Capacity Utilization | 22.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 312 | 242 | 31 | 4 | 188 | 97 | 36 | 50 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 325 | 252 | 32 | 4 | 207 | 107 | 40 | 56 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 325 | 284 | 318 | 96 |
| Volume Left (vph) | 325 | 0 | 4 | 40 |
| Volume Right (vph) | 0 | 32 | 107 | 0 |
| Hadj (s) | 0.53 | -0.05 | -0.16 | 0.12 |
| Departure Headway (s) | 5.6 | 5.0 | 4.8 | 5.9 |
| Degree Utilization, x | 0.51 | 0.40 | 0.42 | 0.16 |
| Capacity (veh/h) | 624 | 703 | 736 | 552 |
| Control Delay (s) | 13.0 | 10.1 | 11.1 | 10.1 |
| Approach Delay (s) | 11.7 | | 11.1 | 10.1 |
| Approach LOS | B | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.4 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 47.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 24 | 207 | 32 | 122 | 64 | 35 | 149 | 176 | 245 | 16 | 78 | 180 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 27 | 230 | 36 | 136 | 71 | 39 | 166 | 196 | 272 | 18 | 87 | 200 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 292 | 246 | 361 | 272 | 304 |
| Volume Left (vph) | 27 | 136 | 166 | 0 | 18 |
| Volume Right (vph) | 36 | 39 | 0 | 272 | 200 |
| Hadj (s) | -0.02 | 0.05 | 0.26 | -0.67 | -0.35 |
| Departure Headway (s) | 7.4 | 7.6 | 7.6 | 6.6 | 7.0 |
| Degree Utilization, x | 0.60 | 0.52 | 0.76 | 0.50 | 0.59 |
| Capacity (veh/h) | 451 | 426 | 455 | 528 | 475 |
| Control Delay (s) | 20.7 | 18.5 | 29.5 | 14.8 | 19.8 |
| Approach Delay (s) | 20.7 | 18.5 | 23.2 | | 19.8 |
| Approach LOS | C | C | C | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.2 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 73.3% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 35 | 188 | 97 | 85 | 216 | 14 | 39 | 275 | 33 | 120 | 270 | 54 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.96 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.98 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1777 | | | 1827 | | 1770 | 1833 | | 1770 | 1816 | |
| Flt Permitted | | 0.94 | | | 0.85 | | 0.48 | 1.00 | | 0.51 | 1.00 | |
| Satd. Flow (perm) | | 1676 | | | 1580 | | 890 | 1833 | | 944 | 1816 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 37 | 198 | 102 | 94 | 240 | 16 | 42 | 299 | 36 | 133 | 300 | 60 |
| RTOR Reduction (vph) | 0 | 39 | 0 | 0 | 4 | 0 | 0 | 11 | 0 | 0 | 18 | 0 |
| Lane Group Flow (vph) | 0 | 298 | 0 | 0 | 346 | 0 | 42 | 324 | 0 | 133 | 342 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 670 | | | 632 | | 356 | 733 | | 378 | 726 | |
| v/s Ratio Prot | | | | | | | | 0.18 | | | c0.19 | |
| v/s Ratio Perm | | 0.18 | | | c0.22 | | 0.05 | | | 0.14 | | |
| v/c Ratio | | 0.44 | | | 0.55 | | 0.12 | 0.44 | | 0.35 | 0.47 | |
| Uniform Delay, d1 | | 8.8 | | | 9.2 | | 7.6 | 8.7 | | 8.4 | 8.9 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.1 | | | 3.4 | | 0.7 | 1.9 | | 2.6 | 2.2 | |
| Delay (s) | | 10.9 | | | 12.6 | | 8.2 | 10.7 | | 10.9 | 11.1 | |
| Level of Service | | B | | | B | | A | B | | B | B | |
| Approach Delay (s) | | 10.9 | | | 12.6 | | | 10.4 | | | 11.0 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.51 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 66.4% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Existing plus Project Conditions
# Weekend Midday Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 104 | 211 | 321 | 10 | 202 | 6 | 146 | 2 | 4 | 13 | 8 | 60 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 113 | 229 | 349 | 11 | 220 | 7 | 162 | 2 | 4 | 14 | 9 | 67 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 113 | 578 | 237 | 162 | 7 | 90 |
| Volume Left (vph) | 113 | 0 | 11 | 162 | 0 | 14 |
| Volume Right (vph) | 0 | 349 | 7 | 0 | 4 | 67 |
| Hadj (s) | 0.53 | -0.39 | 0.03 | 0.53 | -0.43 | -0.38 |
| Departure Headway (s) | 6.4 | 5.5 | 6.4 | 7.7 | 6.7 | 7.0 |
| Degree Utilization, x | 0.20 | 0.88 | 0.42 | 0.34 | 0.01 | 0.17 |
| Capacity (veh/h) | 545 | 651 | 521 | 449 | 507 | 478 |
| Control Delay (s) | 9.8 | 33.4 | 14.1 | 13.4 | 8.6 | 11.4 |
| Approach Delay (s) | 29.5 | | 14.1 | 13.2 | | 11.4 |
| Approach LOS | D | | B | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 22.8 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 67.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

# HCM Signalized Intersection Capacity Analysis
## 2: Golf Links Road & I-580 WB On Ramp

11/8/2010

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 346 | 396 | 0 | 0 | 296 | 230 | 303 | 4 | 304 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.94 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1753 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1753 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 417 | 0 | 0 | 329 | 256 | 333 | 4 | 334 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 47 | 0 | 0 | 0 | 217 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 364 | 417 | 0 | 0 | 538 | 0 | 0 | 337 | 117 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 8.9 | 30.9 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Effective Green, g (s) | 8.9 | 30.9 | | | 18.0 | | | 21.0 | 21.0 | | | |
| Actuated g/C Ratio | 0.15 | 0.52 | | | 0.30 | | | 0.35 | 0.35 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 510 | 961 | | | 527 | | | 622 | 555 | | | |
| v/s Ratio Prot | c0.11 | 0.22 | | | c0.31 | | | c0.19 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.07 | | | |
| v/c Ratio | 0.71 | 0.43 | | | 1.02 | | | 0.54 | 0.21 | | | |
| Uniform Delay, d1 | 24.3 | 9.0 | | | 21.0 | | | 15.6 | 13.6 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 4.7 | 0.3 | | | 44.7 | | | 3.4 | 0.9 | | | |
| Delay (s) | 29.0 | 9.4 | | | 65.6 | | | 19.0 | 14.5 | | | |
| Level of Service | C | A | | | E | | | B | B | | | |
| Approach Delay (s) | | 18.5 | | | 65.6 | | | 16.7 | | | 0.0 | |
| Approach LOS | | B | | | E | | | B | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 31.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.75 | | |
| Actuated Cycle Length (s) | 59.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 77.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 65 | 132 | 424 | 117 | 0 | 31 | 0 | 409 | 230 | 429 | 39 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.98 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3453 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.40 | | 1.00 | | 0.98 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 753 | | 2787 | | 3453 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 72 | 147 | 471 | 130 | 0 | 34 | 0 | 454 | 256 | 477 | 43 |
| RTOR Reduction (vph) | 0 | 0 | 117 | 0 | 0 | 0 | 0 | 0 | 283 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 72 | 30 | 471 | 130 | 0 | 34 | 0 | 171 | 0 | 772 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.3 | 17.3 | 18.0 | 39.3 | | 9.9 | | 31.9 | | 23.7 | |
| Effective Green, g (s) | | 17.3 | 17.3 | 18.0 | 39.3 | | 9.9 | | 31.9 | | 23.7 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.21 | 0.46 | | 0.12 | | 0.38 | | 0.28 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 380 | 323 | 728 | 862 | | 88 | | 1047 | | 964 | |
| v/s Ratio Prot | | c0.04 | | c0.14 | 0.07 | | | | 0.06 | | c0.22 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.19 | 0.09 | 0.65 | 0.15 | | 0.39 | | 0.16 | | 0.80 | |
| Uniform Delay, d1 | | 28.0 | 27.4 | 30.5 | 13.2 | | 34.7 | | 17.6 | | 28.4 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.1 | 0.6 | 2.0 | 0.1 | | 2.8 | | 0.1 | | 4.8 | |
| Delay (s) | | 29.1 | 28.0 | 32.5 | 13.2 | | 37.5 | | 17.7 | | 33.2 | |
| Level of Service | | C | C | C | B | | D | | B | | C | |
| Approach Delay (s) | | 28.4 | | | 28.4 | | | 19.1 | | | 33.2 | |
| Approach LOS | | C | | | C | | | B | | | C | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 28.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.55 | | |
| Actuated Cycle Length (s) | 84.9 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 51.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 57 | 161 | 0 | 0 | 68 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 63 | 164 | 0 | 0 | 76 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 164 | | | | 228 | 164 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 164 | | | | 228 | 164 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 91 |
| cM capacity (veh/h) | 1414 | | | | 761 | 880 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 63 | 164 | 0 | 76 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 76 |
| cSH | 1414 | 1700 | 1700 | 880 |
| Volume to Capacity | 0.00 | 0.10 | 0.00 | 0.09 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 7 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 9.5 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.5 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.4 | | |
| Intersection Capacity Utilization | 19.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 280 | 141 | 17 | 0 | 177 | 104 | 10 | 14 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 292 | 147 | 18 | 0 | 195 | 114 | 11 | 16 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 292 | 165 | 309 | 27 |
| Volume Left (vph) | 292 | 0 | 0 | 11 |
| Volume Right (vph) | 0 | 18 | 114 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.19 | 0.12 |
| Departure Headway (s) | 5.3 | 4.7 | 4.3 | 5.6 |
| Degree Utilization, x | 0.43 | 0.22 | 0.37 | 0.04 |
| Capacity (veh/h) | 669 | 745 | 811 | 573 |
| Control Delay (s) | 11.1 | 7.9 | 9.9 | 8.9 |
| Approach Delay (s) | 9.9 | | 9.9 | 8.9 |
| Approach LOS | A | | A | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 9.9 | | |
| HCM Level of Service | A | | |
| Intersection Capacity Utilization | 44.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 110 | 173 | 166 | 14 | 95 | 143 | 80 | 37 | 22 | 26 | 202 | 26 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 122 | 192 | 184 | 16 | 106 | 159 | 89 | 41 | 24 | 29 | 224 | 29 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 499 | 280 | 130 | 24 | 282 |
| Volume Left (vph) | 122 | 16 | 89 | 0 | 29 |
| Volume Right (vph) | 184 | 159 | 0 | 24 | 29 |
| Hadj (s) | -0.14 | -0.30 | 0.38 | -0.67 | -0.01 |
| Departure Headway (s) | 5.9 | 6.2 | 8.0 | 6.9 | 6.8 |
| Degree Utilization, x | 0.82 | 0.48 | 0.29 | 0.05 | 0.54 |
| Capacity (veh/h) | 590 | 524 | 408 | 462 | 479 |
| Control Delay (s) | 30.2 | 14.9 | 13.0 | 9.0 | 17.4 |
| Approach Delay (s) | 30.2 | 14.9 | 12.4 | | 17.4 |
| Approach LOS | D | B | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.5 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 73.2% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 26 | 200 | 25 | 104 | 167 | 57 | 46 | 165 | 22 | 19 | 196 | 96 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.98 | | 1.00 | 0.98 | | 1.00 | 0.95 | |
| Flt Protected | | 0.99 | | | 0.98 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1829 | | | 1791 | | 1770 | 1830 | | 1770 | 1771 | |
| Flt Permitted | | 0.95 | | | 0.84 | | 0.52 | 1.00 | | 0.63 | 1.00 | |
| Satd. Flow (perm) | | 1738 | | | 1525 | | 966 | 1830 | | 1174 | 1771 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 27 | 211 | 26 | 116 | 186 | 63 | 50 | 179 | 24 | 21 | 218 | 107 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 19 | 0 | 0 | 12 | 0 | 0 | 44 | 0 |
| Lane Group Flow (vph) | 0 | 254 | 0 | 0 | 346 | 0 | 50 | 191 | 0 | 21 | 281 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 695 | | | 610 | | 386 | 732 | | 470 | 708 | |
| v/s Ratio Prot | | | | | | | | 0.10 | | | c0.16 | |
| v/s Ratio Perm | | 0.15 | | | c0.23 | | 0.05 | | | 0.02 | | |
| v/c Ratio | | 0.37 | | | 0.57 | | 0.13 | 0.26 | | 0.04 | 0.40 | |
| Uniform Delay, d1 | | 8.4 | | | 9.3 | | 7.6 | 8.0 | | 7.3 | 8.6 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.5 | | | 3.8 | | 0.7 | 0.9 | | 0.2 | 1.7 | |
| Delay (s) | | 9.9 | | | 13.1 | | 8.3 | 8.9 | | 7.5 | 10.2 | |
| Level of Service | | A | | | B | | A | A | | A | B | |
| Approach Delay (s) | | 9.9 | | | 13.1 | | | 8.8 | | | 10.1 | |
| Approach LOS | | A | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.7 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.48 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 64.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Year 2015 plus Project Conditions
# Weekday AM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 267 | 216 | 48 | 5 | 370 | 23 | 9 | 1 | 2 | 21 | 4 | 228 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 290 | 235 | 52 | 5 | 402 | 25 | 10 | 1 | 2 | 23 | 4 | 253 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 290 | 287 | 433 | 10 | 3 | 281 |
| Volume Left (vph) | 290 | 0 | 5 | 10 | 0 | 23 |
| Volume Right (vph) | 0 | 52 | 25 | 0 | 2 | 253 |
| Hadj (s) | 0.53 | -0.09 | 0.00 | 0.53 | -0.43 | -0.49 |
| Departure Headway (s) | 6.8 | 6.1 | 6.3 | 8.6 | 7.6 | 6.6 |
| Degree Utilization, x | 0.55 | 0.49 | 0.76 | 0.02 | 0.01 | 0.51 |
| Capacity (veh/h) | 517 | 572 | 552 | 377 | 418 | 517 |
| Control Delay (s) | 16.4 | 13.7 | 26.6 | 10.6 | 9.4 | 16.3 |
| Approach Delay (s) | 15.1 | | 26.6 | 10.3 | | 16.3 |
| Approach LOS | C | | D | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 19.1 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.1% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 521 | 260 | 0 | 0 | 333 | 192 | 368 | 4 | 143 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 548 | 274 | 0 | 0 | 370 | 213 | 404 | 4 | 157 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 35 | 0 | 0 | 0 | 112 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 548 | 274 | 0 | 0 | 548 | 0 | 0 | 408 | 45 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 11.8 | 34.8 | | | 19.0 | | | 17.0 | 17.0 | | | |
| Effective Green, g (s) | 11.8 | 34.8 | | | 19.0 | | | 17.0 | 17.0 | | | |
| Actuated g/C Ratio | 0.20 | 0.58 | | | 0.32 | | | 0.28 | 0.28 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 677 | 1084 | | | 563 | | | 505 | 450 | | | |
| v/s Ratio Prot | c0.16 | 0.15 | | | c0.31 | | | c0.23 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.03 | | | |
| v/c Ratio | 0.81 | 0.25 | | | 0.97 | | | 0.81 | 0.10 | | | |
| Uniform Delay, d1 | 22.9 | 6.1 | | | 20.2 | | | 19.9 | 15.8 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 7.1 | 0.1 | | | 31.1 | | | 13.0 | 0.4 | | | |
| Delay (s) | 30.0 | 6.3 | | | 51.2 | | | 32.9 | 16.2 | | | |
| Level of Service | C | A | | | D | | | C | B | | | |
| Approach Delay (s) | | 22.1 | | | 51.2 | | | 28.3 | | | 0.0 | |
| Approach LOS | | C | | | D | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 32.5 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.87 | | |
| Actuated Cycle Length (s) | 59.8 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 74.7% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 91 | 191 | 515 | 173 | 0 | 54 | 0 | 513 | 164 | 442 | 30 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3470 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.38 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 714 | | 2787 | | 3470 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 101 | 212 | 572 | 192 | 0 | 60 | 0 | 570 | 182 | 491 | 33 |
| RTOR Reduction (vph) | 0 | 0 | 170 | 0 | 0 | 0 | 0 | 0 | 334 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 101 | 42 | 572 | 192 | 0 | 60 | 0 | 236 | 0 | 702 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.4 | 17.4 | 20.2 | 41.6 | | 12.5 | | 36.7 | | 22.5 | |
| Effective Green, g (s) | | 17.4 | 17.4 | 20.2 | 41.6 | | 12.5 | | 36.7 | | 22.5 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.23 | 0.47 | | 0.14 | | 0.41 | | 0.25 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 366 | 311 | 783 | 875 | | 101 | | 1154 | | 881 | |
| v/s Ratio Prot | | c0.05 | | c0.17 | 0.10 | | | | 0.08 | | c0.20 | |
| v/s Ratio Perm | | | 0.03 | | | | c0.08 | | | | | |
| v/c Ratio | | 0.28 | 0.13 | 0.73 | 0.22 | | 0.59 | | 0.20 | | 0.80 | |
| Uniform Delay, d1 | | 30.2 | 29.4 | 31.7 | 13.9 | | 35.7 | | 16.6 | | 30.9 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.9 | 0.9 | 3.5 | 0.1 | | 9.0 | | 0.1 | | 5.1 | |
| Delay (s) | | 32.1 | 30.3 | 35.2 | 14.0 | | 44.7 | | 16.7 | | 36.0 | |
| Level of Service | | C | C | D | B | | D | | B | | D | |
| Approach Delay (s) | | 30.9 | | | 29.9 | | | 19.4 | | | 36.0 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 29.0 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.62 | | |
| Actuated Cycle Length (s) | 88.6 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 54.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 221 | 316 | 1 | 0 | 0 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 246 | 322 | 1 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 323 | | | | 569 | 323 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 323 | | | | 569 | 323 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1236 | | | | 484 | 718 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 246 | 323 | 0 | 0 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 1 | 0 | 0 |
| cSH | 1236 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.19 | 0.00 | 0.00 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 0.0 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 20.0% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 368 | 224 | 71 | 1 | 182 | 113 | 19 | 15 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 383 | 233 | 74 | 1 | 200 | 124 | 21 | 17 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 383 | 307 | 325 | 38 |
| Volume Left (vph) | 383 | 0 | 1 | 21 |
| Volume Right (vph) | 0 | 74 | 124 | 0 |
| Hadj (s) | 0.53 | -0.13 | -0.19 | 0.15 |
| Departure Headway (s) | 5.4 | 4.7 | 4.5 | 6.0 |
| Degree Utilization, x | 0.57 | 0.40 | 0.41 | 0.06 |
| Capacity (veh/h) | 651 | 752 | 776 | 539 |
| Control Delay (s) | 14.2 | 9.7 | 10.7 | 9.4 |
| Approach Delay (s) | 12.2 | | 10.7 | 9.4 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.6 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 50.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 20 | 238 | 16 | 95 | 81 | 48 | 222 | 133 | 180 | 7 | 36 | 174 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 22 | 264 | 18 | 106 | 90 | 53 | 247 | 148 | 200 | 8 | 40 | 193 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 304 | 249 | 394 | 200 | 241 |
| Volume Left (vph) | 22 | 106 | 247 | 0 | 8 |
| Volume Right (vph) | 18 | 53 | 0 | 200 | 193 |
| Hadj (s) | 0.01 | -0.01 | 0.35 | -0.67 | -0.44 |
| Departure Headway (s) | 7.1 | 7.2 | 7.4 | 6.4 | 6.9 |
| Degree Utilization, x | 0.60 | 0.50 | 0.81 | 0.35 | 0.46 |
| Capacity (veh/h) | 471 | 445 | 465 | 547 | 468 |
| Control Delay (s) | 20.1 | 17.2 | 34.0 | 11.6 | 15.6 |
| Approach Delay (s) | 20.1 | 17.2 | 26.4 | | 15.6 |
| Approach LOS | C | C | D | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.5 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 72.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 20 | 234 | 63 | 49 | 205 | 23 | 27 | 142 | 19 | 74 | 180 | 52 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 1.00 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1807 | | | 1826 | | 1770 | 1829 | | 1770 | 1800 | |
| Flt Permitted | | 0.97 | | | 0.90 | | 0.60 | 1.00 | | 0.65 | 1.00 | |
| Satd. Flow (perm) | | 1760 | | | 1655 | | 1116 | 1829 | | 1205 | 1800 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 21 | 246 | 66 | 54 | 228 | 26 | 29 | 154 | 21 | 82 | 200 | 58 |
| RTOR Reduction (vph) | 0 | 22 | 0 | 0 | 8 | 0 | 0 | 12 | 0 | 0 | 26 | 0 |
| Lane Group Flow (vph) | 0 | 311 | 0 | 0 | 300 | 0 | 29 | 163 | 0 | 82 | 232 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 704 | | | 662 | | 446 | 732 | | 482 | 720 | |
| v/s Ratio Prot | | | | | | | | 0.09 | | | c0.13 | |
| v/s Ratio Perm | | 0.18 | | | c0.18 | | 0.03 | | | 0.07 | | |
| v/c Ratio | | 0.44 | | | 0.45 | | 0.07 | 0.22 | | 0.17 | 0.32 | |
| Uniform Delay, d1 | | 8.7 | | | 8.8 | | 7.4 | 7.9 | | 7.7 | 8.3 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.0 | | | 2.2 | | 0.3 | 0.7 | | 0.8 | 1.2 | |
| Delay (s) | | 10.7 | | | 11.0 | | 7.7 | 8.6 | | 8.5 | 9.4 | |
| Level of Service | | B | | | B | | A | A | | A | A | |
| Approach Delay (s) | | 10.7 | | | 11.0 | | | 8.5 | | | 9.2 | |
| Approach LOS | | B | | | B | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 10.0 | HCM Level of Service | A |
| HCM Volume to Capacity ratio | 0.39 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 54.5% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Year 2015 plus Project Conditions
# Weekday PM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 290 | 328 | 8 | 0 | 208 | 12 | 226 | 4 | 7 | 17 | 4 | 330 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 315 | 357 | 9 | 0 | 226 | 13 | 251 | 4 | 8 | 18 | 4 | 367 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 315 | 365 | 239 | 251 | 12 | 390 |
| Volume Left (vph) | 315 | 0 | 0 | 251 | 0 | 18 |
| Volume Right (vph) | 0 | 9 | 13 | 0 | 8 | 367 |
| Hadj (s) | 0.53 | 0.02 | 0.00 | 0.53 | -0.41 | -0.52 |
| Departure Headway (s) | 8.6 | 8.1 | 8.9 | 9.2 | 8.3 | 7.8 |
| Degree Utilization, x | 0.75 | 0.82 | 0.59 | 0.64 | 0.03 | 0.85 |
| Capacity (veh/h) | 407 | 438 | 377 | 369 | 409 | 444 |
| Control Delay (s) | 32.2 | 37.0 | 23.9 | 26.4 | 10.3 | 41.2 |
| Approach Delay (s) | 34.8 | | 23.9 | 25.6 | | 41.2 |
| Approach LOS | D | | C | D | | E |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 33.2 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 76.8% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 499 | 305 | 0 | 0 | 419 | 153 | 443 | 3 | 171 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.96 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1796 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1796 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 525 | 321 | 0 | 0 | 466 | 170 | 487 | 3 | 188 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 125 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 525 | 321 | 0 | 0 | 620 | 0 | 0 | 490 | 63 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 13.0 | 45.0 | | | 28.0 | | | 27.0 | 27.0 | | | |
| Effective Green, g (s) | 13.0 | 45.0 | | | 28.0 | | | 27.0 | 27.0 | | | |
| Actuated g/C Ratio | 0.16 | 0.56 | | | 0.35 | | | 0.34 | 0.34 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 558 | 1048 | | | 629 | | | 599 | 534 | | | |
| v/s Ratio Prot | c0.15 | 0.17 | | | c0.35 | | | c0.28 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.04 | | | |
| v/c Ratio | 0.94 | 0.31 | | | 0.99 | | | 0.82 | 0.12 | | | |
| Uniform Delay, d1 | 33.1 | 9.2 | | | 25.8 | | | 24.3 | 18.3 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 24.3 | 0.2 | | | 31.9 | | | 11.8 | 0.5 | | | |
| Delay (s) | 57.4 | 9.4 | | | 57.7 | | | 36.1 | 18.7 | | | |
| Level of Service | E | A | | | E | | | D | B | | | |
| Approach Delay (s) | | 39.2 | | | 57.7 | | | 31.3 | | | 0.0 | |
| Approach LOS | | D | | | E | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 42.1 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.91 | | |
| Actuated Cycle Length (s) | 80.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 82.1% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 87 | 184 | 661 | 168 | 0 | 34 | 0 | 538 | 142 | 545 | 44 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3473 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.37 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 684 | | 2787 | | 3473 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 97 | 204 | 734 | 187 | 0 | 38 | 0 | 598 | 158 | 606 | 49 |
| RTOR Reduction (vph) | 0 | 0 | 164 | 0 | 0 | 0 | 0 | 0 | 347 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 97 | 40 | 734 | 187 | 0 | 38 | 0 | 251 | 0 | 809 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.1 | 18.1 | 24.1 | 46.2 | | 10.9 | | 39.0 | | 24.0 | |
| Effective Green, g (s) | | 18.1 | 18.1 | 24.1 | 46.2 | | 10.9 | | 39.0 | | 24.0 | |
| Actuated g/C Ratio | | 0.19 | 0.19 | 0.26 | 0.50 | | 0.12 | | 0.42 | | 0.26 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 362 | 308 | 889 | 924 | | 80 | | 1167 | | 895 | |
| v/s Ratio Prot | | c0.05 | | c0.21 | 0.10 | | | | 0.09 | | c0.23 | |
| v/s Ratio Perm | | | 0.03 | | | | c0.06 | | | | | |
| v/c Ratio | | 0.27 | 0.13 | 0.83 | 0.20 | | 0.48 | | 0.21 | | 0.90 | |
| Uniform Delay, d1 | | 31.9 | 31.0 | 32.5 | 13.1 | | 38.4 | | 17.3 | | 33.4 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.8 | 0.9 | 6.3 | 0.1 | | 4.4 | | 0.1 | | 12.3 | |
| Delay (s) | | 33.7 | 31.8 | 38.8 | 13.2 | | 42.8 | | 17.4 | | 45.7 | |
| Level of Service | | C | C | D | B | | D | | B | | D | |
| Approach Delay (s) | | 32.4 | | | 33.6 | | | 18.9 | | | 45.7 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 33.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.67 | | |
| Actuated Cycle Length (s) | 93.1 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 60.8% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 258 | 194 | 1 | 2 | 93 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 287 | 198 | 1 | 2 | 103 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 199 | | | | 485 | 198 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 199 | | | | 485 | 198 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 88 |
| cM capacity (veh/h) | 1373 | | | | 541 | 843 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 287 | 199 | 2 | 103 |
| Volume Left | 0 | 0 | 2 | 0 |
| Volume Right | 0 | 1 | 0 | 103 |
| cSH | 1373 | 1700 | 541 | 843 |
| Volume to Capacity | 0.00 | 0.12 | 0.00 | 0.12 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 10 |
| Control Delay (s) | 0.0 | 0.0 | 11.7 | 9.9 |
| Lane LOS | | | B | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.9 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.8 | | |
| Intersection Capacity Utilization | 23.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 324 | 251 | 32 | 4 | 189 | 97 | 36 | 51 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 338 | 261 | 33 | 4 | 208 | 107 | 40 | 57 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 338 | 295 | 319 | 97 |
| Volume Left (vph) | 338 | 0 | 4 | 40 |
| Volume Right (vph) | 0 | 33 | 107 | 0 |
| Hadj (s) | 0.53 | -0.05 | -0.16 | 0.12 |
| Departure Headway (s) | 5.6 | 5.0 | 4.8 | 6.0 |
| Degree Utilization, x | 0.53 | 0.41 | 0.42 | 0.16 |
| Capacity (veh/h) | 624 | 702 | 732 | 549 |
| Control Delay (s) | 13.5 | 10.3 | 11.2 | 10.1 |
| Approach Delay (s) | 12.0 | | 11.2 | 10.1 |
| Approach LOS | B | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 11.6 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 48.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 26 | 226 | 35 | 130 | 59 | 37 | 157 | 186 | 258 | 17 | 84 | 194 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 29 | 251 | 39 | 144 | 66 | 41 | 174 | 207 | 287 | 19 | 93 | 216 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 319 | 251 | 381 | 287 | 328 |
| Volume Left (vph) | 29 | 144 | 174 | 0 | 19 |
| Volume Right (vph) | 39 | 41 | 0 | 287 | 216 |
| Hadj (s) | -0.02 | 0.05 | 0.26 | -0.67 | -0.35 |
| Departure Headway (s) | 7.7 | 8.1 | 8.0 | 7.0 | 7.4 |
| Degree Utilization, x | 0.68 | 0.56 | 0.84 | 0.56 | 0.68 |
| Capacity (veh/h) | 437 | 404 | 439 | 494 | 446 |
| Control Delay (s) | 25.8 | 20.9 | 39.6 | 17.2 | 24.5 |
| Approach Delay (s) | 25.8 | 20.9 | 30.0 | | 24.5 |
| Approach LOS | D | C | D | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 26.5 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 77.1% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 38 | 204 | 105 | 88 | 248 | 16 | 44 | 313 | 38 | 134 | 301 | 60 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.96 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1777 | | | 1828 | | 1770 | 1833 | | 1770 | 1816 | |
| Flt Permitted | | 0.93 | | | 0.85 | | 0.43 | 1.00 | | 0.45 | 1.00 | |
| Satd. Flow (perm) | | 1665 | | | 1582 | | 803 | 1833 | | 846 | 1816 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 40 | 215 | 111 | 98 | 276 | 18 | 48 | 340 | 41 | 149 | 334 | 67 |
| RTOR Reduction (vph) | 0 | 39 | 0 | 0 | 4 | 0 | 0 | 11 | 0 | 0 | 18 | 0 |
| Lane Group Flow (vph) | 0 | 327 | 0 | 0 | 388 | 0 | 48 | 370 | 0 | 149 | 383 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 666 | | | 633 | | 321 | 733 | | 338 | 726 | |
| v/s Ratio Prot | | | | | | | | 0.20 | | | c0.21 | |
| v/s Ratio Perm | | 0.20 | | | c0.25 | | 0.06 | | | 0.18 | | |
| v/c Ratio | | 0.49 | | | 0.61 | | 0.15 | 0.51 | | 0.44 | 0.53 | |
| Uniform Delay, d1 | | 9.0 | | | 9.5 | | 7.7 | 9.0 | | 8.7 | 9.1 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.6 | | | 4.4 | | 1.0 | 2.5 | | 4.1 | 2.7 | |
| Delay (s) | | 11.5 | | | 13.9 | | 8.6 | 11.5 | | 12.9 | 11.9 | |
| Level of Service | | B | | | B | | A | B | | B | B | |
| Approach Delay (s) | | 11.5 | | | 13.9 | | | 11.2 | | | 12.1 | |
| Approach LOS | | B | | | B | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 12.2 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.57 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 71.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Year 2015 plus Project Conditions
# Weekend Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 104 | 212 | 310 | 10 | 203 | 6 | 141 | 2 | 4 | 13 | 8 | 60 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 113 | 230 | 337 | 11 | 221 | 7 | 157 | 2 | 4 | 14 | 9 | 67 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 113 | 567 | 238 | 157 | 7 | 90 |
| Volume Left (vph) | 113 | 0 | 11 | 157 | 0 | 14 |
| Volume Right (vph) | 0 | 337 | 7 | 0 | 4 | 67 |
| Hadj (s) | 0.53 | -0.38 | 0.03 | 0.53 | -0.43 | -0.38 |
| Departure Headway (s) | 6.4 | 5.4 | 6.4 | 7.6 | 6.6 | 6.9 |
| Degree Utilization, x | 0.20 | 0.86 | 0.42 | 0.33 | 0.01 | 0.17 |
| Capacity (veh/h) | 547 | 653 | 536 | 439 | 506 | 480 |
| Control Delay (s) | 9.7 | 30.8 | 14.0 | 13.2 | 8.5 | 11.4 |
| Approach Delay (s) | 27.3 | | 14.0 | 13.0 | | 11.4 |
| Approach LOS | D | | B | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 21.4 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 66.2% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 346 | 345 | 0 | 0 | 272 | 210 | 326 | 4 | 279 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.94 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1753 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1753 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 363 | 0 | 0 | 302 | 233 | 358 | 4 | 307 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 0 | 197 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 364 | 363 | 0 | 0 | 499 | 0 | 0 | 362 | 110 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 11.9 | 40.5 | | | 24.6 | | | 27.2 | 27.2 | | | |
| Effective Green, g (s) | 11.9 | 40.5 | | | 24.6 | | | 27.2 | 27.2 | | | |
| Actuated g/C Ratio | 0.16 | 0.54 | | | 0.32 | | | 0.36 | 0.36 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 540 | 997 | | | 570 | | | 638 | 569 | | | |
| v/s Ratio Prot | c0.11 | 0.19 | | | c0.28 | | | c0.20 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.07 | | | |
| v/c Ratio | 0.67 | 0.36 | | | 0.88 | | | 0.57 | 0.19 | | | |
| Uniform Delay, d1 | 30.1 | 10.2 | | | 24.1 | | | 19.5 | 16.7 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 3.3 | 0.2 | | | 14.1 | | | 3.6 | 0.8 | | | |
| Delay (s) | 33.4 | 10.4 | | | 38.2 | | | 23.1 | 17.5 | | | |
| Level of Service | C | B | | | D | | | C | B | | | |
| Approach Delay (s) | | 21.9 | | | 38.2 | | | 20.5 | | | 0.0 | |
| Approach LOS | | C | | | D | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 25.9 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.71 | | |
| Actuated Cycle Length (s) | 75.7 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 73.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 72 | 160 | 448 | 125 | 0 | 31 | 0 | 408 | 234 | 462 | 42 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.98 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3454 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.40 | | 1.00 | | 0.98 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 738 | | 2787 | | 3454 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 80 | 178 | 498 | 139 | 0 | 34 | 0 | 453 | 260 | 513 | 47 |
| RTOR Reduction (vph) | 0 | 0 | 141 | 0 | 0 | 0 | 0 | 0 | 283 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 80 | 37 | 498 | 139 | 0 | 34 | 0 | 170 | 0 | 816 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.3 | 18.3 | 18.7 | 41.0 | | 10.1 | | 32.8 | | 24.2 | |
| Effective Green, g (s) | | 18.3 | 18.3 | 18.7 | 41.0 | | 10.1 | | 32.8 | | 24.2 | |
| Actuated g/C Ratio | | 0.21 | 0.21 | 0.21 | 0.47 | | 0.12 | | 0.38 | | 0.28 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 391 | 332 | 735 | 875 | | 85 | | 1047 | | 957 | |
| v/s Ratio Prot | | c0.04 | | c0.15 | 0.07 | | | | 0.06 | | c0.24 | |
| v/s Ratio Perm | | | 0.02 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.20 | 0.11 | 0.68 | 0.16 | | 0.40 | | 0.16 | | 0.85 | |
| Uniform Delay, d1 | | 28.5 | 27.9 | 31.5 | 13.3 | | 35.8 | | 18.1 | | 29.9 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 1.2 | 0.7 | 2.5 | 0.1 | | 3.1 | | 0.1 | | 7.4 | |
| Delay (s) | | 29.7 | 28.6 | 34.0 | 13.4 | | 38.9 | | 18.2 | | 37.3 | |
| Level of Service | | C | C | C | B | | D | | B | | D | |
| Approach Delay (s) | | 28.9 | | | 29.5 | | | 19.6 | | | 37.3 | |
| Approach LOS | | C | | | C | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 30.2 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.58 | | |
| Actuated Cycle Length (s) | 87.3 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 53.6% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 66 | 168 | 0 | 0 | 59 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 73 | 171 | 0 | 0 | 66 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 171 | | | | 245 | 171 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 171 | | | | 245 | 171 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 92 |
| cM capacity (veh/h) | 1406 | | | | 744 | 872 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 73 | 171 | 0 | 66 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 66 |
| cSH | 1406 | 1700 | 1700 | 872 |
| Volume to Capacity | 0.00 | 0.10 | 0.00 | 0.08 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 6 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 9.5 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.5 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 2.0 | | |
| Intersection Capacity Utilization | 19.2% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 288 | 145 | 17 | 0 | 183 | 107 | 10 | 14 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 300 | 151 | 18 | 0 | 201 | 118 | 11 | 16 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 300 | 169 | 319 | 27 |
| Volume Left (vph) | 300 | 0 | 0 | 11 |
| Volume Right (vph) | 0 | 18 | 118 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.19 | 0.12 |
| Departure Headway (s) | 5.3 | 4.8 | 4.4 | 5.7 |
| Degree Utilization, x | 0.44 | 0.22 | 0.39 | 0.04 |
| Capacity (veh/h) | 668 | 743 | 809 | 568 |
| Control Delay (s) | 11.3 | 7.9 | 10.1 | 8.9 |
| Approach Delay (s) | 10.1 | | 10.1 | 8.9 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.0 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 45.4% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 119 | 186 | 179 | 16 | 98 | 154 | 85 | 40 | 23 | 28 | 214 | 28 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 132 | 207 | 199 | 18 | 109 | 171 | 94 | 44 | 26 | 31 | 238 | 31 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 538 | 298 | 139 | 26 | 300 |
| Volume Left (vph) | 132 | 18 | 94 | 0 | 31 |
| Volume Right (vph) | 199 | 171 | 0 | 26 | 31 |
| Hadj (s) | -0.14 | -0.30 | 0.37 | -0.67 | -0.01 |
| Departure Headway (s) | 6.2 | 6.6 | 8.5 | 7.4 | 7.2 |
| Degree Utilization, x | 0.93 | 0.55 | 0.33 | 0.05 | 0.60 |
| Capacity (veh/h) | 570 | 512 | 400 | 452 | 477 |
| Control Delay (s) | 47.5 | 17.4 | 14.3 | 9.6 | 20.7 |
| Approach Delay (s) | 47.5 | 17.4 | 13.6 | | 20.7 |
| Approach LOS | E | C | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 30.1 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 77.4% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 27 | 209 | 26 | 117 | 193 | 67 | 51 | 184 | 25 | 20 | 209 | 102 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.98 | | 1.00 | 0.98 | | 1.00 | 0.95 | |
| Flt Protected | | 0.99 | | | 0.98 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1829 | | | 1790 | | 1770 | 1830 | | 1770 | 1771 | |
| Flt Permitted | | 0.94 | | | 0.84 | | 0.50 | 1.00 | | 0.62 | 1.00 | |
| Satd. Flow (perm) | | 1727 | | | 1525 | | 922 | 1830 | | 1149 | 1771 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 28 | 220 | 27 | 130 | 214 | 74 | 55 | 200 | 27 | 22 | 232 | 113 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 19 | 0 | 0 | 12 | 0 | 0 | 44 | 0 |
| Lane Group Flow (vph) | 0 | 265 | 0 | 0 | 399 | 0 | 55 | 215 | 0 | 22 | 301 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 691 | | | 610 | | 369 | 732 | | 460 | 708 | |
| v/s Ratio Prot | | | | | | | | 0.12 | | | c0.17 | |
| v/s Ratio Perm | | 0.15 | | | c0.26 | | 0.06 | | | 0.02 | | |
| v/c Ratio | | 0.38 | | | 0.65 | | 0.15 | 0.29 | | 0.05 | 0.43 | |
| Uniform Delay, d1 | | 8.5 | | | 9.7 | | 7.7 | 8.2 | | 7.3 | 8.7 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 1.6 | | | 5.4 | | 0.9 | 1.0 | | 0.2 | 1.9 | |
| Delay (s) | | 10.1 | | | 15.1 | | 8.5 | 9.2 | | 7.5 | 10.5 | |
| Level of Service | | B | | | B | | A | A | | A | B | |
| Approach Delay (s) | | 10.1 | | | 15.1 | | | 9.0 | | | 10.4 | |
| Approach LOS | | B | | | B | | | A | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 11.5 | HCM Level of Service | B |
| HCM Volume to Capacity ratio | 0.54 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 68.7% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Cumulative Year 2035 plus Project Conditions
# Weekday AM Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 267 | 219 | 45 | 5 | 375 | 23 | 8 | 1 | 2 | 21 | 3 | 228 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 290 | 238 | 49 | 5 | 408 | 25 | 9 | 1 | 2 | 23 | 3 | 253 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 290 | 287 | 438 | 9 | 3 | 279 |
| Volume Left (vph) | 290 | 0 | 5 | 9 | 0 | 23 |
| Volume Right (vph) | 0 | 49 | 25 | 0 | 2 | 253 |
| Hadj (s) | 0.53 | -0.09 | 0.00 | 0.53 | -0.43 | -0.49 |
| Departure Headway (s) | 6.8 | 6.1 | 6.3 | 8.6 | 7.6 | 6.6 |
| Degree Utilization, x | 0.55 | 0.49 | 0.77 | 0.02 | 0.01 | 0.51 |
| Capacity (veh/h) | 517 | 572 | 553 | 368 | 419 | 516 |
| Control Delay (s) | 16.4 | 13.7 | 27.2 | 10.6 | 9.4 | 16.2 |
| Approach Delay (s) | 15.1 | | 27.2 | 10.3 | | 16.2 |
| Approach LOS | C | | D | B | | C |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 19.3 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 68.3% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 521 | 258 | 0 | 0 | 797 | 455 | 496 | 6 | 184 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.95 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1771 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 548 | 272 | 0 | 0 | 886 | 506 | 545 | 7 | 202 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 148 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 548 | 272 | 0 | 0 | 1367 | 0 | 0 | 552 | 54 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 15.9 | 49.9 | | | 30.0 | | | 21.0 | 21.0 | | | |
| Effective Green, g (s) | 15.9 | 49.9 | | | 30.0 | | | 21.0 | 21.0 | | | |
| Actuated g/C Ratio | 0.20 | 0.63 | | | 0.38 | | | 0.27 | 0.27 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 692 | 1178 | | | 673 | | | 472 | 421 | | | |
| v/s Ratio Prot | c0.16 | 0.15 | | | c0.77 | | | c0.31 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.03 | | | |
| v/c Ratio | 0.79 | 0.23 | | | 2.03 | | | 1.17 | 0.13 | | | |
| Uniform Delay, d1 | 29.9 | 6.2 | | | 24.5 | | | 29.0 | 22.0 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 6.2 | 0.1 | | | 469.0 | | | 97.0 | 0.6 | | | |
| Delay (s) | 36.1 | 6.3 | | | 493.4 | | | 125.9 | 22.6 | | | |
| Level of Service | D | A | | | F | | | F | C | | | |
| Approach Delay (s) | | 26.2 | | | 493.4 | | | 98.2 | | | 0.0 | |
| Approach LOS | | C | | | F | | | F | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 263.8 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.47 | | |
| Actuated Cycle Length (s) | 78.9 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 122.4% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 192 | 419 | 691 | 232 | 0 | 54 | 0 | 513 | 213 | 595 | 40 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3471 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.30 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 566 | | 2787 | | 3471 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 213 | 466 | 768 | 258 | 0 | 60 | 0 | 570 | 237 | 661 | 44 |
| RTOR Reduction (vph) | 0 | 0 | 229 | 0 | 0 | 0 | 0 | 0 | 284 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 213 | 237 | 768 | 258 | 0 | 60 | 0 | 286 | 0 | 938 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.1 | 18.1 | 24.2 | 46.3 | | 13.3 | | 41.5 | | 25.1 | |
| Effective Green, g (s) | | 18.1 | 18.1 | 24.2 | 46.3 | | 13.3 | | 41.5 | | 25.1 | |
| Actuated g/C Ratio | | 0.19 | 0.19 | 0.25 | 0.48 | | 0.14 | | 0.43 | | 0.26 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 349 | 296 | 859 | 892 | | 78 | | 1196 | | 901 | |
| v/s Ratio Prot | | 0.11 | | c0.22 | 0.14 | | | | 0.10 | | c0.27 | |
| v/s Ratio Perm | | | c0.15 | | | | c0.11 | | | | | |
| v/c Ratio | | 0.61 | 0.80 | 0.89 | 0.29 | | 0.77 | | 0.24 | | 1.04 | |
| Uniform Delay, d1 | | 36.1 | 37.6 | 35.0 | 15.2 | | 40.2 | | 17.6 | | 35.8 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 7.7 | 19.9 | 11.7 | 0.2 | | 35.7 | | 0.1 | | 41.3 | |
| Delay (s) | | 43.8 | 57.5 | 46.7 | 15.4 | | 75.9 | | 17.7 | | 77.1 | |
| Level of Service | | D | E | D | B | | E | | B | | E | |
| Approach Delay (s) | | 53.2 | | | 38.8 | | | 23.2 | | | 77.1 | |
| Approach LOS | | D | | | D | | | C | | | E | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 49.8 | HCM Level of Service | D |
| HCM Volume to Capacity ratio | 0.90 | | |
| Actuated Cycle Length (s) | 96.7 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 79.6% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 237 | 390 | 1 | 0 | 0 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 263 | 398 | 1 | 0 | 0 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 399 | | | | 662 | 398 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 399 | | | | 662 | 398 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 100 |
| cM capacity (veh/h) | 1160 | | | | 427 | 651 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 263 | 399 | 0 | 0 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 1 | 0 | 0 |
| cSH | 1160 | 1700 | 1700 | 1700 |
| Volume to Capacity | 0.00 | 0.23 | 0.00 | 0.00 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 0 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 0.0 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 0.0 | | |
| Intersection Capacity Utilization | 23.9% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 408 | 248 | 79 | 1 | 226 | 141 | 20 | 16 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 425 | 258 | 82 | 1 | 248 | 155 | 22 | 18 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 425 | 341 | 404 | 40 |
| Volume Left (vph) | 425 | 0 | 1 | 22 |
| Volume Right (vph) | 0 | 82 | 155 | 0 |
| Hadj (s) | 0.53 | -0.14 | -0.20 | 0.15 |
| Departure Headway (s) | 5.5 | 4.8 | 4.6 | 6.3 |
| Degree Utilization, x | 0.65 | 0.45 | 0.52 | 0.07 |
| Capacity (veh/h) | 643 | 741 | 768 | 516 |
| Control Delay (s) | 16.7 | 10.5 | 12.4 | 9.8 |
| Approach Delay (s) | 14.0 | | 12.4 | 9.8 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 13.3 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 56.5% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 24 | 289 | 19 | 128 | 109 | 65 | 299 | 180 | 243 | 9 | 44 | 211 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 27 | 321 | 21 | 142 | 121 | 72 | 332 | 200 | 270 | 10 | 49 | 234 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 369 | 336 | 532 | 270 | 293 |
| Volume Left (vph) | 27 | 142 | 332 | 0 | 10 |
| Volume Right (vph) | 21 | 72 | 0 | 270 | 234 |
| Hadj (s) | 0.01 | -0.01 | 0.35 | -0.67 | -0.44 |
| Departure Headway (s) | 8.2 | 8.4 | 8.8 | 7.8 | 8.3 |
| Degree Utilization, x | 0.84 | 0.78 | 1.30 | 0.58 | 0.68 |
| Capacity (veh/h) | 420 | 414 | 409 | 450 | 399 |
| Control Delay (s) | 42.3 | 35.2 | 178.7 | 19.9 | 26.9 |
| Approach Delay (s) | 42.3 | 35.2 | 125.2 | | 26.9 |
| Approach LOS | E | E | F | | D |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 75.4 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 89.6% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 22 | 258 | 69 | 105 | 441 | 49 | 42 | 220 | 30 | 88 | 216 | 62 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.97 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 1.00 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1807 | | | 1826 | | 1770 | 1829 | | 1770 | 1800 | |
| Flt Permitted | | 0.96 | | | 0.88 | | 0.54 | 1.00 | | 0.58 | 1.00 | |
| Satd. Flow (perm) | | 1738 | | | 1624 | | 1001 | 1829 | | 1084 | 1800 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 23 | 272 | 73 | 117 | 490 | 54 | 46 | 239 | 33 | 98 | 240 | 69 |
| RTOR Reduction (vph) | 0 | 22 | 0 | 0 | 8 | 0 | 0 | 13 | 0 | 0 | 26 | 0 |
| Lane Group Flow (vph) | 0 | 346 | 0 | 0 | 653 | 0 | 46 | 259 | 0 | 98 | 283 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 695 | | | 650 | | 400 | 732 | | 434 | 720 | |
| v/s Ratio Prot | | | | | | | | 0.14 | | | c0.16 | |
| v/s Ratio Perm | | 0.20 | | | c0.40 | | 0.05 | | | 0.09 | | |
| v/c Ratio | | 0.50 | | | 1.00 | | 0.12 | 0.35 | | 0.23 | 0.39 | |
| Uniform Delay, d1 | | 9.0 | | | 12.0 | | 7.5 | 8.4 | | 7.9 | 8.5 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.5 | | | 36.5 | | 0.6 | 1.3 | | 1.2 | 1.6 | |
| Delay (s) | | 11.5 | | | 48.5 | | 8.1 | 9.7 | | 9.1 | 10.2 | |
| Level of Service | | B | | | D | | A | A | | A | B | |
| Approach Delay (s) | | 11.5 | | | 48.5 | | | 9.5 | | | 9.9 | |
| Approach LOS | | B | | | D | | | A | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 24.7 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 0.70 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 82.8% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Cumulative Year 2035 plus Project Conditions
# Weekday PM Peak Hour

