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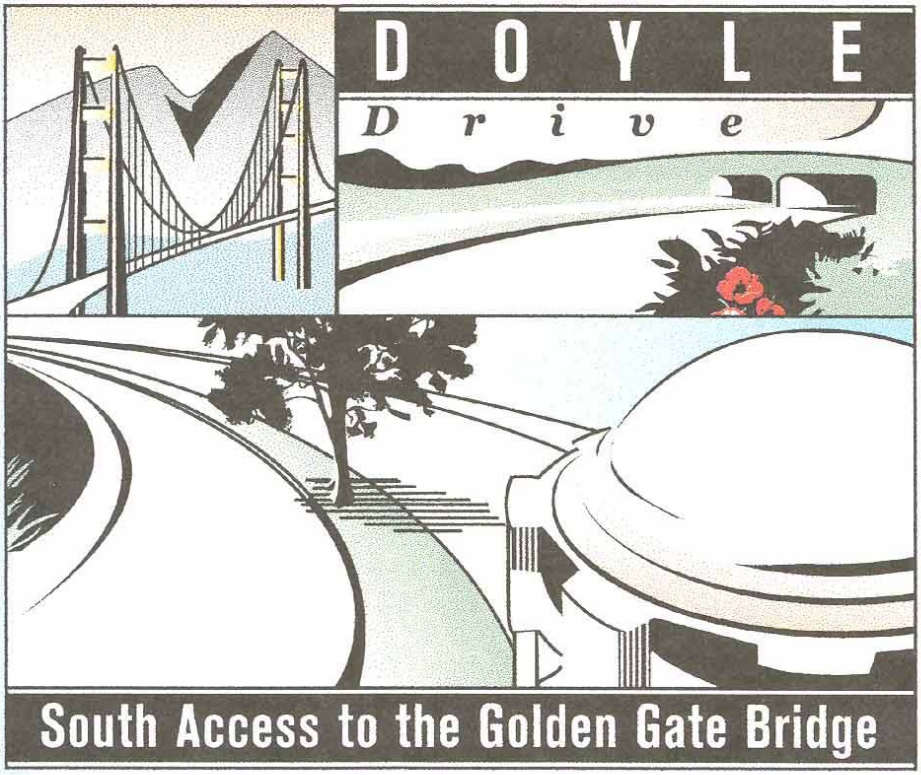

FINAL HYDROLOGY AND WATER RESOURCES TECHNICAL REPORT

OCTOBER 2004

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SECTION 1 METHODOLOGY

This technical study compares potential effects on hydrology and water quality associated with implementation of each of the alternatives for the Doyle Drive project. The main issues addressed in this study include:

- Potential degradation of water quality during and after construction;
- Potential for the project to increase impervious surface area and runoff volume;
- Potential effects associated with flooding;
- Potential effects on aquifer recharge;
- Potential effects on groundwater levels, and the rate and direction of groundwater flow; and
- Potential effects on unique geologic and/or subsurface hydrology resources.

The analysis of hydrology and water quality issues is based on regional studies of hydrology and geology, subsurface investigations at the Presidio associated with hazardous materials releases, and available site-specific geotechnical and drainage system data. A list of specific reports prepared for the Presidio that were considered in this analysis is presented below:

- Presidio of San Francisco, Storm Water Management Plan, October 1994 (Dames and Moore). This plan was prepared to assist the National Park Service (NPS) in planning and managing storm water facilities at the Presidio. The report includes a description of the existing drainage system, summarizes water quality sampling of Presidio runoff, and describes a proposed capital improvement plan to improve the system.
- Wetland and Riparian Corridor Feasibility Study, Presidio of San Francisco, February 1995 (Dames and Moore). This report represents a preliminary step in the implementation process of one of the provisions of the Final General Management Plan Amendment (GMPA) prepared by the NPS. The GMPA established the objective of restoring wetlands and Crissy Field and riparian corridors along the historic Tennessee Hollow drainage. The report includes information on the history and physical setting of Crissy Field and Tennessee Hollow and an analysis of restoration alternatives.
- Basewide Groundwater Monitoring Plan (Draft), Presidio of San Francisco, California, July 1996 (Montgomery Watson). This report provides a description of the physical setting, groundwater conditions, and groundwater quality monitoring results for the Presidio, emphasizing conditions pertinent to ongoing hazardous materials investigations.
- Tennessee Hollow Riparian Restoration Concept and Work Plan, the Presidio, San Francisco, California, July 2000 (Philip Williams and Associates). This report describes the setting, objectives, and a possible restoration concept for the Tennessee Hollow (the concept has not been adopted by the Trust and NPS).
- Draft Preliminary Geotechnical Report, April 2002 (Parsons Brinckerhoff). This report provides a description of geologic site conditions, seismic hazards, and preliminary design considerations of the tunnels and foundations for the Doyle Drive reconstruction process.
- Location Hydraulics Study, December 2001 (Manna Consultants). This report prepared as part of the alternative development process, and inventories, evaluates the characteristics of the storm drainage system along the alignment.
- Doyle Drive Draft Project Report, Advance Planning Studies, Tunnel Structures, May 2002 (MGE Engineering). This report provides preliminary details regarding tunnel design and engineering for the Doyle Drive reconstruction project.
- Draft Doyle Drive Corridor Wetland Delineation, March 2001 (Environmental Science Associates). This report provides information on wetland resources in the vicinity of the alignment.
- Preliminary Site Investigation, January 2002 (Baseline). The investigation provides information on hazardous materials along the alignment alternatives.
- Conceptual Watershed Model and Proposed Surface and Groundwater Monitoring Program for the Tennessee Hollow Riparian Corridor Restoration Project, the Presidio of San Francisco, July 2002 (Kamman Hydrology & Engineering, Inc.). This report provides a conceptual model for the

hydrogeology of the Tennessee Hollow Watershed, and includes technical information on groundwater flow patterns within the watershed.

- Draft Final Hydrologic Monitoring Report for the Tennessee Hollow Riparian Corridor Restoration Project, The Presidio of San Francisco (Kamman Hydrology & Engineering, Inc.), March 2003. This report provides the results of recent surface water and groundwater monitoring.

The analysis is presented in two main sections: Setting (existing conditions) and Impacts and Mitigation Measures. Discussion of contamination of subsurface soils and groundwater resulting from past activities at the site is presented in the Waste and Hazardous Materials Technical Memorandum for the project.

SECTION 2 PROJECT DESCRIPTION

2.1 OVERVIEW

Doyle Drive is located in the Presidio of San Francisco (the Presidio), in the northern part of the City of San Francisco at the southern approach to the Golden Gate Bridge (see Figure 1a). In 1994, when the US Army transferred jurisdiction of the Presidio to the National Park Service (NPS), it became part of the National Park system and Golden Gate National Recreation Area (GGNRA). In 1998, management of the Presidio was divided between two federal agencies: The Presidio Trust (the Trust), the agency responsible for oversight of 80 percent of the Presidio delineated as Area B; and the NPS, which is responsible for management of the coastal portions of the park (the remaining 20 percent) that are delineated as Area A. Doyle Drive lies predominately within the Area B lands managed by the Trust with a small portion at the western end located in Area A on land operated by the Golden Gate Bridge, Highway and Transportation District (GGBHTD). The Presidio has also been designated a National Historic Landmark District (NHLD) since 1962 with the Doyle Drive roadway determined to be a contributing element to that landmark.

Doyle Drive, the southern approach of US 101 to the Golden Gate Bridge, is 2.4 kilometers (1.5 miles) long with six traffic lanes. There are three San Francisco approach ramps which connect to Doyle Drive: one beginning at the intersection of Marina Boulevard and Lyon Street; one at the intersection of Richardson Avenue and Lyon Street; and one where Park Presidio Boulevard (State Route 1) merges into Doyle Drive approximately 1.6 kilometers (one mile) west of the Marina Boulevard approach (see Figure 1a). Doyle Drive passes through the Presidio on an elevated concrete viaduct (low-viaduct) and transitions to a high steel truss viaduct (high-viaduct) as it approaches the Golden Gate Bridge Toll Plaza.

Doyle Drive is nearly 70 years old and it is approaching the end of its useful life, although regular maintenance, seismic retrofit, and partial rehabilitation activities are keeping the structure safe in the short term. However, further structural degradation caused by age and the effects of heavy traffic and exposure to salt air will cause the structures to become seismically and structurally unsafe in the coming years. In addition, the eastern portion of the aging facility is located in a potential liquefaction zone identified on the State of California Seismic Hazard Zones map dated August 2000.

Currently, Doyle Drive has nonstandard design elements, including travel lanes from 2.9 to 3.0 meters (9.5 to 10.0 feet) in width, no fixed median barrier, no shoulders and exit ramps that have tight turning radii. During peak traffic hours, plastic pylons are manually moved to provide a median lane as well as to reverse the direction of traffic flow of several lanes (Project Study Report: Doyle Drive Reconstruction, 1993).