# HCM Unsignalized Intersection Capacity Analysis
## 1: Golf Links Road & Mountain Blvd



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 290 | 333 | 8 | 0 | 211 | 12 | 214 | 3 | 7 | 17 | 3 | 330 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 315 | 362 | 9 | 0 | 229 | 13 | 238 | 3 | 8 | 18 | 3 | 367 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 315 | 371 | 242 | 238 | 11 | 388 |
| Volume Left (vph) | 315 | 0 | 0 | 238 | 0 | 18 |
| Volume Right (vph) | 0 | 9 | 13 | 0 | 8 | 367 |
| Hadj (s) | 0.53 | 0.02 | 0.00 | 0.53 | -0.45 | -0.52 |
| Departure Headway (s) | 8.5 | 8.0 | 8.8 | 9.2 | 8.2 | 7.8 |
| Degree Utilization, x | 0.74 | 0.82 | 0.59 | 0.61 | 0.02 | 0.84 |
| Capacity (veh/h) | 411 | 443 | 382 | 368 | 410 | 447 |
| Control Delay (s) | 31.3 | 37.1 | 23.7 | 24.4 | 10.2 | 39.6 |
| Approach Delay (s) | 34.4 | | 23.7 | 23.8 | | 39.6 |
| Approach LOS | D | | C | C | | E |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 32.3 | | |
| HCM Level of Service | D | | |
| Intersection Capacity Utilization | 76.5% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 641 | 390 | 0 | 0 | 815 | 235 | 596 | 4 | 228 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.97 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1807 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1807 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 675 | 411 | 0 | 0 | 906 | 261 | 655 | 4 | 251 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 137 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 675 | 411 | 0 | 0 | 1158 | 0 | 0 | 659 | 114 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 19.0 | 69.0 | | | 46.0 | | | 33.0 | 33.0 | | | |
| Effective Green, g (s) | 19.0 | 69.0 | | | 46.0 | | | 33.0 | 33.0 | | | |
| Actuated g/C Ratio | 0.17 | 0.63 | | | 0.42 | | | 0.30 | 0.30 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 593 | 1169 | | | 756 | | | 533 | 475 | | | |
| v/s Ratio Prot | c0.20 | 0.22 | | | c0.64 | | | c0.37 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.07 | | | |
| v/c Ratio | 1.14 | 0.35 | | | 1.53 | | | 1.24 | 0.24 | | | |
| Uniform Delay, d1 | 45.5 | 9.8 | | | 32.0 | | | 38.5 | 29.0 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 81.3 | 0.2 | | | 245.8 | | | 121.8 | 1.2 | | | |
| Delay (s) | 126.8 | 10.0 | | | 277.8 | | | 160.3 | 30.2 | | | |
| Level of Service | F | A | | | F | | | F | C | | | |
| Approach Delay (s) | | 82.6 | | | 277.8 | | | 124.4 | | | 0.0 | |
| Approach LOS | | F | | | F | | | F | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 166.7 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.36 | | |
| Actuated Cycle Length (s) | 110.0 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 120.9% | ICU Level of Service | H |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 177 | 378 | 843 | 221 | 0 | 36 | 0 | 577 | 188 | 733 | 59 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3474 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.33 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 616 | | 2787 | | 3474 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 197 | 420 | 937 | 246 | 0 | 40 | 0 | 641 | 209 | 814 | 66 |
| RTOR Reduction (vph) | 0 | 0 | 221 | 0 | 0 | 0 | 0 | 0 | 253 | 0 | 5 | 0 |
| Lane Group Flow (vph) | 0 | 197 | 199 | 937 | 246 | 0 | 40 | 0 | 388 | 0 | 1084 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 17.1 | 17.1 | 29.1 | 50.2 | | 12.1 | | 45.2 | | 21.1 | |
| Effective Green, g (s) | | 17.1 | 17.1 | 29.1 | 50.2 | | 12.1 | | 45.2 | | 21.1 | |
| Actuated g/C Ratio | | 0.18 | 0.18 | 0.31 | 0.53 | | 0.13 | | 0.47 | | 0.22 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 334 | 284 | 1047 | 980 | | 78 | | 1320 | | 768 | |
| v/s Ratio Prot | | 0.11 | | c0.27 | 0.13 | | | | 0.14 | | c0.31 | |
| v/s Ratio Perm | | | c0.13 | | | | c0.06 | | | | | |
| v/c Ratio | | 0.59 | 0.70 | 0.89 | 0.25 | | 0.51 | | 0.29 | | 1.41 | |
| Uniform Delay, d1 | | 35.9 | 36.8 | 31.7 | 12.3 | | 38.9 | | 15.3 | | 37.2 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 7.4 | 13.5 | 10.0 | 0.1 | | 5.6 | | 0.1 | | 193.1 | |
| Delay (s) | | 43.4 | 50.3 | 41.7 | 12.5 | | 44.5 | | 15.5 | | 230.2 | |
| Level of Service | | D | D | D | B | | D | | B | | F | |
| Approach Delay (s) | | 48.1 | | | 35.6 | | | 17.2 | | | 230.2 | |
| Approach LOS | | D | | | D | | | B | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 93.6 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 0.93 | | |
| Actuated Cycle Length (s) | 95.4 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 85.1% | ICU Level of Service | E |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 328 | 222 | 1 | 2 | 88 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 364 | 227 | 1 | 2 | 98 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 228 | | | | 591 | 227 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 228 | | | | 591 | 227 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 88 |
| cM capacity (veh/h) | 1341 | | | | 469 | 812 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 364 | 228 | 2 | 98 |
| Volume Left | 0 | 0 | 2 | 0 |
| Volume Right | 0 | 1 | 0 | 98 |
| cSH | 1341 | 1700 | 469 | 812 |
| Volume to Capacity | 0.00 | 0.13 | 0.00 | 0.12 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 10 |
| Control Delay (s) | 0.0 | 0.0 | 12.7 | 10.0 |
| Lane LOS | | | B | B |
| Approach Delay (s) | 0.0 | 0.0 | 10.1 | |
| Approach LOS | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.5 | | |
| Intersection Capacity Utilization | 27.3% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 366 | 284 | 36 | 5 | 211 | 107 | 38 | 53 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 381 | 296 | 38 | 5 | 232 | 118 | 42 | 59 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 381 | 333 | 355 | 101 |
| Volume Left (vph) | 381 | 0 | 5 | 42 |
| Volume Right (vph) | 0 | 38 | 118 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.16 | 0.12 |
| Departure Headway (s) | 5.7 | 5.1 | 4.9 | 6.2 |
| Degree Utilization, x | 0.60 | 0.47 | 0.48 | 0.17 |
| Capacity (veh/h) | 618 | 695 | 721 | 533 |
| Control Delay (s) | 15.7 | 11.4 | 12.3 | 10.5 |
| Approach Delay (s) | 13.7 | | 12.3 | 10.5 |
| Approach LOS | B | | B | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 13.0 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 53.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 44 | 305 | 47 | 164 | 56 | 46 | 188 | 222 | 309 | 22 | 109 | 252 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 49 | 339 | 52 | 182 | 62 | 51 | 209 | 247 | 343 | 24 | 121 | 280 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 440 | 296 | 456 | 343 | 426 |
| Volume Left (vph) | 49 | 182 | 209 | 0 | 24 |
| Volume Right (vph) | 52 | 51 | 0 | 343 | 280 |
| Hadj (s) | -0.01 | 0.05 | 0.26 | -0.67 | -0.35 |
| Departure Headway (s) | 9.0 | 9.6 | 9.5 | 8.6 | 8.7 |
| Degree Utilization, x | 1.10 | 0.79 | 1.20 | 0.82 | 1.03 |
| Capacity (veh/h) | 411 | 371 | 384 | 416 | 415 |
| Control Delay (s) | 103.7 | 40.1 | 140.9 | 38.7 | 83.3 |
| Approach Delay (s) | 103.7 | 40.1 | 97.0 | | 83.3 |
| Approach LOS | F | E | F | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 86.9 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 94.0% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 50 | 267 | 138 | 121 | 401 | 25 | 69 | 484 | 58 | 191 | 429 | 86 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.96 | | | 0.99 | | 1.00 | 0.98 | | 1.00 | 0.97 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1777 | | | 1831 | | 1770 | 1833 | | 1770 | 1816 | |
| Flt Permitted | | 0.91 | | | 0.80 | | 0.25 | 1.00 | | 0.25 | 1.00 | |
| Satd. Flow (perm) | | 1632 | | | 1481 | | 466 | 1833 | | 466 | 1816 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 53 | 281 | 145 | 134 | 446 | 28 | 75 | 526 | 63 | 212 | 477 | 96 |
| RTOR Reduction (vph) | 0 | 39 | 0 | 0 | 4 | 0 | 0 | 11 | 0 | 0 | 18 | 0 |
| Lane Group Flow (vph) | 0 | 440 | 0 | 0 | 604 | 0 | 75 | 578 | 0 | 212 | 555 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 653 | | | 592 | | 186 | 733 | | 186 | 726 | |
| v/s Ratio Prot | | | | | | | | 0.32 | | | 0.31 | |
| v/s Ratio Perm | | 0.27 | | | c0.41 | | 0.16 | | | c0.46 | | |
| v/c Ratio | | 0.67 | | | 1.02 | | 0.40 | 0.79 | | 1.14 | 0.76 | |
| Uniform Delay, d1 | | 9.9 | | | 12.0 | | 8.6 | 10.5 | | 12.0 | 10.4 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 5.5 | | | 42.1 | | 6.4 | 8.4 | | 108.6 | 7.5 | |
| Delay (s) | | 15.3 | | | 54.1 | | 15.0 | 18.9 | | 120.6 | 17.9 | |
| Level of Service | | B | | | D | | B | B | | F | B | |
| Approach Delay (s) | | 15.3 | | | 54.1 | | | 18.5 | | | 45.6 | |
| Approach LOS | | B | | | D | | | B | | | D | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 34.8 | HCM Level of Service | C |
| HCM Volume to Capacity ratio | 1.08 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 100.9% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Cumulative Year 2035 plus Project Conditions
# Weekend Midday Peak Hour

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Yield | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 104 | 215 | 290 | 8 | 205 | 6 | 131 | 2 | 5 | 13 | 7 | 60 |
| Peak Hour Factor | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.92 | 0.92 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 113 | 234 | 315 | 9 | 223 | 7 | 146 | 2 | 5 | 14 | 8 | 67 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 | NB 2 | SB 1 |
|---|---|---|---|---|---|---|
| Volume Total (vph) | 113 | 549 | 238 | 146 | 8 | 89 |
| Volume Left (vph) | 113 | 0 | 9 | 146 | 0 | 14 |
| Volume Right (vph) | 0 | 315 | 7 | 0 | 5 | 67 |
| Hadj (s) | 0.53 | -0.37 | 0.02 | 0.53 | -0.46 | -0.39 |
| Departure Headway (s) | 6.3 | 5.4 | 6.3 | 7.6 | 6.5 | 6.8 |
| Degree Utilization, x | 0.20 | 0.82 | 0.42 | 0.31 | 0.01 | 0.17 |
| Capacity (veh/h) | 553 | 657 | 545 | 449 | 509 | 483 |
| Control Delay (s) | 9.6 | 26.8 | 13.7 | 12.6 | 8.4 | 11.2 |
| Approach Delay (s) | 23.9 | | 13.7 | 12.4 | | 11.2 |
| Approach LOS | C | | B | B | | B |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 19.2 | | |
| HCM Level of Service | C | | |
| Intersection Capacity Utilization | 64.6% | ICU Level of Service | C |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 346 | 326 | 0 | 0 | 522 | 438 | 440 | 6 | 333 | 0 | 0 | 0 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Lane Util. Factor | 0.97 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Frt | 1.00 | 1.00 | | | 0.94 | | | 1.00 | 0.85 | | | |
| Flt Protected | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (prot) | 3433 | 1863 | | | 1748 | | | 1775 | 1583 | | | |
| Flt Permitted | 0.95 | 1.00 | | | 1.00 | | | 0.95 | 1.00 | | | |
| Satd. Flow (perm) | 3433 | 1863 | | | 1748 | | | 1775 | 1583 | | | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.92 | 0.92 | 0.92 |
| Adj. Flow (vph) | 364 | 343 | 0 | 0 | 580 | 487 | 484 | 7 | 366 | 0 | 0 | 0 |
| RTOR Reduction (vph) | 0 | 0 | 0 | 0 | 37 | 0 | 0 | 0 | 241 | 0 | 0 | 0 |
| Lane Group Flow (vph) | 364 | 343 | 0 | 0 | 1030 | 0 | 0 | 491 | 125 | 0 | 0 | 0 |
| Turn Type | Prot | | | Perm | | | Split | | Perm | | | |
| Protected Phases | 7 | 4 | | | 8 | | 2 | 2 | | | | |
| Permitted Phases | | | | 8 | | | | | 2 | | | |
| Actuated Green, G (s) | 12.1 | 44.1 | | | 28.0 | | | 27.0 | 27.0 | | | |
| Effective Green, g (s) | 12.1 | 44.1 | | | 28.0 | | | 27.0 | 27.0 | | | |
| Actuated g/C Ratio | 0.15 | 0.56 | | | 0.35 | | | 0.34 | 0.34 | | | |
| Clearance Time (s) | 4.0 | 4.0 | | | 4.0 | | | 4.0 | 4.0 | | | |
| Vehicle Extension (s) | 3.0 | 3.0 | | | 3.0 | | | 3.0 | 3.0 | | | |
| Lane Grp Cap (vph) | 525 | 1039 | | | 619 | | | 606 | 540 | | | |
| v/s Ratio Prot | c0.11 | 0.18 | | | c0.59 | | | c0.28 | | | | |
| v/s Ratio Perm | | | | | | | | | 0.08 | | | |
| v/c Ratio | 0.69 | 0.33 | | | 1.66 | | | 0.81 | 0.23 | | | |
| Uniform Delay, d1 | 31.7 | 9.5 | | | 25.5 | | | 23.7 | 18.6 | | | |
| Progression Factor | 1.00 | 1.00 | | | 1.00 | | | 1.00 | 1.00 | | | |
| Incremental Delay, d2 | 3.9 | 0.2 | | | 305.6 | | | 11.2 | 1.0 | | | |
| Delay (s) | 35.7 | 9.7 | | | 331.1 | | | 34.9 | 19.6 | | | |
| Level of Service | D | A | | | F | | | C | B | | | |
| Approach Delay (s) | | 23.1 | | | 331.1 | | | 28.4 | | | 0.0 | |
| Approach LOS | | C | | | F | | | C | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 149.7 | HCM Level of Service | F |
| HCM Volume to Capacity ratio | 1.15 | | |
| Actuated Cycle Length (s) | 79.1 | Sum of lost time (s) | 12.0 |
| Intersection Capacity Utilization | 106.1% | ICU Level of Service | G |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 0 | 123 | 343 | 572 | 162 | 0 | 31 | 0 | 407 | 265 | 622 | 57 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | 4.0 | | 4.0 | |
| Lane Util. Factor | | 1.00 | 1.00 | 0.97 | 1.00 | | 1.00 | | 0.88 | | 0.95 | |
| Frt | | 1.00 | 0.85 | 1.00 | 1.00 | | 1.00 | | 0.85 | | 0.99 | |
| Flt Protected | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.95 | | 1.00 | | 0.99 | |
| Satd. Flow (prot) | | 1863 | 1583 | 3433 | 1863 | | 1770 | | 2787 | | 3459 | |
| Flt Permitted | | 1.00 | 1.00 | 0.95 | 1.00 | | 0.36 | | 1.00 | | 0.99 | |
| Satd. Flow (perm) | | 1863 | 1583 | 3433 | 1863 | | 677 | | 2787 | | 3459 | |
| Peak-hour factor, PHF | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 0 | 137 | 381 | 636 | 180 | 0 | 34 | 0 | 452 | 294 | 691 | 63 |
| RTOR Reduction (vph) | 0 | 0 | 231 | 0 | 0 | 0 | 0 | 0 | 268 | 0 | 4 | 0 |
| Lane Group Flow (vph) | 0 | 137 | 150 | 636 | 180 | 0 | 34 | 0 | 184 | 0 | 1044 | 0 |
| Turn Type | | | Perm | Prot | | | custom | | custom | Split | | |
| Protected Phases | | 2 | | 1 | 6 | | | | 1 8 | 4 | 4 | |
| Permitted Phases | | | 2 | | | | 8 | | | | | |
| Actuated Green, G (s) | | 18.2 | 18.2 | 22.2 | 44.4 | | 11.0 | | 37.2 | | 24.2 | |
| Effective Green, g (s) | | 18.2 | 18.2 | 22.2 | 44.4 | | 11.0 | | 37.2 | | 24.2 | |
| Actuated g/C Ratio | | 0.20 | 0.20 | 0.24 | 0.48 | | 0.12 | | 0.41 | | 0.26 | |
| Clearance Time (s) | | 4.0 | 4.0 | 4.0 | 4.0 | | 4.0 | | | | 4.0 | |
| Vehicle Extension (s) | | 3.0 | 3.0 | 3.0 | 3.0 | | 3.0 | | | | 3.0 | |
| Lane Grp Cap (vph) | | 370 | 315 | 832 | 903 | | 81 | | 1132 | | 914 | |
| v/s Ratio Prot | | 0.07 | | c0.19 | 0.10 | | | | 0.07 | | c0.30 | |
| v/s Ratio Perm | | | c0.09 | | | | c0.05 | | | | | |
| v/c Ratio | | 0.37 | 0.48 | 0.76 | 0.20 | | 0.42 | | 0.16 | | 1.14 | |
| Uniform Delay, d1 | | 31.7 | 32.5 | 32.3 | 13.5 | | 37.3 | | 17.3 | | 33.7 | |
| Progression Factor | | 1.00 | 1.00 | 1.00 | 1.00 | | 1.00 | | 1.00 | | 1.00 | |
| Incremental Delay, d2 | | 2.8 | 5.1 | 4.2 | 0.1 | | 3.5 | | 0.1 | | 76.9 | |
| Delay (s) | | 34.6 | 37.6 | 36.5 | 13.6 | | 40.8 | | 17.4 | | 110.6 | |
| Level of Service | | C | D | D | B | | D | | B | | F | |
| Approach Delay (s) | | 36.8 | | | 31.4 | | | 19.0 | | | 110.6 | |
| Approach LOS | | D | | | C | | | B | | | F | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 59.2 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 0.77 | | |
| Actuated Cycle Length (s) | 91.6 | Sum of lost time (s) | 16.0 |
| Intersection Capacity Utilization | 74.3% | ICU Level of Service | D |
| Analysis Period (min) | 15 | | |
| c Critical Lane Group | | | |

| Movement | EBL | EBT | WBT | WBR | SBL | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (veh/h) | 0 | 71 | 201 | 0 | 0 | 62 |
| Sign Control | | Free | Free | | Stop | |
| Grade | | 0% | 0% | | 0% | |
| Peak Hour Factor | 0.90 | 0.90 | 0.98 | 0.98 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 79 | 205 | 0 | 0 | 69 |
| Pedestrians | | | | | | |
| Lane Width (ft) | | | | | | |
| Walking Speed (ft/s) | | | | | | |
| Percent Blockage | | | | | | |
| Right turn flare (veh) | | | | | | |
| Median type | | None | None | | | |
| Median storage veh) | | | | | | |
| Upstream signal (ft) | | | | | | |
| pX, platoon unblocked | | | | | | |
| vC, conflicting volume | 205 | | | | 284 | 205 |
| vC1, stage 1 conf vol | | | | | | |
| vC2, stage 2 conf vol | | | | | | |
| vCu, unblocked vol | 205 | | | | 284 | 205 |
| tC, single (s) | 4.1 | | | | 6.4 | 6.2 |
| tC, 2 stage (s) | | | | | | |
| tF (s) | 2.2 | | | | 3.5 | 3.3 |
| p0 queue free % | 100 | | | | 100 | 92 |
| cM capacity (veh/h) | 1366 | | | | 706 | 835 |

| Direction, Lane # | EB 1 | WB 1 | SB 1 | SB 2 |
|---|---|---|---|---|
| Volume Total | 79 | 205 | 0 | 69 |
| Volume Left | 0 | 0 | 0 | 0 |
| Volume Right | 0 | 0 | 0 | 69 |
| cSH | 1366 | 1700 | 1700 | 835 |
| Volume to Capacity | 0.00 | 0.12 | 0.00 | 0.08 |
| Queue Length 95th (ft) | 0 | 0 | 0 | 7 |
| Control Delay (s) | 0.0 | 0.0 | 0.0 | 9.7 |
| Lane LOS | | | A | A |
| Approach Delay (s) | 0.0 | 0.0 | 9.7 | |
| Approach LOS | | | A | |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 1.9 | | |
| Intersection Capacity Utilization | 21.1% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 322 | 162 | 20 | 0 | 211 | 123 | 11 | 15 | 0 | 0 | 0 | 0 |
| Peak Hour Factor | 0.96 | 0.96 | 0.96 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 335 | 169 | 21 | 0 | 232 | 135 | 12 | 17 | 0 | 0 | 0 | 0 |

| Direction, Lane # | EB 1 | EB 2 | WB 1 | NB 1 |
|---|---|---|---|---|
| Volume Total (vph) | 335 | 190 | 367 | 29 |
| Volume Left (vph) | 335 | 0 | 0 | 12 |
| Volume Right (vph) | 0 | 21 | 135 | 0 |
| Hadj (s) | 0.53 | -0.04 | -0.19 | 0.12 |
| Departure Headway (s) | 5.4 | 4.8 | 4.4 | 5.9 |
| Degree Utilization, x | 0.50 | 0.25 | 0.45 | 0.05 |
| Capacity (veh/h) | 662 | 737 | 800 | 546 |
| Control Delay (s) | 12.5 | 8.2 | 11.0 | 9.2 |
| Approach Delay (s) | 10.9 | | 11.0 | 9.2 |
| Approach LOS | B | | B | A |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 10.9 | | |
| HCM Level of Service | B | | |
| Intersection Capacity Utilization | 49.8% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Sign Control | | Stop | | | Stop | | | Stop | | | Stop | |
| Volume (vph) | 160 | 251 | 241 | 20 | 119 | 205 | 111 | 51 | 31 | 35 | 268 | 35 |
| Peak Hour Factor | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 178 | 279 | 268 | 22 | 132 | 228 | 123 | 57 | 34 | 39 | 298 | 39 |

| Direction, Lane # | EB 1 | WB 1 | SE 1 | SE 2 | NW 1 |
|---|---|---|---|---|---|
| Volume Total (vph) | 724 | 382 | 180 | 34 | 376 |
| Volume Left (vph) | 178 | 22 | 123 | 0 | 39 |
| Volume Right (vph) | 268 | 228 | 0 | 34 | 39 |
| Hadj (s) | -0.14 | -0.31 | 0.38 | -0.67 | -0.01 |
| Departure Headway (s) | 7.5 | 7.5 | 9.3 | 8.2 | 7.9 |
| Degree Utilization, x | 1.50 | 0.80 | 0.46 | 0.08 | 0.83 |
| Capacity (veh/h) | 464 | 464 | 355 | 400 | 434 |
| Control Delay (s) | 257.1 | 34.2 | 18.9 | 10.7 | 39.1 |
| Approach Delay (s) | 257.1 | 34.2 | 17.6 | | 39.1 |
| Approach LOS | F | D | C | | E |

| Intersection Summary | | | |
|---|---|---|---|
| Delay | 128.4 | | |
| HCM Level of Service | F | | |
| Intersection Capacity Utilization | 97.0% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

| Movement | EBL | EBT | EBR | WBL | WBT | WBR | SEL | SET | SER | NWL | NWT | NWR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (vph) | 33 | 250 | 31 | 200 | 352 | 125 | 79 | 284 | 38 | 26 | 271 | 133 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Total Lost time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Util. Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Frt | | 0.99 | | | 0.98 | | 1.00 | 0.98 | | 1.00 | 0.95 | |
| Flt Protected | | 0.99 | | | 0.99 | | 0.95 | 1.00 | | 0.95 | 1.00 | |
| Satd. Flow (prot) | | 1828 | | | 1790 | | 1770 | 1830 | | 1770 | 1771 | |
| Flt Permitted | | 0.92 | | | 0.79 | | 0.38 | 1.00 | | 0.49 | 1.00 | |
| Satd. Flow (perm) | | 1687 | | | 1433 | | 705 | 1830 | | 912 | 1771 | |
| Peak-hour factor, PHF | 0.95 | 0.95 | 0.95 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Adj. Flow (vph) | 35 | 263 | 33 | 222 | 391 | 139 | 86 | 309 | 41 | 29 | 301 | 148 |
| RTOR Reduction (vph) | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 12 | 0 | 0 | 44 | 0 |
| Lane Group Flow (vph) | 0 | 321 | 0 | 0 | 732 | 0 | 86 | 338 | 0 | 29 | 405 | 0 |
| Turn Type | Perm | | | Perm | | | Perm | | | Perm | | |
| Protected Phases | | 4 | | | 8 | | | 6 | | | 2 | |
| Permitted Phases | 4 | | | 8 | | | 6 | | | 2 | | |
| Actuated Green, G (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Effective Green, g (s) | | 16.0 | | | 16.0 | | 16.0 | 16.0 | | 16.0 | 16.0 | |
| Actuated g/C Ratio | | 0.40 | | | 0.40 | | 0.40 | 0.40 | | 0.40 | 0.40 | |
| Clearance Time (s) | | 4.0 | | | 4.0 | | 4.0 | 4.0 | | 4.0 | 4.0 | |
| Lane Grp Cap (vph) | | 675 | | | 573 | | 282 | 732 | | 365 | 708 | |
| v/s Ratio Prot | | | | | | | | 0.18 | | | c0.23 | |
| v/s Ratio Perm | | 0.19 | | | c0.51 | | 0.12 | | | 0.03 | | |
| v/c Ratio | | 0.48 | | | 1.28 | | 0.30 | 0.46 | | 0.08 | 0.57 | |
| Uniform Delay, d1 | | 8.9 | | | 12.0 | | 8.2 | 8.8 | | 7.4 | 9.3 | |
| Progression Factor | | 1.00 | | | 1.00 | | 1.00 | 1.00 | | 1.00 | 1.00 | |
| Incremental Delay, d2 | | 2.4 | | | 137.7 | | 2.8 | 2.1 | | 0.4 | 3.3 | |
| Delay (s) | | 11.3 | | | 149.7 | | 11.0 | 10.9 | | 7.9 | 12.7 | |
| Level of Service | | B | | | F | | B | B | | A | B | |
| Approach Delay (s) | | 11.3 | | | 149.7 | | | 10.9 | | | 12.4 | |
| Approach LOS | | B | | | F | | | B | | | B | |

| Intersection Summary | | | |
|---|---|---|---|
| HCM Average Control Delay | 63.6 | HCM Level of Service | E |
| HCM Volume to Capacity ratio | 0.92 | | |
| Actuated Cycle Length (s) | 40.0 | Sum of lost time (s) | 8.0 |
| Intersection Capacity Utilization | 94.1% | ICU Level of Service | F |
| Analysis Period (min) | 15 | | |

c Critical Lane Group

# Appendix X-3

## Peak Hour Signal Warrant Worksheets

Traffic Signal Warrants Worksheet
Warrant 3: Peak Hour
(*from the MUTCD 2003 California Supplement*)

Scenario: 2015 plus Project PM
Intersection: 1. Golf Links Road/ Mountain Boulevard/ Zoo Drive

PART A or PART B SATISFIED YES ☐ NO ☒

---

PART A SATISFIED YES ☐ NO ☒
(All parts 1, 2, and 3 below must be satisfied)

1. The total delay experienced for traffic on one minor street approach controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach and five vehicle-hours for a two-lane approach; AND — Yes ☐ No ☒

2. The volume on the same minor street approach equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; AND — Yes ☒ No ☐

3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches. — Yes ☒ No ☐

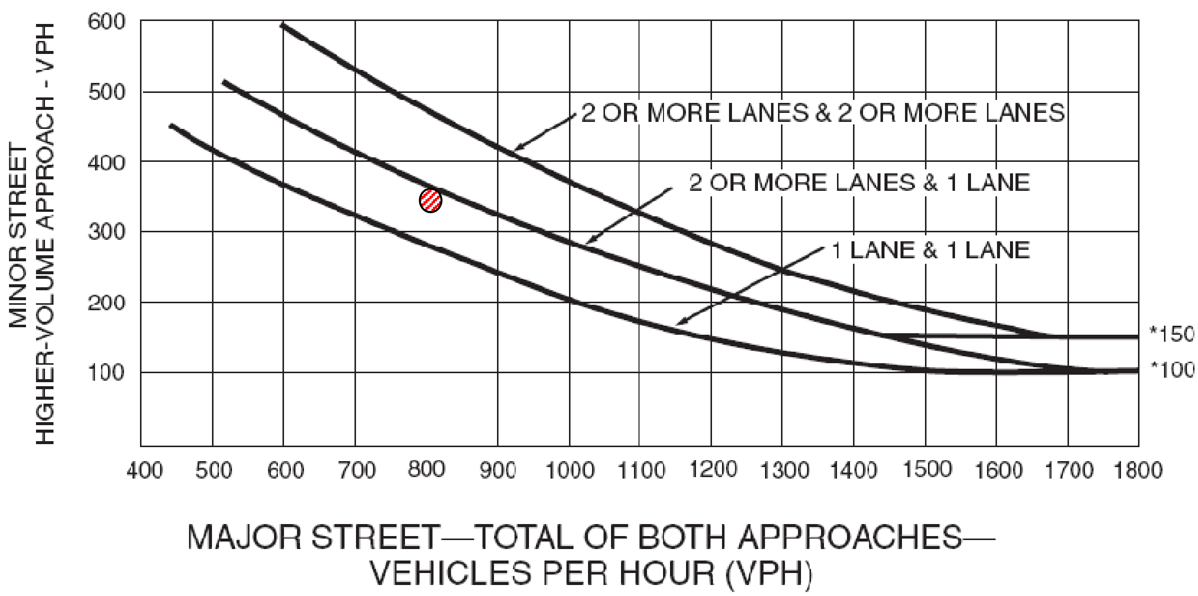
---

PART B SATISFIED YES ☐ NO ☒

| APPROACH LANES | One | 2 or More | | | | |
|---|---|---|---|---|---|---|
| Both Approaches – Major Street | | 846 | | | | |
| Highest Approaches – Minor Street | | 351 | | | | |

The plotted points for vehicles per hour on major streets (both approaches) and the corresponding per hour higher volume minor street approach (one direction only) for one hour (any consecutive 15 minute period) fall above the applicable curves in MUTCD Figure 4C-3.

**Figure 4C-3.Warrant 3, Peak Hour**




*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Traffic Signal Warrants Worksheet
Warrant 3: Peak Hour
(*from the MUTCD 2003 California Supplement*)

Scenario: 2035 plus Project PM
Intersection: 1. Golf Links Road/ Mountain Boulevard/ Zoo Drive

PART A or PART B SATISFIED YES ☐ NO ☒

---

PART A SATISFIED YES ☐ NO ☒
(All parts 1, 2, and 3 below must be satisfied)

1. The total delay experienced for traffic on one minor street approach controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach and five vehicle-hours for a two-lane approach; AND — Yes ☐ No ☒

2. The volume on the same minor street approach equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; AND — Yes ☒ No ☐

3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches. — Yes ☒ No ☐

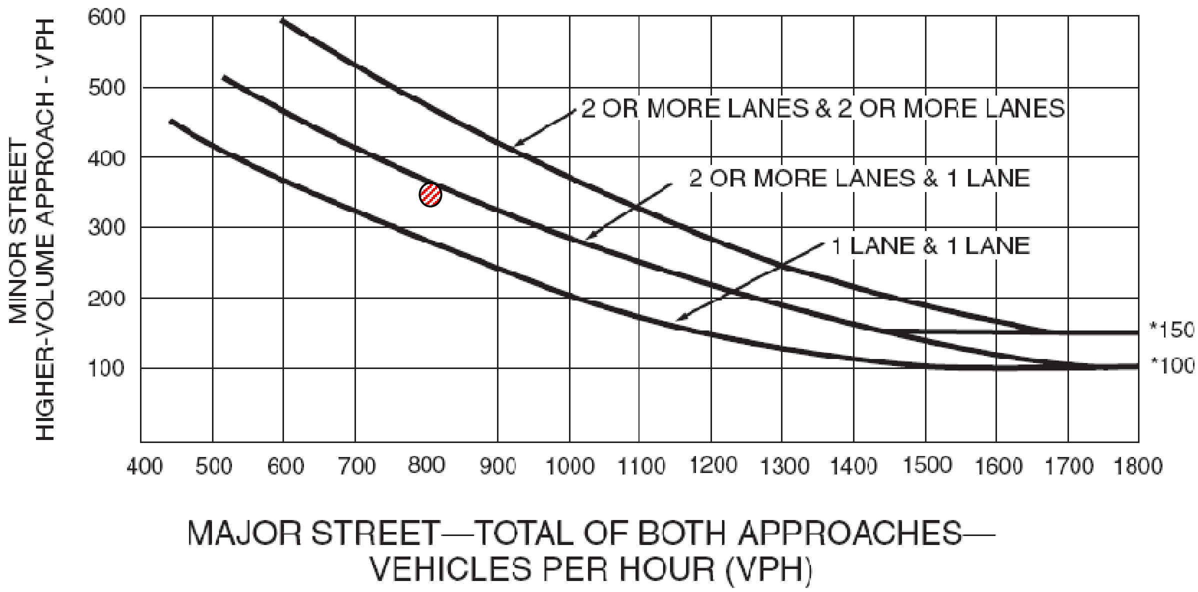
---

PART B SATISFIED YES ☐ NO ☒

| APPROACH LANES | One | 2 or More | | | | |
|---|---|---|---|---|---|---|
| Both Approaches – Major Street | | 854 | | | | |
| Highest Approaches – Minor Street | | 350 | | | | |

The plotted points for vehicles per hour on major streets (both approaches) and the corresponding per hour higher volume minor street approach (one direction only) for one hour (any consecutive 15 minute period) fall above the applicable curves in MUTCD Figure 4C-3.

**Figure 4C-3.Warrant 3, Peak Hour**



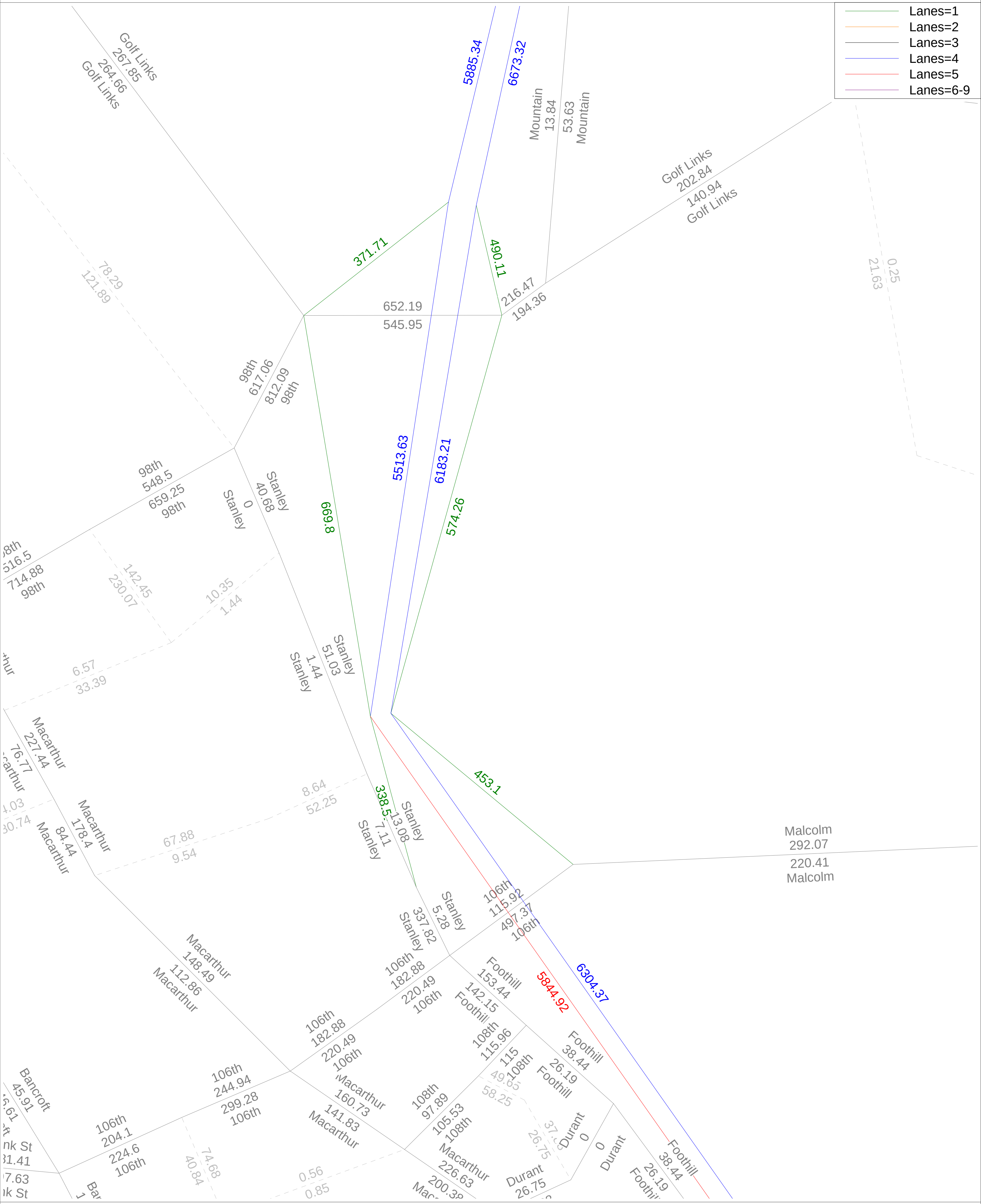

*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

# Appendix X-4

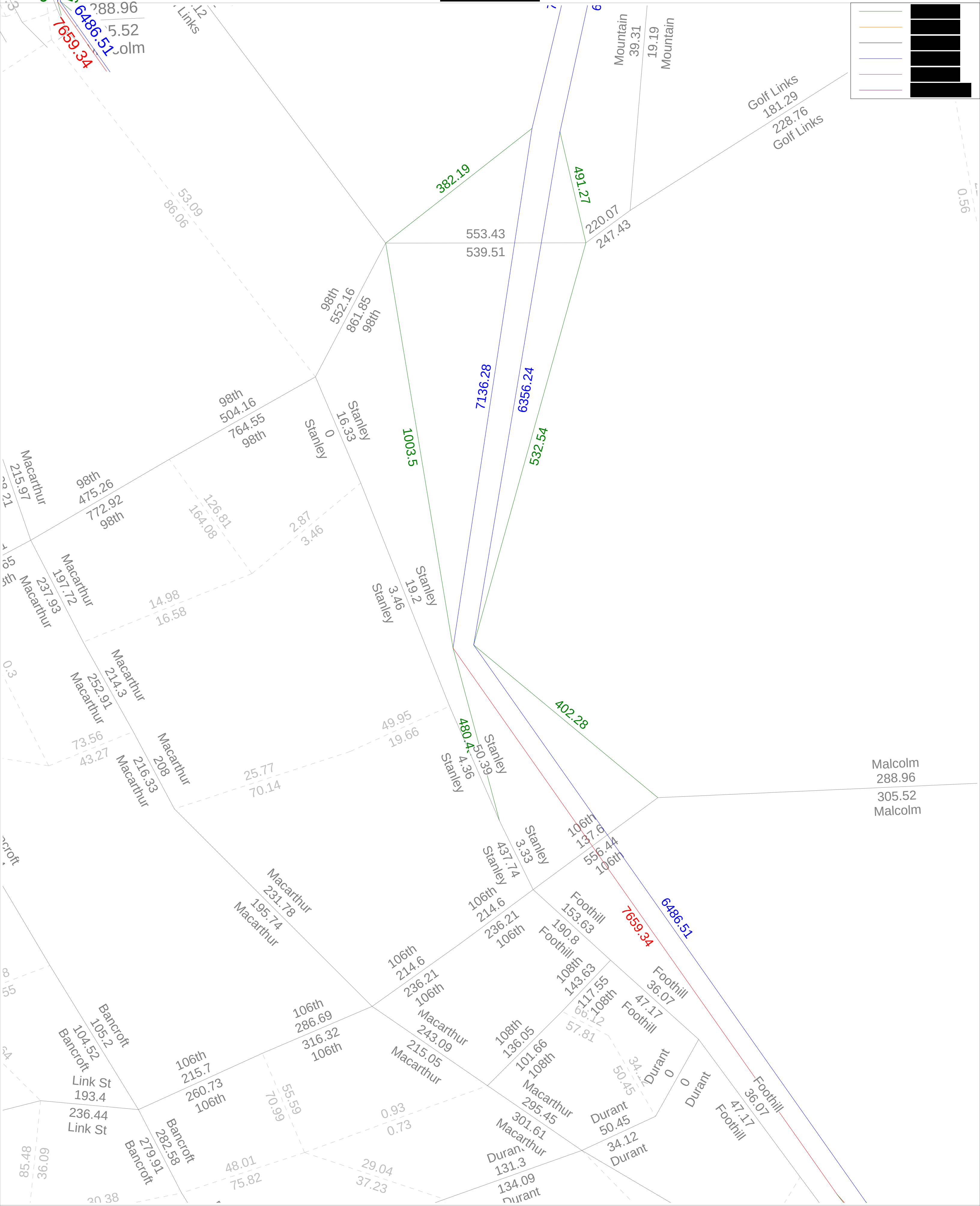
## ACCMA Model Output

# 2005 AM

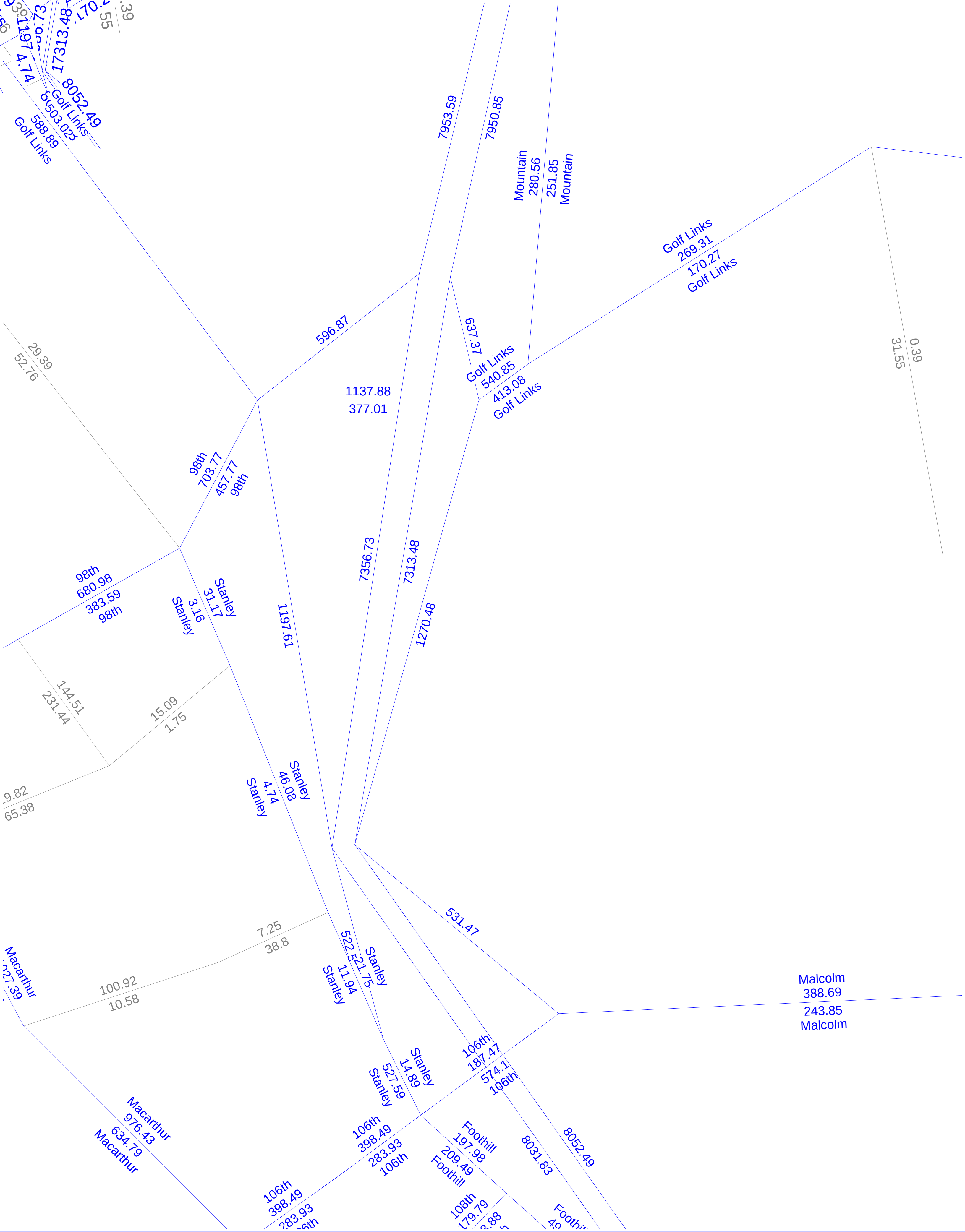
ACCMA 2005 Travel Forecasting Model
Number of Lanes on Freeway and Ramps
No-Build Network



2005 PM

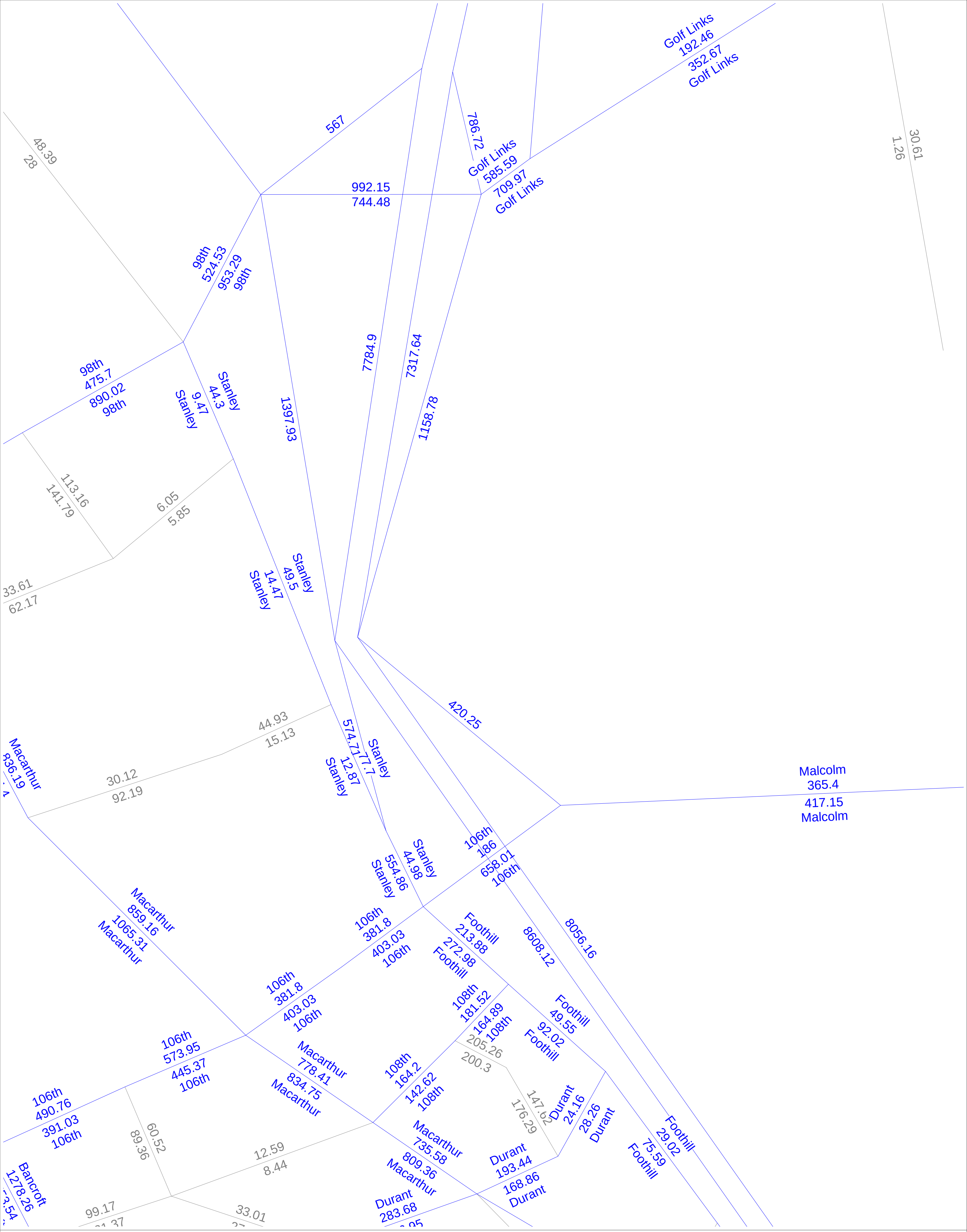

[redacted]
Malcolm
288.96
305.52
Malcolm
Golf Links
181.29
228.76
Golf Links
Mountain
39.31
19.19
Mountain
382.19
491.27
220.07
247.43
553.43
539.51
98th
552.16
861.85
98th
7136.28
6356.24
1003.5
532.54
98th
504.16
764.55
98th
Stanley
16.33
0
Stanley
98th
475.26
772.92
98th
Macarthur
215.97
53.09
86.06
126.81
164.08
2.87
3.46
Macarthur
197.72
237.93
Macarthur
Stanley
19.2
3.46
Stanley
14.98
16.58
Macarthur
214.3
252.91
Macarthur
402.28
Macarthur
208
216.33
Macarthur
49.95
19.66
73.56
43.27
25.77
70.14
Stanley
50.39
4.36
Stanley
106th
137.6
556.44
106th
Stanley
3.33
437.74
Stanley
Macarthur
231.78
195.74
Macarthur
106th
214.6
236.21
106th
Foothill
153.63
190.8
Foothill
7659.34
6486.51
106th
214.6
236.21
106th
108th
143.63
117.55
108th
Foothill
36.07
47.17
Foothill
66.12
57.81
Bancroft
105.2
104.52
Bancroft
106th
286.69
316.32
106th
Macarthur
243.09
215.05
Macarthur
108th
136.05
101.66
108th
Durant
0
0
Durant
50.45
Link St
193.4
236.44
Link St
106th
215.7
260.73
106th
55.59
70.99
0.93
0.73
Macarthur
295.45
301.61
Macarthur
Durant
50.45
34.12
Durant
Foothill
36.07
47.17
Foothill
Bancroft
282.58
279.91
Bancroft
85.48
36.09
48.01
75.82
29.04
37.23
Durant
131.3
134.09
Durant
30.38
0.56
0.3

# 2035 AM



7953.59
7950.85
Mountain
280.56
251.85
Mountain
Golf Links
269.31
170.27
Golf Links
8052.49
Golf Links
503.023
588.89
Golf Links
596.87
637.37
Golf Links
540.85
413.08
Golf Links
1137.88
377.01
0.39
31.55
29.39
52.76
98th
703.77
457.77
98th
7356.73
7313.48
1197.61
1270.48
98th
680.98
383.59
98th
Stanley
31.17
3.16
Stanley
144.51
231.44
15.09
1.75
Stanley
46.08
4.74
Stanley
65.38
531.47
7.25
38.8
100.92
10.58
Macarthur
027.39
522.52
21.75
Stanley
11.94
Stanley
Malcolm
388.69
243.85
Malcolm
106th
187.47
574.1
106th
Stanley
14.89
527.59
Stanley
Macarthur
976.43
634.79
Macarthur
106th
398.49
283.93
106th
Foothill
197.98
209.49
Foothill
8031.83
8052.49
106th
398.49
283.93
108th
179.79

# 2035 PM


Golf Links
192.46
352.67
Golf Links
567
786.72
Golf Links
585.59
709.97
Golf Links
30.61
1.26
48.39
28
992.15
744.48
98th
524.53
953.29
98th
7784.9
7317.64
98th
475.7
890.02
98th
Stanley
44.3
9.47
Stanley
1397.93
1158.78
113.16
141.79
6.05
5.85
33.61
62.17
Stanley
49.5
14.47
Stanley
420.25
44.93
15.13
Macarthur
836.19
30.12
92.19
574.71
12.87
Stanley
Stanley
77.7
Malcolm
365.4
417.15
Malcolm
106th
186
658.01
106th
Stanley
44.98
554.86
Stanley
Macarthur
859.16
1065.31
Macarthur
106th
381.8
403.03
106th
Foothill
213.88
272.98
Foothill
8608.12
8056.16
106th
381.8
403.03
106th
108th
181.52
164.89
108th
Foothill
49.55
92.02
Foothill
106th
573.95
445.37
106th
Macarthur
778.41
834.75
Macarthur
205.26
200.3
108th
164.2
142.62
108th
147.62
176.29
Durant
24.16
28.26
Durant
106th
490.76
391.03
106th
89.36
60.52
12.59
8.44
Macarthur
735.58
809.36
Macarthur
Foothill
29.02
75.59
Foothill
Durant
193.44
168.86
Durant
Bancroft
1278.26
99.17
33.01
Durant
283.68