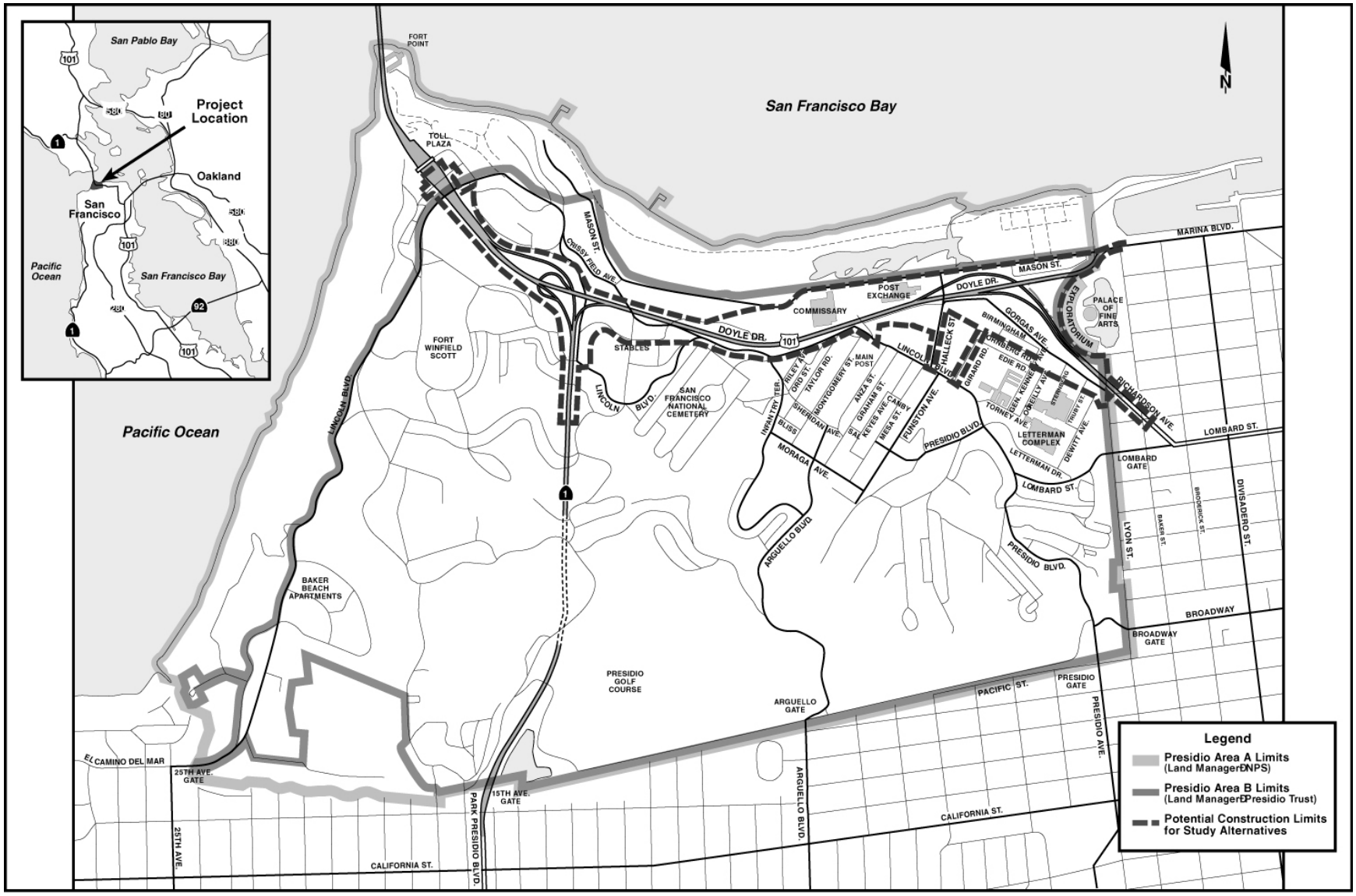
2.2 PROJECT PURPOSE

The purpose of the South Access to the Golden Gate Bridge - Doyle Drive Project is to replace Doyle Drive in order to improve the seismic, structural, and traffic safety of the roadway within the setting and context of the Presidio of San Francisco and its purpose as a National Park.

2.3 ALTERNATIVES DEVELOPMENT

The build alternatives for the Doyle Drive Project were developed with input from public scoping and reflected the parkway concept that evolved from previous studies. Through the screening analysis, six alternatives were selected for consideration in the Administrative DEIS/DEIR: Alternative 1, No-Build; Alternative 2, Replace and Widen; Alternatives 3a and 3b, Long Tunnels; and Alternatives 4a and 4b, Short Tunnels.

FIGURE 1a
PROJECT LOCATION



Subsequent to the Administrative DEIS/DEIR in 2002, a fifth alternative, the Presidio Parkway, was added to the list of alternatives for more detailed study. In comparison to the tunnel alternatives it was determined that Alternative 5, Presidio Parkway, would provide all the benefits and functions of Alternatives 3a, 3b, 4a, and 4b with less cost, construction duration and environmental impact. Hence, in November 2003 the four tunnel alternatives were recommended to be removed from further consideration and analysis in the DEIS/DEIR.

At a public meeting held in February 2004, the public agreed with the decision to drop Alternatives 3a, 3b, 4a, and 4b and retain Alternative 1, No-Build, Alternative 2, Replace and Widen, and Alternative 5, Presidio Parkway for consideration in the DEIS/DEIR.

2.3.1 Project Alternatives

This section describes the build alternatives in terms of physical and operating characteristics and a No-Build Alternative. As shown in Figure 1a, the project limits are from Merchant Road, just south of the Golden Gate Bridge Toll Plaza, to the intersection of Richardson Avenue/Francisco Street and Marina Boulevard/Lyon Street. During the screening process, all alternatives were evaluated for their ability to meet the project's Purpose and Need. Detailed drawings showing the plan and profile of each alternative in addition to the various design options can be found in Appendix A.

Alternative 1: No-Build Alternative

The No-Build Alternative represents the future year conditions if no other actions are taken in the study area beyond what is already programmed by the year 2020. The No-Build Alternative provides the baseline for existing environmental conditions and future travel conditions against which all other alternatives are compared.

Doyle Drive would remain in its current configuration, with six traffic lanes ranging in width from 2.9 to 3.0 meters (9.5 to 10 feet) and an overall facility width of 20.4 meters (67 feet) (see Figure 1b). There are no fixed median barriers or shoulders. The lane configuration is changed by manually moving plastic pylons to increase the number of lanes in the peak direction of traffic. The facility passes through the Presidio on a high steel truss viaduct and a low elevated concrete viaduct with lengths of 463 meters (1,519 feet) and 1,137 meters (3,730 feet), respectively. This alternative does not improve the seismic, structural, or traffic safety of the roadway.

Vehicular access to the Presidio is available from Doyle Drive via the off-ramp to Merchant Road at the Golden Gate Bridge Toll Plaza. Presidio access at the east end of the project will be provided for southbound traffic via a right turn from Richardson Avenue to Gorgas Avenue. Presidio access for northbound traffic will be provided by a slip ramp from Richardson Avenue to Gorgas Avenue, which is currently under construction.

Alternative 2: Replace and Widen Alternative

The Replace and Widen Alternative would replace the 463-meter (1,519-foot) high-viaduct and the 1,137-meter (3,730-foot) low-viaduct with wider structures that meet the most current seismic and structural design standards (see Figure 1c). The new facility would be replaced on the existing alignment and widened to incorporate improvements for increased traffic safety.

This alternative would include either six 3.6-meter (12-foot) lanes and a 3.6-meter (12-foot) eastbound auxiliary lane with a fixed median barrier or six 3.6-meter (12-foot) lanes with a moveable median barrier. The new facility would have an overall width of 38.0 meters (124 feet). The fixed median barrier option would require localized lane width reduction to 3.3 meters (11 feet) to avoid impacts to the historic batteries and Lincoln Boulevard, reducing the facility width to 32.4 meters (106 feet). Both options would include continuous outside shoulders along the facility. At the Park Presidio interchange, the two ramps connecting eastbound Doyle Drive to Park Presidio Boulevard and the ramp connecting westbound Doyle Drive to southbound Park Presidio Boulevard would be reconfigured to accommodate the wider facility. The Replace and Widen Alternative would

operate similar to the existing facility except that there would be a median barrier and shoulders to accommodate disabled vehicles.

The Replace and Widen Alternative includes two options for the construction staging:

No Detour Option – The widened portion of the new facility would be constructed on both sides and above the existing low-viaduct and would maintain traffic on the existing structure. Traffic would be incrementally shifted to the new facility as it is widened over the top of the existing structure. Once all traffic is on the new structure, the existing structure would be demolished and the new portions of the facility would be connected. To allow for the construction staging using the existing facility, the new low-viaduct would be constructed two meters (six feet) higher than the existing low-viaduct structure.

With Detour Option - A 20.4-meter (67-foot) wide temporary detour facility would be constructed to the north of the existing Doyle Drive to maintain traffic through the construction period. Access to Marina Boulevard during construction would be maintained on an elevated temporary structure south of Mason Street. On and off ramps to the mainline detour facility would be located near the Post Exchange (PX) building.

Vehicular access to the Presidio is available from Doyle Drive via the off-ramp to Merchant Road at the Golden Gate Bridge Toll Plaza. Presidio access at the east end of the project will be provided for southbound traffic via a right turn from Richardson Avenue to Gorgas Avenue. There would be no Presidio access for northbound traffic at the east end of Doyle Drive due to geometric constraints and concerns for traffic safety.