# Appendix X-5

## Oakland Zoo Traffic Volumes

**Traffic Study**

Sep-06 Jun-07

Vehicle Info

| | DATE | LOCATION | PARKING PAID | MEMBERS | PROMO | TOTAL Cars | Month | Cummulative Year | All | | Sat | Sun | Mon | Tues | Wed | Thurs | Fri |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Friday | **1-Sep** | **Sept** | 236 | 234 | | **470** | 470 | 470 | 470 | | - | - | - | - | - | - | 470 |
| Saturday | **2** | | 745 | 364 | 14 | **1123** | 1,593 | 1,593 | 1,593 | | 1,123 | - | - | - | - | - | - |
| Sunday | **3** | | 943 | 367 | 2 | **1312** | 2,905 | 2,905 | 2,905 | | - | 1,312 | - | - | - | - | - |
| Monday | **4** | | 884 | 323 | | **1207** | 4,112 | 4,112 | 4,112 | | - | - | 1,207 | - | - | - | - |
| Tuesday | **5** | | 119 | 120 | | **239** | 4,351 | 4,351 | 4,351 | | - | - | - | 239 | - | - | - |
| Wednesday | **6** | | 88 | 109 | | **197** | 4,548 | 4,548 | 4,548 | | - | - | - | - | 197 | - | - |
| Thursday | **7** | | 104 | 112 | 4 | **220** | 4,768 | 4,768 | 4,768 | | - | - | - | - | - | 220 | - |
| Friday | **8** | | 113 | 133 | 7 | **253** | 5,021 | 5,021 | 5,021 | | - | - | - | - | - | - | 253 |
| Saturday | **9** | | 501 | 340 | 7 | **848** | 5,869 | 5,869 | 5,869 | | 848 | - | - | - | - | - | - |
| Sunday | **10** | | 581 | 299 | 1 | **881** | 6,750 | 6,750 | 6,750 | | - | 881 | - | - | - | - | - |
| Monday | **11** | | 102 | 88 | | **190** | 6,940 | 6,940 | 6,940 | | - | - | 190 | - | - | - | - |
| Tuesday | **12** | | 103 | 21 | 1 | **125** | 7,065 | 7,065 | 7,065 | | - | - | - | 125 | - | - | - |
| Wednesday | **13** | | 98 | 81 | | **179** | 7,244 | 7,244 | 7,244 | | - | - | - | - | 179 | - | - |
| Thursday | **14** | | 103 | 106 | 6 | **215** | 7,459 | 7,459 | 7,459 | | - | - | - | - | - | 215 | - |
| Friday | **15** | | 179 | 198 | 5 | **382** | 7,841 | 7,841 | 7,841 | | - | - | - | - | - | - | 382 |
| Saturday | **16** | | 636 | 360 | 12 | **1008** | 8,849 | 8,849 | 8,849 | | 1,008 | - | - | - | - | - | - |
| Sunday | **17** | | 657 | 355 | 3 | **1015** | 9,864 | 9,864 | 9,864 | | - | 1,015 | - | - | - | - | - |
| Monday | **18** | | 113 | 113 | | **226** | 10,090 | 10,090 | 10,090 | | - | - | 226 | - | - | - | - |
| Tuesday | **19** | | 109 | 52 | 1 | **162** | 10,252 | 10,252 | 10,252 | | - | - | - | 162 | - | - | - |
| Wednesday | **20** | | 133 | 101 | 3 | **237** | 10,489 | 10,489 | 10,489 | | - | - | - | - | 237 | - | - |
| Thursday | **21** | | 122 | 143 | | **265** | 10,754 | 10,754 | 10,754 | | - | - | - | - | - | 265 | - |
| Friday | **22** | | 213 | 130 | 3 | **346** | 11,100 | 11,100 | 11,100 | | - | - | - | - | - | - | 346 |
| Saturday | **23** | | 640 | 288 | 2 | **930** | 12,030 | 12,030 | 12,030 | | 930 | - | - | - | - | - | - |
| Sunday | **24** | | 617 | 375 | 1 | **993** | 13,023 | 13,023 | 13,023 | | - | 993 | - | - | - | - | - |
| Monday | **25** | | 110 | 127 | | **237** | 13,260 | 13,260 | 13,260 | | - | - | 237 | - | - | - | - |
| Tuesday | **26** | | 88 | 136 | | **224** | 13,484 | 13,484 | 13,484 | | - | - | - | 224 | - | - | - |
| Wednesday | **27** | | 99 | 106 | | **205** | 13,689 | 13,689 | 13,689 | | - | - | - | - | 205 | - | - |
| Thursday | **28** | | 113 | 93 | | **206** | 13,895 | 13,895 | 13,895 | | - | - | - | - | - | 206 | - |
| Friday | **29** | | 120 | 155 | 3 | **278** | 14,173 | 14,173 | 14,173 | | - | - | - | - | - | - | 278 |
| Saturday | **30** | | 518 | 267 | 23 | **808** | 14,981 | 14,981 | 14,981 | | 808 | - | - | - | - | - | - |
| **TOTAL** | **30 DAYS** | | **9187** | **5696** | **98** | **14981** | **256869** | **256869** | **256869** | **0** | **4717** | **4201** | **1860** | **750** | **818** | **906** | **1729** |
| Sunday | 1-Oct | ADMISSIO | 453 | 287 | 1 | 741 | 741 | 741 | 15,722 | | - | 741 | - | - | - | - | - |
| Monday | 2 | | 95 | 104 | 2 | 201 | 942 | 942 | 15,923 | | - | - | 201 | - | - | - | - |
| Tuesday | 3 | | 106 | 99 | | 205 | 1,147 | 1,147 | 16,128 | | - | - | - | 205 | - | - | - |
| Wednesday | 4 | | 58 | 50 | | 108 | 1,255 | 1,255 | 16,236 | | - | - | - | - | 108 | - | - |
| Thursday | 5 | | 40 | 45 | | 85 | 1,340 | 1,340 | 16,321 | | - | - | - | - | - | 85 | - |
| Friday | 6 | | 82 | 89 | 3 | 174 | 1,514 | 1,514 | 16,495 | | - | - | - | - | - | - | 174 |
| Saturday | 7 | | 455 | 281 | 2 | 738 | 2,252 | 2,252 | 17,233 | | 738 | - | - | - | - | - | - |
| Sunday | 8 | | 532 | 297 | 24 | 853 | 3,105 | 3,105 | 18,086 | | - | 853 | - | - | - | - | - |
| Monday | 9 | | 284 | 274 | 1 | 559 | 3,664 | 3,664 | 18,645 | | - | - | 559 | - | - | - | - |
| Tuesday | 10 | | 98 | 109 | | 207 | 3,871 | 3,871 | 18,852 | | - | - | - | 207 | - | - | - |
| Wednesday | 11 | | 110 | 126 | 3 | 239 | 4,110 | 4,110 | 19,091 | | - | - | - | - | 239 | - | - |
| Thursday | 12 | | 166 | 98 | | 264 | 4,374 | 4,374 | 19,355 | | - | - | - | - | - | 264 | - |
| Friday | 13 | | 180 | 177 | 2 | 359 | 4,733 | 4,733 | 19,714 | | - | - | - | - | - | - | 359 |
| Saturday | 14 | | 437 | 264 | 4 | 705 | 5,438 | 5,438 | 20,419 | | 705 | - | - | - | - | - | - |
| Sunday | 15 | | 347 | 220 | 9 | 576 | 6,014 | 6,014 | 20,995 | | - | 576 | - | - | - | - | - |
| Monday | 16 | | 59 | 65 | 1 | 125 | 6,139 | 6,139 | 21,120 | | - | - | 125 | - | - | - | - |
| Tuesday | 17 | | 99 | 105 | 3 | 207 | 6,346 | 6,346 | 21,327 | | - | - | - | 207 | - | - | - |
| Wednesday | 18 | | 91 | 120 | | 211 | 6,557 | 6,557 | 21,538 | | - | - | - | - | 211 | - | - |
| Thursday | 19 | | 132 | 118 | | 250 | 6,807 | 6,807 | 21,788 | | - | - | - | - | - | 250 | - |
| Friday | 20 | | 166 | 172 | | 338 | 7,145 | 7,145 | 22,126 | | - | - | - | - | - | - | 338 |
| Saturday | 21 | | 531 | 274 | 1 | 806 | 7,951 | 7,951 | 22,932 | | 806 | - | - | - | - | - | - |
| Sunday | 22 | | 594 | 295 | 15 | 904 | 8,855 | 8,855 | 23,836 | | - | 904 | - | - | - | - | - |
| Monday | 23 | | 75 | 478 | 2 | 555 | 9,410 | 9,410 | 24,391 | | - | - | 555 | - | - | - | - |
| Tuesday | 24 | | 96 | 108 | 3 | 207 | 9,617 | 9,617 | 24,598 | | - | - | - | 207 | - | - | - |
| Wednesday | 25 | | 102 | 87 | | 189 | 9,806 | 9,806 | 24,787 | | - | - | - | - | 189 | - | - |
| Thursday | 26 | | 96 | 95 | 1 | 192 | 9,998 | 9,998 | 24,979 | | - | - | - | - | - | 192 | - |
| Friday | 27 | | 134 | 150 | | 284 | 10,282 | 10,282 | 25,263 | | - | - | - | - | - | - | 284 |
| Saturday | 28 | | 694 | 448 | 9 | 1151 | 11,433 | 11,433 | 26,414 | | 1,151 | - | - | - | - | - | - |
| Sunday | 29 | | 607 | 613 | 8 | 1228 | 12,661 | 12,661 | 27,642 | | - | 1,228 | - | - | - | - | - |
| Monday | 30 | | 102 | 85 | 2 | 189 | 12,850 | 12,850 | 27,831 | | - | - | 189 | - | - | - | - |
| Tuesday | 31 | | 59 | 47 | | 106 | 12,956 | 12,956 | 27,937 | | - | - | - | 106 | - | - | - |
| **TOTAL** | **31 DAYS** | | **7080** | **5780** | **96** | **12956** | **193313** | **193313** | **657724** | **0** | **3400** | **4302** | **1629** | **932** | **747** | **791** | **1155** |
| Wednesday | 1 | Nov | 62 | 98 | | **160** | 160 | 13,116 | 28,097 | | - | - | - | - | 160 | - | - |
| Thursday | 2 | | 25 | 18 | | **43** | 203 | 13,159 | 28,140 | | - | - | - | - | - | 43 | - |
| Friday | 3 | | 54 | 50 | | **104** | 307 | 13,263 | 28,244 | | - | - | - | - | - | - | 104 |
| Saturday | 4 | | 382 | 270 | 8 | **660** | 967 | 13,923 | 28,904 | | 660 | - | - | - | - | - | - |
| Sunday | 5 | | 549 | 402 | 5 | **956** | 1,923 | 14,879 | 29,860 | | - | 956 | - | - | - | - | - |
| Monday | 6 | | 111 | 114 | 2 | **227** | 2,150 | 15,106 | 30,087 | | - | - | 227 | - | - | - | - |
| Tuesday | 7 | | 83 | 104 | 1 | **188** | 2,338 | 15,294 | 30,275 | | - | - | - | 188 | - | - | - |
| Wednesday | 8 | | 62 | 55 | | **117** | 2,455 | 15,411 | 30,392 | | - | - | - | - | 117 | - | - |
| Thursday | 9 | | 120 | 140 | 2 | **262** | 2,717 | 15,673 | 30,654 | | - | - | - | - | - | 262 | - |
| Friday | 10 | | 593 | 469 | 1 | **1063** | 3,780 | 16,736 | 31,717 | | - | - | - | - | - | - | 1,063 |
| Saturday | 11 | | 102 | 73 | 8 | **183** | 3,963 | 16,919 | 31,900 | | 183 | - | - | - | - | - | - |
| Sunday | 12 | | 447 | 363 | 6 | **816** | 4,779 | 17,735 | 32,716 | | - | 816 | - | - | - | - | - |
| Monday | 13 | | 26 | 17 | 1 | **44** | 4,823 | 17,779 | 32,760 | | - | - | 44 | - | - | - | - |
| Tuesday | 14 | | 63 | 84 | | **147** | 4,970 | 17,926 | 32,907 | | - | - | - | 147 | - | - | - |
| Wednesday | 15 | | 61 | 119 | | **180** | 5,150 | 18,106 | 33,087 | | - | - | - | - | 180 | - | - |
| Thursday | 16 | | 58 | 59 | 1 | **118** | 5,268 | 18,224 | 33,205 | | - | - | - | - | - | 118 | - |
| Friday | 17 | | 46 | 43 | | **89** | 5,357 | 18,313 | 33,294 | | - | - | - | - | - | - | 89 |
| Saturday | 18 | | 365 | 318 | 4 | **687** | 6,044 | 19,000 | 33,981 | | 687 | - | - | - | - | - | - |
| Sunday | 19 | | 366 | 313 | 1 | **680** | 6,724 | 19,680 | 34,661 | | - | 680 | - | - | - | - | - |
| Monday | 20 | | 158 | 154 | 1 | **313** | 7,037 | 19,993 | 34,974 | | - | - | 313 | - | - | - | - |
| Tuesday | 21 | | 124 | 134 | | **258** | 7,295 | 20,251 | 35,232 | | - | - | - | 258 | - | - | - |
| Wednesday | 22 | | 130 | 134 | 3 | **267** | 7,562 | 20,518 | 35,499 | | - | - | - | - | 267 | - | - |
| Thursday | 23 | | | | | | 7,562 | 20,518 | 35,499 | | - | - | - | - | - | - | - |
| Friday | 24 | | 537 | 438 | 2 | **977** | 8,539 | 21,495 | 36,476 | | - | - | - | - | - | - | 977 |
| Saturday | 25 | | 671 | 375 | 3 | **1049** | 9,588 | 22,544 | 37,525 | | 1,049 | - | - | - | - | - | - |
| Sunday | 26 | | 42 | 38 | | **80** | 9,668 | 22,624 | 37,605 | | - | 80 | - | - | - | - | - |
| Monday | 27 | | 27 | 27 | 1 | **55** | 9,723 | 22,679 | 37,660 | | - | - | 55 | - | - | - | - |
| Tuesday | 28 | | 41 | 55 | | **96** | 9,819 | 22,775 | 37,756 | | - | - | - | 96 | - | - | - |
| Wednesday | 29 | | 42 | 73 | 1 | **116** | 9,935 | 22,891 | 37,872 | | - | - | - | - | 116 | - | - |
| Thursday | 30 | | 59 | 55 | | **114** | 10,049 | 23,005 | 37,986 | | - | - | - | - | - | 114 | - |
| **TOTAL** | **30 DAYS** | | **5406** | **4592** | **51** | **10049** | **160855** | **549535** | **998965** | **0** | **2579** | **2532** | **639** | **689** | **840** | **537** | **2233** |
| Friday | 1 | dec | 60 | 112 | 1 | 173 | 173 | 23,178 | 38,159 | | - | - | - | - | - | - | 173 |
| Saturday | 2 | | 238 | 199 | 2 | 439 | 612 | 23,617 | 38,598 | | 439 | - | - | - | - | - | - |
| Sunday | 3 | | 290 | 314 | | 604 | 1,216 | 24,221 | 39,202 | | - | 604 | - | - | - | - | - |
| Monday | 4 | | 55 | 76 | | 131 | 1,347 | 24,352 | 39,333 | | - | - | 131 | - | - | - | - |
| Tuesday | 5 | | 45 | 80 | | 125 | 1,472 | 24,477 | 39,458 | | - | - | - | 125 | - | - | - |
| Wednesday | 6 | | 55 | 76 | | 131 | 1,603 | 24,608 | 39,589 | | - | - | - | - | 131 | - | - |
| Thursday | 7 | | | | | 0 | 1,603 | 24,608 | 39,589 | | - | - | - | - | - | - | - |
| Friday | 8 | | 25 | 27 | | 52 | 1,655 | 24,660 | 39,641 | | - | - | - | - | - | - | 52 |
| Saturday | 9 | | 88 | 176 | 1 | 265 | 1,920 | 24,925 | 39,906 | | 265 | - | - | - | - | - | - |
| Sunday | 10 | | 105 | 67 | | 172 | 2,092 | 25,097 | 40,078 | | - | 172 | - | - | - | - | - |
| Monday | 11 | | 23 | 30 | | 53 | 2,145 | 25,150 | 40,131 | | - | - | 53 | - | - | - | - |
| Tuesday | 12 | | 276 | 278 | | 554 | 2,699 | 25,704 | 40,685 | | - | - | - | 554 | - | - | - |
| Wednesday | 13 | | 5 | 9 | | 14 | 2,713 | 25,718 | 40,699 | | - | - | - | - | 14 | - | - |
| Thursday | 14 | | 2 | 10 | | 12 | 2,725 | 25,730 | 40,711 | | - | - | - | - | - | 12 | - |
| Friday | 15 | | 60 | 60 | | 120 | 2,845 | 25,850 | 40,831 | | - | - | - | - | - | - | 120 |
| Saturday | 16 | | 109 | 184 | 1 | 294 | 3,139 | 26,144 | 41,125 | | 294 | - | - | - | - | - | - |
| Sunday | 17 | | 276 | 278 | | 554 | 3,693 | 26,698 | 41,679 | | - | 554 | - | - | - | - | - |
| Monday | 18 | | 89 | 82 | | 171 | 3,864 | 26,869 | 41,850 | | - | - | 171 | - | - | - | - |
| Tuesday | 19 | | 86 | 118 | 1 | 205 | 4,069 | 27,074 | 42,055 | | - | - | - | 205 | - | - | - |
| Wednesday | 20 | | | | | 0 | 4,069 | 27,074 | 42,055 | | - | - | - | - | - | - | - |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Thursday | | 21 | 8 | 3 | | 11 | 4,080 | 27,085 | 42,066 | | - | - | - | - | - | 11 | - |
| Friday | | 22 | 120 | 149 | 1 | 270 | 4,350 | 27,355 | 42,336 | | - | - | - | - | - | - | 270 |
| Saturday | | 23 | 127 | 112 | 1 | 240 | 4,590 | 27,595 | 42,576 | | 240 | - | - | - | - | - | - |
| Sunday | | 24 | 78 | 73 | 1 | 152 | 4,742 | 27,747 | 42,728 | | - | 152 | - | - | - | - | - |
| Monday | | 25 **CLOSED** | | | | 0 | 4,742 | 27,747 | 42,728 | | - | - | - | - | - | - | - |
| Tuesday | | 26 | 101 | 88 | | 189 | 4,931 | 27,936 | 42,917 | | - | - | - | 189 | - | - | - |
| Wednesday | | 27 | 130 | 114 | | 244 | 5,175 | 28,180 | 43,161 | | - | - | - | - | 244 | - | - |
| Thursday | | 28 | 434 | 286 | 1 | 721 | 5,896 | 28,901 | 43,882 | | - | - | - | - | - | 721 | - |
| Friday | | 29 | 420 | 359 | 1 | 780 | 6,676 | 29,681 | 44,662 | | - | - | - | - | - | - | 780 |
| Saturday | | 30 | 555 | 350 | 1 | 906 | 7,582 | 30,587 | 45,568 | | 906 | - | - | - | - | - | - |
| Sunday | | 31 | 263 | 192 | 2 | 457 | 8,039 | 31,044 | 46,025 | | - | 457 | - | - | - | - | - |
| **TOTAL** | **31 DAYS** | | **4123** | **3902** | **14** | **8039** | **106457** | **819612** | **1284023** | **0** | **2144** | **1939** | **355** | **1073** | **389** | **744** | **1395** |
| Monday | | 1 Jan-07 | 218 | 243 | 1 | 462 | 462 | 31,506 | 46,487 | | - | - | 462 | - | - | - | - |
| Tuesday | | 2 | 237 | 256 | 1 | 494 | 956 | 32,000 | 46,981 | | - | - | - | 494 | - | - | - |
| Wednesday | | 3 | 174 | 151 | 1 | 326 | 1,282 | 32,326 | 47,307 | | - | - | - | - | 326 | - | - |
| Thursday | | 4 | | | | 0 | 1,282 | 32,326 | 47,307 | | - | - | - | - | - | - | - |
| Friday | | 5 | 190 | 235 | 2 | 427 | 1,709 | 32,753 | 47,734 | | - | - | - | - | - | - | 427 |
| Saturday | | 6 | **443** | **358** | | 801 | 2,510 | 33,554 | 48,535 | | 801 | - | - | - | - | - | - |
| Sunday | | 7 | 491 | 383 | 3 | 877 | 3,387 | 34,431 | 49,412 | | - | 877 | - | - | - | - | - |
| Monday | | 8 | 82 | 116 | 1 | 199 | 3,586 | 34,630 | 49,611 | | - | - | 199 | - | - | - | - |
| Tuesday | | 9 | **90** | **143** | | 233 | 3,819 | 34,863 | 49,844 | | - | - | - | 233 | - | - | - |
| Wednesday | | 10 | 70 | 89 | 1 | 160 | 3,979 | 35,023 | 50,004 | | - | - | - | - | 160 | - | - |
| Thursday | | 11 | 42 | 57 | 1 | 100 | 4,079 | 35,123 | 50,104 | | - | - | - | - | - | 100 | - |
| Friday | | 12 | 53 | **60** | | 113 | 4,192 | 35,236 | 50,217 | | - | - | - | - | - | - | 113 |
| Saturday | | 13 | 255 | 187 | | 442 | 4,634 | 35,678 | 50,659 | | 442 | - | - | - | - | - | - |
| Sunday | | 14 | 417 | 286 | | 703 | 5,337 | 36,381 | 51,362 | | - | 703 | - | - | - | - | - |
| Monday | | 15 | 502 | **287** | | 789 | 6,126 | 37,170 | 52,151 | | - | - | 789 | - | - | - | - |
| Tuesday | | 16 | 43 | 33 | | 76 | 6,202 | 37,246 | 52,227 | | - | - | - | 76 | - | - | - |
| Wednesday | | 17 | 58 | 51 | | 109 | 6,311 | 37,355 | 52,336 | | - | - | - | - | 109 | - | - |
| Thursday | | 18 | **82** | **79** | **1** | 162 | 6,473 | 37,517 | 52,498 | | - | - | - | - | - | 162 | - |
| Friday | | 19 | 78 | 139 | | 217 | 6,690 | 37,734 | 52,715 | | - | - | - | - | - | - | 217 |
| Saturday | | 20 | 520 | 380 | 2 | 902 | 7,592 | 38,636 | 53,617 | | 902 | - | - | - | - | - | - |
| Sunday | | 21 | **440** | **429** | **1** | 870 | 8,462 | 39,506 | 54,487 | | - | 870 | - | - | - | - | - |
| Monday | | 22 | 148 | 188 | | 336 | 8,798 | 39,842 | 54,823 | | - | - | 336 | - | - | - | - |
| Tuesday | | 23 | 90 | 141 | | 231 | 9,029 | 40,073 | 55,054 | | - | - | - | 231 | - | - | - |
| Wednesday | | 24 | 79 | **134** | | 213 | 9,242 | 40,286 | 55,267 | | - | - | - | - | 213 | - | - |
| Thursday | | 25 | 60 | 85 | 3 | 148 | 9,390 | 40,434 | 55,415 | | - | - | - | - | - | 148 | - |
| Friday | | 26 | 85 | 96 | 1 | 182 | 9,572 | 40,616 | 55,597 | | - | - | - | - | - | - | 182 |
| Saturday | | 27 | 217 | **168** | **2** | 387 | 9,959 | 41,003 | 55,984 | | 387 | - | - | - | - | - | - |
| Sunday | | 28 | 334 | 268 | 20 | 622 | 10,581 | 41,625 | 56,606 | | - | 622 | - | - | - | - | - |
| Monday | | 29 | 102 | 128 | 3 | 233 | 10,814 | 41,858 | 56,839 | | - | - | 233 | - | - | - | - |
| Tuesday | | 30 | 57 | 97 | 2 | 156 | 10,970 | 42,014 | 56,995 | | - | - | - | 156 | - | - | - |
| Wednesday | | 31 | 57 | 75 | | 132 | 11,102 | 42,146 | 57,127 | | - | - | - | - | 132 | - | - |
| **TOTAL** | **31 DAYS** | | **5714** | **5342** | **46** | **11102** | **188527** | **1150891** | **1615302** | **0** | **2532** | **3072** | **2019** | **1190** | **940** | **410** | **939** |
| Thursday | | 1 feb | 67 | 105 | 0 | 172 | 172 | 42,318 | 57,299 | | - | - | - | - | - | 172 | - |
| Friday | | 2 | 90 | 123 | 0 | 213 | 385 | 42,531 | 57,512 | | - | - | - | - | - | - | 213 |
| Saturday | | 3 | 634 | 462 | 0 | 1096 | 1,481 | 43,627 | 58,608 | | 1,096 | - | - | - | - | - | - |
| Sunday | | 4 | 485 | 367 | 0 | 852 | 2,333 | 44,479 | 59,460 | | - | 852 | - | - | - | - | - |
| Monday | | 5 | 78 | 97 | 0 | 175 | 2,508 | 44,654 | 59,635 | | - | - | 175 | - | - | - | - |
| Tuesday | | 6 | 95 | 118 | 0 | 213 | 2,721 | 44,867 | 59,848 | | - | - | - | 213 | - | - | - |
| Wednesday | | 7 | 21 | 9 | 0 | 30 | 2,751 | 44,897 | 59,878 | | - | - | - | - | 30 | - | - |
| Thursday | | 8 | 9 | 7 | 0 | 16 | 2,767 | 44,913 | 59,894 | | - | - | - | - | - | 16 | - |
| Friday | | 9 | 0 | 0 | 0 | 0 | 2,767 | 44,913 | 59,894 | | - | - | - | - | - | - | - |
| Saturday | | 10 | 20 | 14 | 0 | 34 | 2,801 | 44,947 | 59,928 | | 34 | - | - | - | - | - | - |
| Sunday | | 11 | 267 | 276 | 0 | 543 | 3,344 | 45,490 | 60,471 | | - | 543 | - | - | - | - | - |
| Monday | | 12 | 122 | 171 | 0 | 293 | 3,637 | 45,783 | 60,764 | | - | - | 293 | - | - | - | - |
| Tuesday | | 13 | 43 | 76 | 0 | 119 | 3,756 | 45,902 | 60,883 | | - | - | - | 119 | - | - | - |
| Wednesday | | 14 | 106 | 109 | 0 | 215 | 3,971 | 46,117 | 61,098 | | - | - | - | - | 215 | - | - |
| Thursday | | 15 | 127 | 143 | 0 | 270 | 4,241 | 46,387 | 61,368 | | - | - | - | - | - | 270 | - |
| Friday | | 16 | 370 | 256 | 0 | 626 | 4,867 | 47,013 | 61,994 | | - | - | - | - | - | - | 626 |
| Saturday | | 17 | 1078 | 646.8 | 0 | 1724.8 | 6,592 | 48,738 | 63,719 | | 1,725 | - | - | - | - | - | - |
| Sunday | | 18 | 911 | 546.6 | 0 | 1457.6 | 8,049 | 50,195 | 65,176 | | - | 1,458 | - | - | - | - | - |
| Monday | | 19 | 923 | 356 | 0 | 1279 | 9,328 | 51,474 | 66,455 | | - | - | 1,279 | - | - | - | - |
| Tuesday | | 20 | 168 | 134 | 0 | 302 | 9,630 | 51,776 | 66,757 | | - | - | - | 302 | - | - | - |
| Wednesday | | 21 | 89 | 72 | 0 | 161 | 9,791 | 51,937 | 66,918 | | - | - | - | - | 161 | - | - |
| Thursday | | 22 | 0 | 0 | 0 | 0 | 9,791 | 51,937 | 66,918 | | - | - | - | - | - | - | - |
| Friday | | 23 | 142 | 163 | 0 | 305 | 10,096 | 52,242 | 67,223 | | - | - | - | - | - | - | 305 |
| Saturday | | 24 | 253 | 223 | 0 | 476 | 10,572 | 52,718 | 67,699 | | 476 | - | - | - | - | - | - |
| Sunday | | 25 | 88 | 89 | 0 | 177 | 10,749 | 52,895 | 67,876 | | - | 177 | - | - | - | - | - |
| Monday | | 26 | 1 | 1 | 0 | 2 | 10,751 | 52,897 | 67,878 | | - | - | 2 | - | - | - | - |
| Tuesday | | 27 | 9 | 26 | 0 | 35 | 10,786 | 52,932 | 67,913 | | - | - | - | 35 | - | - | - |
| Wednesday | | 28 | 38 | 59 | | 97 | 10,883 | 53,029 | 68,010 | | - | - | - | - | 97 | - | - |
| **TOTAL** | **28 DAYS** | | **6234** | **4649.4** | **0** | **10883.4** | **161524.2** | **1341612.2** | **1761080.2** | **0** | **3330.8** | **3029.6** | **1749** | **669** | **503** | **458** | **1144** |
| Thursday | | 1 mar | 44 | 46 | 0 | 90 | 90 | 53,119 | 68,100 | | - | - | - | - | - | 90 | - |
| Friday | | 2 | 142 | 166 | 0 | 308 | 398 | 53,427 | 68,408 | | - | - | - | - | - | - | 308 |
| Saturday | | 3 | 862 | 225 | 0 | 1087 | 1,485 | 54,514 | 69,495 | | 1,087 | - | - | - | - | - | - |
| Sunday | | 4 | 809 | 474 | 0 | 1283 | 2,768 | 55,797 | 70,778 | | - | 1,283 | - | - | - | - | - |
| Monday | | 5 | 129 | 155 | 0 | 284 | 3,052 | 56,081 | 71,062 | | - | - | 284 | - | - | - | - |
| Tuesday | | 6 | 145 | 171 | 0 | 316 | 3,368 | 56,397 | 71,378 | | - | - | - | 316 | - | - | - |
| Wednesday | | 7 | 92 | 75 | 0 | 167 | 3,535 | 56,564 | 71,545 | | - | - | - | - | 167 | - | - |
| Thursday | | 8 | 132 | 165 | 0 | 297 | 3,832 | 56,861 | 71,842 | | - | - | - | - | - | 297 | - |
| Friday | | 9 | 193 | 243 | 0 | 436 | 4,268 | 57,297 | 72,278 | | - | - | - | - | - | - | 436 |
| Saturday | | 10 | 992 | 387 | 0 | 1379 | 5,647 | 58,676 | 73,657 | | 1,379 | - | - | - | - | - | - |
| Sunday | | 11 | 999 | 312 | 0 | 1311 | 6,958 | 59,987 | 74,968 | | - | 1,311 | - | - | - | - | - |
| Monday | | 12 | 184 | 183 | 0 | 367 | 7,325 | 60,354 | 75,335 | | - | - | 367 | - | - | - | - |
| Tuesday | | 13 | 155 | 182 | 0 | 337 | 7,662 | 60,691 | 75,672 | | - | - | - | 337 | - | - | - |
| Wednesday | | 14 | 189 | 173 | 0 | 362 | 8,024 | 61,053 | 76,034 | | - | - | - | - | 362 | - | - |
| Thursday | | 15 | 153 | 130 | 0 | 283 | 8,307 | 61,336 | 76,317 | | - | - | - | - | - | 283 | - |
| Friday | | 16 | 284 | 276 | 0 | 560 | 8,867 | 61,896 | 76,877 | | - | - | - | - | - | - | 560 |
| Saturday | | 17 | 798 | 342 | 0 | 1140 | 10,007 | 63,036 | 78,017 | | 1,140 | - | - | - | - | - | - |
| Sunday | | 18 | 941 | 276 | 0 | 1217 | 11,224 | 64,253 | 79,234 | | - | 1,217 | - | - | - | - | - |
| Monday | | 19 | 193 | 172 | 0 | 365 | 11,589 | 64,618 | 79,599 | | - | - | 365 | - | - | - | - |
| Tuesday | | 20 | 25 | 15 | 0 | 40 | 11,629 | 64,658 | 79,639 | | - | - | - | 40 | - | - | - |
| Wednesday | | 21 | 168 | 171 | 0 | 339 | 11,968 | 64,997 | 79,978 | | - | - | - | - | 339 | - | - |
| Thursday | | 22 | 223 | 142 | 0 | 365 | 12,333 | 65,362 | 80,343 | | - | - | - | - | - | 365 | - |
| Friday | | 23 | 275 | 223 | 0 | 498 | 12,831 | 65,860 | 80,841 | | - | - | - | - | - | - | 498 |
| Saturday | | 24 | 877 | 319 | 0 | 1196 | 14,027 | 67,056 | 82,037 | | 1,196 | - | - | - | - | - | - |
| Sunday | | 25 | 748 | 341 | 0 | 1089 | 15,116 | 68,145 | 83,126 | | - | 1,089 | - | - | - | - | - |
| Monday | | 26 | 81 | 45 | 0 | 126 | 15,242 | 68,271 | 83,252 | | - | - | 126 | - | - | - | - |
| Tuesday | | 27 | 84 | 86 | 0 | 170 | 15,412 | 68,441 | 83,422 | | - | - | - | 170 | - | - | - |
| Wednesday | | 28 | 181 | 129 | 0 | 310 | 15,722 | 68,751 | 83,732 | | - | - | - | - | 310 | - | - |
| Thursday | | 29 | 238 | 176 | 0 | 414 | 16,136 | 69,165 | 84,146 | | - | - | - | - | - | 414 | - |
| Friday | | 30 | 315 | 316 | 0 | 631 | 16,767 | 69,796 | 84,777 | | - | - | - | - | - | - | 631 |
| Saturday | | 31 | 806 | 268 | 0 | 1074 | 17,841 | 70,870 | 85,851 | | 1,074 | - | - | - | - | - | - |
| **TOTAL** | **31 DAYS** | | **11457** | **6384** | **0** | **17841** | **283430** | **1927341.4** | **2391752.4** | **0** | **5876** | **4900** | **1142** | **863** | **1178** | **1449** | **2433** |
| Sunday | | 1 april | 792 | 410 | 4 | 1206 | 1,206 | 72,076 | 87,057 | | - | 1,206 | - | - | - | - | - |
| Monday | | 2 | 288 | 201 | 4 | 493 | 1,699 | 72,569 | 87,550 | | - | - | 493 | - | - | - | - |
| Tuesday | | 3 | 274 | 206 | 4 | 484 | 2,183 | 73,053 | 88,034 | | - | - | - | 484 | - | - | - |
| Wednesday | | 4 | 287 | 73 | 0 | 360 | 2,543 | 73,413 | 88,394 | | - | - | - | - | 360 | - | - |
| Thursday | | 5 | 261 | 174 | 4 | 439 | 2,982 | 73,852 | 88,833 | | - | - | - | - | - | 439 | - |
| Friday | | 6 | 426 | 279 | 1 | 706 | 3,688 | 74,558 | 89,539 | | - | - | - | - | - | - | 706 |
| Saturday | | 7 | 335 | 119 | 14 | 468 | 4,156 | 75,026 | 90,007 | | 468 | - | - | - | - | - | - |
| Sunday | | 8 | 541 | 158 | 6 | 705 | 4,861 | 75,731 | 90,712 | | - | 705 | - | - | - | - | - |
| Monday | | 9 | 587 | 418 | 1 | 1006 | 5,867 | 76,737 | 91,718 | | - | - | 1,006 | - | - | - | - |
| Tuesday | | 10 | 769 | 65 | 3 | 837 | 6,704 | 77,574 | 92,555 | | - | - | - | 837 | - | - | - |
| Wednesday | | 11 | 182 | 84 | 1 | 267 | 6,971 | 77,841 | 92,822 | | - | - | - | - | 267 | - | - |
| Thursday | | 12 | 699 | 250 | 0 | 949 | 7,920 | 78,790 | 93,771 | | - | - | - | - | - | 949 | - |
| Friday | | 13 | 840 | 265 | 6 | 1111 | 9,031 | 79,901 | 94,882 | | - | - | - | - | - | - | 1,111 |
| Saturday | | 14 | 31 | 19 | 1 | 51 | 9,082 | 79,952 | 94,933 | | 51 | - | - | - | - | - | - |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sunday | | 15 | 896 | 549 | 5 | 1450 | 10,532 | 81,402 | 96,383 | - | - | 1,450 | - | - | - | - | - |
| Monday | | 16 | 176 | 154 | 4 | 334 | 10,866 | 81,736 | 96,717 | - | - | - | 334 | - | - | - | - |
| Tuesday | | 17 | 165 | 144 | 4 | 313 | 11,179 | 82,049 | 97,030 | - | - | - | - | 313 | - | - | - |
| Wednesday | | 18 | 140 | 124 | 2 | 266 | 11,445 | 82,315 | 97,296 | - | - | - | - | - | 266 | - | - |
| Thursday | | 19 | 112 | 72 | 3 | 187 | 11,632 | 82,502 | 97,483 | - | - | - | - | - | - | 187 | - |
| Friday | | 20 | 141 | 98 | 1 | 240 | 11,872 | 82,742 | 97,723 | - | - | - | - | - | - | - | 240 |
| Saturday | | 21 | 418 | 241 | 7 | 666 | 12,538 | 83,408 | 98,389 | - | 666 | - | - | - | - | - | - |
| Sunday | | 22 | 475 | 346 | 9 | 830 | 13,368 | 84,238 | 99,219 | - | - | 830 | - | - | - | - | - |
| Monday | | 23 | 134 | 161 | 0 | 295 | 13,663 | 84,533 | 99,514 | - | - | - | 295 | - | - | - | - |
| Tuesday | | 24 | 239 | 158 | 1 | 398 | 14,061 | 84,931 | 99,912 | - | - | - | - | 398 | - | - | - |
| Wednesday | | 25 | 147 | 134 | 6 | 287 | 14,348 | 85,218 | 100,199 | - | - | - | - | - | 287 | - | - |
| Thursday | | 26 | 237 | 124 | 2 | 363 | 14,711 | 85,581 | 100,562 | - | - | - | - | - | - | 363 | - |
| Friday | | 27 | 200 | 134 | 90 | 424 | 15,135 | 86,005 | 100,986 | - | - | - | - | - | - | - | 424 |
| Saturday | | 28 | 999 | 366 | 4 | 1369 | 16,504 | 87,374 | 102,355 | - | 1,369 | - | - | - | - | - | - |
| Sunday | | 29 | 799 | 317 | 1 | 1117 | 17,621 | 88,491 | 103,472 | - | - | 1,117 | - | - | - | - | - |
| Monday | | 30 | 169 | 174 | 0 | 343 | 17,964 | 88,834 | 103,815 | - | - | - | 343 | - | - | - | - |
| **TOTAL** | **30 DAYS** | | **11759** | **6017** | **188** | **17964** | **286332** | **2412444** | **2861874** | **0** | **2554** | **5308** | **2471** | **2032** | **1180** | **1938** | **2481** |
| Tuesday | | 1 may | 154 | 123 | 1 | 278 | 278 | 89,112 | 104,093 | - | - | - | - | 278 | - | - | - |
| Wednesday | | 2 | 56 | 65 | 16 | 137 | 415 | 89,249 | 104,230 | - | - | - | - | - | 137 | - | - |
| Thursday | | 3 | 207 | 106 | | 313 | 728 | 89,562 | 104,543 | - | - | - | - | - | - | 313 | - |
| Friday | | 4 | 174 | 63 | | 237 | 965 | 89,799 | 104,780 | - | - | - | - | - | - | - | 237 |
| Saturday | | 5 | 680 | 409 | 2 | 1091 | 2,056 | 90,890 | 105,871 | - | 1,091 | - | - | - | - | - | - |
| Sunday | | 6 | 795 | 382 | 1 | 1178 | 3,234 | 92,068 | 107,049 | - | - | 1,178 | - | - | - | - | - |
| Monday | | 7 | 167 | 108 | | 275 | 3,509 | 92,343 | 107,324 | - | - | - | 275 | - | - | - | - |
| Tuesday | | 8 | 205 | 118 | 89 | 412 | 3,921 | 92,755 | 107,736 | - | - | - | - | 412 | - | - | - |
| Wednesday | | 9 | 205 | 119 | | 324 | 4,245 | 93,079 | 108,060 | - | - | - | - | - | 324 | - | - |
| Thursday | | 10 | 178 | 102 | | 280 | 4,525 | 93,359 | 108,340 | - | - | - | - | - | - | 280 | - |
| Friday | | 11 | 286 | 148 | 1 | 435 | 4,960 | 93,794 | 108,775 | - | - | - | - | - | - | - | 435 |
| Saturday | | 12 | 724 | 392 | 1 | 1117 | 6,077 | 94,911 | 109,892 | - | 1,117 | - | - | - | - | - | - |
| Sunday | | 13 | 975 | 352 | | 1327 | 7,404 | 96,238 | 111,219 | - | - | 1,327 | - | - | - | - | - |
| Monday | | 14 | 261 | 158 | | 419 | 7,823 | 96,657 | 111,638 | - | - | - | 419 | - | - | - | - |
| Tuesday | | 15 | 176 | 97 | 1 | 274 | 8,097 | 96,931 | 111,912 | - | - | - | - | 274 | - | - | - |
| Wednesday | | 16 | 177 | 133 | | 310 | 8,407 | 97,241 | 112,222 | - | - | - | - | - | 310 | - | - |
| Thursday | | 17 | 225 | 130 | 1 | 356 | 8,763 | 97,597 | 112,578 | - | - | - | - | - | - | 356 | - |
| Friday | | 18 | 385 | 248 | | 633 | 9,396 | 98,230 | 113,211 | - | - | - | - | - | - | - | 633 |
| Saturday | | 19 | 596 | 287 | | 883 | 10,279 | 99,113 | 114,094 | - | 883 | - | - | - | - | - | - |
| Sunday | | 20 | 717 | 390 | 4 | 1111 | 11,390 | 100,224 | 115,205 | - | - | 1,111 | - | - | - | - | - |
| Monday | | 21 | 227 | 149 | | 376 | 11,766 | 100,600 | 115,581 | - | - | - | 376 | - | - | - | - |
| Tuesday | | 22 | 220 | 153 | 1 | 374 | 12,140 | 100,974 | 115,955 | - | - | - | - | 374 | - | - | - |
| Wednesday | | 23 | 214 | 146 | 1 | 361 | 12,501 | 101,335 | 116,316 | - | - | - | - | - | 361 | - | - |
| Thursday | | 24 | 548 | 179 | | 727 | 13,228 | 102,062 | 117,043 | - | - | - | - | - | - | 727 | - |
| Friday | | 25 | 346 | 221 | | 567 | 13,795 | 102,629 | 117,610 | - | - | - | - | - | - | - | 567 |
| Saturday | | 26 | 861 | 379 | 4 | 1244 | 15,039 | 103,873 | 118,854 | - | 1,244 | - | - | - | - | - | - |
| Sunday | | 27 | 1038 | 391 | | 1429 | 16,468 | 105,302 | 120,283 | - | - | 1,429 | - | - | - | - | - |
| Monday | | 28 | 1013 | 405 | 2 | 1420 | 17,888 | 106,722 | 121,703 | - | - | - | 1,420 | - | - | - | - |
| Tuesday | | 29 | 143 | 122 | | 265 | 18,153 | 106,987 | 121,968 | - | - | - | - | 265 | - | - | - |
| Wednesday | | 30 | 218 | 132 | | 350 | 18,503 | 107,337 | 122,318 | - | - | - | - | - | 350 | - | - |
| Thursday | | 31 | 270 | 130 | 4 | 404 | 18,907 | 107,741 | 122,722 | - | - | - | - | - | - | 404 | - |
| **TOTAL** | **31 DAYS** | | **12441** | **6337** | **129** | **18907** | **274860** | **3028726.4** | **3493137.4** | **0** | **4335** | **5045** | **2490** | **1603** | **1482** | **2080** | **1872** |
| Friday | | 1 june | 350 | 160 | 1 | 511 | 511 | 108,252 | 123,233 | - | - | - | - | - | - | - | 511 |
| Saturday | | 2 | 522 | 307 | 1 | 830 | 1,341 | 109,082 | 124,063 | - | 830 | - | - | - | - | - | - |
| Sunday | | 3 | 637 | 335 | 3 | 975 | 2,316 | 110,057 | 125,038 | - | - | 975 | - | - | - | - | - |
| Monday | | 4 | 319 | 153 | 5 | 477 | 2,793 | 110,534 | 125,515 | - | - | - | 477 | - | - | - | - |
| Tuesday | | 5 | 295 | 173 | 5 | 473 | 3,266 | 111,007 | 125,988 | - | - | - | - | 473 | - | - | - |
| Wednesday | | 6 | 261 | 155 | 0 | 416 | 3,682 | 111,423 | 126,404 | - | - | - | - | - | 416 | - | - |
| Thursday | | 7 | 271 | 156 | 2 | 429 | 4,111 | 111,852 | 126,833 | - | - | - | - | - | - | 429 | - |
| Friday | | 8 | 324 | 119 | 1 | 444 | 4,555 | 112,296 | 127,277 | - | - | - | - | - | - | - | 444 |
| Saturday | | 9 | 127 | 57 | 430 | 4482 | 9,037 | 116,778 | 131,759 | - | 4,482 | - | - | - | - | - | - |
| Sunday | | 10 | 823 | 316 | 6 | 1145 | 10,182 | 117,923 | 132,904 | - | - | 1,145 | - | - | - | - | - |
| Monday | | 11 | 264 | 168 | 4 | 436 | 10,618 | 118,359 | 133,340 | - | - | - | 436 | - | - | - | - |
| Tuesday | | 12 | 254 | 165 | 0 | 419 | 11,037 | 118,778 | 133,759 | - | - | - | - | 419 | - | - | - |
| Wednesday | | 13 | 181 | 168 | 0 | 349 | 11,386 | 119,127 | 134,108 | - | - | - | - | - | 349 | - | - |
| Thursday | | 14 | 279 | 171 | 2 | 452 | 11,838 | 119,579 | 134,560 | - | - | - | - | - | - | 452 | - |
| Friday | | 15 | 281 | 155 | 8 | 444 | 12,282 | 120,023 | 135,004 | - | - | - | - | - | - | - | 444 |
| Saturday | | 16 | 528 | 127 | 4 | 659 | 12,941 | 120,682 | 135,663 | - | 659 | - | - | - | - | - | - |
| Sunday | | 17 | 693 | 194 | 9 | 896 | 13,837 | 121,578 | 136,559 | - | - | 896 | - | - | - | - | - |
| Monday | | 18 | 288 | 171 | 6 | 465 | 14,302 | 122,043 | 137,024 | - | - | - | 465 | - | - | - | - |
| Tuesday | | 19 | 282 | 217 | 5 | 504 | 14,806 | 122,547 | 137,528 | - | - | - | - | 504 | - | - | - |
| Wednesday | | 20 | 290 | 213 | 2 | 505 | 15,311 | 123,052 | 138,033 | - | - | - | - | - | 505 | - | - |
| Thursday | | 21 | 287 | 244 | 2 | 533 | 15,844 | 123,585 | 138,566 | - | - | - | - | - | - | 533 | - |
| Friday | | 22 | 377 | 288 | 3 | 668 | 16,512 | 124,253 | 139,234 | - | - | - | - | - | - | - | 668 |
| Saturday | | 23 | 0 | 0 | 0 | 0 | 16,512 | 124,253 | 139,234 | - | - | - | - | - | - | - | - |
| Sunday | | 24 | 747 | 239 | 4 | 990 | 17,502 | 125,243 | 140,224 | - | - | 990 | - | - | - | - | - |
| Monday | | 25 | 239 | 179 | | 418 | 17,920 | 125,661 | 140,642 | - | - | - | 418 | - | - | - | - |
| Tuesday | | 26 | 252 | 124 | 2 | 378 | 18,298 | 126,039 | 141,020 | - | - | - | - | 378 | - | - | - |
| Wednesday | | 27 | 284 | 209 | 4 | 497 | 18,795 | 126,536 | 141,517 | - | - | - | - | - | 497 | - | - |
| Thursday | | 28 | 232 | 175 | | 407 | 19,202 | 126,943 | 141,924 | - | - | - | - | - | - | 407 | - |
| Friday | | 29 | 277 | 259 | | 536 | 19,738 | 127,479 | 142,460 | - | - | - | - | - | - | - | 536 |
| Saturday | | 30 | 681 | 320 | 8 | 1009 | 20,747 | 128,488 | 143,469 | - | 1,009 | - | - | - | - | - | - |
| **TOTAL** | **30 DAYS** | | **10645** | **5717** | **517** | **20747** | **351222** | **3583464** | **4032894** | **0** | **6980** | **4006** | **1796** | **1774** | **1767** | **1821** | **2603** |
| Sunday | | 1 Jul-07 | 676 | 331 | 1 | 1008 | 1,008 | 129,496 | 144,477 | - | - | 1,008 | - | - | - | - | - |
| Monday | | 2 | 252 | 182 | 3 | 437 | 1,445 | 129,933 | 144,914 | - | - | - | 437 | - | - | - | - |