FIGURE 1b
ALTERNATIVE 1: NO-BUILD

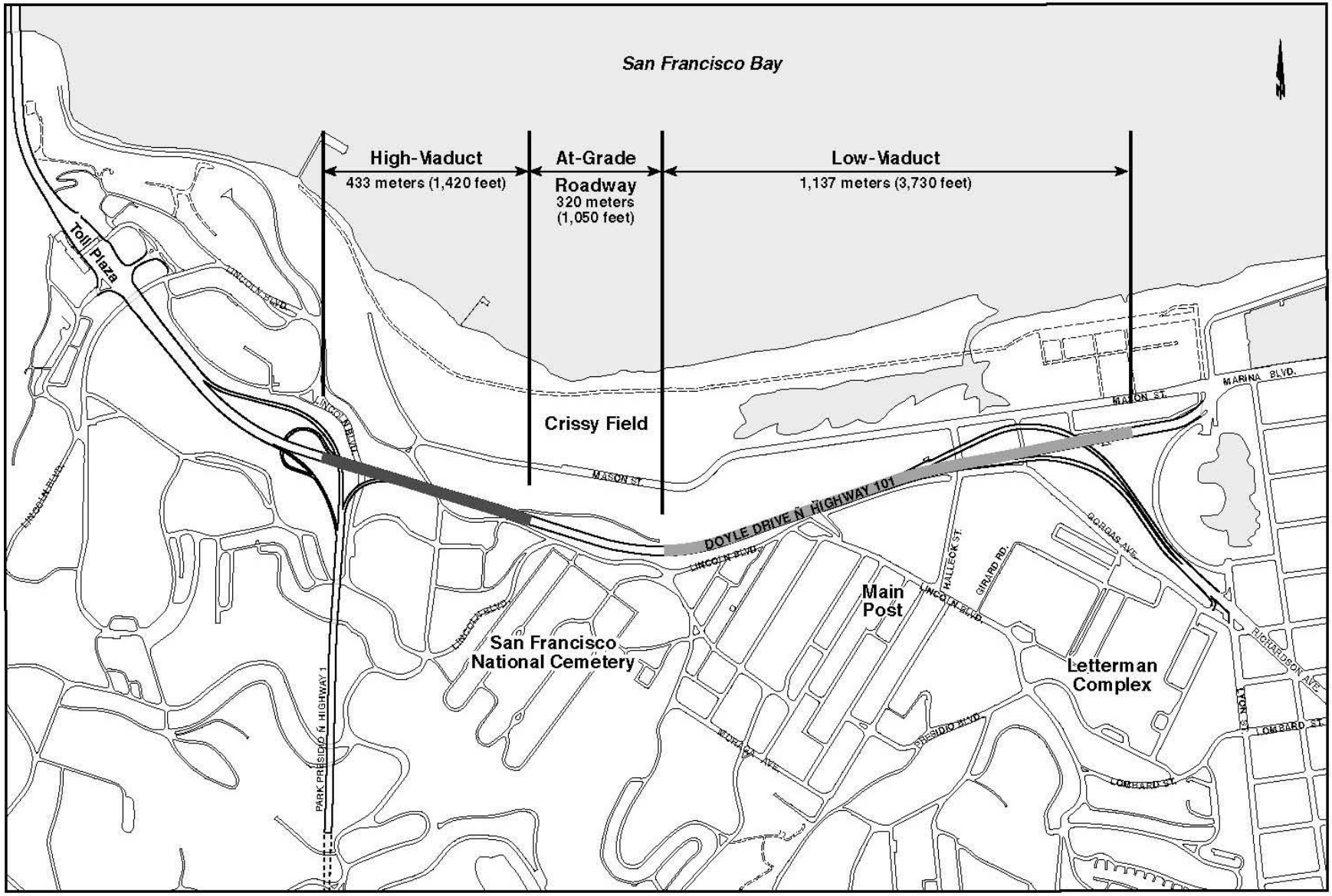
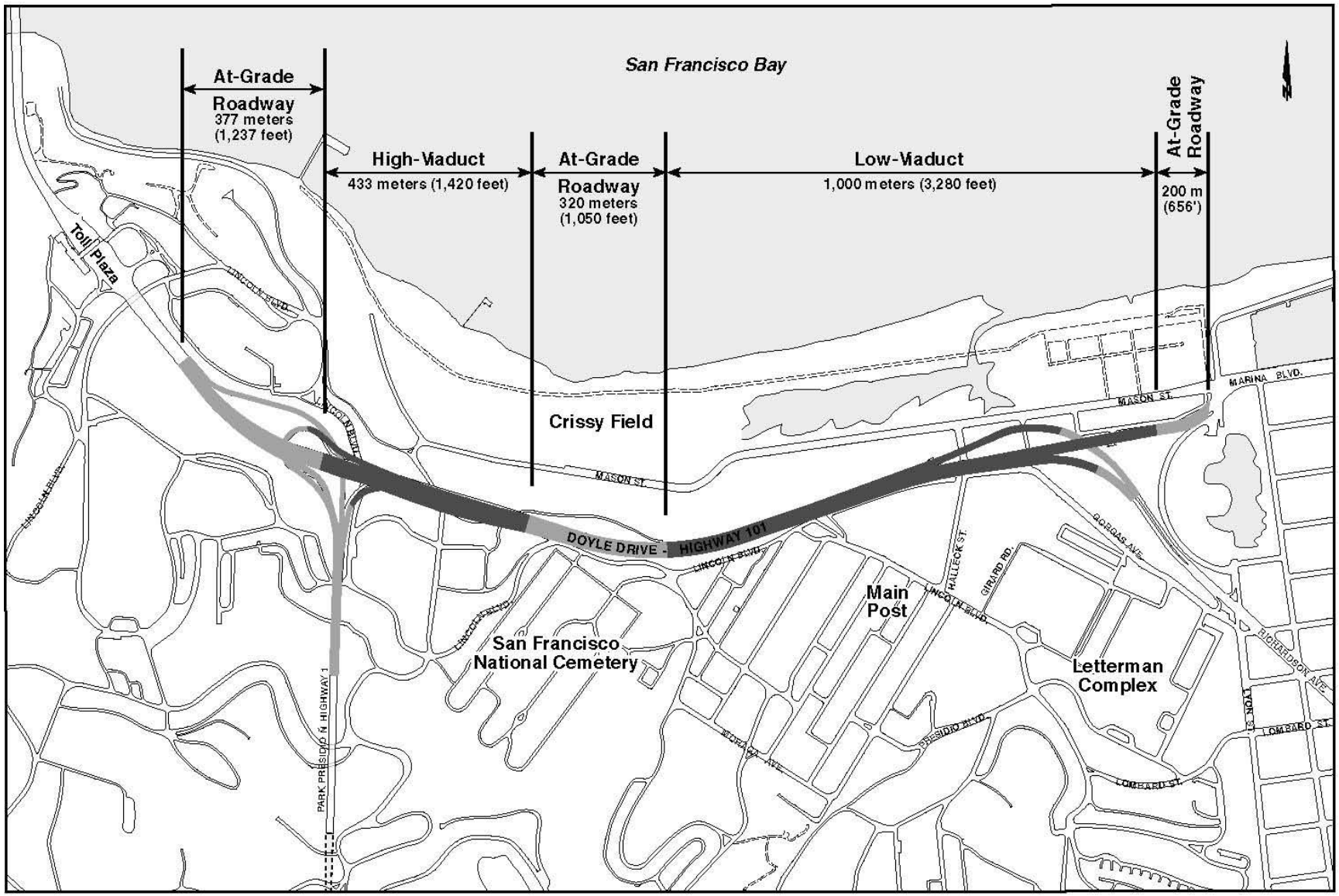


FIGURE 1c
ALTERNATIVE 2: REPLACE AND WIDEN



Alternative 5: Presidio Parkway Alternative

The Presidio Parkway Alternative would replace the existing facility with a new six-lane facility and an eastbound auxiliary lane between the Park Presidio interchange and the new Presidio access at Girard Road (see Figure 1d). The new facility would have an overall width of up to 45 meters (148 feet), and would incorporate wide landscaped medians and continuous shoulders. To minimize impacts to the park, the footprint of the new facility would include a large portion of the existing facility's footprint east of the Park Presidio interchange. A 450-meter (1,476-foot) high-viaduct would be constructed between the Park Presidio interchange and the San Francisco National Cemetery. Shallow cut-and-cover tunnels would extend 240 meters (787 feet) past the cemetery to east of Battery Blaney. The facility would then continue towards the Main Post in an open depressed roadway with a wide, heavily landscaped median. From Building 106 (Band Barracks) cut-and-cover tunnels up to 310 meters long (984 feet) would extend to east of Halleck Street. The facility would then rise slightly on a low level causeway 160 meters (525 feet) long over the site of the proposed Tennessee Hollow restoration and a depressed Girard Road. East of Girard Road the facility would return to existing grade north of the Gorgas warehouses and connect to Richardson Avenue.

The Presidio Parkway Alternative would include an underground parking facility at the eastern end of the project corridor between the Mason Street Warehouses, Gorgas Street Warehouses and Palace of Fine Arts. The parking garage would supply approximately 500 spaces to maintain the existing parking supply in the area and improve pedestrian and vehicular access between the Presidio and the Palace of Fine Arts.

At the intersection with Merchant Road, just east of the toll plaza, a design option has been developed for a Merchant Road slip ramp. This option would provide an additional new connection from westbound Doyle Drive to Merchant Road. This ramp would provide direct access to the Golden Gate Visitors' Center and alleviate the congested weaving section where northbound Park Presidio Boulevard merges into Doyle Drive.

The Park Presidio interchange would be reconfigured due to the realignment of Doyle Drive to the south. The exit ramp from eastbound Doyle Drive to southbound Park Presidio Boulevard would be replaced with standard exit ramp geometry and widened to two lanes. The loop of the westbound Doyle Drive exit ramp to southbound Park Presidio Boulevard would be improved to provide standard exit ramp geometry. The northbound Park Presidio Boulevard connection to westbound Doyle Drive would be realigned to provide standard entrance ramp geometry. There are two options for the northbound Park Presidio Boulevard ramp to an eastbound Doyle Drive connection:

Option 1: Loop Ramp - Replace the existing ramp with a loop ramp to the left to reduce construction close to the Calvary Stables and provide standard entrance and exit ramp geometry.

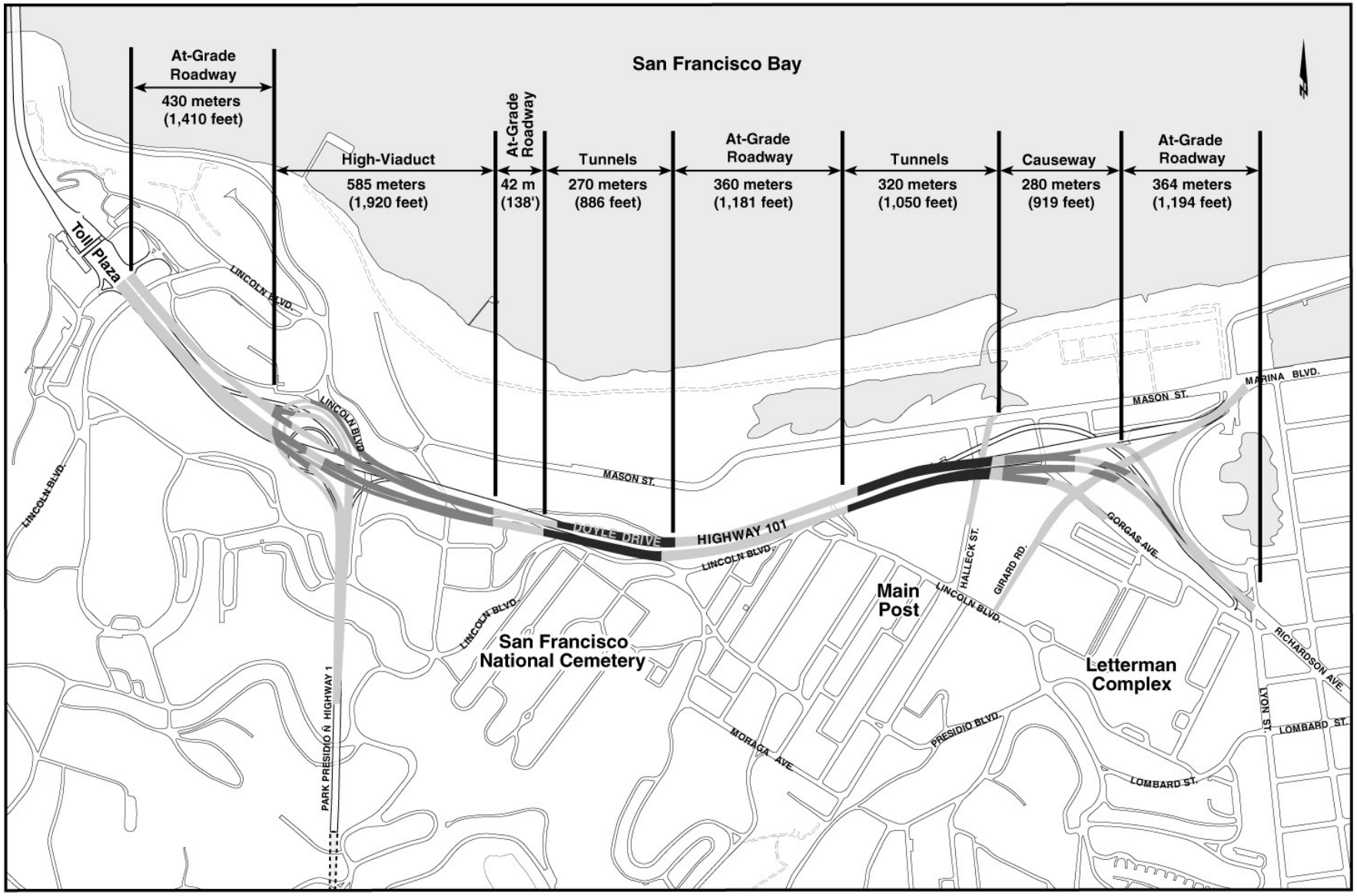
Option 2: Hook Ramp - Rebuild the ramp with a similar configuration as the existing ramp with a curve to the right and improved exit and entrance geometry.

The Presidio Parkway Alternative includes two options for direct access to the Presidio and Marina Boulevard at the eastern end of the project:

Diamond Option – Direct access to the Presidio and Marina Boulevard in both directions is provided by the access ramps from Doyle Drive connecting to a grade-separated interchange at Girard Road. East of the new Letterman garage, Gorgas Avenue is a one-way street and connects to Richardson Avenue with access to Palace Drive via a signalized intersection at Lyon Street.

Circle Drive Option – The Circle Drive Option provides direct access to the Presidio and Marina Boulevard for eastbound traffic by access ramps connecting to a grade-separated interchange of Girard Road. Westbound traffic from Richardson Avenue would access the Presidio and Palace Drive through a jug handle intersection with Gorgas Avenue.

FIGURE 1d
ALTERNATIVE 5: PRESIDIO PARKWAY



SECTION 3 SETTING

3.1 CLIMATE

The climate of the San Francisco waterfront area is characterized as dry-summer subtropical (often referred to as Mediterranean), with cool winters and relatively warmer dry summers. Two types of Mediterranean climate are recognized and are based primarily on summertime temperatures. San Francisco is an example of the "cool summer" type where cool temperatures on a windward coast are further cooled by cold ocean currents. The mean annual rainfall in the vicinity of the project site, for the period between 1914 and 2000, is approximately 50 centimeters (20 inches).[1] Analysis of long-term precipitation records indicates that wetter and drier cycles, lasting several years, are common in the region. Severe, damaging rainstorms occur at a frequency of about once every three years.[2]

3.2 PHYSIOGRAPHY

Topography within the Presidio is variable, ranging from the relatively flat coastal plain near sea level along the western and northern shorelines to approximately 120 meters (400 feet) in the south-central hilly uplands. Prior to placement of fill in the early 1900s, the north coastal relatively flat lowlands (in the areas now known as Crissy Field and Marina Green) included a back dune marsh system with salt marsh, mudflats, sandflats, subtidal channels, and sand dunes.[3] The western coastal area is characterized by steep rocky bedrock slopes and outcrops of Franciscan Assemblage rocks, including sandstone, shale, chert, and serpentinite.[4] The inland portions of the site consist mainly of gently sloping hills, with several relatively large flat areas in the eastern portion of the site where most of the Presidio buildings are located.

3.3 STORM DRAINAGE

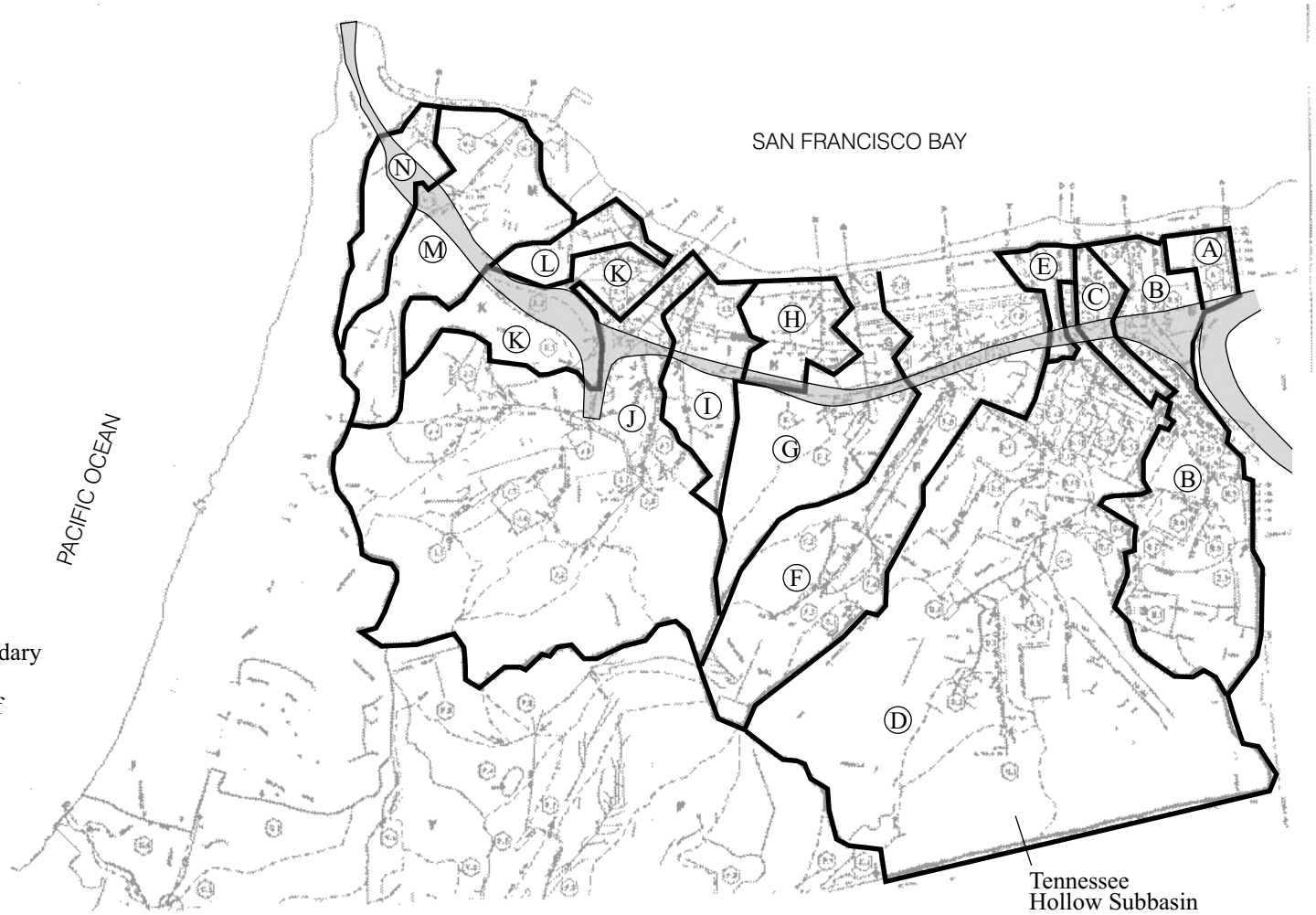
There are three main watersheds within the Presidio comprising an area of approximately 550 hectares (1,360 acres):[5] 1) the Lobos Creek watershed, 2) the western coastal watershed, and 3) the San Francisco Bay watershed (which includes the Fort Scott and Tennessee Hollow subwatersheds).[6] The Lobos Creek watershed in the southwestern portion of the site (approximately 111 hectares (275 acres) total area) and the western coastal watershed (approximately 85 hectares (210 acres) total area) drain to the Pacific Ocean and would not be directly affected by the proposed project because the Doyle Drive alignment does not cross the basin boundaries. Therefore, the Lobos Creek and western coastal watersheds are not further discussed.

The portion of the Presidio that drains to San Francisco Bay (San Francisco Bay watershed) is comprised of approximately 354 hectares (875 acres) of various types of land uses, including open space, residential, commercial, industrial, institutional, and special use (cemeteries and roads). There are 14 drainage basins within the watershed and each ultimately drains to San Francisco Bay. The Doyle Drive alignment either crosses or passes near each of the 14 drainage basins and therefore activities associated with reconstruction of the roadway could directly affect water quality within these drainage basins (Figure 2). A Location Hydraulics Study was prepared for the project that includes an inventory of storm drain crossings of

[1] Western Regional Climate Center (website: http://www.wrcc.dri.edu/elimsmsfo.html), 2000.
[2] Brown, William, M. III, 1988, Historical Setting of the Storm: Perspectives on Population, Development, and Damaging Rainstorms in the San Francisco Bay Region, in Landslides, Floods, and Marine Effects of the Storm of January 3-5, 1982, in the San Francisco Bay Region, California, Stephen D. Ellen and Gerald F. Wieczorek, Eds., U.S. Geological Survey Professional Paper 1434. 1988.
[3] Dames and Moore, 1995, Wetland and Riparian Corridor Restoration and Feasibility Study, Presidio of San Francisco, National Park Service, February.
[4] Montgomery Watson, 1996, Basewide Groundwater Monitoring Plan (Draft), Presidio of San Francisco, California, prepared for the U.S. Army Corps of Engineers, July.
[5] Acreages reported are for the portions of the watershed within the Presidio.
[6] Dames and Moore, 1994, Presidio of San Francisco Storm Water Management Plan, October.

WATERSHED SUBBASINS

Figure 2



Legend

Drainage Subbasin Boundary

Approximate Location of Doyle Drive Alignment

Ⓝ Subbasin Designation

Doyle Drive
San Francisco, California

Source: Dames & Moore, 1994.