| Tuesday | | 3 | 237 | 146 | 6 | 389 | 1,834 | 130,322 | 145,303 | - | - | - | - | 389 | - | - | - |
| Wednesday | | 4 | 454 | 152 | 1 | 607 | 2,441 | 130,929 | 145,910 | - | - | - | - | - | 607 | - | - |
| Thursday | | 5 | 253 | 95 | 8 | 356 | 2,797 | 131,285 | 146,266 | - | - | - | - | - | - | 356 | - |
| Friday | | 6 | 288 | 168 | 2 | 458 | 3,255 | 131,743 | 146,724 | - | - | - | - | - | - | - | 458 |
| Saturday | | 7 | 634 | 181 | 2 | 817 | 4,072 | 132,560 | 147,541 | - | 817 | - | - | - | - | - | - |
| Sunday | | 8 | 592 | 400 | 8 | 1000 | 5,072 | 133,560 | 148,541 | - | - | 1,000 | - | - | - | - | - |
| Monday | | 9 | 244 | 137 | 0 | 381 | 5,453 | 133,941 | 148,922 | - | - | - | 381 | - | - | - | - |
| Tuesday | | 10 | 224 | 114 | 12 | 350 | 5,803 | 134,291 | 149,272 | - | - | - | - | 350 | - | - | - |
| Wednesday | | 11 | 248 | 197 | 0 | 445 | 6,248 | 134,736 | 149,717 | - | - | - | - | - | 445 | - | - |
| Thursday | | 12 | 296 | 218 | 0 | 514 | 6,762 | 135,250 | 150,231 | - | - | - | - | - | - | 514 | - |
| Friday | | 13 | 385 | 268 | 11 | 664 | 7,426 | 135,914 | 150,895 | - | - | - | - | - | - | - | 664 |
| Saturday | | 14 | 737 | 312 | 24 | 1073 | 8,499 | 136,987 | 151,968 | - | 1,073 | - | - | - | - | - | - |
| Sunday | | 15 | 685 | 229 | 4 | 918 | 9,417 | 137,905 | 152,886 | - | - | 918 | - | - | - | - | - |
| Monday | | 16 | 234 | 163 | 5 | 402 | 9,819 | 138,307 | 153,288 | - | - | - | 402 | - | - | - | - |
| Tuesday | | 17 | 286 | 207 | 2 | 495 | 10,314 | 138,802 | 153,783 | - | - | - | - | 495 | - | - | - |
| Wednesday | | 18 | 256 | 161 | 4 | 421 | 10,735 | 139,223 | 154,204 | - | - | - | - | - | 421 | - | - |
| Thursday | | 19 | 316 | 243 | 5 | 564 | 11,299 | 139,787 | 154,768 | - | - | - | - | - | - | 564 | - |
| Friday | | 20 | 404 | 216 | 0 | 620 | 11,919 | 140,407 | 155,388 | - | - | - | - | - | - | - | 620 |
| Saturday | | 21 | 718 | 313 | 2 | 1033 | 12,952 | 141,440 | 156,421 | - | 1,033 | - | - | - | - | - | - |
| Sunday | | 22 | 678 | 130 | 11 | 819 | 13,771 | 142,259 | 157,240 | - | - | 819 | - | - | - | - | - |
| Monday | | 23 | 272 | 217 | 1 | 490 | 14,261 | 142,749 | 157,730 | - | - | - | 490 | - | - | - | - |
| Tuesday | | 24 | 274 | 174 | 0 | 448 | 14,709 | 143,197 | 158,178 | - | - | - | - | 448 | - | - | - |
| Wednesday | | 25 | 274 | 139 | 6 | 419 | 15,128 | 143,616 | 158,597 | - | - | - | - | - | 419 | - | - |
| Thursday | | 26 | 329 | 218 | 1 | 548 | 15,676 | 144,164 | 159,145 | - | - | - | - | - | - | 548 | - |
| Friday | | 27 | 336 | 252 | 1 | 589 | 16,265 | 144,753 | 159,734 | - | - | - | - | - | - | - | 589 |
| Saturday | | 28 | 786 | 248 | 7 | 1041 | 17,306 | 145,794 | 160,775 | - | 1,041 | - | - | - | - | - | - |
| Sunday | | 29 | 718 | 212 | 2 | 932 | 18,238 | 146,726 | 161,707 | - | - | 932 | - | - | - | - | - |
| Monday | | 30 | 224 | 144 | 0 | 368 | 18,606 | 147,094 | 162,075 | - | - | - | 368 | - | - | - | - |
| Tuesday | | 31 | 290 | 144 | 3 | 437 | 19,043 | 147,531 | 162,512 | - | - | - | - | 437 | - | - | - |
| **TOTAL** | **31 DAYS** | | **12600** | **6311** | **132** | **19043** | **301573** | **4284713.4** | **4749124.4** | **0** | **3964** | **4677** | **2078** | **2119** | **1892** | **1982** | **2331** |
| Wednesday | | 1 Aug-07 | 328 | 201 | 3 | 532 | 532 | 148,063 | 163,044 | - | - | - | - | - | 532 | - | - |
| Thursday | | 2 | 268 | 150 | 2 | 420 | 952 | 148,483 | 163,464 | - | - | - | - | - | - | 420 | - |
| Friday | | 3 | 343 | 242 | 1 | 586 | 1,538 | 149,069 | 164,050 | - | - | - | - | - | - | - | 586 |
| Saturday | | 4 | 684 | 283 | 1 | 968 | 2,506 | 150,037 | 165,018 | - | 968 | - | - | - | - | - | - |
| Sunday | | 5 | 612 | 255 | 1 | 868 | 3,374 | 150,905 | 165,886 | - | - | 868 | - | - | - | - | - |
| Monday | | 6 | 225 | 134 | 3 | 362 | 3,736 | 151,267 | 166,248 | - | - | - | 362 | - | - | - | - |
| Tuesday | | 7 | 282 | 115 | 3 | 400 | 4,136 | 151,667 | 166,648 | - | - | - | - | 400 | - | - | - |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wednesday | | 8 | | 323 | 114 | 2 | 439 | 4,575 | 152,106 | 167,087 | | - | - | - | - | 439 | - | - |
| Thursday | | 9 | | 292 | 231 | 1 | 524 | 5,099 | 152,630 | 167,611 | | - | - | - | - | - | 524 | - |
| Friday | | 10 | | 361 | 168 | 1 | 530 | 5,629 | 153,160 | 168,141 | | - | - | - | - | - | - | 530 |
| Saturday | | 11 | | 754 | 340 | 6 | 1100 | 6,729 | 154,260 | 169,241 | | 1,100 | - | - | - | - | - | - |
| Sunday | | 12 | | 668 | 342 | 6 | 1016 | 7,745 | 155,276 | 170,257 | | - | 1,016 | - | - | - | - | - |
| Monday | | 13 | | 282 | 205 | 15 | 502 | 8,247 | 155,778 | 170,759 | | - | - | 502 | - | - | - | - |
| Tuesday | | 14 | | 323 | 192 | 6 | 521 | 8,768 | 156,299 | 171,280 | | - | - | - | 521 | - | - | - |
| Wednesday | | 15 | | 320 | 215 | 3 | 538 | 9,306 | 156,837 | 171,818 | | - | - | - | - | 538 | - | - |
| Thursday | | 16 | | 316 | 186 | 1 | 503 | 9,809 | 157,340 | 172,321 | | - | - | - | - | - | 503 | - |
| Friday | | 17 | | 343 | 225 | 1 | 569 | 10,378 | 157,909 | 172,890 | | - | - | - | - | - | - | 569 |
| Saturday | | 18 | | 772 | 324 | 20 | 1116 | 11,494 | 159,025 | 174,006 | | 1,116 | - | - | - | - | - | - |
| Sunday | | 19 | | 658 | 288 | 1 | 947 | 12,441 | 159,972 | 174,953 | | - | 947 | - | - | - | - | - |
| Monday | | 20 | | 259 | 224 | 0 | 483 | 12,924 | 160,455 | 175,436 | | - | - | 483 | - | - | - | - |
| Tuesday | | 21 | | 324 | 233 | 3 | 560 | 13,484 | 161,015 | 175,996 | | - | - | - | 560 | - | - | - |
| Wednesday | | 22 | | 288 | 202 | 0 | 490 | 13,974 | 161,505 | 176,486 | | - | - | - | - | 490 | - | - |
| Thursday | | 23 | | 266 | 181 | 1 | 448 | 14,422 | 161,953 | 176,934 | | - | - | - | - | - | 448 | - |
| Friday | | 24 | | 358 | 260 | 2 | 620 | 15,042 | 162,573 | 177,554 | | - | - | - | - | - | - | 620 |
| Saturday | | 25 | | 665 | 369 | 0 | 1034 | 16,076 | 163,607 | 178,588 | | 1,034 | - | - | - | - | - | - |
| Sunday | | 26 | | 705 | 362 | 4 | 1071 | 17,147 | 164,678 | 179,659 | | - | 1,071 | - | - | - | - | - |
| Monday | | 27 | | 223 | 234 | 1 | 458 | 17,605 | 165,136 | 180,117 | | - | - | 458 | - | - | - | - |
| Tuesday | | 28 | | 191 | 191 | 3 | 385 | 17,990 | 165,521 | 180,502 | | - | - | - | 385 | - | - | - |
| Wednesday | | 29 | | 160 | 130 | 1 | 291 | 18,281 | 165,812 | 180,793 | | - | - | - | - | 291 | - | - |
| Thursday | | 30 | | 152 | 123 | 8 | 283 | 18,564 | 166,095 | 181,076 | | - | - | - | - | - | 283 | - |
| Friday | | 31 | | 181 | 194 | 1 | 376 | 18,940 | 166,471 | 181,452 | | - | - | - | - | - | - | 376 |
| **TOTAL** | **31 DAYS** | | | **11926** | **6913** | **101** | **18940** | **311443** | **4884916.4** | **5349327.4** | **0** | **4218** | **3902** | **1805** | **1866** | **2290** | **2178** | **2681** |
| Saturday | | 1 | Sep-07 | 699 | 296 | 0 | 995 | 995 | 167,466 | 182,447 | | 995 | - | - | - | - | - | - |
| Sunday | | 2 | | 797 | 292 | 4 | 1093 | 2,088 | 168,559 | 183,540 | | - | 1,093 | - | - | - | - | - |
| Monday | | 3 | | 661 | 339 | 6 | 1006 | 3,094 | 169,565 | 184,546 | | - | - | 1,006 | - | - | - | - |
| Tuesday | | 4 | | 118 | 131 | 0 | 249 | 3,343 | 169,814 | 184,795 | | - | - | - | 249 | - | - | - |
| Wednesday | | 5 | | 112 | 94 | 0 | 206 | 3,549 | 170,020 | 185,001 | | - | - | - | - | 206 | - | - |
| Thursday | | 6 | | 109 | 200 | 1 | 310 | 3,859 | 170,330 | 185,311 | | - | - | - | - | - | 310 | - |
| Friday | | 7 | | 116 | 108 | 0 | 224 | 4,083 | 170,554 | 185,535 | | - | - | - | - | - | - | 224 |
| Saturday | | 8 | | 590 | 372 | 2 | 964 | 5,047 | 171,518 | 186,499 | | 964 | - | - | - | - | - | - |
| Sunday | | 9 | | 550 | 314 | 49 | 913 | 5,960 | 172,431 | 187,412 | | - | 913 | - | - | - | - | - |
| Monday | | 10 | | 103 | 94 | 0 | 197 | 6,157 | 172,628 | 187,609 | | - | - | 197 | - | - | - | - |
| Tuesday | | 11 | | 110 | 118 | 6 | 234 | 6,391 | 172,862 | 187,843 | | - | - | - | 234 | - | - | - |
| Wednesday | | 12 | | 73 | 96 | 1 | 170 | 6,561 | 173,032 | 188,013 | | - | - | - | - | 170 | - | - |
| Thursday | | 13 | | 90 | 128 | 8 | 226 | 6,787 | 173,258 | 188,239 | | - | - | - | - | - | 226 | - |
| Friday | | 14 | | 133 | 138 | 1 | 272 | 7,059 | 173,530 | 188,511 | | - | - | - | - | - | - | 272 |
| Saturday | | 15 | | 541 | 326 | 0 | 867 | 7,926 | 174,397 | 189,378 | | 867 | - | - | - | - | - | - |
| Sunday | | 16 | | 528 | 419 | 12 | 959 | 8,885 | 175,356 | 190,337 | | - | 959 | - | - | - | - | - |
| Monday | | 17 | | 109 | 107 | 10 | 226 | 9,111 | 175,582 | 190,563 | | - | - | 226 | - | - | - | - |
| Tuesday | | 18 | | 123 | 121 | 0 | 244 | 9,355 | 175,826 | 190,807 | | - | - | - | 244 | - | - | - |
| Wednesday | | 19 | | 56 | 72 | 0 | 128 | 9,483 | 175,954 | 190,935 | | - | - | - | - | 128 | - | - |
| Thursday | | 20 | | 58 | 55 | | 113 | 9,596 | 176,067 | 191,048 | | - | - | - | - | - | 113 | - |
| Friday | | 21 | | 134 | 134 | | 268 | 9,864 | 176,335 | 191,316 | | - | - | - | - | - | - | 268 |
| Saturday | | 22 | | 131 | 104 | 2 | 237 | 10,101 | 176,572 | 191,553 | | 237 | - | - | - | - | - | - |
| Sunday | | 23 | | 455 | 310 | 4 | 769 | 10,870 | 177,341 | 192,322 | | - | 769 | - | - | - | - | - |
| Monday | | 24 | | 90 | 124 | 1 | 215 | 11,085 | 177,556 | 192,537 | | - | - | 215 | - | - | - | - |
| Tuesday | | 25 | | 95 | 104 | 1 | 200 | 11,285 | 177,756 | 192,737 | | - | - | - | 200 | - | - | - |
| Wednesday | | 26 | | 88 | 79 | 7 | 174 | 11,459 | 177,930 | 192,911 | | - | - | - | - | 174 | - | - |
| Thursday | | 27 | | 113 | 140 | 1 | 254 | 11,713 | 178,184 | 193,165 | | - | - | - | - | - | 254 | - |
| Friday | | 28 | | 106 | 111 | 7 | 224 | 11,937 | 178,408 | 193,389 | | - | - | - | - | - | - | 224 |
| Saturday | | 29 | | 650 | 366 | 4 | 1020 | 12,957 | 179,428 | 194,409 | | 1,020 | - | - | - | - | - | - |
| Sunday | | 30 | | 529 | 346 | 6 | 881 | 13,838 | 180,309 | 195,290 | | - | 881 | - | - | - | - | - |
| **TOTAL** | **30 DAYS** | | | **8067** | **5638** | **133** | **13838** | **234438** | **5228580** | **5678010** | **0** | **4083** | **4615** | **1644** | **927** | **678** | **903** | **988** |
| Monday | | 1 | Oct-07 | 93 | 104 | 1 | 198 | 198 | 198 | 195,488 | | - | - | 198 | - | - | - | - |
| Tuesday | | 2 | | 122 | 93 | | 215 | 413 | 413 | 195,703 | | - | - | - | 215 | - | - | - |
| Wednesday | | 3 | | 105 | 102 | 1 | 208 | 621 | 621 | 195,911 | | - | - | - | - | 208 | - | - |
| Thursday | | 4 | | 116 | 130 | 2 | 248 | 869 | 869 | 196,159 | | - | - | - | - | - | 248 | - |
| Friday | | 5 | | 185 | 165 | 2 | 352 | 1,221 | 1,221 | 196,511 | | - | - | - | - | - | - | 352 |
| Saturday | | 6 | | 489 | 310 | 2 | 801 | 2,022 | 2,022 | 197,312 | | 801 | - | - | - | - | - | - |
| Sunday | | 7 | | 660 | 380 | | 1040 | 3,062 | 3,062 | 198,352 | | - | 1,040 | - | - | - | - | - |
| Monday | | 8 | | 309 | 241 | 4 | 554 | 3,616 | 3,616 | 198,906 | | - | - | 554 | - | - | - | - |
| Tuesday | | 9 | | 112 | 107 | | 219 | 3,835 | 3,835 | 199,125 | | - | - | - | 219 | - | - | - |
| Wednesday | | 10 | | 95 | 49 | 2 | 146 | 3,981 | 3,981 | 199,271 | | - | - | - | - | 146 | - | - |
| Thursday | | 11 | | 116 | 117 | | 233 | 4,214 | 4,214 | 199,504 | | - | - | - | - | - | 233 | - |
| Friday | | 12 | | | | | 0 | 4,214 | 4,214 | 199,504 | | - | - | - | - | - | - | - |
| Saturday | | 13 | | 498 | 378 | 7 | 883 | 5,097 | 5,097 | 200,387 | | 883 | - | - | - | - | - | - |
| Sunday | | 14 | | 434 | 303 | 65 | 802 | 5,899 | 5,899 | 201,189 | | - | 802 | - | - | - | - | - |
| Monday | | 15 | | 53 | 66 | 12 | 131 | 6,030 | 6,030 | 201,320 | | - | - | 131 | - | - | - | - |
| Tuesday | | 16 | | 51 | 27 | | 78 | 6,108 | 6,108 | 201,398 | | - | - | - | 78 | - | - | - |
| Wednesday | | 17 | | | | | 0 | 6,108 | 6,108 | 201,398 | | - | - | - | - | - | - | - |
| Thursday | | 18 | | 88 | 88 | | 176 | 6,284 | 6,284 | 201,574 | | - | - | - | - | - | 176 | - |
| Friday | | 19 | | 65 | 85 | | 150 | 6,434 | 6,434 | 201,724 | | - | - | - | - | - | - | 150 |
| Saturday | | 20 | | 392 | 283 | 2 | 677 | 7,111 | 7,111 | 202,401 | | 677 | - | - | - | - | - | - |
| Sunday | | 21 | | 539 | 277 | 5 | 821 | 7,932 | 7,932 | 203,222 | | - | 821 | - | - | - | - | - |
| Monday | | 22 | | 134 | 146 | | 280 | 8,212 | 8,212 | 203,502 | | - | - | 280 | - | - | - | - |
| Tuesday | | 23 | | 106 | 113 | | 219 | 8,431 | 8,431 | 203,721 | | - | - | - | 219 | - | - | - |
| Wednesday | | 24 | | 92 | 136 | 1 | 229 | 8,660 | 8,660 | 203,950 | | - | - | - | - | 229 | - | - |
| Thursday | | 25 | | 128 | 123 | | 251 | 8,911 | 8,911 | 204,201 | | - | - | - | - | - | 251 | - |
| Friday | | 26 | | 158 | 138 | | 296 | 9,207 | 9,207 | 204,497 | | - | - | - | - | - | - | 296 |
| Saturday | | 27 | | 689 | 587 | 25 | 1301 | 10,508 | 10,508 | 205,798 | | 1,301 | - | - | - | - | - | - |
| Sunday | | 28 | | 788 | 757 | 29 | 1574 | 12,082 | 12,082 | 207,372 | | - | 1,574 | - | - | - | - | - |
| Monday | | 29 | | 74 | 105 | 11 | 190 | 12,272 | 12,272 | 207,562 | | - | - | 190 | - | - | - | - |
| Tuesday | | 30 | | 63 | 49 | 2 | 114 | 12,386 | 12,386 | 207,676 | | - | - | - | 114 | - | - | - |
| Wednesday | | 31 | | 45 | 41 | | 86 | 12,472 | 12,472 | 207,762 | | - | - | - | - | 86 | - | - |
| **TOTAL** | **31 DAYS** | | | **6799** | **5500** | **173** | **12472** | **188410** | **188410** | **6242412.4** | **0** | **3662** | **4237** | **1353** | **845** | **669** | **908** | **798** |
| Thursday | | 1 | Nov-07 | 77 | 84 | | 161 | 161 | 12,633 | 207,923 | | - | - | - | - | - | 161 | - |
| Friday | | 2 | | 155 | 37 | 168 | 360 | 521 | 12,993 | 208,283 | | - | - | - | - | - | - | 360 |
| Saturday | | 3 | | 582 | 255 | 149 | 986 | 1,507 | 13,979 | 209,269 | | 986 | - | - | - | - | - | - |
| Sunday | | 4 | | 658 | 499 | 501 | 1658 | 3,165 | 15,637 | 210,927 | | - | 1,658 | - | - | - | - | - |
| Monday | | 5 | | 109 | 126 | 6 | 241 | 3,406 | 15,878 | 211,168 | | - | - | 241 | - | - | - | - |
| Tuesday | | 6 | | 60 | 86 | 3 | 149 | 3,555 | 16,027 | 211,317 | | - | - | - | 149 | - | - | - |
| Wednesday | | 7 | | 99 | 102 | | 201 | 3,756 | 16,228 | 211,518 | | - | - | - | - | 201 | - | - |
| Thursday | | 8 | | 56 | 66 | | 122 | 3,878 | 16,350 | 211,640 | | - | - | - | - | - | 122 | - |
| Friday | | 9 | | 140 | 173 | 1 | 314 | 4,192 | 16,664 | 211,954 | | - | - | - | - | - | - | 314 |
| Saturday | | 10 | | 372 | 223 | 2 | 597 | 4,789 | 17,261 | 212,551 | | 597 | - | - | - | - | - | - |
| Sunday | | 11 | | 467 | 392 | 2 | 861 | 5,650 | 18,122 | 213,412 | | - | 861 | - | - | - | - | - |
| Monday | | 12 | | 571 | 596 | 4 | 1171 | 6,821 | 19,293 | 214,583 | | - | - | 1,171 | - | - | - | - |
| Tuesday | | 13 | | 99 | 89 | | 188 | 7,009 | 19,481 | 214,771 | | - | - | - | 188 | - | - | - |
| Wednesday | | 14 | | 105 | 119 | 1 | 225 | 7,234 | 19,706 | 214,996 | | - | - | - | - | 225 | - | - |
| Thursday | | 15 | | 131 | 125 | | 256 | 7,490 | 19,962 | 215,252 | | - | - | - | - | - | 256 | - |
| Friday | | 16 | | 103 | 128 | 1 | 232 | 7,722 | 20,194 | 215,484 | | - | - | - | - | - | - | 232 |
| Saturday | | 17 | | 500 | 335 | | 835 | 8,557 | 21,029 | 216,319 | | 835 | - | - | - | - | - | - |
| Sunday | | 18 | | 407 | 346 | 1 | 754 | 9,311 | 21,783 | 217,073 | | - | 754 | - | - | - | - | - |
| Monday | | 19 | | 154 | 145 | 2 | 301 | 9,612 | 22,084 | 217,374 | | - | - | 301 | - | - | - | - |
| Tuesday | | 20 | | 223 | 233 | | 456 | 10,068 | 22,540 | 217,830 | | - | - | - | 456 | - | - | - |
| Wednesday | | 21 | | 218 | 204 | 1 | 423 | 10,491 | 22,963 | 218,253 | | - | - | - | - | 423 | - | - |
| Thursday | | 22 | Thanksgiving | | | | | 10,491 | 22,963 | 218,253 | | - | - | - | - | - | - | - |
| Friday | | 23 | | 627 | 373 | 1 | 1001 | 11,492 | 23,964 | 219,254 | | - | - | - | - | - | - | 1,001 |
| Saturday | | 24 | | 676 | 388 | 6 | 1070 | 12,562 | 25,034 | 220,324 | | 1,070 | - | - | - | - | - | - |
| Sunday | | 25 | | 334 | 284 | 5 | 623 | 13,185 | 25,657 | 220,947 | | - | 623 | - | - | - | - | - |
| Monday | | 26 | | 74 | 103 | 1 | 178 | 13,363 | 25,835 | 221,125 | | - | - | 178 | - | - | - | - |
| Tuesday | | 27 | | 51 | 77 | | 128 | 13,491 | 25,963 | 221,253 | | - | - | - | 128 | - | - | - |
| Wednesday | | 28 | | 32 | 62 | | 94 | 13,585 | 26,057 | 221,347 | | - | - | - | - | 94 | - | - |
| Thursday | | 29 | | 65 | 95 | | 160 | 13,745 | 26,217 | 221,507 | | - | - | - | - | - | 160 | - |
| Friday | | 30 | | 83 | 1 | 129 | 213 | 13,958 | 26,430 | 221,720 | | - | - | - | - | - | - | 213 |
| **TOTAL** | **29 DAYS (holiday)** | | | **7228** | **5746** | **984** | **13958** | **234767** | **608927** | **6467639** | **0** | **3488** | **3896** | **1891** | **921** | **943** | **699** | **2120** |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | 1 | Dec-07 | 316 | 198 | 0 | 514 | 514 | 26,944 | 222,234 | | 514 | - | - | - | - | - | - |
| Sunday | 2 | | 245 | 190 | 0 | 435 | 949 | 27,379 | 222,669 | | - | 435 | - | - | - | - | - |
| Monday | 3 | | 44 | 77 | 0 | 121 | 1,070 | 27,500 | 222,790 | | - | - | 121 | - | - | - | - |
| Tuesday | 4 | | 4 | 10 | 0 | 14 | 1,084 | 27,514 | 222,804 | | - | - | - | 14 | - | - | - |
| Wednesday | 5 | | 30 | 60 | 41 | 131 | 1,215 | 27,645 | 222,935 | | - | - | - | - | 131 | - | - |
| Thursday | 6 | | 1 | 3 | 0 | 4 | 1,219 | 27,649 | 222,939 | | - | - | - | - | - | 4 | - |
| Friday | 7 | | 28 | 78 | 2 | 108 | 1,327 | 27,757 | 223,047 | | - | - | - | - | - | - | 108 |
| Saturday | 8 | | 233 | 242 | 0 | 475 | 1,802 | 28,232 | 223,522 | | 475 | - | - | - | - | - | - |
| Sunday | 9 | | 229 | 280 | 1 | 510 | 2,312 | 28,742 | 224,032 | | - | 510 | - | - | - | - | - |
| Monday | 10 | | 45 | 78 | 2 | 125 | 2,437 | 28,867 | 224,157 | | - | - | 125 | - | - | - | - |
| Tuesday | 11 | | 63 | 63 | 2 | 128 | 2,565 | 28,995 | 224,285 | | - | - | - | 128 | - | - | - |
| Wednesday | 12 | | 36 | 77 | 1 | 114 | 2,679 | 29,109 | 224,399 | | - | - | - | - | 114 | - | - |
| Thursday | 13 | | 41 | 70 | 0 | 111 | 2,790 | 29,220 | 224,510 | | - | - | - | - | - | 111 | - |
| Friday | 14 | | 42 | 73 | 0 | 115 | 2,905 | 29,335 | 224,625 | | - | - | - | - | - | - | 115 |
| Saturday | 15 | | 186 | 233 | 0 | 419 | 3,324 | 29,754 | 225,044 | | 419 | - | - | - | - | - | - |
| Sunday | 16 | | 203 | 284 | 3 | 490 | 3,814 | 30,244 | 225,534 | | - | 490 | - | - | - | - | - |
| Monday | 17 | | 18 | 37 | 0 | 55 | 3,869 | 30,299 | 225,589 | | - | - | 55 | - | - | - | - |
| Tuesday | 18 | | 0 | 0 | 0 | 0 | 3,869 | 30,299 | 225,589 | | - | - | - | - | - | - | - |
| Wednesday | 19 | | 43 | 58 | 0 | 101 | 3,970 | 30,400 | 225,690 | | - | - | - | - | 101 | - | - |
| Thursday | 20 | | 45 | 52 | 0 | 97 | 4,067 | 30,497 | 225,787 | | - | - | - | - | - | 97 | - |
| Friday | 21 | | 68 | 100 | 0 | 168 | 4,235 | 30,665 | 225,955 | | - | - | - | - | - | - | 168 |
| Saturday | 22 | | 145 | 155 | 3 | 303 | 4,538 | 30,968 | 226,258 | | 303 | - | - | - | - | - | - |
| Sunday | 23 | | 253 | 213 | 0 | 466 | 5,004 | 31,434 | 226,724 | | - | 466 | - | - | - | - | - |
| Monday | 24 | | 107 | 132 | 0 | 239 | 5,243 | 31,673 | 226,963 | | - | - | 239 | - | - | - | - |
| Tuesday | 25 | | | | | | 5,243 | 31,673 | 226,963 | | - | - | - | - | - | - | - |
| Wednesday | 26 | | 342 | 212 | 2 | 556 | 5,799 | 32,229 | 227,519 | | - | - | - | - | 556 | - | - |
| Thursday | 27 | | 337 | 237 | 3 | 577 | 6,376 | 32,806 | 228,096 | | - | - | - | - | - | 577 | - |
| Friday | 28 | | 51 | 22 | 3 | 76 | 6,452 | 32,882 | 228,172 | | - | - | - | - | - | - | 76 |
| Saturday | 29 | | 51 | 34 | 0 | 85 | 6,537 | 32,967 | 228,257 | | 85 | - | - | - | - | - | - |
| Sunday | 30 | | 351 | 260 | 2 | 613 | 7,150 | 33,580 | 228,870 | | - | 613 | - | - | - | - | - |
| Monday | 31 | | 339 | 305 | 1 | 645 | 7,795 | 34,225 | 229,515 | | - | - | 645 | - | - | - | - |
| **TOTAL** | **31 days** | | **3896** | **3833** | **66** | **7795** | **112153** | **931483** | **6985485.4** | **0** | **1796** | **2514** | **1185** | **142** | **902** | **789** | **467** |
| Tuesday | 1 | Jan-08 | 422 | 254 | 2 | 678 | 678 | 34,903 | 230,193 | | - | - | - | 678 | - | - | - |
| Wednesday | 2 | | 311 | 249 | 1 | 561 | 1,239 | 35,464 | 230,754 | | - | - | - | - | 561 | - | - |
| Thursday | 3 | | 34 | 58 | 0 | 92 | 1,331 | 35,556 | 230,846 | | - | - | - | - | - | 92 | - |
| Friday | 4 | RAIN/CLOS | 0 | 0 | 0 | 0 | 1,331 | 35,556 | 230,846 | | - | - | - | - | - | - | - |
| Saturday | 5 | | 4 | 14 | 0 | 18 | 1,349 | 35,574 | 230,864 | | 18 | - | - | - | - | - | - |
| Sunday | 6 | | 86 | 100 | 0 | 186 | 1,535 | 35,760 | 231,050 | | - | 186 | - | - | - | - | - |
| Monday | 7 | | 62 | 82 | 0 | 144 | 1,679 | 35,904 | 231,194 | | - | - | 144 | - | - | - | - |
| Tuesday | 8 | | 2 | 3 | 0 | 5 | 1,684 | 35,909 | 231,199 | | - | - | - | 5 | - | - | - |
| Wednesday | 9 | | 30 | 25 | 0 | 55 | 1,739 | 35,964 | 231,254 | | - | - | - | - | 55 | - | - |
| Thursday | 10 | | 5 | 21 | 1 | 27 | 1,766 | 35,991 | 231,281 | | - | - | - | - | - | 27 | - |
| Friday | 11 | | 47 | 58 | 4 | 109 | 1,875 | 36,100 | 231,390 | | - | - | - | - | - | - | 109 |
| Saturday | 12 | | 360 | 377 | 1 | 738 | 2,613 | 36,838 | 232,128 | | 738 | - | - | - | - | - | - |
| Sunday | 13 | | 515 | 439 | 9 | 963 | 3,576 | 37,801 | 233,091 | | - | 963 | - | - | - | - | - |
| Monday | 14 | | 77 | 128 | 0 | 205 | 3,781 | 38,006 | 233,296 | | - | - | 205 | - | - | - | - |
| Tuesday | 15 | | 37 | 75 | 0 | 112 | 3,893 | 38,118 | 233,408 | | - | - | - | 112 | - | - | - |
| Wednesday | 16 | | 68 | 86 | 0 | 154 | 4,047 | 38,272 | 233,562 | | - | - | - | - | 154 | - | - |
| Thursday | 17 | | 93 | 109 | 6 | 208 | 4,255 | 38,480 | 233,770 | | - | - | - | - | - | 208 | - |
| Friday | 18 | | 92 | 161 | 0 | 253 | 4,508 | 38,733 | 234,023 | | - | - | - | - | - | - | 253 |
| Saturday | 19 | | 622 | 452 | 2 | 1076 | 5,584 | 39,809 | 235,099 | | 1,076 | - | - | - | - | - | - |
| Sunday | 20 | | 394 | 296 | 6 | 696 | 6,280 | 40,505 | 235,795 | | - | 696 | - | - | - | - | - |
| Monday | 21 | | 76 | 52 | 1 | 129 | 6,409 | 40,634 | 235,924 | | - | - | 129 | - | - | - | - |
| Tuesday | 22 | | 0 | 0 | 0 | 0 | 6,409 | 40,634 | 235,924 | | - | - | - | - | - | - | - |
| Wednesday | 23 | | 10 | 16 | 0 | 26 | 6,435 | 40,660 | 235,950 | | - | - | - | - | 26 | - | - |
| Thursday | 24 | RAIN | 6 | 4 | 0 | 10 | 6,445 | 40,670 | 235,960 | | - | - | - | - | - | 10 | - |
| Friday | 25 | | 0 | 0 | 0 | 0 | 6,445 | 40,670 | 235,960 | | - | - | - | - | - | - | - |
| Saturday | 26 | | 104 | 136 | 1 | 241 | 6,686 | 40,911 | 236,201 | | 241 | - | - | - | - | - | - |
| Sunday | 27 | | 37 | 57 | 1 | 95 | 6,781 | 41,006 | 236,296 | | - | 95 | - | - | - | - | - |
| Monday | 28 | | 67 | 132 | 2 | 201 | 6,982 | 41,207 | 236,497 | | - | - | 201 | - | - | - | - |
| Tuesday | 29 | RAIN | 0 | 2 | 0 | 2 | 6,984 | 41,209 | 236,499 | | - | - | - | 2 | - | - | - |
| Wednesday | 30 | | 44 | 94 | 0 | 138 | 7,122 | 41,347 | 236,637 | | - | - | - | - | 138 | - | - |
| Thursday | 31 | | 22 | 32 | 0 | 54 | 7,176 | 41,401 | 236,691 | | - | - | - | - | - | 54 | - |
| **TOTAL** | **31 days** | | **3627** | **3512** | **37** | **7176** | **128617** | **1189592** | **7243594.4** | **0** | **2073** | **1940** | **679** | **797** | **934** | **391** | **362** |
| Friday | 1 | Feb-08 | 73 | 125 | 0 | 198 | 198 | 41,599 | 236,889 | | - | - | - | - | - | - | 198 |
| Saturday | 2 | | 43 | 57 | 0 | 100 | 298 | 41,699 | 236,989 | | 100 | - | - | - | - | - | - |
| Sunday | 3 | | 66 | 116 | 0 | 182 | 480 | 41,881 | 237,171 | | - | 182 | - | - | - | - | - |
| Monday | 4 | | 89 | 145 | 0 | 234 | 714 | 42,115 | 237,405 | | - | - | 234 | - | - | - | - |
| Tuesday | 5 | | 72 | 115 | 0 | 187 | 901 | 42,302 | 237,592 | | - | - | - | 187 | - | - | - |
| Wednesday | 6 | | 69 | 108 | 0 | 177 | 1,078 | 42,479 | 237,769 | | - | - | - | - | 177 | - | - |
| Thursday | 7 | | 104 | 145 | 0 | 249 | 1,327 | 42,728 | 238,018 | | - | - | - | - | - | 249 | - |
| Friday | 8 | | 123 | 168 | 4 | 295 | 1,622 | 43,023 | 238,313 | | - | - | - | - | - | - | 295 |
| Saturday | 9 | | 793 | 565 | 1 | 1359 | 2,981 | 44,382 | 239,672 | | 1,359 | - | - | - | - | - | - |
| Sunday | 10 | | 803 | 540 | 15 | 1358 | 4,339 | 45,740 | 241,030 | | - | 1,358 | - | - | - | - | - |
| Monday | 11 | | 204 | 245 | 2 | 451 | 4,790 | 46,191 | 241,481 | | - | - | 451 | - | - | - | - |
| Tuesday | 12 | | 120 | 183 | 0 | 303 | 5,093 | 46,494 | 241,784 | | - | - | - | 303 | - | - | - |
| Wednesday | 13 | | 119 | 144 | 0 | 263 | 5,356 | 46,757 | 242,047 | | - | - | - | - | 263 | - | - |
| Thursday | 14 | | 135 | 87 | 0 | 222 | 5,578 | 46,979 | 242,269 | | - | - | - | - | - | 222 | - |
| Friday | 15 | | 264 | 299 | 4 | 567 | 6,145 | 47,546 | 242,836 | | - | - | - | - | - | - | 567 |
| Saturday | 16 | | 904 | 516 | 3 | 1423 | 7,568 | 48,969 | 244,259 | | 1,423 | - | - | - | - | - | - |
| Sunday | 17 | | 1015 | 510 | 13 | 1538 | 9,106 | 50,507 | 245,797 | | - | 1,538 | - | - | - | - | - |
| Monday | 18 | | 1012 | 716 | 1 | 1729 | 10,835 | 52,236 | 247,526 | | - | - | 1,729 | - | - | - | - |
| Tuesday | 19 | | 9 | 7 | 1 | 17 | 10,852 | 52,253 | 247,543 | | - | - | - | 17 | - | - | - |
| Wednesday | 20 | | 96 | 58 | 0 | 154 | 11,006 | 52,407 | 247,697 | | - | - | - | - | 154 | - | - |
| Thursday | 21 | | 3 | 2 | 0 | 5 | 11,011 | 52,412 | 247,702 | | - | - | - | - | - | 5 | - |
| Friday | 22 | | 54 | 24 | 0 | 78 | 11,089 | 52,490 | 247,780 | | - | - | - | - | - | - | 78 |
| Saturday | 23 | | 25 | 28 | 0 | 53 | 11,142 | 52,543 | 247,833 | | 53 | - | - | - | - | - | - |
| Sunday | 24 | CLOSED | 0 | 0 | 0 | 0 | - | 52,543 | 247,833 | | - | - | - | - | - | - | - |
| Monday | 25 | | 91 | 118 | 0 | 209 | 209 | 52,752 | 248,042 | | - | - | 209 | - | - | - | - |
| Tuesday | 26 | | 144 | 142 | 0 | 286 | 495 | 53,038 | 248,328 | | - | - | - | 286 | - | - | - |
| Wednesday | 27 | | 115 | 145 | 1 | 261 | 756 | 53,299 | 248,589 | | - | - | - | - | 261 | - | - |
| Thursday | 28 | | 147 | 173 | 0 | 320 | 1,076 | 53,619 | 248,909 | | - | - | - | - | - | 320 | - |
| Friday | 29 | | 206 | 236 | 0 | 442 | 1,518 | 54,061 | 249,351 | | - | - | - | - | - | - | 442 |
| **TOTAL** | **28 days (closed 1)** | | **6898** | **5717** | **45** | **12660** | **127563** | **1395044** | **7058465.6** | **0** | **2935** | **3078** | **2623** | **793** | **855** | **796** | **1580** |
| Saturday | 1 | Mar-08 | 656 | 401 | 24 | 1081 | 1,081 | 55,142 | 250,432 | | 1,081 | - | - | - | - | - | - |
| Sunday | 2 | | 864 | 526 | 2 | 1392 | 2,473 | 56,534 | 251,824 | | - | 1,392 | - | - | - | - | - |
| Monday | 3 | | 106 | 165 | 0 | 271 | 2,744 | 56,805 | 252,095 | | - | - | 271 | - | - | - | - |
| Tuesday | 4 | | 122 | 130 | 0 | 252 | 2,996 | 57,057 | 252,347 | | - | - | - | 252 | - | - | - |
| Wednesday | 5 | | 136 | 195 | 0 | 331 | 3,327 | 57,388 | 252,678 | | - | - | - | - | 331 | - | - |
| Thursday | 6 | | 144 | 150 | 0 | 294 | 3,621 | 57,682 | 252,972 | | - | - | - | - | - | 294 | - |
| Friday | 7 | | 235 | 213 | 3 | 451 | 4,072 | 58,133 | 253,423 | | - | - | - | - | - | - | 451 |
| Saturday | 8 | | 837 | 456 | 8 | 1301 | 5,373 | 59,434 | 254,724 | | 1,301 | - | - | - | - | - | - |
| Sunday | 9 | | 748 | 456 | 9 | 1213 | 6,586 | 60,647 | 255,937 | | - | 1,213 | - | - | - | - | - |
| Monday | 10 | | 154 | 111 | 1 | 266 | 6,852 | 60,913 | 256,203 | | - | - | 266 | - | - | - | - |
| Tuesday | 11 | | 152 | 133 | 0 | 285 | 7,137 | 61,198 | 256,488 | | - | - | - | 285 | - | - | - |
| Wednesday | 12 | | 93 | 109 | 0 | 202 | 7,339 | 61,400 | 256,690 | | - | - | - | - | 202 | - | - |
| Thursday | 13 | | 104 | 73 | 0 | 177 | 7,516 | 61,577 | 256,867 | | - | - | - | - | - | 177 | - |
| Friday | 14 | | 140 | 128 | 0 | 268 | 7,784 | 61,845 | 257,135 | | - | - | - | - | - | - | 268 |
| Saturday | 15 | | 343 | 232 | 0 | 575 | 8,359 | 62,420 | 257,710 | | 575 | - | - | - | - | - | - |
| Sunday | 16 | | 619 | 375 | 6 | 1000 | 9,359 | 63,420 | 258,710 | | - | 1,000 | - | - | - | - | - |
| Monday | 17 | | 162 | 145 | 0 | 307 | 9,666 | 63,727 | 259,017 | | - | - | 307 | - | - | - | - |
| Tuesday | 18 | | 191 | 145 | 3 | 339 | 10,005 | 64,066 | 259,356 | | - | - | - | 339 | - | - | - |
| Wednesday | 19 | | 112 | 81 | 3 | 196 | 10,201 | 64,262 | 259,552 | | - | - | - | - | 196 | - | - |
| Thursday | 20 | | 201 | 156 | 3 | 360 | 10,561 | 64,622 | 259,912 | | - | - | - | - | - | 360 | - |
| Friday | 21 | | 396 | 308 | 1 | 705 | 11,266 | 65,327 | 260,617 | | - | - | - | - | - | - | 705 |
| Saturday | 22 | | 676 | 345 | 1 | 1022 | 12,288 | 66,349 | 261,639 | | 1,022 | - | - | - | - | - | - |
| Sunday | 23 | | 699 | 241 | 5 | 945 | 13,233 | 67,294 | 262,584 | | - | 945 | - | - | - | - | - |
| Monday | 24 | | 572 | 399 | 1 | 972 | 14,205 | 68,266 | 263,556 | | - | - | 972 | - | - | - | - |
| Tuesday | 25 | | 673 | 408 | 12 | 1093 | 15,298 | 69,359 | 264,649 | | - | - | - | 1,093 | - | - | - |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wednesday | 26 | | 638 | 392 | 1 | 1031 | 16,329 | 70,390 | 265,680 | - | - | - | - | - | 1,031 | - | - |
| Thursday | 27 | | 685 | 388 | 1 | 1074 | 17,403 | 71,464 | 266,754 | - | - | - | - | - | - | 1,074 | - |
| Friday | 28 | | 629 | 382 | 0 | 1011 | 18,414 | 72,475 | 267,765 | - | - | - | - | - | - | - | 1,011 |
| Saturday | 29 | | 498 | 242 | 1 | 741 | 19,155 | 73,216 | 268,506 | - | 741 | - | - | - | - | - | - |
| Sunday | 30 | | 803 | 484 | 3 | 1290 | 20,445 | 74,506 | 269,796 | - | - | 1,290 | - | - | - | - | - |
| Monday | 31 | | 271 | 286 | 0 | 557 | 21,002 | 75,063 | 270,353 | - | - | - | 557 | - | - | - | - |
| TOTAL | 31 days | | 12659 | 8255 | 88 | 21002 | 306090 | 1981981 | 8035983.4 | 0 | 4720 | 5840 | 2373 | 1969 | 1760 | 1905 | 2435 |
| Tuesday | 1 | Apr-08 | 216 | 120 | 0 | 336 | 336 | 75,399 | 270,689 | - | - | - | - | 336 | - | - | - |
| Wednesday | 2 | | 142 | 96 | 1 | 239 | 575 | 75,638 | 270,928 | - | - | - | - | - | 239 | - | - |
| Thursday | 3 | | 233 | 171 | 0 | 404 | 979 | 76,042 | 271,332 | - | - | - | - | - | - | 404 | - |
| Friday | 4 | | 272 | 235 | 2 | 509 | 1,488 | 76,551 | 271,841 | - | - | - | - | - | - | - | 509 |
| Saturday | 5 | | 878 | 424 | 11 | 1313 | 2,801 | 77,864 | 273,154 | - | 1,313 | - | - | - | - | - | - |
| Sunday | 6 | | 663 | 478 | 11 | 1152 | 3,953 | 79,016 | 274,306 | - | - | 1,152 | - | - | - | - | - |
| Monday | 7 | | 221 | 190 | 1 | 412 | 4,365 | 79,428 | 274,718 | - | - | - | 412 | - | - | - | - |
| Tuesday | 8 | | 156 | 110 | 1 | 267 | 4,632 | 79,695 | 274,985 | - | - | - | - | 267 | - | - | - |
| Wednesday | 9 | | 205 | 150 | 2 | 357 | 4,989 | 80,052 | 275,342 | - | - | - | - | - | 357 | - | - |
| Thursday | 10 | | 309 | 214 | 2 | 525 | 5,514 | 80,577 | 275,867 | - | - | - | - | - | - | 525 | - |
| Friday | 11 | | 328 | 246 | 2 | 576 | 6,090 | 81,153 | 276,443 | - | - | - | - | - | - | - | 576 |
| Saturday | 12 | | 906 | 469 | 1 | 1376 | 7,466 | 82,529 | 277,819 | - | 1,376 | - | - | - | - | - | - |
| Sunday | 13 | | 828 | 404 | 7 | 1239 | 8,705 | 83,768 | 279,058 | - | - | 1,239 | - | - | - | - | - |
| Monday | 14 | | 145 | 144 | 1 | 290 | 8,995 | 84,058 | 279,348 | - | - | - | 290 | - | - | - | - |
| Tuesday | 15 | | 189 | 141 | 2 | 332 | 9,327 | 84,390 | 279,680 | - | - | - | - | 332 | - | - | - |
| Wednesday | 16 | | 225 | 155 | 1 | 381 | 9,708 | 84,771 | 280,061 | - | - | - | - | - | 381 | - | - |
| Thursday | 17 | | 248 | 168 | 0 | 416 | 10,124 | 85,187 | 280,477 | - | - | - | - | - | - | 416 | - |
| Friday | 18 | | 328 | 224 | 1 | 553 | 10,677 | 85,740 | 281,030 | - | - | - | - | - | - | - | 553 |
| Saturday | 19 | | 705 | 357 | 0 | 1062 | 11,739 | 86,802 | 282,092 | - | 1,062 | - | - | - | - | - | - |
| Sunday | 20 | | 631 | 434 | 19 | 1084 | 12,823 | 87,886 | 283,176 | - | - | 1,084 | - | - | - | - | - |
| Monday | 21 | | 175 | 152 | 1 | 328 | 13,151 | 88,214 | 283,504 | - | - | - | 328 | - | - | - | - |
| Tuesday | 22 | | 94 | 123 | 0 | 217 | 13,368 | 88,431 | 283,721 | - | - | - | - | 217 | - | - | - |
| Wednesday | 23 | | 103 | 100 | 1 | 204 | 13,572 | 88,635 | 283,925 | - | - | - | - | - | 204 | - | - |
| Thursday | 24 | | 261 | 166 | 2 | 429 | 14,001 | 89,064 | 284,354 | - | - | - | - | - | - | 429 | - |
| Friday | 25 | | 246 | 185 | 0 | 431 | 14,432 | 89,495 | 284,785 | - | - | - | - | - | - | - | 431 |
| Saturday | 26 | | 871 | 532 | 1 | 1404 | 15,836 | 90,899 | 286,189 | - | 1,404 | - | - | - | - | - | - |
| Sunday | 27 | | 840 | 477 | 12 | 1329 | 17,165 | 92,228 | 287,518 | - | - | 1,329 | - | - | - | - | - |
| Monday | 28 | | 220 | 138 | 2 | 360 | 17,525 | 92,588 | 287,878 | - | - | - | 360 | - | - | - | - |
| Tuesday | 29 | | 155 | 138 | 3 | 296 | 17,821 | 92,884 | 288,174 | - | - | - | - | 296 | - | - | - |
| Wednesday | 30 | | 129 | 127 | 2 | 258 | 18,079 | 93,142 | 288,432 | - | - | - | - | - | 258 | - | - |
| TOTAL | 30 days | | 10922 | 7068 | 89 | 18079 | 280236 | 2532126 | 8390838 | 0 | 5155 | 4804 | 1390 | 1448 | 1439 | 1774 | 2069 |
| Thursday | 1 | May-08 | 187 | 145 | 1 | 333 | 333 | 93,475 | 288,765 | - | - | - | - | - | - | 333 | - |
| Friday | 2 | | 251 | 209 | 3 | 463 | 796 | 93,938 | 289,228 | - | - | - | - | - | - | - | 463 |
| Saturday | 3 | | 850 | 554 | 8 | 1412 | 2,208 | 95,350 | 290,640 | - | 1,412 | - | - | - | - | - | - |
| Sunday | 4 | | 606 | 447 | 4 | 1057 | 3,265 | 96,407 | 291,697 | - | - | 1,057 | - | - | - | - | - |
| Monday | 5 | | 154 | 132 | 1 | 287 | 3,552 | 96,694 | 291,984 | - | - | - | 287 | - | - | - | - |
| Tuesday | 6 | | 249 | 144 | 0 | 393 | 3,945 | 97,087 | 292,377 | - | - | - | - | 393 | - | - | - |
| Wednesday | 7 | | 207 | 153 | 4 | 364 | 4,309 | 97,451 | 292,741 | - | - | - | - | - | 364 | - | - |
| Thursday | 8 | | 171 | 124 | 1 | 296 | 4,605 | 97,747 | 293,037 | - | - | - | - | - | - | 296 | - |
| Friday | 9 | | 208 | 218 | 0 | 426 | 5,031 | 98,173 | 293,463 | - | - | - | - | - | - | - | 426 |
| Saturday | 10 | | 618 | 375 | 2 | 995 | 6,026 | 99,168 | 294,458 | - | 995 | - | - | - | - | - | - |
| Sunday | 11 | | 871 | 347 | 3 | 1221 | 7,247 | 100,389 | 295,679 | - | - | 1,221 | - | - | - | - | - |
| Monday | 12 | | 240 | 192 | 1 | 433 | 7,680 | 100,822 | 296,112 | - | - | - | 433 | - | - | - | - |
| Tuesday | 13 | | 239 | 160 | 0 | 399 | 8,079 | 101,221 | 296,511 | - | - | - | - | 399 | - | - | - |
| Wednesday | 14 | | 162 | 120 | 1 | 283 | 8,362 | 101,504 | 296,794 | - | - | - | - | - | 283 | - | - |
| Thursday | 15 | | 231 | 72 | 1 | 304 | 8,666 | 101,808 | 297,098 | - | - | - | - | - | - | 304 | - |
| Friday | 16 | | 267 | 94 | 0 | 361 | 9,027 | 102,169 | 297,459 | - | - | - | - | - | - | - | 361 |
| Saturday | 17 | | 483 | 231 | 11 | 725 | 9,752 | 102,894 | 298,184 | - | 725 | - | - | - | - | - | - |
| Sunday | 18 | | 639 | 437 | 1 | 1077 | 10,829 | 103,971 | 299,261 | - | - | 1,077 | - | - | - | - | - |
| Monday | 19 | | 259 | 192 | 4 | 455 | 11,284 | 104,426 | 299,716 | - | - | - | 455 | - | - | - | - |
| Tuesday | 20 | | 235 | 160 | 3 | 398 | 11,682 | 104,824 | 300,114 | - | - | - | - | 398 | - | - | - |
| Wednesday | 21 | | 214 | 143 | 1 | 358 | 12,040 | 105,182 | 300,472 | - | - | - | - | - | 358 | - | - |
| Thursday | 22 | | 288 | 147 | 0 | 435 | 12,475 | 105,617 | 300,907 | - | - | - | - | - | - | 435 | - |
| Friday | 23 | | 403 | 279 | 1 | 683 | 13,158 | 106,300 | 301,590 | - | - | - | - | - | - | - | 683 |
| Saturday | 24 | | 463 | 221 | 4 | 688 | 13,846 | 106,988 | 302,278 | - | 688 | - | - | - | - | - | - |
| Sunday | 25 | | 1080 | 536 | 6 | 1622 | 15,468 | 108,610 | 303,900 | - | - | 1,622 | - | - | - | - | - |
| Monday | 26 | | 996 | 545 | 1 | 1542 | 17,010 | 110,152 | 305,442 | - | - | - | 1,542 | - | - | - | - |
| Tuesday | 27 | | 225 | 141 | 1 | 367 | 17,377 | 110,519 | 305,809 | - | - | - | - | 367 | - | - | - |
| Wednesday | 28 | | 371 | 174 | 0 | 545 | 17,922 | 111,064 | 306,354 | - | - | - | - | - | 545 | - | - |
| Thursday | 29 | | 292 | 204 | 5 | 501 | 18,423 | 111,565 | 306,855 | - | - | - | - | - | - | 501 | - |
| Friday | 30 | | 308 | 214 | 1 | 523 | 18,946 | 112,088 | 307,378 | - | - | - | - | - | - | - | 523 |
| Saturday | 31 | | 630 | 430 | 10 | 1070 | 20,016 | 113,158 | 308,448 | - | 1,070 | - | - | - | - | - | - |
| TOTAL | 31 days | | 12397 | 7540 | 79 | 20016 | 303359 | 3190761 | 9244763.4 | 0 | 4890 | 4977 | 2717 | 1557 | 1550 | 1869 | 2456 |
| Sunday | 1 | Jun-08 | 766 | 523 | 3 | 1292 | 1,292 | 114,450 | 309,740 | - | - | 1,292 | - | - | - | - | - |
| Monday | 2 | | 316 | 185 | 6 | 507 | 1,799 | 114,957 | 310,247 | - | - | - | 507 | - | - | - | - |
| Tuesday | 3 | | 304 | 174 | 5 | 483 | 2,282 | 115,440 | 310,730 | - | - | - | - | 483 | - | - | - |
| Wednesday | 4 | | 298 | 181 | 0 | 479 | 2,761 | 115,919 | 311,209 | - | - | - | - | - | 479 | - | - |
| Thursday | 5 | | 331 | 148 | 0 | 479 | 3,240 | 116,398 | 311,688 | - | - | - | - | - | - | 479 | - |
| Friday | 6 | | 382 | 231 | 1 | 614 | 3,854 | 117,012 | 312,302 | - | - | - | - | - | - | - | 614 |
| Saturday | 7 | | 765 | 401 | 14 | 1180 | 5,034 | 118,192 | 313,482 | - | 1,180 | - | - | - | - | - | - |
| Sunday | 8 | | 740 | 493 | 3 | 1236 | 6,270 | 119,428 | 314,718 | - | - | 1,236 | - | - | - | - | - |
| Monday | 9 | | 237 | 168 | 1 | 406 | 6,676 | 119,834 | 315,124 | - | - | - | 406 | - | - | - | - |
| Tuesday | 10 | | 197 | 127 | 0 | 324 | 7,000 | 120,158 | 315,448 | - | - | - | - | 324 | - | - | - |
| Wednesday | 11 | | 244 | 170 | 1 | 415 | 7,415 | 120,573 | 315,863 | - | - | - | - | - | 415 | - | - |
| Thursday | 12 | | 218 | 189 | 1 | 408 | 7,823 | 120,981 | 316,271 | - | - | - | - | - | - | 408 | - |
| Friday | 13 | | 300 | 229 | 2 | 531 | 8,354 | 121,512 | 316,802 | - | - | - | - | - | - | - | 531 |
| Saturday | 14 | | 582 | 399 | 981 | 1962 | 10,316 | 123,474 | 318,764 | - | 1,962 | - | - | - | - | - | - |
| Sunday | 15 | | 639 | 358 | 0 | 997 | 11,313 | 124,471 | 319,761 | - | - | 997 | - | - | - | - | - |
| Monday | 16 | | 312 | 221 | 2 | 535 | 11,848 | 125,006 | 320,296 | - | - | - | 535 | - | - | - | - |
| Tuesday | 17 | | 270 | 264 | 2 | 536 | 12,384 | 125,542 | 320,832 | - | - | - | - | 536 | - | - | - |
| Wednesday | 18 | | 317 | 241 | 1 | 559 | 12,943 | 126,101 | 321,391 | - | - | - | - | - | 559 | - | - |
| Thursday | 19 | | 278 | 226 | 2 | 506 | 13,449 | 126,607 | 321,897 | - | - | - | - | - | - | 506 | - |
| Friday | 20 | | 308 | 220 | 1 | 529 | 13,978 | 127,136 | 322,426 | - | - | - | - | - | - | - | 529 |
| Saturday | 21 | | 0 | 0 | 0 | 0 | 13,978 | 127,136 | 322,426 | - | - | - | - | - | - | - | - |
| Sunday | 22 | | 631 | 424 | 14 | 1069 | 15,047 | 128,205 | 323,495 | - | - | 1,069 | - | - | - | - | - |
| Monday | 23 | | 229 | 3 | 216 | 448 | 15,495 | 128,653 | 323,943 | - | - | - | 448 | - | - | - | - |
| Tuesday | 24 | | 248 | 201 | 1 | 450 | 15,945 | 129,103 | 324,393 | - | - | - | - | 450 | - | - | - |
| Wednesday | 25 | | 273 | 190 | 0 | 463 | 16,408 | 129,566 | 324,856 | - | - | - | - | - | 463 | - | - |
| Thursday | 26 | | 256 | 187 | 7 | 450 | 16,858 | 130,016 | 325,306 | - | - | - | - | - | - | 450 | - |
| Friday | 27 | | 274 | 274 | 1 | 549 | 17,407 | 130,565 | 325,855 | - | - | - | - | - | - | - | 549 |
| Saturday | 28 | | 626 | 440 | 4 | 1070 | 18,477 | 131,635 | 326,925 | - | 1,070 | - | - | - | - | - | - |
| Sunday | 29 | | 751 | 519 | 0 | 1270 | 19,747 | 132,905 | 328,195 | - | - | 1,270 | - | - | - | - | - |
| Monday | 30 | | 284 | 256 | 1 | 541 | 20,288 | 133,446 | 328,736 | - | - | - | 541 | - | - | - | - |
| TOTAL | 30 days | | 11376 | 7642 | 1270 | 20288 | 319681 | 3714421 | 9573133 | 0 | 4212 | 5864 | 2437 | 1793 | 1916 | 1843 | 2223 |
| Tuesday | 1 | Jul-08 | 273 | 304 | 20 | 597 | 597 | 134,043 | 329,333 | - | - | - | - | - | 597 | - | - |
| Wednesday | 2 | | 315 | 267 | 1 | 583 | 1,180 | 134,626 | 329,916 | - | - | - | - | - | - | 583 | - |
| Thursday | 3 | | 325 | 273 | 1 | 599 | 1,779 | 135,225 | 330,515 | - | - | - | - | - | - | - | 599 |
| Friday | 4 | | 590 | 244 | 4 | 838 | 2,617 | 136,063 | 331,353 | - | 838 | - | - | - | - | - | - |
| Saturday | 5 | | 847 | 441 | 1 | 1289 | 3,906 | 137,352 | 332,642 | - | - | 1,289 | - | - | - | - | - |
| Sunday | 6 | | 666 | 464 | 2 | 1132 | 5,038 | 138,484 | 333,774 | - | - | - | 1,132 | - | - | - | - |
| Monday | 7 | | 271 | 195 | 10 | 476 | 5,514 | 138,960 | 334,250 | - | - | - | - | 476 | - | - | - |
| Tuesday | 8 | | 162 | 109 | 0 | 271 | 5,785 | 139,231 | 334,521 | - | - | - | - | - | 271 | - | - |
| Wednesday | 9 | | 142 | 110 | 1 | 253 | 6,038 | 139,484 | 334,774 | - | - | - | - | - | - | 253 | - |
| Thursday | 10 | | 165 | 154 | 0 | 319 | 6,357 | 139,803 | 335,093 | - | - | - | - | - | - | - | 319 |
| Friday | 11 | | 333 | 264 | 5 | 602 | 6,959 | 140,405 | 335,695 | - | 602 | - | - | - | - | - | - |
| Saturday | 12 | | 854 | 710 | 3 | 1567 | 8,526 | 141,972 | 337,262 | - | - | 1,567 | - | - | - | - | - |
| Sunday | 13 | | 830 | 511 | 2 | 1343 | 9,869 | 143,315 | 338,605 | - | - | - | 1,343 | - | - | - | - |
| Monday | 14 | | 297 | 247 | 2 | 546 | 10,415 | 143,861 | 339,151 | - | - | - | - | 546 | - | - | - |
| Tuesday | 15 | | 302 | 238 | 4 | 544 | 10,959 | 144,405 | 339,695 | - | - | - | - | - | 544 | - | - |
| Wednesday | 16 | | 291 | 261 | 3 | 555 | 11,514 | 144,960 | 340,250 | - | - | - | - | - | - | 555 | - |
| Thursday | 17 | | 348 | 258 | 1 | 607 | 12,121 | 145,567 | 340,857 | - | - | - | - | - | - | - | 607 |
| Friday | 18 | | 437 | 244 | 2 | 683 | 12,804 | 146,250 | 341,540 | - | 683 | - | - | - | - | - | - |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | 19 | | 939 | 494 | 20 | 1453 | 14,257 | 147,703 | 342,993 | | - | 1,453 | - | - | - | - | - |
| Sunday | 20 | | 905 | 643 | 7 | 1555 | 15,812 | 149,258 | 344,548 | | - | - | 1,555 | - | - | - | - |
| Monday | 21 | | 280 | 211 | 0 | 491 | 16,303 | 149,749 | 345,039 | | - | - | - | 491 | - | - | - |
| Tuesday | 22 | | 302 | 264 | 1 | 567 | 16,870 | 150,316 | 345,606 | | - | - | - | - | 567 | - | - |
| Wednesday | 23 | | 326 | 283 | 1 | 610 | 17,480 | 150,926 | 346,216 | | - | - | - | - | - | 610 | - |
| Thursday | 24 | | 349 | 246 | 4 | 599 | 18,079 | 151,525 | 346,815 | | - | - | - | - | - | - | 599 |
| Friday | 25 | | 361 | 343 | 4 | 708 | 18,787 | 152,233 | 347,523 | | 708 | - | - | - | - | - | - |
| Saturday | 26 | | 867 | 419 | 1 | 1287 | 20,074 | 153,520 | 348,810 | | - | 1,287 | - | - | - | - | - |
| Sunday | 27 | | 762 | 448 | 3 | 1213 | 21,287 | 154,733 | 350,023 | | - | - | 1,213 | - | - | - | - |
| Monday | 28 | | 297 | 279 | 0 | 576 | 21,863 | 155,309 | 350,599 | | - | - | - | 576 | - | - | - |
| Tuesday | 29 | | 344 | 293 | 6 | 643 | 22,506 | 155,952 | 351,242 | | - | - | - | - | 643 | - | - |
| Wednesday | 30 | | 345 | 271 | 2 | 618 | 23,124 | 156,570 | 351,860 | | - | - | - | - | - | 618 | - |
| Thursday | 31 | | 314 | 285 | 0 | 599 | 23,723 | 157,169 | 352,459 | | - | - | - | - | - | - | 599 |
| **TOTAL** | **31 days** | | **13839** | **9773** | **111** | **23723** | **372143** | **4508969** | **10562971.4** | **0** | **2831** | **5596** | **5243** | **2089** | **2622** | **2619** | **2723** |
| Friday | 1 | Aug-08 | 418 | 322 | 2 | 742 | 742 | 157,911 | 353,201 | | 742 | - | - | - | - | - | - |
| Saturday | 2 | | 905 | 457 | 10 | 1372 | 2,114 | 159,283 | 354,573 | | - | 1,372 | - | - | - | - | - |
| Sunday | 3 | | 748 | 507 | 1 | 1256 | 3,370 | 160,539 | 355,829 | | - | - | 1,256 | - | - | - | - |
| Monday | 4 | | 309 | 260 | 4 | 573 | 3,943 | 161,112 | 356,402 | | - | - | - | 573 | - | - | - |
| Tuesday | 5 | | 318 | 251 | 3 | 572 | 4,515 | 161,684 | 356,974 | | - | - | - | - | 572 | - | - |
| Wednesday | 6 | | 349 | 257 | 2 | 608 | 5,123 | 162,292 | 357,582 | | - | - | - | - | - | 608 | - |
| Thursday | 7 | | 363 | 276 | 5 | 644 | 5,767 | 162,936 | 358,226 | | - | - | - | - | - | - | 644 |
| Friday | 8 | | 352 | 298 | 1 | 651 | 6,418 | 163,587 | 358,877 | | 651 | - | - | - | - | - | - |
| Saturday | 9 | | 913 | 470 | 4 | 1387 | 7,805 | 164,974 | 360,264 | | - | 1,387 | - | - | - | - | - |
| Sunday | 10 | | 922 | 467 | 0 | 1389 | 9,194 | 166,363 | 361,653 | | - | - | 1,389 | - | - | - | - |
| Monday | 11 | | 320 | 222 | 0 | 542 | 9,736 | 166,905 | 362,195 | | - | - | - | 542 | - | - | - |
| Tuesday | 12 | | 359 | 282 | 2 | 643 | 10,379 | 167,548 | 362,838 | | - | - | - | - | 643 | - | - |
| Wednesday | 13 | | 319 | 267 | 4 | 590 | 10,969 | 168,138 | 363,428 | | - | - | - | - | - | 590 | - |
| Thursday | 14 | | 328 | 253 | 1 | 582 | 11,551 | 168,720 | 364,010 | | - | - | - | - | - | - | 582 |
| Friday | 15 | | 310 | 217 | 2 | 529 | 12,080 | 169,249 | 364,539 | | 529 | - | - | - | - | - | - |
| Saturday | 16 | | 737 | 366 | 3 | 1106 | 13,186 | 170,355 | 365,645 | | - | 1,106 | - | - | - | - | - |
| Sunday | 17 | | 806 | 459 | 8 | 1273 | 14,459 | 171,628 | 366,918 | | - | - | 1,273 | - | - | - | - |
| Monday | 18 | | 305 | 232 | 4 | 541 | 15,000 | 172,169 | 367,459 | | - | - | - | 541 | - | - | - |
| Tuesday | 19 | | 354 | 286 | 3 | 643 | 15,643 | 172,812 | 368,102 | | - | - | - | - | 643 | - | - |
| Wednesday | 20 | | 344 | 266 | 1 | 611 | 16,254 | 173,423 | 368,713 | | - | - | - | - | - | 611 | - |
| Thursday | 21 | | 304 | 309 | 4 | 617 | 16,871 | 174,040 | 369,330 | | - | - | - | - | - | - | 617 |
| Friday | 22 | | 372 | 337 | 2 | 711 | 17,582 | 174,751 | 370,041 | | 711 | - | - | - | - | - | - |
| Saturday | 23 | | 778 | 480 | 10 | 1268 | 18,850 | 176,019 | 371,309 | | - | 1,268 | - | - | - | - | - |
| Sunday | 24 | | 788 | 562 | 25 | 1375 | 20,225 | 177,394 | 372,684 | | - | - | 1,375 | - | - | - | - |
| Monday | 25 | | 251 | 271 | 1 | 523 | 20,748 | 177,917 | 373,207 | | - | - | - | 523 | - | - | - |
| Tuesday | 26 | | 222 | 219 | 0 | 441 | 21,189 | 178,358 | 373,648 | | - | - | - | - | 441 | - | - |
| Wednesday | 27 | | 175 | 160 | 3 | 338 | 21,527 | 178,696 | 373,986 | | - | - | - | - | - | 338 | - |
| Thursday | 28 | | 139 | 138 | 1 | 278 | 21,805 | 178,974 | 374,264 | | - | - | - | - | - | - | 278 |
| Friday | 29 | | 169 | 198 | 1 | 368 | 22,173 | 179,342 | 374,632 | | 368 | - | - | - | - | - | - |
| Saturday | 30 | | 945 | 585 | 1 | 1531 | 23,704 | 180,873 | 376,163 | | - | 1,531 | - | - | - | - | - |
| Sunday | 31 | | 1038 | 880 | 5 | 1923 | 25,627 | 182,796 | 378,086 | | - | - | 1,923 | - | - | - | - |
| **TOTAL** | **31 days** | | **14960** | **10554** | **113** | **25627** | **408549** | **5280788** | **11334790.4** | **0** | **3001** | **6664** | **7216** | **2179** | **2299** | **2147** | **2121** |
| Monday | 1 | Sep-08 | 912 | 480 | 2 | 1394 | 1,394 | 184,190 | 379,480 | | - | - | - | 1,394 | - | - | - |
| Tuesday | 2 | | 133 | 113 | 0 | 246 | 1,640 | 184,436 | 379,726 | | - | - | - | - | 246 | - | - |
| Wednesday | 3 | | 115 | 163 | 1 | 279 | 1,919 | 184,715 | 380,005 | | - | - | - | - | - | 279 | - |
| Thursday | 4 | | 88 | 96 | 2 | 186 | 2,105 | 184,901 | 380,191 | | - | - | - | - | - | - | 186 |
| Friday | 5 | | 96 | 98 | 0 | 194 | 2,299 | 185,095 | 380,385 | | 194 | - | - | - | - | - | - |
| Saturday | 6 | | 415 | 204 | 1 | 620 | 2,919 | 185,715 | 381,005 | | - | 620 | - | - | - | - | - |
| Sunday | 7 | | 490 | 330 | 11 | 831 | 3,750 | 186,546 | 381,836 | | - | - | 831 | - | - | - | - |
| Monday | 8 | | 100 | 143 | 3 | 246 | 3,996 | 186,792 | 382,082 | | - | - | - | 246 | - | - | - |
| Tuesday | 9 | | 129 | 103 | 0 | 232 | 4,228 | 187,024 | 382,314 | | - | - | - | - | 232 | - | - |
| Wednesday | 10 | | 96 | 112 | 3 | 211 | 4,439 | 187,235 | 382,525 | | - | - | - | - | - | 211 | - |
| Thursday | 11 | | 108 | 132 | 0 | 240 | 4,679 | 187,475 | 382,765 | | - | - | - | - | - | - | 240 |
| Friday | 12 | | 108 | 157 | 5 | 270 | 4,949 | 187,745 | 383,035 | | 270 | - | - | - | - | - | - |
| Saturday | 13 | | 735 | 412 | 4 | 1151 | 6,100 | 188,896 | 384,186 | | - | 1,151 | - | - | - | - | - |
| Sunday | 14 | | 565 | 342 | 4 | 911 | 7,011 | 189,807 | 385,097 | | - | - | 911 | - | - | - | - |
| Monday | 15 | | 94 | 91 | 0 | 185 | 7,196 | 189,992 | 385,282 | | - | - | - | 185 | - | - | - |
| Tuesday | 16 | | 99 | 122 | 0 | 221 | 7,417 | 190,213 | 385,503 | | - | - | - | - | 221 | - | - |
| Wednesday | 17 | | 84 | 87 | 2 | 173 | 7,590 | 190,386 | 385,676 | | - | - | - | - | - | 173 | - |
| Thursday | 18 | | 113 | 151 | 0 | 264 | 7,854 | 190,650 | 385,940 | | - | - | - | - | - | - | 264 |
| Friday | 19 | | 160 | 160 | 1 | 321 | 8,175 | 190,971 | 386,261 | | 321 | - | - | - | - | - | - |
| Saturday | 20 | | 575 | 380 | 2 | 957 | 9,132 | 191,928 | 387,218 | | - | 957 | - | - | - | - | - |
| Sunday | 21 | | 596 | 435 | 2 | 1033 | 10,165 | 192,961 | 388,251 | | - | - | 1,033 | - | - | - | - |
| Monday | 22 | | 121 | 109 | 0 | 230 | 10,395 | 193,191 | 388,481 | | - | - | - | 230 | - | - | - |
| Tuesday | 23 | | 104 | 119 | 1 | 224 | 10,619 | 193,415 | 388,705 | | - | - | - | - | 224 | - | - |
| Wednesday | 24 | | 97 | 122 | 1 | 220 | 10,839 | 193,635 | 388,925 | | - | - | - | - | - | 220 | - |
| Thursday | 25 | | 100 | 106 | 0 | 206 | 11,045 | 193,841 | 389,131 | | - | - | - | - | - | - | 206 |
| Friday | 26 | | 168 | 203 | 0 | 371 | 11,416 | 194,212 | 389,502 | | 371 | - | - | - | - | - | - |
| Saturday | 27 | | 767 | 413 | 0 | 1180 | 12,596 | 195,392 | 390,682 | | - | 1,180 | - | - | - | - | - |
| Sunday | 28 | | 635 | 429 | 1 | 1065 | 13,661 | 196,457 | 391,747 | | - | - | 1,065 | - | - | - | - |
| Monday | 29 | | 110 | 111 | 0 | 221 | 13,882 | 196,678 | 391,968 | | - | - | - | 221 | - | - | - |
| Tuesday | 30 | | 176 | 133 | 0 | 309 | 14,191 | 196,987 | 392,277 | | - | - | - | - | 309 | - | - |
| **TOTAL** | **30 days** | | **8089** | **6056** | **46** | **14191** | **217601** | **5701481** | **11560193** | **0** | **1156** | **3908** | **3840** | **2276** | **1232** | **883** | **896** |
| Wednesday | 1-Oct | Oct-08 | 86 | 106 | 0 | 192 | 192 | 192 | 392,469 | | - | - | - | - | - | 192 | - |
| Thursday | 2 | | 101 | 125 | 0 | 226 | 418 | 418 | 392,695 | | - | - | - | - | - | - | 226 |
| Friday | 3 | | 141 | 129 | 3 | 273 | 691 | 691 | 392,968 | | 273 | - | - | - | - | - | - |
| Saturday | 4 | | 265 | 156 | 5 | 426 | 1,117 | 1,117 | 393,394 | | - | 426 | - | - | - | - | - |
| Sunday | 5 | | 498 | 410 | 5 | 913 | 2,030 | 2,030 | 394,307 | | - | - | 913 | - | - | - | - |
| Monday | 6 | | 84 | 118 | 1 | 203 | 2,233 | 2,233 | 394,510 | | - | - | - | 203 | - | - | - |
| Tuesday | 7 | | 104 | 110 | 2 | 216 | 2,449 | 2,449 | 394,726 | | - | - | - | - | 216 | - | - |
| Wednesday | 8 | | 102 | 136 | 0 | 238 | 2,687 | 2,687 | 394,964 | | - | - | - | - | - | 238 | - |
| Thursday | 9 | | 96 | 126 | 2 | 224 | 2,911 | 2,911 | 395,188 | | - | - | - | - | - | - | 224 |
| Friday | 10 | | 189 | 236 | 4 | 429 | 3,340 | 3,340 | 395,617 | | 429 | - | - | - | - | - | - |
| Saturday | 11 | | 442 | 400 | 1 | 843 | 4,183 | 4,183 | 396,460 | | - | 843 | - | - | - | - | - |
| Sunday | 12 | | 467 | 356 | 1 | 824 | 5,007 | 5,007 | 397,284 | | - | - | 824 | - | - | - | - |
| Monday | 13 | | 260 | 314 | 1 | 575 | 5,582 | 5,582 | 397,859 | | - | - | - | 575 | - | - | - |
| Tuesday | 14 | | 151 | 114 | 0 | 265 | 5,847 | 5,847 | 398,124 | | - | - | - | - | 265 | - | - |
| Wednesday | 15 | | 84 | 100 | 0 | 184 | 6,031 | 6,031 | 398,308 | | - | - | - | - | - | 184 | - |
| Thursday | 16 | | 87 | 111 | 2 | 200 | 6,231 | 6,231 | 398,508 | | - | - | - | - | - | - | 200 |
| Friday | 17 | | 178 | 185 | 4 | 367 | 6,598 | 6,598 | 398,875 | | 367 | - | - | - | - | - | - |
| Saturday | 18 | | 534 | 340 | 2 | 876 | 7,474 | 7,474 | 399,751 | | - | 876 | - | - | - | - | - |
| Sunday | 19 | | 464 | 340 | 2 | 806 | 8,280 | 8,280 | 400,557 | | - | - | 806 | - | - | - | - |
| Monday | 20 | | 107 | 102 | 1 | 210 | 8,490 | 8,490 | 400,767 | | - | - | - | 210 | - | - | - |
| Tuesday | 21 | | 103 | 121 | 1 | 225 | 8,715 | 8,715 | 400,992 | | - | - | - | - | 225 | - | - |
| Wednesday | 22 | | 115 | 125 | 1 | 241 | 8,956 | 8,956 | 401,233 | | - | - | - | - | - | 241 | - |
| Thursday | 23 | | 88 | 125 | 0 | 213 | 9,169 | 9,169 | 401,446 | | - | - | - | - | - | - | 213 |
| Friday | 24 | | 200 | 142 | 0 | 342 | 9,511 | 9,511 | 401,788 | | 342 | - | - | - | - | - | - |
| Saturday | 25 | | 829 | 722 | 6 | 1557 | 11,068 | 11,068 | 403,345 | | - | 1,557 | - | - | - | - | - |
| Sunday | 26 | | 894 | 925 | 5 | 1824 | 12,892 | 12,892 | 405,169 | | - | - | 1,824 | - | - | - | - |
| Monday | 27 | | 91 | 80 | 1 | 172 | 13,064 | 13,064 | 405,341 | | - | - | - | 172 | - | - | - |
| Tuesday | 28 | | 71 | 94 | 0 | 165 | 13,229 | 13,229 | 405,506 | | - | - | - | - | 165 | - | - |
| Wednesday | 29 | | 89 | 104 | 0 | 193 | 13,422 | 13,422 | 405,699 | | - | - | - | - | - | 193 | - |
| Thursday | 30 | | 110 | 97 | 0 | 207 | 13,629 | 13,629 | 405,906 | | - | - | - | - | - | - | 207 |
| Friday | 31 | | 2 | 6 | 0 | 8 | 13,637 | 13,637 | 405,914 | | 8 | - | - | - | - | - | - |
| **TOTAL** | **31 days** | | **7032** | **6555** | **50** | **13637** | **209083** | **209083** | **12369682.4** | **0** | **1419** | **3702** | **4367** | **1160** | **871** | **1048** | **1070** |
| Saturday | 1 | Nov-08 | 0 | 0 | 0 | 0 | - | 13,637 | 405,914 | | - | - | - | - | - | - | - |
| Sunday | 2 | | 178 | 201 | 2 | 381 | 381 | 14,018 | 406,295 | | - | - | 381 | - | - | - | - |
| Monday | 3 | | 0 | 0 | 0 | 0 | 381 | 14,018 | 406,295 | | - | - | - | - | - | - | - |
| Tuesday | 4 | | 47 | 84 | 0 | 131 | 512 | 14,149 | 406,426 | | - | - | - | - | 131 | - | - |
| Wednesday | 5 | | 59 | 98 | 0 | 157 | 669 | 14,306 | 406,583 | | - | - | - | - | - | 157 | - |
| Thursday | 6 | | 90 | 162 | 10 | 262 | 931 | 14,568 | 406,845 | | - | - | - | - | - | - | 262 |
| Friday | 7 | | 150 | 188 | 2 | 340 | 1,271 | 14,908 | 407,185 | | 340 | - | - | - | - | - | - |
| Saturday | 8 | | 291 | 233 | 4 | 528 | 1,799 | 15,436 | 407,713 | | - | 528 | - | - | - | - | - |
| Sunday | 9 | | 468 | 432 | 0 | 900 | 2,699 | 16,336 | 408,613 | | - | - | 900 | - | - | - | - |
| Monday | 10 | | 242 | 281 | 19 | 542 | 3,241 | 16,878 | 409,155 | | - | - | - | 542 | - | - | - |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tuesday | | 11 | | 517 | 544 | 1 | 1062 | 4,303 | 17,940 | 410,217 | | - | - | - | - | 1,062 | - | - |
| Wednesday | | 12 | | 61 | 111 | 1 | 173 | 4,476 | 18,113 | 410,390 | | - | - | - | - | - | 173 | - |
| Thursday | | 13 | | 79 | 141 | 0 | 220 | 4,696 | 18,333 | 410,610 | | - | - | - | - | - | - | 220 |
| Friday | | 14 | | 210 | 228 | 1 | 439 | 5,135 | 18,772 | 411,049 | | 439 | - | - | - | - | - | - |
| Saturday | | 15 | | 762 | 531 | 7 | 1300 | 6,435 | 20,072 | 412,349 | | - | 1,300 | - | - | - | - | - |
| Sunday | | 16 | | 647 | 549 | 2 | 1198 | 7,633 | 21,270 | 413,547 | | - | - | 1,198 | - | - | - | - |
| Monday | | 17 | | 111 | 120 | 1 | 232 | 7,865 | 21,502 | 413,779 | | - | - | - | 232 | - | - | - |
| Tuesday | | 18 | | 88 | 137 | 0 | 225 | 8,090 | 21,727 | 414,004 | | - | - | - | - | 225 | - | - |
| Wednesday | | 19 | | 69 | 104 | 0 | 173 | 8,263 | 21,900 | 414,177 | | - | - | - | - | - | 173 | - |
| Thursday | | 20 | | 69 | 86 | 1 | 156 | 8,419 | 22,056 | 414,333 | | - | - | - | - | - | - | 156 |
| Friday | | 21 | | 112 | 146 | 5 | 263 | 8,682 | 22,319 | 414,596 | | 263 | - | - | - | - | - | - |
| Saturday | | 22 | | 563 | 387 | 6 | 956 | 9,638 | 23,275 | 415,552 | | - | 956 | - | - | - | - | - |
| Sunday | | 23 | | 604 | 481 | 16 | 1101 | 10,739 | 24,376 | 416,653 | | - | - | 1,101 | - | - | - | - |
| Monday | | 24 | | 226 | 226 | 0 | 452 | 11,191 | 24,828 | 417,105 | | - | - | - | 452 | - | - | - |
| Tuesday | | 25 | | 119 | 153 | 1 | 273 | 11,464 | 25,101 | 417,378 | | - | - | - | - | 273 | - | - |
| Wednesday | | 26 | | 18 | 11 | 0 | 29 | 11,493 | 25,130 | 417,407 | | - | - | - | - | - | 29 | - |
| Thursday | | 27 | | 0 | 0 | 0 | 0 | 11,493 | 25,130 | 417,407 | | - | - | - | - | - | - | - |
| Friday | | 28 | | 418 | 340 | 4 | 762 | 12,255 | 25,892 | 418,169 | | 762 | - | - | - | - | - | - |
| Saturday | | 29 | | 668 | 430 | 1 | 1099 | 13,354 | 26,991 | 419,268 | | - | 1,099 | - | - | - | - | - |
| Sunday | | 30 | | 420 | 344 | 2 | 766 | 14,120 | 27,757 | 420,034 | | - | - | 766 | - | - | - | - |
| **TOTAL** | **30 days** | | | **7286** | **6748** | **86** | **14120** | **191628** | **600738** | **12369060** | **0** | **1804** | **3883** | **4346** | **1226** | **1691** | **532** | **638** |
| Monday | | 1 | Dec-08 | 33 | 60 | 0 | 93 | 93 | 27,850 | 420,127 | | - | - | - | 93 | - | - | - |
| Tuesday | | 2 | | 48 | 66 | 1 | 115 | 208 | 27,965 | 420,242 | | - | - | - | - | 115 | - | - |
| Wednesday | | 3 | | 60 | 69 | 0 | 129 | 337 | 28,094 | 420,371 | | - | - | - | - | - | 129 | - |
| Thursday | | 4 | | 57 | 91 | 1 | 149 | 486 | 28,243 | 420,520 | | - | - | - | - | - | - | 149 |
| Friday | | 5 | | 83 | 99 | 0 | 182 | 668 | 28,425 | 420,702 | | 182 | - | - | - | - | - | - |
| Saturday | | 6 | | 313 | 208 | 1 | 522 | 1,190 | 28,947 | 421,224 | | - | 522 | - | - | - | - | - |
| Sunday | | 7 | | 223 | 249 | 1 | 473 | 1,663 | 29,420 | 421,697 | | - | - | 473 | - | - | - | - |
| Monday | | 8 | | 39 | 36 | 1 | 76 | 1,739 | 29,496 | 421,773 | | - | - | - | 76 | - | - | - |
| Tuesday | | 9 | | 65 | 82 | 1 | 148 | 1,887 | 29,644 | 421,921 | | - | - | - | - | 148 | - | - |
| Wednesday | | 10 | | 42 | 62 | 1 | 105 | 1,992 | 29,749 | 422,026 | | - | - | - | - | - | 105 | - |
| Thursday | | 11 | | 52 | 87 | 1 | 140 | 2,132 | 29,889 | 422,166 | | - | - | - | - | - | - | 140 |
| Friday | | 12 | | 68 | 100 | 3 | 171 | 2,303 | 30,060 | 422,337 | | 171 | - | - | - | - | - | - |
| Saturday | | 13 | | 177 | 207 | 0 | 384 | 2,687 | 30,444 | 422,721 | | - | 384 | - | - | - | - | - |
| Sunday | | 14 | | 12 | 20 | 0 | 32 | 2,719 | 30,476 | 422,753 | | - | - | 32 | - | - | - | - |
| Monday | | 15 | | 0 | 0 | 0 | 0 | 2,719 | 30,476 | 422,753 | | - | - | - | - | - | - | - |
| Tuesday | | 16 | | 0 | 0 | 0 | 0 | 2,719 | 30,476 | 422,753 | | - | - | - | - | - | - | - |
| Wednesday | | 17 | | 25 | 42 | 0 | 67 | 2,786 | 30,543 | 422,820 | | - | - | - | - | - | 67 | - |
| Thursday | | 18 | | 31 | 27 | 0 | 58 | 2,844 | 30,601 | 422,878 | | - | - | - | - | - | - | 58 |
| Friday | | 19 | | 11 | 13 | 1 | 25 | 2,869 | 30,626 | 422,903 | | 25 | - | - | - | - | - | - |
| Saturday | | 20 | | 180 | 222 | 0 | 402 | 3,271 | 31,028 | 423,305 | | - | 402 | - | - | - | - | - |
| Sunday | | 21 | | 9 | 29 | 0 | 38 | 3,309 | 31,066 | 423,343 | | - | - | 38 | - | - | - | - |
| Monday | | 22 | | 92 | 157 | 1 | 250 | 3,559 | 31,316 | 423,593 | | - | - | - | 250 | - | - | - |
| Tuesday | | 23 | | 86 | 122 | 0 | 208 | 3,767 | 31,524 | 423,801 | | - | - | - | - | 208 | - | - |
| Wednesday | | 24 | | 11 | 13 | 0 | 24 | 3,791 | 31,548 | 423,825 | | - | - | - | - | - | 24 | - |
| Thursday | | 25 | | 0 | 0 | 0 | 0 | 3,791 | 31,548 | 423,825 | | - | - | - | - | - | - | - |
| Friday | | 26 | | 331 | 262 | 0 | 593 | 4,384 | 32,141 | 424,418 | | 593 | - | - | - | - | - | - |
| Saturday | | 27 | | 436 | 288 | 5 | 729 | 5,113 | 32,870 | 425,147 | | - | 729 | - | - | - | - | - |
| Sunday | | 28 | | 424 | 295 | 1 | 720 | 5,833 | 33,590 | 425,867 | | - | - | 720 | - | - | - | - |
| Monday | | 29 | | 432 | 333 | 0 | 765 | 6,598 | 34,355 | 426,632 | | - | - | - | 765 | - | - | - |
| Tuesday | | 30 | | 494 | 395 | 1 | 890 | 7,488 | 35,245 | 427,522 | | - | - | - | - | 890 | - | - |
| Wednesday | | 31 | | 284 | 265 | 0 | 549 | 8,037 | 35,794 | 428,071 | | - | - | - | - | - | 549 | - |
| **TOTAL** | **31 days** | | | **4118** | **3899** | **20** | **8037** | **92982** | **953449** | **13114048.4** | **0** | **971** | **2037** | **1263** | **1184** | **1361** | **874** | **347** |
| Thursday | | 1 | Jan-09 | 372 | 218 | 3 | 593 | 593 | 36,387 | 428,664 | | - | - | - | - | - | - | 593 |
| Friday | | 2 | | 0 | 0 | 0 | 0 | 593 | 36,387 | 428,664 | | - | - | - | - | - | - | - |
| Saturday | | 3 | | 680 | 403 | 3 | 1086 | 1,679 | 37,473 | 429,750 | | - | 1,086 | - | - | - | - | - |
| Sunday | | 4 | | 393 | 303 | 2 | 698 | 2,377 | 38,171 | 430,448 | | - | - | 698 | - | - | - | - |
| Monday | | 5 | | 0 | 0 | 0 | 0 | 2,377 | 38,171 | 430,448 | | - | - | - | - | - | - | - |
| Tuesday | | 6 | | 56 | 68 | 0 | 124 | 2,501 | 38,295 | 430,572 | | - | - | - | - | 124 | - | - |
| Wednesday | | 7 | | 56 | 91 | 0 | 147 | 2,648 | 38,442 | 430,719 | | - | - | - | - | - | 147 | - |
| Thursday | | 8 | | 28 | 76 | 0 | 104 | 2,752 | 38,546 | 430,823 | | - | - | - | - | - | - | 104 |
| Friday | | 9 | | 106 | 143 | 0 | 249 | 3,001 | 38,795 | 431,072 | | 249 | - | - | - | - | - | - |
| Saturday | | 10 | | 528 | 465 | 2 | 995 | 3,996 | 39,790 | 432,067 | | - | 995 | - | - | - | - | - |
| Sunday | | 11 | | 588 | 538 | 1 | 1127 | 5,123 | 40,917 | 433,194 | | - | - | 1,127 | - | - | - | - |
| Monday | | 12 | | 103 | 124 | 0 | 227 | 5,350 | 41,144 | 433,421 | | - | - | - | 227 | - | - | - |
| Tuesday | | 13 | | 122 | 176 | 16 | 314 | 5,664 | 41,458 | 433,735 | | - | - | - | - | 314 | - | - |
| Wednesday | | 14 | | 112 | 198 | 0 | 310 | 5,974 | 41,768 | 434,045 | | - | - | - | - | - | 310 | - |
| Thursday | | 15 | | 114 | 180 | 1 | 295 | 6,269 | 42,063 | 434,340 | | - | - | - | - | - | - | 295 |
| Friday | | 16 | | 153 | 199 | 0 | 352 | 6,621 | 42,415 | 434,692 | | 352 | - | - | - | - | - | - |
| Saturday | | 17 | | 803 | 490 | 3 | 1296 | 7,917 | 43,711 | 435,988 | | - | 1,296 | - | - | - | - | - |
| Sunday | | 18 | | 911 | 506 | 0 | 1417 | 9,334 | 45,128 | 437,405 | | - | - | 1,417 | - | - | - | - |
| Monday | | 19 | | 782 | 424 | 4 | 1210 | 10,544 | 46,338 | 438,615 | | - | - | - | 1,210 | - | - | - |
| Tuesday | | 20 | | 74 | 73 | 0 | 147 | 10,691 | 46,485 | 438,762 | | - | - | - | - | 147 | - | - |
| Wednesday | | 21 | | 30 | 46 | 1 | 77 | 10,768 | 46,562 | 438,839 | | - | - | - | - | - | 77 | - |
| Thursday | | 22 | | 0 | 0 | 0 | 0 | 10,768 | 46,562 | 438,839 | | - | - | - | - | - | - | - |
| Friday | | 23 | | 0 | 0 | 0 | 0 | 10,768 | 46,562 | 438,839 | | - | - | - | - | - | - | - |
| Saturday | | 24 | | 136 | 101 | 8 | 245 | 11,013 | 46,807 | 439,084 | | - | 245 | - | - | - | - | - |
| Sunday | | 25 | | 239 | 281 | 1 | 521 | 11,534 | 47,328 | 439,605 | | - | - | 521 | - | - | - | - |
| Monday | | 26 | | 138 | 194 | 1 | 333 | 11,867 | 47,661 | 439,938 | | - | - | - | 333 | - | - | - |
| Tuesday | | 27 | | 108 | 94 | 0 | 202 | 12,069 | 47,863 | 440,140 | | - | - | - | - | 202 | - | - |
| Wednesday | | 28 | | 85 | 118 | 0 | 203 | 12,272 | 48,066 | 440,343 | | - | - | - | - | - | 203 | - |
| Thursday | | 29 | | 88 | 162 | 0 | 250 | 12,522 | 48,316 | 440,593 | | - | - | - | - | - | - | 250 |
| Friday | | 30 | | 128 | 196 | 1 | 325 | 12,847 | 48,641 | 440,918 | | 325 | - | - | - | - | - | - |
| Saturday | | 31 | | 699 | 520 | 1 | 1220 | 14,067 | 49,861 | 442,138 | | - | 1,220 | - | - | - | - | - |
| **TOTAL** | **31 days** | | | **7632** | **6387** | **48** | **14067** | **226499** | **1336113** | **13496712.4** | **0** | **926** | **4842** | **3763** | **1770** | **787** | **737** | **1242** |
| Sunday | | 1 | Feb-09 | 467 | 368 | 0 | 835 | 835 | 50,696 | 442,973 | | - | - | 835 | - | - | - | - |
| Monday | | 2 | | 115 | 151 | 0 | 266 | 1,101 | 50,962 | 443,239 | | - | - | - | 266 | - | - | - |
| Tuesday | | 3 | | 84 | 135 | 1 | 220 | 1,321 | 51,182 | 443,459 | | - | - | - | - | 220 | - | - |
| Wednesday | | 4 | | 97 | 145 | 0 | 242 | 1,563 | 51,424 | 443,701 | | - | - | - | - | - | 242 | - |
| Thursday | | 5 | | 3 | 10 | 0 | 13 | 1,576 | 51,437 | 443,714 | | - | - | - | - | - | - | 13 |
| Friday | | 6 | | 0 | 0 | 0 | 0 | 1,576 | 51,437 | 443,714 | | - | - | - | - | - | - | - |
| Saturday | | 7 | | 399 | 295 | 0 | 694 | 2,270 | 52,131 | 444,408 | | - | 694 | - | - | - | - | - |
| Sunday | | 8 | | 158 | 123 | 1 | 282 | 2,552 | 52,413 | 444,690 | | - | - | 282 | - | - | - | - |
| Monday | | 9 | | 78 | 109 | 3 | 190 | 2,742 | 52,603 | 444,880 | | - | - | - | 190 | - | - | - |
| Tuesday | | 10 | | 78 | 86 | 2 | 166 | 2,908 | 52,769 | 445,046 | | - | - | - | - | 166 | - | - |
| Wednesday | | 11 | | 5 | 10 | 0 | 15 | 2,923 | 52,784 | 445,061 | | - | - | - | - | - | 15 | - |
| Thursday | | 12 | | 36 | 80 | 0 | 116 | 3,039 | 52,900 | 445,177 | | - | - | - | - | - | - | 116 |
| Friday | | 13 | | 27 | 57 | 0 | 84 | 3,123 | 52,984 | 445,261 | | 84 | - | - | - | - | - | - |
| Saturday | | 14 | | 221 | 172 | 4 | 397 | 3,520 | 53,381 | 445,658 | | - | 397 | - | - | - | - | - |
| Sunday | | 15 | | 0 | 0 | 0 | 0 | 3,520 | 53,381 | 445,658 | | - | - | - | - | - | - | - |
| Monday | | 16 | | 0 | 0 | 0 | 0 | 3,520 | 53,381 | 445,658 | | - | - | - | - | - | - | - |
| Tuesday | | 17 | | 1 | 2 | 0 | 3 | 3,523 | 53,384 | 445,661 | | - | - | - | - | 3 | - | - |
| Wednesday | | 18 | | 143 | 207 | 4 | 354 | 3,877 | 53,738 | 446,015 | | - | - | - | - | - | 354 | - |
| Thursday | | 19 | | 0 | 0 | 0 | 0 | 3,877 | 53,738 | 446,015 | | - | - | - | - | - | - | - |
| Friday | | 20 | | 0 | 0 | 0 | 0 | 3,877 | 53,738 | 446,015 | | - | - | - | - | - | - | - |
| Saturday | | 21 | | 165 | 195 | 1 | 361 | 4,238 | 54,099 | 446,376 | | - | 361 | - | - | - | - | - |
| Sunday | | 22 | | 0 | 0 | 0 | 0 | 4,238 | 54,099 | 446,376 | | - | - | - | - | - | - | - |
| Monday | | 23 | | 0 | 0 | 0 | 0 | 4,238 | 54,099 | 446,376 | | - | - | - | - | - | - | - |
| Tuesday | | 24 | | 95 | 167 | 3 | 265 | 4,503 | 54,364 | 446,641 | | - | - | - | - | 265 | - | - |
| Wednesday | | 25 | | 51 | 66 | 1 | 118 | 4,621 | 54,482 | 446,759 | | - | - | - | - | - | 118 | - |
| Thursday | | 26 | | 45 | 59 | 1 | 105 | 4,726 | 54,587 | 446,864 | | - | - | - | - | - | - | 105 |
| Friday | | 27 | | 0 | 0 | 0 | 0 | 4,726 | 54,587 | 446,864 | | - | - | - | - | - | - | - |
| Saturday | | 28 | | 471 | 433 | 5 | 909 | 909 | 55,496 | 447,773 | | - | 909 | - | - | - | - | - |
| **TOTAL** | **28 days** | | | **2739** | **2870** | **26** | **5635** | **85442** | **1486276** | **12470043.2** | **0** | **84** | **2361** | **1117** | **456** | **654** | **729** | **234** |
| Sunday | | 1 | Mar-09 | 2 | 4 | 0 | 6 | 915 | 55,502 | 447,779 | | - | - | 6 | - | - | - | - |
| Monday | | 2 | | 0 | 0 | 0 | 0 | 915 | 55,502 | 447,779 | | - | - | - | - | - | - | - |
| Tuesday | | 3 | | 0 | 0 | 0 | 0 | 915 | 55,502 | 447,779 | | - | - | - | - | - | - | - |
| Wednesday | | 4 | | 16 | 19 | 0 | 35 | 950 | 55,537 | 447,814 | | - | - | - | - | - | 35 | - |
| Thursday | | 5 | | 49 | 64 | 1 | 114 | 1,064 | 55,651 | 447,928 | | - | - | - | - | - | - | 114 |