0 500 Meters

BASELINE

D:\Graphics\Y0239-03\Hydro\Figure2 Watershed SubBasins Revised.cdr 9/1/04

the alignment and their characteristics.[7] Of the 14 drainage basins that could be affected, the largest is referred to as the Tennessee Hollow (or sometimes the El Polin/Tennessee Hollow) watershed. A biological and hydrological linkage between the Tennessee Hollow surface and groundwater system and the Crissy Field wetland is considered by the Presidio Trust to be integral to the health and ecological function of the future health of the wetland restoration at Crissy Field. The Trust and the NPS are conducting research to further define the linkage.

Open space in the project area is generally drained by overland flow and open channels. The open spaces are vegetated and include minimal impervious surfaces, and therefore runoff rates and volumes are low relative to the more developed land uses. Natural drainage features within the more developed urban-type areas have been largely eliminated and/or altered by past grading, filling, and construction activities, leaving only a few isolated segments of riparian corridor. Most of the drainage in the urban areas now occurs through the Presidio storm drain system in underground pipes and open channels along roads. There are no open channel creeks or streams that cross the alignment. The storm drain system, which was built mainly by the U.S. Army, was constructed in a piecemeal fashion over a period of more than 200 years. The drainage system was constructed with a variety of materials, including wood, clay, brick, rock, concrete, stone, corrugated metal, and steel,[8] and much of the system is damaged or of insufficient capacity to accommodate design flows. Based on results of hydrologic modeling, the total runoff in any given year is expected to be approximately 30 percent of annual precipitation.[9] Under current conditions, it is estimated that approximately 3,000 lineal meters (10,000 feet) of the drainage system [out of a total of 11,300 lineal meters (37,000 feet) within the entire Presidio] has insufficient capacity to convey the 10-year design storm.[10] However, based on the lack of reported flooding problems in the vicinity of the Doyle Drive alignment, it appears that this area is not subject to frequent flooding.

It is important to note that unlike most of the City and County of San Francisco (City), the Presidio operates separate storm water and sanitary sewer systems (the City operates a combined system where storm water and sewerage flows in the same piping systems and are treated simultaneously at the various treatment plants prior to discharge). Historically, the Presidio operated a combination of separate and combined systems, but recently has undertaken a program to separate the systems and eliminate illicit sewerage discharges to the storm sewer system. However, based on the results of runoff sampling and analysis for coliform bacteria conducted in 1994, some concerns remain that not all illicit discharges have been eliminated.[11]

3.3.1 Tennessee Hollow and Crissy Marsh

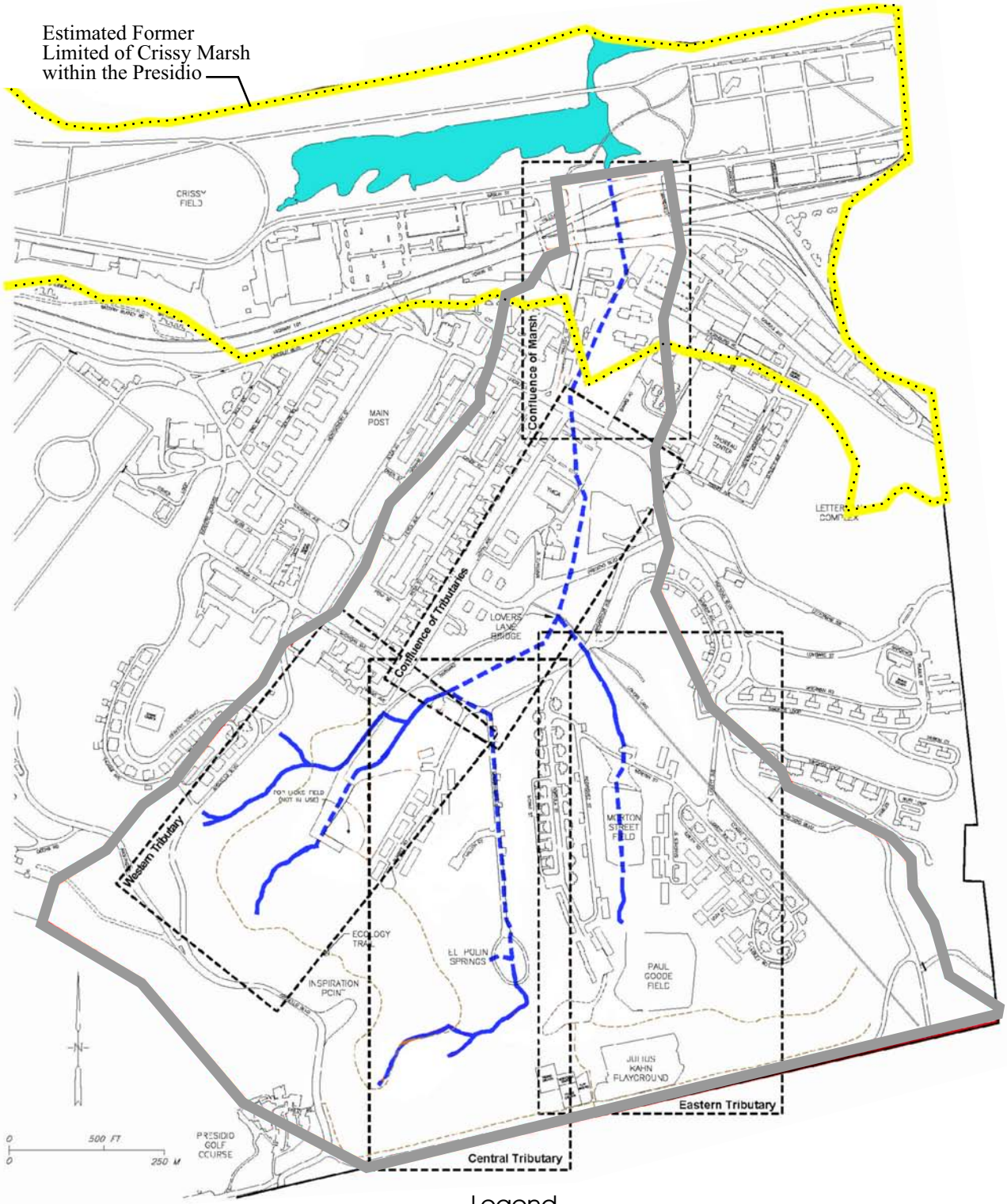
The largest drainage basin in the Presidio is Tennessee Hollow watershed, which consists of approximately 110 hectares (270 acres) (upgradient of Doyle Drive) of mixed land uses, primarily open space, residential, and recreational. The Doyle Drive alignment crosses Tennessee Hollow in the northern portion of the watershed (Figure 3).

Two of the three creek tributaries experience year-round flows (the Central/El Polin Springs and Eastern Tributaries), while the third – the Western Tributary – is intermittent, flowing only during precipitation events.[12] The characteristics of these streams have been substantially altered over the last 225+ years by the construction of roads and buildings, placement of fill, planting of the historic forest and other removal or alteration of vegetative cover. The Tennessee Hollow watershed today is covered by approximately 19

[7] Manna Consultants, 2001, Location Hydraulics Study
[8] Ibid.
[9] Dames and Moore, 1995, op. cit.
[10] Dames and Moore, 1994, op. cit.
[11] Ibid.
[12] Dames and Moore, 1995, op. cit, Kamman Hydrology & Engineering, Inc. 2002, Conceptual Watershed Model and Proposed Surface and Groundwater Monitoring Program for the Tennessee Hollow Riparian Corridor Restoration Project, 2003, Draft Final Hydrologic Monitoring Report for the Tennessee Hollow Riparian Corridor Restoration Project.

TENNESSEE HOLLOW WATERSHED

Figure 3



Legend

- Existing Natural Channel
- Existing Underground Storm Drain or Lined Channel
- Watershed Boundary

Doyle Drive
San Francisco, California

Source Presidio Trust, 2003 (base); NPS, Trust & GGNPC, 2004 (Crissy Marsh limits within the Presidio)

BASELINE

D:\Graphics\Y0239-03\Hydro\Figure 3 Watershed BW.cdr 10/12/04

hectares (46 acres) (16 percent) of impervious surfaces (i.e., roads, parking lots, and buildings).[13] Currently more than half of the creek system has been diverted into storm drains or lined concrete channels. Although there have been substantial changes to the creek system, small pockets of remnant creek and associated wetland habitat remain. These areas support some of the most biologically abundant and diverse wildlife habitat at the Presidio.

The vast majority of the Tennessee Hollow watershed is within the planning jurisdiction of the Presidio Trust (Trust). The Trust's adopted land use plan – the Presidio Trust Management Plan (PTMP) (2002) – acknowledges the rich ecological and cultural values of this area of the Presidio and calls for its restoration, protection, and interpretation. In broad terms the PTMP directs the Trust to:

Restore a functioning stream ecosystem with associated riparian and wetland habitats; improve the quality of freshwater flows into Crissy Marsh; improve management practices in the surrounding watershed; protect and enhance cultural and archeological resources; provide recreational, educational, and interpretative opportunities; and adapt existing infrastructure to support the restoration (pg. 19).

The PTMP also provides specific policy guidance on what the Trust should consider in achieving these broad goals (pgs 3-20, 42-45, and 110-106), and acknowledges that a separate public planning and environmental review process will be undertaken to develop, analyze and seek public input into project alternatives. The Trust formally initiated this process in November 2002 by seeking early public input into the formation of alternatives and scope of the environmental analysis. In total, nearly 500 comment letters were received by the Trust between November 2002 and November 2003. These comments addressed a wide range of issues including opinions or preferences regarding the project, suggested changes to the alternatives, and recommendations that specific issues be evaluated in the forthcoming Environmental Assessment (EA). The Trust and its consultants reviewed these comments, refined the project alternatives and proposed scope of the EA, and are currently preparing the EA that will be released for public review and comment in early Fall 2004. The EA will evaluate the impacts of the project alternatives, as well as the required "No Action" and identify mitigation measures that would be implemented by the Trust to minimize potential adverse impacts. The Trust will review public comments on the EA and determine the appropriate next steps for completing the environmental and other compliance processes.

The Tennessee Hollow project covers a large area and as a practical matter all of the project alternatives would be implemented in phases extending over a period of several decades. The timing and duration of each phase cannot be precisely defined at present. However, for the purposes of the Trust's current planning efforts, the EA will assume that Phase 1 (including post-restoration maintenance and monitoring) would require up to 10 years to complete. All project alternatives share a similar approach to phasing, focusing on the upland area of the watershed – primarily on the Eastern Tributary. Over time, the Trust would adaptively manage and implement additional phases of the project with the long-term objective of providing a continuous habitat corridor from the Bay to upland areas.