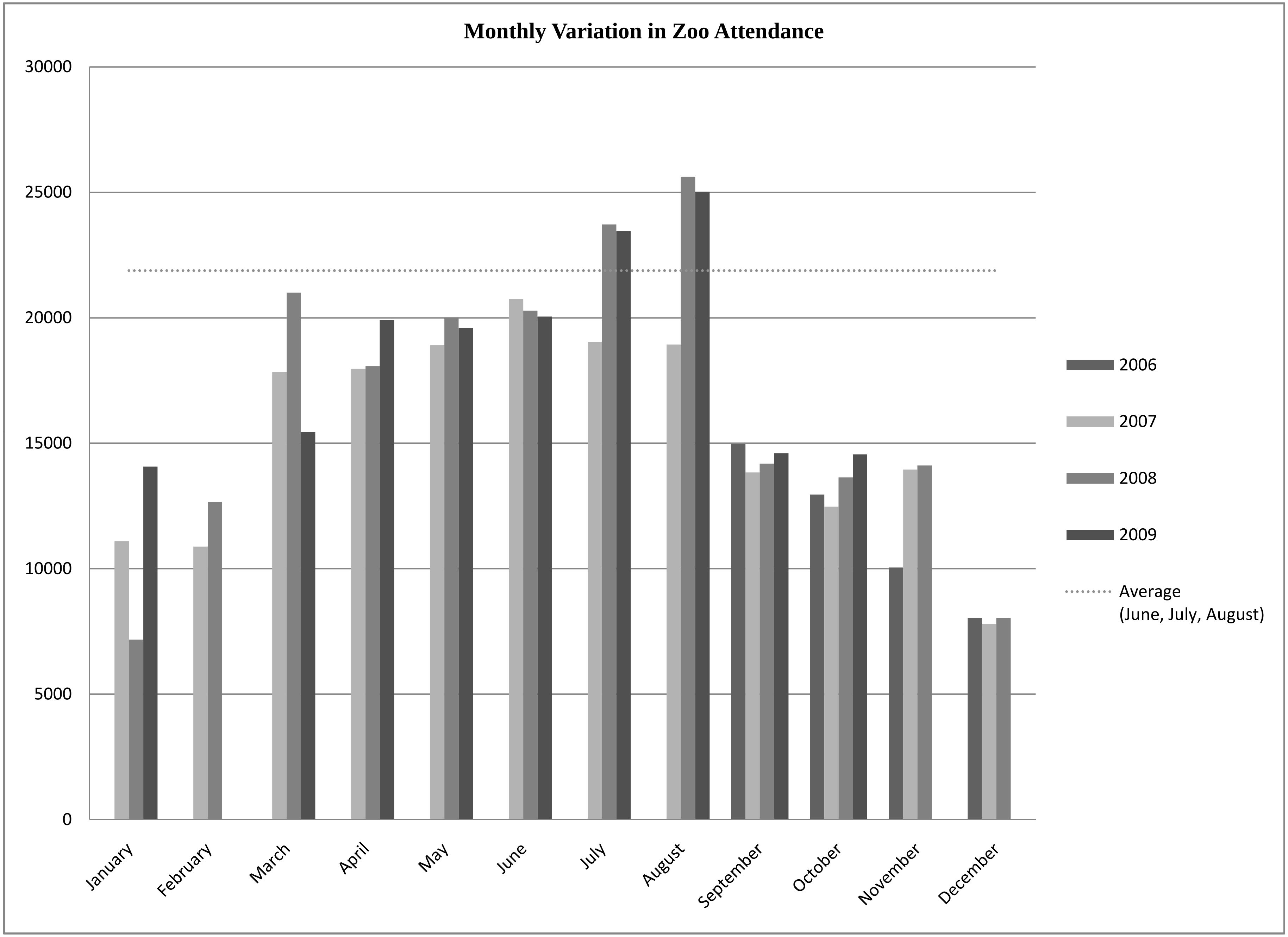
| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Friday | | 6 | | 220 | 201 | 1 | 422 | 1,486 | 56,073 | 448,350 | | 422 | - | - | - | - | - | - |
| Saturday | | 7 | | 735 | 584 | 2 | 1321 | 2,807 | 57,394 | 449,671 | | - | 1,321 | - | - | - | - | - |
| Sunday | | 8 | | 659 | 490 | 2 | 1151 | 3,958 | 58,545 | 450,822 | | - | - | 1,151 | - | - | - | - |
| Monday | | 9 | | 147 | 180 | 2 | 329 | 4,287 | 58,874 | 451,151 | | - | - | - | 329 | - | - | - |
| Tuesday | | 10 | | 125 | 168 | 0 | 293 | 4,580 | 59,167 | 451,444 | | - | - | - | - | 293 | - | - |
| Wednesday | | 11 | | 135 | 144 | 0 | 279 | 4,859 | 59,446 | 451,723 | | - | - | - | - | - | 279 | - |
| Thursday | | 12 | | 167 | 205 | 0 | 372 | 5,231 | 59,818 | 452,095 | | - | - | - | - | - | - | 372 |
| Friday | | 13 | | 182 | 252 | 1 | 435 | 5,666 | 60,253 | 452,530 | | 435 | - | - | - | - | - | - |
| Saturday | | 14 | | 627 | 397 | 3 | 1027 | 6,693 | 61,280 | 453,557 | | - | 1,027 | - | - | - | - | - |
| Sunday | | 15 | | 206 | 125 | 1 | 332 | 7,025 | 61,612 | 453,889 | | - | - | 332 | - | - | - | - |
| Monday | | 16 | | 60 | 36 | 2 | 98 | 7,123 | 61,710 | 453,987 | | - | - | - | 98 | - | - | - |
| Tuesday | | 17 | | 160 | 131 | 4 | 295 | 7,418 | 62,005 | 454,282 | | - | - | - | - | 295 | - | - |
| Wednesday | | 18 | | 178 | 177 | 3 | 358 | 7,776 | 62,363 | 454,640 | | - | - | - | - | - | 358 | - |
| Thursday | | 19 | | 224 | 202 | 27 | 453 | 8,229 | 62,816 | 455,093 | | - | - | - | - | - | - | 453 |
| Friday | | 20 | | 272 | 234 | 2 | 508 | 8,737 | 63,324 | 455,601 | | 508 | - | - | - | - | - | - |
| Saturday | | 21 | | 423 | 322 | 1 | 746 | 9,483 | 64,070 | 456,347 | | - | 746 | - | - | - | - | - |
| Sunday | | 22 | | 388 | 298 | 4 | 690 | 10,173 | 64,760 | 457,037 | | - | - | 690 | - | - | - | - |
| Monday | | 23 | | 185 | 150 | 3 | 338 | 10,511 | 65,098 | 457,375 | | - | - | - | 338 | - | - | - |
| Tuesday | | 24 | | 228 | 167 | 0 | 395 | 10,906 | 65,493 | 457,770 | | - | - | - | - | 395 | - | - |
| Wednesday | | 25 | | 212 | 9 | 5 | 226 | 11,132 | 65,719 | 457,996 | | - | - | - | - | - | 226 | - |
| Thursday | | 26 | | 314 | 113 | 5 | 432 | 11,564 | 66,151 | 458,428 | | - | - | - | - | - | - | 432 |
| Friday | | 27 | | 354 | 301 | 2 | 657 | 12,221 | 66,808 | 459,085 | | 657 | - | - | - | - | - | - |
| Saturday | | 28 | | 992 | 646 | 1 | 1639 | 13,860 | 68,447 | 460,724 | | - | 1,639 | - | - | - | - | - |
| Sunday | | 29 | | 896 | 571 | 36 | 1503 | 15,363 | 69,950 | 462,227 | | - | - | 1,503 | - | - | - | - |
| Monday | | 30 | | 300 | 294 | 0 | 594 | 15,957 | 70,544 | 462,821 | | - | - | - | 594 | - | - | - |
| Tuesday | | 31 | | 194 | 203 | 2 | 399 | 16,356 | 70,943 | 463,220 | | - | - | - | - | 399 | - | - |
| **TOTAL** | **31 days** | | | **8650** | **6687** | **110** | **15447** | **228160** | **1920357** | **14080956.4** | **0** | **2022** | **4733** | **3682** | **1359** | **1382** | **898** | **1371** |
| Wednesday | | 1 | Apr-09 | 254 | 215 | 0 | 469 | 469 | 71,412 | 463,689 | | - | - | - | - | - | 469 | - |
| Thursday | | 2 | | 229 | 203 | 2 | 434 | 903 | 71,846 | 464,123 | | - | - | - | - | - | - | 434 |
| Friday | | 3 | | 258 | 203 | 5 | 466 | 1,369 | 72,312 | 464,589 | | 466 | - | - | - | - | - | - |
| Saturday | | 4 | | 830 | 498 | 26 | 1354 | 2,723 | 73,666 | 465,943 | | - | 1,354 | - | - | - | - | - |
| Sunday | | 5 | | 832 | 440 | 1 | 1273 | 3,996 | 74,939 | 467,216 | | - | - | 1,273 | - | - | - | - |
| Monday | | 6 | | 388 | 301 | 1 | 690 | 4,686 | 75,629 | 467,906 | | - | - | - | 690 | - | - | - |
| Tuesday | | 7 | | 13 | 8 | 2 | 23 | 4,709 | 75,652 | 467,929 | | - | - | - | - | 23 | - | - |
| Wednesday | | 8 | | 146 | 60 | 2 | 208 | 4,917 | 75,860 | 468,137 | | - | - | - | - | - | 208 | - |
| Thursday | | 9 | | 59 | 36 | 6 | 101 | 5,018 | 75,961 | 468,238 | | - | - | - | - | - | - | 101 |
| Friday | | 10 | | 316 | 196 | 1 | 513 | 5,531 | 76,474 | 468,751 | | 513 | - | - | - | - | - | - |
| Saturday | | 11 | | 641 | 300 | 4 | 945 | 6,476 | 77,419 | 469,696 | | - | 945 | - | - | - | - | - |
| Sunday | | 12 | | 561 | 303 | 3 | 867 | 7,343 | 78,286 | 470,563 | | - | - | 867 | - | - | - | - |
| Monday | | 13 | | 571 | 393 | 6 | 970 | 8,313 | 79,256 | 471,533 | | - | - | - | 970 | - | - | - |
| Tuesday | | 14 | | 486 | 366 | 4 | 856 | 9,169 | 80,112 | 472,389 | | - | - | - | - | 856 | - | - |
| Wednesday | | 15 | | 483 | 317 | 6 | 806 | 9,975 | 80,918 | 473,195 | | - | - | - | - | - | 806 | - |
| Thursday | | 16 | | 747 | 362 | 2 | 1111 | 11,086 | 82,029 | 474,306 | | - | - | - | - | - | - | 1,111 |
| Friday | | 17 | | 442 | 612 | 9 | 1063 | 12,149 | 83,092 | 475,369 | | 1,063 | - | - | - | - | - | - |
| Saturday | | 18 | | 984 | 509 | 2 | 1495 | 13,644 | 84,587 | 476,864 | | - | 1,495 | - | - | - | - | - |
| Sunday | | 19 | | 930 | 519 | 1 | 1450 | 15,094 | 86,037 | 478,314 | | - | - | 1,450 | - | - | - | - |
| Monday | | 20 | | 140 | 77 | 3 | 220 | 15,314 | 86,257 | 478,534 | | - | - | - | 220 | - | - | - |
| Tuesday | | 21 | | 113 | 91 | 2 | 206 | 15,520 | 86,463 | 478,740 | | - | - | - | - | 206 | - | - |
| Wednesday | | 22 | | 191 | 156 | 0 | 347 | 15,867 | 86,810 | 479,087 | | - | - | - | - | - | 347 | - |
| Thursday | | 23 | | 171 | 143 | 3 | 317 | 16,184 | 87,127 | 479,404 | | - | - | - | - | - | - | 317 |
| Friday | | 24 | | 224 | 163 | 0 | 387 | 16,571 | 87,514 | 479,791 | | 387 | - | - | - | - | - | - |
| Saturday | | 25 | | 659 | 347 | 12 | 1018 | 17,589 | 88,532 | 480,809 | | - | 1,018 | - | - | - | - | - |
| Sunday | | 26 | | 691 | 433 | 1 | 1125 | 18,714 | 89,657 | 481,934 | | - | - | 1,125 | - | - | - | - |
| Monday | | 27 | | 126 | 101 | 0 | 227 | 18,941 | 89,884 | 482,161 | | - | - | - | 227 | - | - | - |
| Tuesday | | 28 | | 131 | 116 | 0 | 247 | 19,188 | 90,131 | 482,408 | | - | - | - | - | 247 | - | - |
| Wednesday | | 29 | | 164 | 139 | 0 | 303 | 19,491 | 90,434 | 482,711 | | - | - | - | - | - | 303 | - |
| Thursday | | 30 | | 249 | 161 | 4 | 414 | 19,905 | 90,848 | 483,125 | | - | - | - | - | - | - | 414 |
| **TOTAL** | **30 days** | | | **12029** | **7768** | **108** | **19905** | **320854** | **2449144** | **14217466** | **0** | **2429** | **4812** | **4715** | **2107** | **1332** | **2133** | **2377** |
| Friday | | 1 | May-09 | 93 | 46 | 1 | 140 | 140 | 90,988 | 483,265 | | 140 | - | - | - | - | - | - |
| Saturday | | 2 | | 47 | 35 | 0 | 82 | 222 | 91,070 | 483,347 | | - | 82 | - | - | - | - | - |
| Sunday | | 3 | | 183 | 87 | 13 | 283 | 505 | 91,353 | 483,630 | | - | - | 283 | - | - | - | - |
| Monday | | 4 | | 149 | 91 | 0 | 240 | 745 | 91,593 | 483,870 | | - | - | - | 240 | - | - | - |
| Tuesday | | 5 | | 62 | 31 | 6 | 99 | 844 | 91,692 | 483,969 | | - | - | - | - | 99 | - | - |
| Wednesday | | 6 | | 181 | 134 | 0 | 315 | 1,159 | 92,007 | 484,284 | | - | - | - | - | - | 315 | - |
| Thursday | | 7 | | 223 | 148 | 1 | 372 | 1,531 | 92,379 | 484,656 | | - | - | - | - | - | - | 372 |
| Friday | | 8 | | 341 | 229 | 2 | 572 | 2,103 | 92,951 | 485,228 | | 572 | - | - | - | - | - | - |
| Saturday | | 9 | | 782 | 405 | 2 | 1189 | 3,292 | 94,140 | 486,417 | | - | 1,189 | - | - | - | - | - |
| Sunday | | 10 | | 830 | 347 | 2 | 1179 | 4,471 | 95,319 | 487,596 | | - | - | 1,179 | - | - | - | - |
| Monday | | 11 | | 240 | 131 | 3 | 374 | 4,845 | 95,693 | 487,970 | | - | - | - | 374 | - | - | - |
| Tuesday | | 12 | | 237 | 174 | 5 | 416 | 5,261 | 96,109 | 488,386 | | - | - | - | - | 416 | - | - |
| Wednesday | | 13 | | 228 | 191 | 4 | 423 | 5,684 | 96,532 | 488,809 | | - | - | - | - | - | 423 | - |
| Thursday | | 14 | | 279 | 206 | 6 | 491 | 6,175 | 97,023 | 489,300 | | - | - | - | - | - | - | 491 |
| Friday | | 15 | | 251 | 191 | 1 | 443 | 6,618 | 97,466 | 489,743 | | 443 | - | - | - | - | - | - |
| Saturday | | 16 | | 733 | 438 | 5 | 1176 | 7,794 | 98,642 | 490,919 | | - | 1,176 | - | - | - | - | - |
| Sunday | | 17 | | 457 | 224 | 11 | 692 | 8,486 | 99,334 | 491,611 | | - | - | 692 | - | - | - | - |
| Monday | | 18 | | 217 | 181 | 2 | 400 | 8,886 | 99,734 | 492,011 | | - | - | - | 400 | - | - | - |
| Tuesday | | 19 | | 262 | 167 | 3 | 432 | 9,318 | 100,166 | 492,443 | | - | - | - | - | 432 | - | - |
| Wednesday | | 20 | | 291 | 192 | 0 | 483 | 9,801 | 100,649 | 492,926 | | - | - | - | - | - | 483 | - |
| Thursday | | 21 | | 304 | 192 | 0 | 496 | 10,297 | 101,145 | 493,422 | | - | - | - | - | - | - | 496 |
| Friday | | 22 | | 378 | 236 | 7 | 621 | 10,918 | 101,766 | 494,043 | | 621 | - | - | - | - | - | - |
| Saturday | | 23 | | 1048 | 535 | 5 | 1588 | 12,506 | 103,354 | 495,631 | | - | 1,588 | - | - | - | - | - |
| Sunday | | 24 | | 1023 | 428 | 0 | 1451 | 13,957 | 104,805 | 497,082 | | - | - | 1,451 | - | - | - | - |
| Monday | | 25 | | 1013 | 525 | 67 | 1605 | 15,562 | 106,410 | 498,687 | | - | - | - | 1,605 | - | - | - |
| Tuesday | | 26 | | 239 | 140 | 0 | 379 | 15,941 | 106,789 | 499,066 | | - | - | - | - | 379 | - | - |
| Wednesday | | 27 | | 273 | 157 | 1 | 431 | 16,372 | 107,220 | 499,497 | | - | - | - | - | - | 431 | - |
| Thursday | | 28 | | 227 | 165 | 3 | 395 | 16,767 | 107,615 | 499,892 | | - | - | - | - | - | - | 395 |
| Friday | | 29 | | 382 | 245 | 1 | 628 | 17,395 | 108,243 | 500,520 | | 628 | - | - | - | - | - | - |
| Saturday | | 30 | | 674 | 413 | 1 | 1088 | 18,483 | 109,331 | 501,608 | | - | 1,088 | - | - | - | - | - |
| Sunday | | 31 | | 650 | 462 | 6 | 1118 | 19,601 | 110,449 | 502,726 | | - | - | 1,118 | - | - | - | - |
| **TOTAL** | **31 days** | | | **12297** | **7146** | **158** | **19601** | **255679** | **3071967** | **15232566.4** | **0** | **2404** | **5123** | **4723** | **2619** | **1326** | **1652** | **1754** |
| Monday | | 1 | Jun-09 | 158 | 108 | 1 | 267 | 267 | 110,716 | 502,993 | | - | - | - | 267 | - | - | - |
| Tuesday | | 2 | | 262 | 148 | 1 | 411 | 678 | 111,127 | 503,404 | | - | - | - | - | 411 | - | - |
| Wednesday | | 3 | | 279 | 158 | 1 | 438 | 1,116 | 111,565 | 503,842 | | - | - | - | - | - | 438 | - |
| Thursday | | 4 | | 267 | 152 | 1 | 420 | 1,536 | 111,985 | 504,262 | | - | - | - | - | - | - | 420 |
| Friday | | 5 | | 300 | 238 | 0 | 538 | 2,074 | 112,523 | 504,800 | | 538 | - | - | - | - | - | - |
| Saturday | | 6 | | 653 | 457 | 13 | 1123 | 3,197 | 113,646 | 505,923 | | - | 1,123 | - | - | - | - | - |
| Sunday | | 7 | | 715 | 478 | 3 | 1196 | 4,393 | 114,842 | 507,119 | | - | - | 1,196 | - | - | - | - |
| Monday | | 8 | | 285 | 190 | 4 | 479 | 4,872 | 115,321 | 507,598 | | - | - | - | 479 | - | - | - |
| Tuesday | | 9 | | 292 | 198 | 0 | 490 | 5,362 | 115,811 | 508,088 | | - | - | - | - | 490 | - | - |
| Wednesday | | 10 | | 325 | 185 | 4 | 514 | 5,876 | 116,325 | 508,602 | | - | - | - | - | - | 514 | - |
| Thursday | | 11 | | 266 | 202 | 6 | 474 | 6,350 | 116,799 | 509,076 | | - | - | - | - | - | - | 474 |
| Friday | | 12 | | 413 | 279 | 4 | 696 | 7,046 | 117,495 | 509,772 | | 696 | - | - | - | - | - | - |
| Saturday | | 13 | | 749 | 456 | 7 | 1212 | 8,258 | 118,707 | 510,984 | | - | 1,212 | - | - | - | - | - |
| Sunday | | 14 | | 834 | 534 | 3 | 1371 | 9,629 | 120,078 | 512,355 | | - | - | 1,371 | - | - | - | - |
| Monday | | 15 | | 301 | 262 | 4 | 567 | 10,196 | 120,645 | 512,922 | | - | - | - | 567 | - | - | - |
| Tuesday | | 16 | | 312 | 308 | 3 | 623 | 10,819 | 121,268 | 513,545 | | - | - | - | - | 623 | - | - |
| Wednesday | | 17 | | 357 | 269 | 3 | 629 | 11,448 | 121,897 | 514,174 | | - | - | - | - | - | 629 | - |
| Thursday | | 18 | | 393 | 343 | 2 | 738 | 12,186 | 122,635 | 514,912 | | - | - | - | - | - | - | 738 |
| Friday | | 19 | | 469 | 344 | 2 | 815 | 13,001 | 123,450 | 515,727 | | 815 | - | - | - | - | - | - |
| Saturday | | 20 | | 702 | 411 | 2 | 1115 | 14,116 | 124,565 | 516,842 | | - | 1,115 | - | - | - | - | - |
| Sunday | | 21 | | 784 | 411 | 6 | 1201 | 15,317 | 125,766 | 518,043 | | - | - | 1,201 | - | - | - | - |
| Monday | | 22 | | 293 | 239 | 3 | 535 | 15,852 | 126,301 | 518,578 | | - | - | - | 535 | - | - | - |
| Tuesday | | 23 | | 324 | 235 | 3 | 562 | 16,414 | 126,863 | 519,140 | | - | - | - | - | 562 | - | - |
| Wednesday | | 24 | | 296 | 229 | 0 | 525 | 16,939 | 127,388 | 519,665 | | - | - | - | - | - | 525 | - |
| Thursday | | 25 | | 323 | 269 | 4 | 596 | 17,535 | 127,984 | 520,261 | | - | - | - | - | - | - | 596 |
| Friday | | 26 | | 442 | 354 | 6 | 802 | 18,337 | 128,786 | 521,063 | | 802 | - | - | - | - | - | - |
| Saturday | | 27 | | 0 | 0 | 0 | 0 | 18,337 | 128,786 | 521,063 | | - | - | - | - | - | - | - |
| Sunday | | 28 | | 443 | 266 | 4 | 713 | 19,050 | 129,499 | 521,776 | | - | - | 713 | - | - | - | - |
| Monday | | 29 | | 219 | 211 | 2 | 432 | 19,482 | 129,931 | 522,208 | | - | - | - | 432 | - | - | - |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tuesday | 30 | | | 301 | 259 | 5 | 565 | 20,047 | 130,496 | 522,773 | | - | - | - | - | 565 | - | - |
| **TOTAL** | | **30 days** | | **11757** | **8193** | **97** | **20047** | **309730** | **3623200** | **15391522** | **0** | **2851** | **3450** | **4481** | **2280** | **2651** | **2106** | **2228** |
| Wednesday | 1 | | Jul-09 | 334 | 259 | 4 | 597 | 597 | 131,093 | 523,370 | | - | - | - | - | - | 597 | - |
| Thursday | 2 | | | 317 | 228 | 2 | 547 | 1,144 | 131,640 | 523,917 | | - | - | - | - | - | - | 547 |
| Friday | 3 | | | 899 | 585 | 2 | 1486 | 2,630 | 133,126 | 525,403 | | 1,486 | - | - | - | - | - | - |
| Saturday | 4 | | | 569 | 267 | 2 | 838 | 3,468 | 133,964 | 526,241 | | - | 838 | - | - | - | - | - |
| Sunday | 5 | | | 468 | 280 | 1 | 749 | 4,217 | 134,713 | 526,990 | | - | - | 749 | - | - | - | - |
| Monday | 6 | | | 368 | 240 | 0 | 608 | 4,825 | 135,321 | 527,598 | | - | - | - | 608 | - | - | - |
| Tuesday | 7 | | | 284 | 243 | 30 | 557 | 5,382 | 135,878 | 528,155 | | - | - | - | - | 557 | - | - |
| Wednesday | 8 | | | 322 | 243 | 2 | 567 | 5,949 | 136,445 | 528,722 | | - | - | - | - | - | 567 | - |
| Thursday | 9 | | | 319 | 234 | 18 | 571 | 6,520 | 137,016 | 529,293 | | - | - | - | - | - | - | 571 |
| Friday | 10 | | | 435 | 302 | 7 | 744 | 7,264 | 137,760 | 530,037 | | 744 | - | - | - | - | - | - |
| Saturday | 11 | | | 748 | 557 | 7 | 1312 | 8,576 | 139,072 | 531,349 | | - | 1,312 | - | - | - | - | - |
| Sunday | 12 | | | 746 | 506 | 6 | 1258 | 9,834 | 140,330 | 532,607 | | - | - | 1,258 | - | - | - | - |
| Monday | 13 | | | 269 | 215 | 8 | 492 | 10,326 | 140,822 | 533,099 | | - | - | - | 492 | - | - | - |
| Tuesday | 14 | | | 245 | 140 | 11 | 396 | 10,722 | 141,218 | 533,495 | | - | - | - | - | 396 | - | - |
| Wednesday | 15 | | | 232 | 230 | 0 | 462 | 11,184 | 141,680 | 533,957 | | - | - | - | - | - | 462 | - |
| Thursday | 16 | | | 257 | 212 | 11 | 480 | 11,664 | 142,160 | 534,437 | | - | - | - | - | - | - | 480 |
| Friday | 17 | | | 399 | 240 | 6 | 645 | 12,309 | 142,805 | 535,082 | | 645 | - | - | - | - | - | - |
| Saturday | 18 | | | 816 | 420 | 17 | 1253 | 13,562 | 144,058 | 536,335 | | - | 1,253 | - | - | - | - | - |
| Sunday | 19 | | | 672 | 523 | 11 | 1206 | 14,768 | 145,264 | 537,541 | | - | - | 1,206 | - | - | - | - |
| Monday | 20 | | | 283 | 226 | 4 | 513 | 15,281 | 145,777 | 538,054 | | - | - | - | 513 | - | - | - |
| Tuesday | 21 | | | 321 | 224 | 1 | 546 | 15,827 | 146,323 | 538,600 | | - | - | - | - | 546 | - | - |
| Wednesday | 22 | | | 300 | 253 | 2 | 555 | 16,382 | 146,878 | 539,155 | | - | - | - | - | - | 555 | - |
| Thursday | 23 | | | 361 | 274 | 1 | 636 | 17,018 | 147,514 | 539,791 | | - | - | - | - | - | - | 636 |
| Friday | 24 | | | 452 | 304 | 4 | 760 | 17,778 | 148,274 | 540,551 | | 760 | - | - | - | - | - | - |
| Saturday | 25 | | | 861 | 509 | 3 | 1373 | 19,151 | 149,647 | 541,924 | | - | 1,373 | - | - | - | - | - |
| Sunday | 26 | | | 748 | 493 | 2 | 1243 | 20,394 | 150,890 | 543,167 | | - | - | 1,243 | - | - | - | - |
| Monday | 27 | | | 293 | 226 | 6 | 525 | 20,919 | 151,415 | 543,692 | | - | - | - | 525 | - | - | - |
| Tuesday | 28 | | | 321 | 285 | 3 | 609 | 21,528 | 152,024 | 544,301 | | - | - | - | - | 609 | - | - |
| Wednesday | 29 | | | 312 | 246 | 9 | 567 | 22,095 | 152,591 | 544,868 | | - | - | - | - | - | 567 | - |
| Thursday | 30 | | | 335 | 286 | 2 | 623 | 22,718 | 153,214 | 545,491 | | - | - | - | - | - | - | 623 |
| Friday | 31 | | | 414 | 319 | 1 | 734 | 23,452 | 153,948 | 546,225 | | 734 | - | - | - | - | - | - |
| **TOTAL** | | **31 days** | | **13700** | **9569** | **183** | **23452** | **377484** | **4422860** | **16583459.4** | **0** | **4369** | **4776** | **4456** | **2138** | **2108** | **2748** | **2857** |
| Saturday | 1 | | Aug-09 | 886 | 444 | 4 | 1334 | 1,334 | 155,282 | 547,559 | | - | 1,334 | - | - | - | - | - |
| Sunday | 2 | | | 754 | 407 | 5 | 1166 | 2,500 | 156,448 | 548,725 | | - | - | 1,166 | - | - | - | - |
| Monday | 3 | | | 336 | 273 | 5 | 614 | 3,114 | 157,062 | 549,339 | | - | - | - | 614 | - | - | - |
| Tuesday | 4 | | | 349 | 276 | 6 | 631 | 3,745 | 157,693 | 549,970 | | - | - | - | - | 631 | - | - |
| Wednesday | 5 | | | 367 | 278 | 1 | 646 | 4,391 | 158,339 | 550,616 | | - | - | - | - | - | 646 | - |
| Thursday | 6 | | | 344 | 289 | 8 | 641 | 5,032 | 158,980 | 551,257 | | - | - | - | - | - | - | 641 |
| Friday | 7 | | | 440 | 329 | 6 | 775 | 5,807 | 159,755 | 552,032 | | 775 | - | - | - | - | - | - |
| Saturday | 8 | | | 860 | 492 | 7 | 1359 | 7,166 | 161,114 | 553,391 | | - | 1,359 | - | - | - | - | - |
| Sunday | 9 | | | 678 | 425 | 2 | 1105 | 8,271 | 162,219 | 554,496 | | - | - | 1,105 | - | - | - | - |
| Monday | 10 | | | 268 | 172 | 9 | 449 | 8,720 | 162,668 | 554,945 | | - | - | - | 449 | - | - | - |
| Tuesday | 11 | | | 303 | 273 | 3 | 579 | 9,299 | 163,247 | 555,524 | | - | - | - | - | 579 | - | - |
| Wednesday | 12 | | | 333 | 266 | 6 | 605 | 9,904 | 163,852 | 556,129 | | - | - | - | - | - | 605 | - |
| Thursday | 13 | | | 373 | 254 | 7 | 634 | 10,538 | 164,486 | 556,763 | | - | - | - | - | - | - | 634 |
| Friday | 14 | | | 417 | 284 | 6 | 707 | 11,245 | 165,193 | 557,470 | | 707 | - | - | - | - | - | - |
| Saturday | 15 | | | 759 | 373 | 7 | 1139 | 12,384 | 166,332 | 558,609 | | - | 1,139 | - | - | - | - | - |
| Sunday | 16 | | | 705 | 491 | 4 | 1200 | 13,584 | 167,532 | 559,809 | | - | - | 1,200 | - | - | - | - |
| Monday | 17 | | | 336 | 279 | 2 | 617 | 14,201 | 168,149 | 560,426 | | - | - | - | 617 | - | - | - |
| Tuesday | 18 | | | 339 | 272 | 4 | 615 | 14,816 | 168,764 | 561,041 | | - | - | - | - | 615 | - | - |
| Wednesday | 19 | | | 347 | 277 | 4 | 628 | 15,444 | 169,392 | 561,669 | | - | - | - | - | - | 628 | - |
| Thursday | 20 | | | 336 | 275 | 3 | 614 | 16,058 | 170,006 | 562,283 | | - | - | - | - | - | - | 614 |
| Friday | 21 | | | 408 | 317 | 3 | 728 | 16,786 | 170,734 | 563,011 | | 728 | - | - | - | - | - | - |
| Saturday | 22 | | | 758 | 534 | 1 | 1293 | 18,079 | 172,027 | 564,304 | | - | 1,293 | - | - | - | - | - |
| Sunday | 23 | | | 668 | 553 | 0 | 1221 | 19,300 | 173,248 | 565,525 | | - | - | 1,221 | - | - | - | - |
| Monday | 24 | | | 363 | 329 | 1 | 693 | 19,993 | 173,941 | 566,218 | | - | - | - | 693 | - | - | - |
| Tuesday | 25 | | | 271 | 308 | 3 | 582 | 20,575 | 174,523 | 566,800 | | - | - | - | - | 582 | - | - |
| Wednesday | 26 | | | 262 | 262 | 1 | 525 | 21,100 | 175,048 | 567,325 | | - | - | - | - | - | 525 | - |
| Thursday | 27 | | | 266 | 277 | 1 | 544 | 21,644 | 175,592 | 567,869 | | - | - | - | - | - | - | 544 |
| Friday | 28 | | | 245 | 293 | 1 | 539 | 22,183 | 176,131 | 568,408 | | 539 | - | - | - | - | - | - |
| Saturday | 29 | | | 558 | 414 | 1 | 973 | 23,156 | 177,104 | 569,381 | | - | 973 | - | - | - | - | - |
| Sunday | 30 | | | 637 | 808 | 2 | 1447 | 24,603 | 178,551 | 570,828 | | - | - | 1,447 | - | - | - | - |
| Monday | 31 | | | 199 | 220 | 2 | 421 | 25,024 | 178,972 | 571,249 | | - | - | - | 421 | - | - | - |
| **TOTAL** | | **31 days** | | **14165** | **10744** | **115** | **25024** | **409996** | **5182384** | **17342983.4** | **0** | **2749** | **6098** | **6139** | **2794** | **2407** | **2404** | **2433** |
| Tuesday | 1 | | Sep-09 | 157 | 206 | 0 | 363 | 363 | 179,335 | 571,612 | | - | - | - | - | 363 | - | - |
| Wednesday | 2 | | | 134 | 137 | 0 | 271 | 634 | 179,606 | 571,883 | | - | - | - | - | - | 271 | - |
| Thursday | 3 | | | 121 | 109 | 0 | 230 | 864 | 179,836 | 572,113 | | - | - | - | - | - | - | 230 |
| Friday | 4 | | | 234 | 200 | 0 | 434 | 1,298 | 180,270 | 572,547 | | 434 | - | - | - | - | - | - |
| Saturday | 5 | | | 973 | 405 | 1 | 1379 | 2,677 | 181,649 | 573,926 | | - | 1,379 | - | - | - | - | - |
| Sunday | 6 | | | 1074 | 489 | 5 | 1568 | 4,245 | 183,217 | 575,494 | | - | - | 1,568 | - | - | - | - |
| Monday | 7 | | | 893 | 615 | 0 | 1508 | 5,753 | 184,725 | 577,002 | | - | - | - | 1,508 | - | - | - |
| Tuesday | 8 | | | 116 | 110 | 1 | 227 | 5,980 | 184,952 | 577,229 | | - | - | - | - | 227 | - | - |
| Wednesday | 9 | | | 103 | 113 | 0 | 216 | 6,196 | 185,168 | 577,445 | | - | - | - | - | - | 216 | - |
| Thursday | 10 | | | 91 | 119 | 0 | 210 | 6,406 | 185,378 | 577,655 | | - | - | - | - | - | - | 210 |
| Friday | 11 | | | 157 | 144 | 0 | 301 | 6,707 | 185,679 | 577,956 | | 301 | - | - | - | - | - | - |
| Saturday | 12 | | | 280 | 341 | 1 | 622 | 7,329 | 186,301 | 578,578 | | - | 622 | - | - | - | - | - |
| Sunday | 13 | | | 511 | 438 | 2 | 951 | 8,280 | 187,252 | 579,529 | | - | - | 951 | - | - | - | - |
| Monday | 14 | | | 76 | 115 | 0 | 191 | 8,471 | 187,443 | 579,720 | | - | - | - | 191 | - | - | - |
| Tuesday | 15 | | | 113 | 119 | 2 | 234 | 8,705 | 187,677 | 579,954 | | - | - | - | - | 234 | - | - |
| Wednesday | 16 | | | 111 | 110 | 1 | 222 | 8,927 | 187,899 | 580,176 | | - | - | - | - | - | 222 | - |
| Thursday | 17 | | | 114 | 105 | 3 | 222 | 9,149 | 188,121 | 580,398 | | - | - | - | - | - | - | 222 |
| Friday | 18 | | | 150 | 159 | 0 | 309 | 9,458 | 188,430 | 580,707 | | 309 | - | - | - | - | - | - |
| Saturday | 19 | | | 550 | 326 | 2 | 878 | 10,336 | 189,308 | 581,585 | | - | 878 | - | - | - | - | - |
| Sunday | 20 | | | 482 | 333 | 3 | 818 | 11,154 | 190,126 | 582,403 | | - | - | 818 | - | - | - | - |
| Monday | 21 | | | 82 | 120 | 2 | 204 | 11,358 | 190,330 | 582,607 | | - | - | - | 204 | - | - | - |
| Tuesday | 22 | | | 80 | 84 | 0 | 164 | 11,522 | 190,494 | 582,771 | | - | - | - | - | 164 | - | - |
| Wednesday | 23 | | | 92 | 97 | 1 | 190 | 11,712 | 190,684 | 582,961 | | - | - | - | - | - | 190 | - |
| Thursday | 24 | | | 110 | 100 | 4 | 214 | 11,926 | 190,898 | 583,175 | | - | - | - | - | - | - | 214 |
| Friday | 25 | | | 177 | 180 | 0 | 357 | 12,283 | 191,255 | 583,532 | | 357 | - | - | - | - | - | - |
| Saturday | 26 | | | 530 | 326 | 8 | 864 | 13,147 | 192,119 | 584,396 | | - | 864 | - | - | - | - | - |
| Sunday | 27 | | | 499 | 291 | 9 | 799 | 13,946 | 192,918 | 585,195 | | - | - | 799 | - | - | - | - |
| Monday | 28 | | | 147 | 118 | 1 | 266 | 14,212 | 193,184 | 585,461 | | - | - | - | 266 | - | - | - |
| Tuesday | 29 | | | 96 | 101 | 0 | 197 | 14,409 | 193,381 | 585,658 | | - | - | - | - | 197 | - | - |
| Wednesday | 30 | | | 84 | 103 | | 187 | 14,596 | 193,568 | 585,845 | | - | - | - | - | - | 187 | - |
| **TOTAL** | | **30 days** | | **8337** | **6213** | **46** | **14596** | **252043** | **5621203** | **17389525** | **0** | **1401** | **3743** | **4136** | **2169** | **1185** | **1086** | **876** |
| Thursday | 1 | | Oct-09 | 120 | 126 | 1 | 247 | 247 | 247 | 586,092 | | - | - | - | - | - | - | 247 |
| Friday | 2 | | | 200 | 218 | 0 | 418 | 665 | 665 | 586,510 | | 418 | - | - | - | - | - | - |
| Saturday | 3 | | | 594 | 435 | 2 | 1031 | 1,696 | 1,696 | 587,541 | | - | 1,031 | - | - | - | - | - |
| Sunday | 4 | | | 516 | 408 | 2 | 926 | 2,622 | 2,622 | 588,467 | | - | - | 926 | - | - | - | - |
| Monday | 5 | | | 118 | 132 | 0 | 250 | 2,872 | 2,872 | 588,717 | | - | - | - | 250 | - | - | - |
| Tuesday | 6 | | | 117 | 115 | 6 | 238 | 3,110 | 3,110 | 588,955 | | - | - | - | - | 238 | - | - |
| Wednesday | 7 | | | 136 | 114 | 0 | 250 | 3,360 | 3,360 | 589,205 | | - | - | - | - | - | 250 | - |
| Thursday | 8 | | | 122 | 95 | 1 | 218 | 3,578 | 3,578 | 589,423 | | - | - | - | - | - | - | 218 |
| Friday | 9 | | | 265 | 199 | 0 | 464 | 4,042 | 4,042 | 589,887 | | 464 | - | - | - | - | - | - |
| Saturday | 10 | | | 485 | 313 | 81 | 879 | 4,921 | 4,921 | 590,766 | | - | 879 | - | - | - | - | - |
| Sunday | 11 | | | 427 | 296 | 3 | 726 | 5,647 | 5,647 | 591,492 | | - | - | 726 | - | - | - | - |
| Monday | 12 | | | 202 | 271 | 1 | 474 | 6,121 | 6,121 | 591,966 | | - | - | - | 474 | - | - | - |
| Tuesday | 13 | | | 0 | 0 | 0 | 0 | 6,121 | 6,121 | 591,966 | | - | - | - | - | - | - | - |
| Wednesday | 14 | | | 21 | 28 | 0 | 49 | 6,170 | 6,170 | 592,015 | | - | - | - | - | - | 49 | - |
| Thursday | 15 | | | 68 | 94 | 0 | 162 | 6,332 | 6,332 | 592,177 | | - | - | - | - | - | - | 162 |
| Friday | 16 | | | 214 | 196 | 0 | 410 | 6,742 | 6,742 | 592,587 | | 410 | - | - | - | - | - | - |
| Saturday | 17 | | | 481 | 324 | 4 | 809 | 7,551 | 7,551 | 593,396 | | - | 809 | - | - | - | - | - |
| Sunday | 18 | | | 434 | 313 | 0 | 747 | 8,298 | 8,298 | 594,143 | | - | - | 747 | - | - | - | - |
| Monday | 19 | | | 15 | 15 | 1 | 31 | 8,329 | 8,329 | 594,174 | | - | - | - | 31 | - | - | - |
| Tuesday | 20 | | | 92 | 108 | 0 | 200 | 8,529 | 8,529 | 594,374 | | - | - | - | - | 200 | - | - |
| Wednesday | 21 | | | 74 | 102 | 11 | 187 | 8,716 | 8,716 | 594,561 | | - | - | - | - | - | 187 | - |
| Thursday | 22 | | | 88 | 96 | 1 | 185 | 8,901 | 8,901 | 594,746 | | - | - | - | - | - | - | 185 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Friday | | 23 | 199 | 250 | 4 | 453 | 9,354 | 9,354 | 595,199 | | 453 | - | - | - | - | - | - | |
| Saturday | | 24 | 764 | 652 | 39 | 1455 | 10,809 | 10,809 | 596,654 | | - | 1,455 | - | - | - | - | - | |
| Sunday | | 25 | 806 | 568 | 1 | 1375 | 12,184 | 12,184 | 598,029 | | - | - | 1,375 | - | - | - | - | |
| Monday | | 26 | 117 | 126 | 0 | 243 | 12,427 | 12,427 | 598,272 | | - | - | - | 243 | - | - | - | |
| Tuesday | | 27 | 70 | 88 | | 158 | 12,585 | 12,585 | 598,430 | | - | - | - | - | 158 | - | - | |
| Wednesday | | 28 | 67 | 120 | 1 | 188 | 12,773 | 12,773 | 598,618 | | - | - | - | - | - | 188 | - | |
| Thursday | | 29 | 147 | 109 | 2 | 258 | 13,031 | 13,031 | 598,876 | | - | - | - | - | - | - | 258 | |
| Friday | | 30 | 170 | 134 | 0 | 304 | 13,335 | 13,335 | 599,180 | | 304 | - | - | - | - | - | - | |
| Saturday | | 31 | 662 | 554 | 3 | 1219 | 14,554 | 14,554 | 600,399 | | - | 1,219 | - | - | - | - | - | |
| Sunday | | | | | | | | | | Total | 127,994 | 171,776 | 111,630 | 59,694 | 54,451 | 55,157 | 68,428 | 649,130 |
| **TOTAL** | **31 days** | | **7791** | **6599** | **164** | **14554** | **225622** | **225622** | **18386829.4** | Count | 165 | 165 | 164 | 163 | 164 | 164 | 165 | 1,150 |

# Appendix X-6

## Seasonal Variation and Attendance Growth Adjustment Factors


Monthly Variation in Zoo Attendance
30000
25000
20000
15000
10000
5000
0
January
February
March
April
May
June
July
August
September
October
November
December
2006
2007
2008
2009
Average
(June, July, August)

**2006 - 2009 MONTHLY VEHICLE ATTENDANCE VOLUMES**

| | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|
| **January** | | 11102 | 7176 | 14067 |
| **February** | | 10883 | 12660 | |
| **March** | | 17841 | 21002 | 15447 |
| **April** | | 17964 | 18079 | 19905 |
| **May** | | 18907 | 20016 | 19601 |
| **June** | | 20747 | 20288 | 20047 |
| **July** | | 19043 | 23723 | 23452 |
| **August** | | 18940 | 25627 | 25024 |
| **September** | 14981 | 13838 | 14191 | 14596 |
| **October** | 12956 | 12472 | 13637 | 14554 |
| **November** | 10049 | 13958 | 14120 | |
| **December** | 8039 | 7795 | 8037 | |

Source: AECOM, 2010, Oakland Zoo, 2010.

Traffic volumes provided by the Oakland Zoo.

**SEASONAL VARIATION ADJUSTMENT FACTOR**

| Count Date | % Peak Summer | Adjustment Factor | Monthly Volume | |
|---|---|---|---|---|
| | | | Average | Adjusted |
| April, 2009 | 85.2% | 1.17 | 18649 | 21877 |
| January, 2010 | 49.3% | 2.03 | 10782 | 21877 |
| Peak Summer Month | 100.0% | 1.00 | 21877 | 21877 |

Source: AECOM, 2010, Oakland Zoo, 2010.

Peak summer month volume is an average of June, July, and August traffic. Traffic volumes provided by the Oakland Zoo.

**ATTENDANCE ADJUSTMENT FACTORS**

**2009 (Weekday) Counts**

| Scenario | Annual Attendance | | Adjustment Factor | |
|---|---|---|---|---|
| | Baseline | Project | Baseline | Project |
| Existing | 670,700 | 779,300 | | 1.162 |
| 2015 | 600,000 | 750,000 | 0.895 | 1.118 |
| 2035 | 600,000 | 700,000 | 0.895 | 1.044 |

**2010 (Weekend) Counts**

| Scenario | Annual Attendance | | Adjustment Factor | |
|---|---|---|---|---|
| | Baseline | Project | Baseline | Project |
| Existing | 629,300 | 779,300 | | 1.238 |
| 2015 | 600,000 | 750,000 | 0.953 | 1.192 |
| 2035 | 600,000 | 700,000 | 0.953 | 1.112 |

## ITE TRIP GENERATION

| Description | ITE LU Code | Amount | Units | AM Peak Hour Equation | AM Peak Hour In | AM Peak Hour Out | PM Peak Hour Equation | PM Peak Hour In | PM Peak Hour Out |
|---|---|---|---|---|---|---|---|---|---|
| Overnight Camping Area | 416 | 33 | camp sites | 0.2 | 42% | 58% | 0.37 | 69% | 31% |
| Veterinary Medical Hospital | | 1 | employee | | 1 | 0 | | 0 | 1 |

## CALIFORNIA! EXHIBIT TRIP GENERATION
### Existing and Year 2015 Conditions - 150,000 trips

| | AM Peak Hour | | | PM Peak Hour | | | Weekend Midday | | |
|---|---|---|---|---|---|---|---|---|---|
| | In | Out | Total | In | Out | Total | In | Out | Total |
| Existing Zoo Trips (from counts) | 43 | 11 | **54** | 11 | 266 | **277** | 141 | 82 | **223** |
| Seasonal Adjustment | 50 | 13 | **63** | 13 | 312 | **325** | 286 | 166 | **452** |
| Project Attendance | 58 | 15 | **73** | 15 | 363 | **378** | 354 | 206 | **560** |
| **Project Volume** | **8** | **3** | **11** | **2** | **51** | **53** | **68** | **40** | **108** |

### Year 2035 Conditions - 100,000 trips

| | AM Peak Hour | | | PM Peak Hour | | | Weekend Midday | | |
|---|---|---|---|---|---|---|---|---|---|
| | In | Out | Total | In | Out | Total | In | Out | Total |
| Existing Zoo Trips (from counts) | 43 | 11 | **54** | 11 | 266 | **277** | 141 | 82 | **223** |
| Seasonal Adjustment | 45 | 12 | **57** | 12 | 279 | **291** | 273 | 159 | **432** |
| Project Attendance | 47 | 13 | **60** | 13 | 291 | **304** | 304 | 177 | **481** |
| **Project Volume** | **5** | **2** | **7** | **1** | **34** | **35** | **45** | **27** | **72** |

## PROJECT TRIP GENERATION
### Existing and Year 2015 conditions

| | | | AM Peak Hour | | | PM Peak Hour | | | Weekend Midday | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Land Use | Amount | Units | In | Out | Total | In | Out | Total | In | Out | Total |
| Veterinary Medical Hospital | 17,123 | SF | 1 | 0 | **1** | 0 | 1 | **1** | 0 | 0 | **0** |
| Overnight Camping Area | 33 | tents | 3 | 4 | **7** | 8 | 4 | **12** | 2 | 2 | **4** |
| California! Exhibit | 18.35 | Acres | 8 | 3 | **11** | 2 | 51 | **53** | 68 | 40 | **108** |
| **TOTAL** | | | **12** | **7** | **19** | **10** | **56** | **66** | **70** | **42** | **112** |

### Year 2035 conditions

| | | | AM Peak Hour | | | PM Peak Hour | | | Weekend Midday | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Land Use | Amount | Units | In | Out | Total | In | Out | Total | In | Out | Total |
| Veterinary Medical Hospital | 17,123 | SF | 1 | 0 | **1** | 0 | 1 | **1** | 0 | 0 | **0** |
| Overnight Camping Area | 33 | tents | 3 | 4 | **7** | 8 | 4 | **12** | 2 | 2 | **4** |
| California! Exhibit | 18.35 | Acres | 5 | 2 | **7** | 1 | 34 | **35** | 45 | 27 | **72** |
| **TOTAL** | | | **9** | **6** | **15** | **9** | **39** | **48** | **47** | **29** | **76** |