Crissy Marsh, at the downstream end of the Tennessee Hollow watershed, is also being studied and at some time in the future Crissy Marsh may be expanded. The Crissy Marsh Technical Study – a technical study examining the health and function of the marsh – was completed and the results presented to the public at a workshop in the Spring 2004. The Trust, National Park Service, and the Golden Gate National Parks Conservancy are currently preparing to initiate a public planning/NEPA process for the Crissy Marsh expansion project, which will evaluate a full range of options for the long-term health and viability of the marsh. The area being considered for expansion (which approximates the estimated former extent of the marsh) is shown on Figure 3.

The Doyle Drive alignment crosses the Tennessee Hollow drainage just south of the recently restored Crissy Field Marsh and within the area being considered for marsh expansion. Therefore, depending on which alternative is selected, it is possible that the proposed project could affect hydrology and water quality within

[13] Ibid.

the watershed and marsh. Potential impacts are discussed in the Potential Impacts and Mitigation Measures section of this report.

3.4 FLOODING

The project site has not been included in the Federal Emergency Management Agency's (FEMA) regional flooding hazards mapping program (none of the City has been included in the federal program). Therefore, areas subject to flooding during the 100-year storm event, if any, have not been delineated within the Presidio by FEMA. No other sources of floodplain data for the project site have been identified.

3.4.1 Coastal Hazards

The location of the project site (adjacent to San Francisco Bay) may result in the site being affected by coastal hazards, such as tsunamis, extreme high tides, or sea level rise.

3.4.1.1 Tsunamis

A tsunami is a sea wave produced by an offshore earthquake, volcanic eruption, or landslide.[14] Tsunamis are difficult to observe in the open ocean because they have relatively low wave heights [typically less than 3 meters (10 feet)] and travel very fast [up to 800 kilometers (500 miles) per hour].[15] Tsunamis can be exceedingly destructive upon reaching exposed coastlines, where they are capable of rising to 30 meters (100 feet) in height and moving at 50 kilometers (30 miles) per hour. San Francisco Bay, and its tidally influenced tributaries, are partially protected from inundation and damage associated with tsunamis because of the restricted hydraulic access at the Golden Gate. The predicted wave run-up at the bay front adjacent to the project site has been estimated to range between 2.4 and 2.5 meters (7.8 and 8.2 feet), National Geodetic Vertical Datum (NGVD) for the 100-year tsunami.[16] Converted to the more modern North American Vertical Datum (NAVD), the predicted wave run-up is 3.2 meters (10.5 feet).[17]

3.4.1.2 Extreme High Tides

Extreme high tides in San Francisco Bay result from the combined effects of astronomical high tides (related to the lunar cycle) and other factors, including winds, barometric pressure, ocean temperatures, and freshwater runoff. In California, the highest astronomical tides occur in the summer and winter, and therefore extreme high tides occur during these times. The highest tide ever recorded in San Francisco Bay (between 1855 and 1983) occurred on December 3, 1983 [tide elevation of 1.83 meters (6.0 feet) NGVD]. Based on the 129-year record of daily high tide, the U.S. Army Corps of Engineers (Corps) has developed an estimated 100-year high tide elevation for various locations in the Bay (an extreme high tide with the probability of occurrence once every 100 years). The elevation of the adopted 100-year tide at the project site is approximately 1.83 meters (6.0 feet) above NGVD.[18] Converted to NAVD, the elevation of the extreme high tide is 2.6 meters (8.5 feet).

[14] Steinbrugge, K., 1982, Earthquakes, Volcanoes, and Tsunamis, An Anatomy of Hazards, Skandia America Group.
[15] Costa, J. and Baker, V., 1981, Surficial Geology, Building with the Earth, John Wiley and Sons, pp 435-440.
[16] Houston, J.R., Garcia, A.W., 1975, Type 16 Flood Insurance Study: Tsunami Predictions for Monterey and San Francisco Bays and Puget Sound, Technical Report H-75-17, November.
[17] The nearest benchmark to the Main Post 15 N813 (Appendix A). This datum indicates approximately a 0.8 meter (2.5 foot) difference between NGVD and NAVD.
[18] United States Army Corps of Engineers, 1989, San Mateo and Northern Alameda Counties Interim San Francisco Bay Shoreline Study, September.

3.4.1.3 Sea Level Rise

Tidal gauge measurements collected over the last 100 years indicate that sea level is rising relative to the land surface in many locations throughout the world.[19] Over the last 100 years, the temperature of the earth's surface has risen approximately 0.6 degree Celsius (1.8 degrees Fahrenheit).[20] It is widely believed that sea levels will continue to rise in response to global warming. Global warming causes thermal expansion of the upper layers of the ocean (increasing the volume of water) and melting of the earth's glaciers and polar ice fields. Such increases in sea level, if sustained over long periods, could create flooding problems (or exacerbate existing problems) for those areas currently protected from flooding with only minimal freeboard. To plan for, and mitigate, potential flooding problems associated with sea level rise, it is important to be able to quantify the amount of sea level rise expected at a specific location over a given time period. Long-range projections of the behavior of physical systems are extremely difficult because of the uncertainties involved. Since the Environmental Protection Agency (EPA) released its first major study on sea level rise in 1983, estimates for amount of predicted sea level rise have steadily decreased. In 1983, EPA predicted a 1.8 meter (5.7 foot) rise at the project site by 2100.[21] EPA's most recent prediction for the expected total sea level rise at the project site is 16 centimeters (0.5 foot) by the year 2050 and 37 centimeters (1.2 feet) by the year 2100.[22]

Those portions of the project site below the elevation of extreme high tide or tsunami wave run-up elevation, added to the incremental increase in elevation resulting from predicted sea level rise, and not protected by berms, levees or other similar features, could be subject to increased flooding hazards as time progresses. Based on review of a detailed topographic map,[23] it appears that the existing grade along some portions of the alignment in the vicinity of the Main Post and Tennessee Hollow is at or below the elevation that may allow flooding by the tsunami hazard described. Potential impacts from coastal flooding are further discussed in the impacts and mitigation measures section of this report.

Predicted inundation elevations associated with the coastal hazards described are presented in Table 1. All subsequent discussion of inundation elevations is relative to the NAVD datum.

TABLE 1
PREDICTED INUNDATION ELEVATIONS ASSOCIATED WITH 100-YEAR EXTREME HIGH TIDE AND TSUNAMI EVENTS

Coastal Hazard	Predicted Elevation at the Presidio (NGVD of 1929)	Predicted Elevation at the Presidio (NAVD of 1988)	Sea Level Rise (predicted by 2050)	Predicted Elevation at the Presidio, Including Sea Level Rise (NAVD of 1988)
Extreme High Tide (100-year event)	1.8 meters (6.0 feet)	2.6 meters (8.5 feet)	0.15 meter (0.5 foot)	2.75 meters (9.0 feet)
Tsunami Wave Run-up (100-year event)	2.4 meters (7.8 feet)	3.2 meters (10.5 feet)	0.15 meter (0.5 foot)	3.35 meters (11.0 feet)

[19] Bay Conservation and Development Commission (BCDC), 1987, Sea Level Rise: Predictions and Implications for San Francisco Bay, December.
[20] United States Environmental Protection Agency (U.S. EPA), 1995, The Probability of Sea Level Rise, EPA 230-R-95-008, October.
[21] United States Environmental Protection Agency (U.S. EPA), 1983, Can We Delay Greenhouse Warming?, authors: Seidel, S., and Keyes, D.
[22] U.S. EPA, 1995, The Probability of Sea Level Rise, EPA 230-R-95-008, October.
[23] Parsons Brinckerhoff, 2000, Topographic Map of Doyle Drive Alignment, contour interval = 0.5 meter.

Note: Studies that predicted extreme high tides and tsunami wave run-up elevations were reported relative to the National Geodetic Vertical Datum of 1929 (prior to conversion to North American Vertical Datum of 1988). The data used in the conversion between NGVD and NAVD are included in Appendix A. The datum used for all current project plans and specifications is NAVD 1988.

3.5 GROUNDWATER OCCURRENCE

Groundwater occurs in the geologic materials underlying the site. The quantity and quality of groundwater are highly dependent on the type and thickness and configuration of the geologic materials present. In addition, the historic land uses within the Presidio (including placement of artificial fill and releases of hazardous substances) have affected groundwater quality in some areas (refer to Final Preliminary Site Investigation, January 2002, for a description of on-site hazardous materials releases relevant to the proposed project). Available information on ambient groundwater quality is included in the Water Quality section of this analysis. Following is a discussion of the geological stratigraphy and fill materials placed at the site and the occurrence of groundwater in these materials.

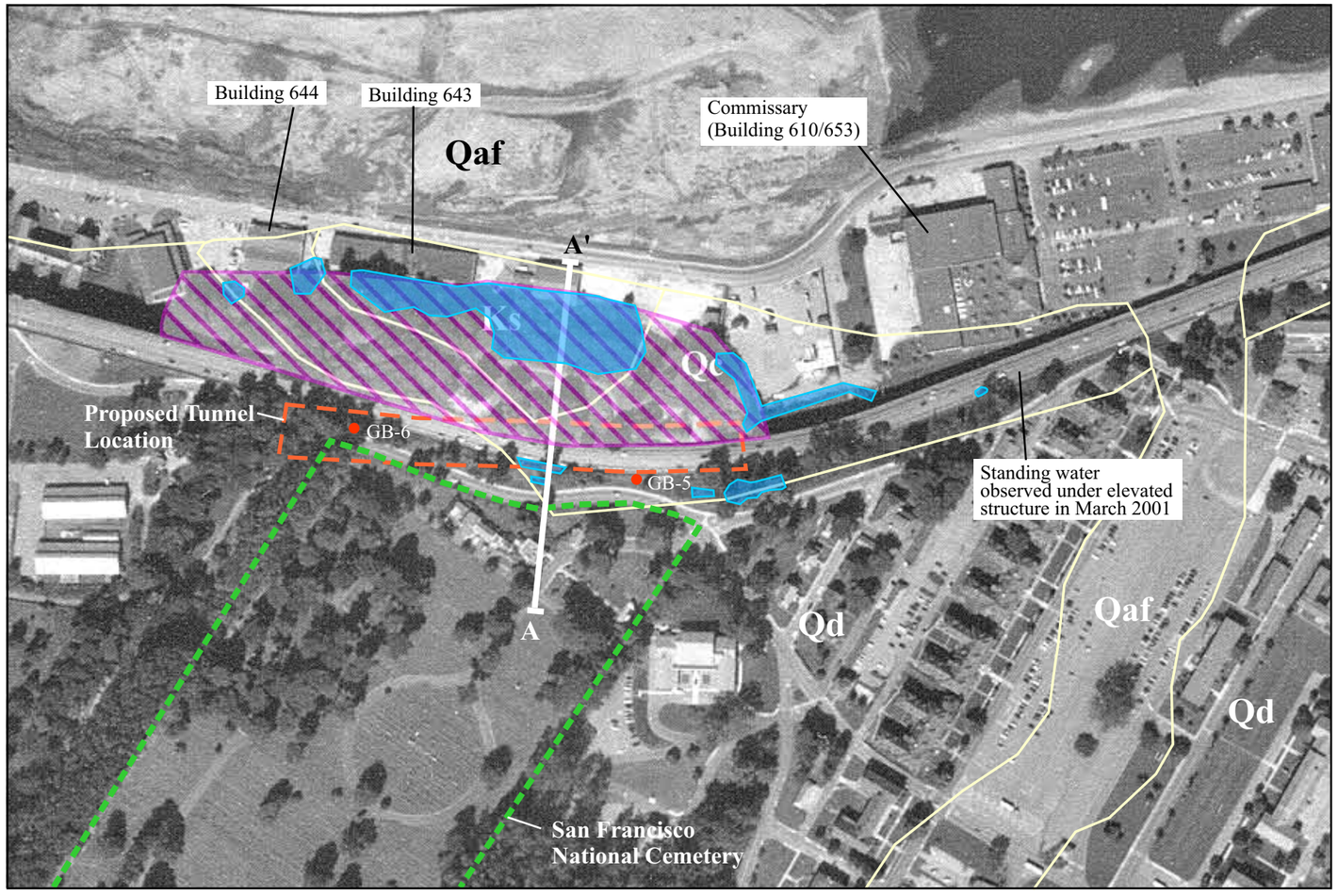
The bedrock material underlying the Presidio is the Franciscan formation, a complex assemblage of shale, sandstone, chert, volcanics, and metamorphic rocks (including serpentinite).[24] The Franciscan is highly deformed (folded and faulted) and extends hundreds to thousands of feet below the surface at the Presidio. Franciscan rocks outcrop at various locations in the Presidio, including along the western boundary and the south-central and eastern hilltops. Overlying the Franciscan bedrock is the Colma formation, an unconsolidated to weakly consolidated fine- to medium-grained sand unit with lesser amounts of silt and clay.

The Colma formation is overlain by dune sands in the central and southwestern portions of the site. The dune sands are highly permeable with a fine- to medium-grained texture.[25] The thickness of the dune sands is typically less than 30 meters (100 feet). Beach sands and Bay Mud are present at the northern Presidio boundary. Artificial fill has been placed in many of the low-lying areas of the Presidio, including the areas now known as Crissy Field, Marina Green, and Tennessee Hollow. The fill is composed of on-site soil and lesser amounts of construction debris (brick, mortar, road base, concrete, and metal).

Groundwater occurs in both the bedrock and overlying unconsolidated sediments and fill. The majority of the water in the bedrock probably occurs within fractures rather than in the interstitial pore spaces (since the primary porosity of the types of rocks that make up the Franciscan is very low). In general, Franciscan bedrock “aquifers” are of low yield. Groundwater also occurs in the overlying unconsolidated sediments, at depths ranging from near the surface (at El Polin spring) to greater than 15 meters (50 feet) below the surface in the hilly uplands. It is expected that the uppermost groundwater is unconfined, that is, the upper water table surface is free to move up or down and is not confined by a low permeability layer (e.g., clay or silt).

Based on historic observations, a reconnaissance conducted in March 2001, and a delineation of jurisdictional waters of the United States,[26] numerous seeps and springs occur on the slopes and along the base of the bluffs north of the San Francisco National Military Cemetery (Figure 4). The slopes of the bluffs support a variety of native and non-native vegetation (for additional discussion of the biotic resources, refer to the biological assessment prepared for this project). During the March 2001 reconnaissance, the following features indicating near-surface groundwater flow were identified:

[24] Schlocker, Julius, 1974, Geology of the San Francisco North Quadrangle, California, U.S. Geological Survey Professional Paper 782.
[25] Ibid.
[26] Environmental Science Associates, 2001, Draft Doyle Drive Corridor Wetland Delineation, 21 March.



Legend

GB-6 ● Geotechnical boring location (January 2001)

Waters of the U.S. (Source ESA, 2001 - Draft)

Geologic formation contact

Geologic Units:

Qaf Artificial Fill

Qd Dune Sand

Qc Colma Formation

Ks Sheared Rocks, undifferentiated (Franciscan Formation)

Approximate extent of "Bluff" area

Refer to Figure 5 for geologic cross-section along A'-A

Doyle Drive
San Francisco, California

Source: Geologic Base - Schloeker, 1974.

D:\Graphics\Y0239-03\Figure4 Bluff .cdr 7/7/04

0 180 Meters

BASELINE

- An area of standing water approximately 4.6 by 9.1 meters (15 by 30 feet) was observed on the fill terrace below the bluffs under the existing elevated Doyle Drive roadway (Figure 4). During the field reconnaissance, it did not appear that the standing water was being supported by overland flow from the slopes (no visible springs). It is likely that the pond was supported by a combination of surface runoff from the slope and Doyle Drive and underflow from the toe of the slope. Historic observations indicate that the area remains moist throughout the summer (although standing water may not be present).[27]
- The vegetation on the bluff slopes below the existing Doyle Drive (between McDowell Avenue to the west and the eastern edge of the cemetery to the east) includes several species indicative of near-surface high moisture and/or saturated conditions. Specific plant types identified include willows, calla lily, horsetail, and elderberry. Several places on the slope currently support relatively dense growth of one or more of these high water need plants, and indicate the presence of springs.
- A substantial amount of drainage from the slope onto the pavement on the fill terrace was observed between buildings 643 and 644 (Figure 4).

3.5.1 Tennessee Hollow and Crissy Field

The geologic materials underlying the tributaries of Tennessee Hollow consist of bedrock overlain by Colma formation, which, in turn, is overlain in some areas by artificial fill. The fill thicknesses range from zero to 9 meters (30 feet), but are more typically 1.5 to 3 meters (5 to 10 feet) thick.[28] Groundwater appears to occur primarily in the Colma formation and the underlying bedrock, although the lower portion of the fill is saturated in most areas. Springs in the upland area of the Presidio feed each of the eastern and central tributaries with approximately 2.8 cubic meters (100 cubic feet) per day of groundwater discharge.[29] More recent flow monitoring indicates that a sustained baseflow of about 9.3 cubic meters (327 cubic feet) per day of groundwater discharge occurs in these springs (with high flows in the rainy season).[30]

Crissy Field is underlain by artificial fill, beach and dune sands, Bay Mud, and Franciscan bedrock.[31] The fill consists of locally derived soil with relatively small amounts of debris, and ranges in thickness between 0.6 to 1.8 meters (2 to 6 feet). Depth to first groundwater in the Crissy Field area, which generally flows north toward the Bay, is typically about 1.5 meters (5 feet) below the ground surface (bgs).[32]

In January 2001, an investigation was conducted to further define the hydrogeology in the vicinity where the Tennessee Hollow drainage crosses the Doyle Drive alignment.[33] As part of this investigation, three borings were installed (HGB-1, HGB-2, and HGB-3) to depths ranging from 21 to 27 meters (70 to 90 feet) bgs. Three nested piezometers were installed at each location. The boring logs developed during drilling indicate that, in general, the stratigraphy includes a hard to very stiff clay [upper bound at about 18 to 21 meters (60 to 70 feet) bgs] overlain by 6 to 15 meters (20 to 50 feet) of silty fine sand [upper bound at about 6 to 9 meters (20 to 30 feet) bgs], which in turn is overlain by a mixture of clay, silt, and sand layers. The upper 2.1 to 3.0 meters (7 to 10 feet) is composed of artificial fill. An effort was made to sample the borings continuously so that the stratigraphy could be accurately characterized. However, actual recovery of soil

[27] Castellini, Laura, 2001, Wetland Specialist, NPS, personal communication with Bruce Abelli-Amen of BASELINE, 13 March.
[28] Dames and Moore, 1995, op. cit.
[29] Ibid.
[30] Kamman Hydrology and Engineering, 2003, Draft Final Hydrologic Monitoring Report for the Tennessee Hollow Riparian Corridor Restoration Project, the Presidio of San Francisco, March.
[31] Watkins-Johnson Environmental, 1993, Remedial Investigation Report Presidio Main Installation, Volumes I, IIA, and IIB in Dames and Moore, 1995, Wetland and Riparian Corridor Restoration Feasibility Study, Presidio of San Francisco, National Park Service.
[32] Dames and Moore, 1995, op.cit.
[33] BASELINE Environmental Consulting, 2001, Data Report, Piezometer Installation and Development, Doyle Drive Reconstruction Project, San Francisco, 11 April (included as Appendix B).

cores was not complete due to obstructions and/or loss of material during retrieval of the sample (i.e., less than 100 percent),[34] so discrete thin strata, if positioned in zones where recovery was incomplete, may not have been observed.

Based on the water levels measured in the piezometers in February 2001, a substantial upward groundwater gradient is present in the vicinity of the crossing. Piezometers HGB-2-40, HGB-2-71, HGB-3-64, and HGB-3-74 were found to be flowing artesian wells (i.e., the stabilized potentiometric water level was found to be above the ground surface), whereas water was first encountered during drilling at depths ranging from 1.5 to 3 meters (5 to 10 feet) bgs. Based on review of the boring logs, the silty fine sand unit that the artesian piezometers were screened within appeared to be confined by a 0.6 to 0.9 meter (2 to 3 foot) thick stiff silty clay layer at a depth of approximately 6 meters (20 feet) (at HGB-3). Based on water level measurements made in February 2001 in the nested piezometers at HGB-2, the potentiometric head within the fine sand unit was substantially higher than the head in the overlying water-bearing zone.

3.6 WATER QUALITY

The quality of surface and ground water at the project site is affected by historic and current land uses and the composition of subsurface geologic materials. Water quality in surface and ground water bodies is regulated by the State Water Resources Control Board and Regional Water Quality Control Boards. The project site is under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board (RWQCB), which is responsible for implementation of state and federal water quality protection laws and regulations in the vicinity of the project site. The RWQCB prepares and adopts the Water Quality Control Plan, San Francisco Bay Basin (Basin Plan),[35] a master policy document for managing surface and ground water quality issues in the region. The Basin Plan establishes beneficial uses for waterways and water bodies within the region. Beneficial uses of coastal waters in San Francisco Bay include water contact recreation, noncontact water recreation, industrial service supply, navigation, marine habitat, shellfish harvesting, fishing, and preservation of rare and endangered species. Existing beneficial uses of the groundwater aquifer underlying the site (characterized as part of the San Francisco Sand Dune Area) include municipal and agricultural supply with industrial process and service water supply as potential beneficial uses.

The State Water Resources Control Board and the San Francisco Bay Regional Water Quality Control Board issue permits that implement the standards included in the Basin Plan as well as other requirements of the State Water Code and the Federal Clean Water Act.

3.6.1 Surface Water

Runoff water quality within the Presidio is currently subject to the Federal Nonpoint Source Program (established through the Clean Water Act), and implemented by individual states. The objective of this program is to control and reduce pollutant discharges to water bodies from nonpoint sources (which includes storm water runoff not regulated by a National Pollutant Discharge Elimination System (NPDES) permit). The Program is administered by the California Regional Water Quality Control Boards. The project site would be under the jurisdiction of the San Francisco Bay RWQCB.

In 1999, U.S. EPA promulgated storm water regulations, known as Phase II, requiring permits for storm water discharges from small municipal separate storm sewer systems (MS4s). To implement the Phase II program, the State Water Resources Control Board has issued a General Permit designated Water Quality Order No. 2003-0005-DWQ (NPDES No. CAS000004). This is known as the Phase II Small MS4 General Permit.

[34] Based on review of the field notes for the boring logs, it appears that recovery ranged from zero to 100 percent (for individual sample runs), and overall was approximately 70 percent. On average, about 17 inches of sample was recovered for each 24-inch sampler retrieved.
[35] San Francisco Bay Regional Water Quality Control Board, 1995, Water Quality Control Plan, June 21.

As part of this program, the SWRCB has listed in Attachment 3 to the General Permit, "Non-Traditional Small MS4s" anticipated to be designated in the future as being subject to the General Permit. The Presidio is included on this list. Once formally designated, the Presidio Trust will be required to prepare a Stormwater Management Plan and comply with the other provisions of the General Permit.

Discharges from Caltrans roadway facilities are regulated by an NPDES Statewide Storm Water Permit (Caltrans Permit – Order No. 99-06-DWQ) (NPDES No. CAS000003). This permit regulates discharges both during and after construction. The Caltrans permit requires that Caltrans implement the technical provisions of the statewide general permit for construction activities (Construction General Permit – Order No. 99-08-DWQ) (CAS000002). All construction projects resulting in soil disturbance of more than 0.4 hectare (1 acre) are subject to regulation under the Construction General Permit, which would apply to this project (through the Caltrans statewide permit). The Caltrans statewide permit requires Caltrans to implement and maintain an effective Storm Water Management Plan (SWMP). Caltrans uses the approved SWMP to address water quality concerns both during and after construction. The permit and SWMP specify that Caltrans will implement maximum extent practicable (MEP) pollutant control for roadway runoff. In addition, construction site runoff must be controlled using best available technology economically achievable (BAT) for toxic pollutants, and best conventional pollutant control technology (BCT) for other pollutants. Procedures to achieve compliance with water quality standards are also specified in both permits.

Projects within the Presidio disturbing more than 0.4 hectare (1 acre) of land during construction are required to file a Notice of Intent (NOI) with the RWQCB to be covered under the State NPDES General Construction Permit for discharges of storm water associated with construction activity. Caltrans construction projects have a different notification procedure, as specified in the Caltrans Statewide Permit. Proposed control measures must be consistent with the General Construction Permit. A Storm Water Pollution Prevention Plan (SWPPP) must be developed and implemented for each site covered by the general permit or by the Caltrans permit.

Data on surface water quality in the Presidio are limited. In support of the preparation of the Storm Water Management Plan for the Presidio, the chemical quality of several samples collected from runoff in the storm drainage system were analyzed for biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total kjeldahl nitrogen, total phosphorus, heavy metals, oil and grease, and coliform. The following interpretations were made of the data by the investigators conducting the sampling:[36]

- Runoff is neutral to slightly basic;
- COD and TSS were similar to the mean concentration identified for urban runoff by the U.S. EPA in their National Urban Runoff Program (NURP),[37]
- BOD was found to be similar to the mean concentration identified for urban runoff by the NURP study (except in the industrial areas[38] of the Presidio, where concentrations were typically twice as high as the mean);
- Oil and grease were consistently detected in the industrial areas;
- Total kjeldahl nitrogen was identified in all areas at concentrations similar to the mean concentration identified in the NURP study;
- Phosphate was not identified in any of the samples;
- Metals were occasionally detected in the samples, particularly samples collected from the industrial areas.

In summary, BOD, COD, certain metals, and oil and grease were consistently detected at elevated concentrations in runoff from the industrial/urban areas near Buildings 610 and 979. Elevated concentrations

[36] Dames and Moore, 1994, op. cit.
[37] U.S. EPA, 1983, National Urban Runoff Program, 1983, Results of the Nationwide Urban Runoff Program, Vol. 1, December.
[38] The industrial areas sampled as part of the Presidio Storm Water Management Plan include the parking area northwest of Building 979 and the north side of Doyle Drive near Building 610.

of pollutants in runoff from industrial/urban areas are not unexpected since activities (e.g., chemical use and increased roadway and parking density) that could contribute to pollutant loading are concentrated in these areas.

In addition, as part of the effort to gather data for the restoration of Tennessee Hollow, the Trust has collected data on water quality parameters (temperature, specific conductance, and pH) of surface water flows at various locations in the Tennessee Hollow watershed.[39] Evaluation of the results of water quality parameter testing indicates a wide range of values and that the character of the surface water is influenced by the quantity of flow in the stream (e.g., high flows are generally characterized by lower specific conductance than low flows).

3.6.2 Groundwater

Discussion of impacts to groundwater quality resulting from past activities at the site (e.g., hazardous materials releases) is presented in the Preliminary Site Investigation, January 2002. This discussion focuses on ambient groundwater quality underlying the Presidio. The Presidio is underlain by three distinct groundwater basins: Lobos Creek, Coastal Bluffs, and the Marina basin. The Marina basin (which largely coincides with the San Francisco Bay watershed area) is the basin that could be affected by the proposed project. The Lobos Creek and Coastal Bluffs basins are not crossed by the project alignment (except a small segment of the south approach to the Golden Gate Bridge which crosses the Coastal Bluffs basin), and are not further discussed.

The Marina basin's aquifer is thin, with a high potential for subsidence (if groundwater were to be extracted), and largely of unknown water quality.[40] For these reasons, use of the aquifer as a drinking water resource is limited. In the vicinity of Crissy Field, tidal effects appear to be limited to the near-shore environment. A study evaluating the tidal effect on groundwater level fluctuation determined that, at 150 meters (500 feet) from the shore, tide-related oscillations in groundwater level were less than 0.015 meter (0.05 foot).[41] Recent tidal studies conducted on existing monitoring wells associated with a petroleum hydrocarbon release investigation at Building 231 indicate that the upper water-bearing zones in the vicinity of monitoring well 231GW15 are tidally influenced.[42] A figure showing the location of monitoring well 231GW15 is included in Appendix B.

Saltwater intrusion into shallow groundwater underlying the Presidio appears to be restricted to the near-shore areas. Several wells located in the Crissy Field area [ranging from 45 to 170 meters (150 to 550 feet) from the shore] indicate that levels of total dissolved solids and chloride are nearer to freshwater than sea water.[43] Groundwater samples collected from various depths from nested piezometers HGB-2 and HGB-3 were analyzed for electrical conductivity and found to range between 554 and 909 µmhos/cm, indicating fresh water.[44]

[39] Kamman Hydrology and Engineering, 2003, Draft Final Hydrologic Monitoring Report for the Tennessee Hollow Riparian Corridor Restoration Project, the Presidio of San Francisco, March.
[40] San Francisco Water Department, 1996, San Francisco Groundwater Master Plan.
[41] Dames and Moore, 1995, op. cit.
[42] Ullensvang, Brian, 2001, Remediation Manager, National Park Service, written communication of preliminary data collected by the Presidio Trust with Bruce Abelli-Amen of BASELINE, 14 March.
[43] The water samples that this conclusion was based on were collected from shallow wells (screened to a depth of 10 feet below the ground surface).
[44] The electrical conductance of a substance is its ability to conduct an electrical current. Current flows in ionized or mineralized water because the ions are electrically charged and move toward a current source that will neutralize them. The higher the electrical conductivity, the higher the salinity of water. The EC for fresh water typically ranges from 0 to 1,500 µmhos, for brackish water from 1,500 to 15,000 µmhos, and saline (including ocean water) above 15,000 µmhos.

SECTION 4: POTENTIAL IMPACTS AND MITIGATION MEASURES

4.1 SIGNIFICANCE CRITERIA

The following list of criteria of significance for environmental effects is largely based on the California Environmental Quality Act (CEQA) Guidelines Appendix G Environmental Checklist Form. Each criterion is discussed for relevance to the project.

The proposed project may have a significant effect if it would:

- Significantly increase the pollutant load associated with storm water runoff.
- Cause a violation of the Caltrans Statewide Permit (for Caltrans associated discharges) or the General Construction Permit for non-Caltrans projects).

  Discharge of dewatering effluent or runoff from any of the proposed alternatives (either during the construction or operation periods) that includes sediment and/or urban pollutants above allowable regulated thresholds could affect receiving waters, if handled improperly.
- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level.

  The net change in impervious surfaces will vary for each of the proposed alternatives. The Presidio Parkway Alternative includes one tunnel segment (in the bluff area) that may cause effects on aquifer volume and local groundwater table levels.
- Substantially alter drainage patterns, currents, or the course or direction of water movements, in a manner that would result in substantial erosion or siltation on- or off-site, or substantially increase the rate or amount of surface water runoff in a manner that would result in flooding on- or off-site.

  If runoff volumes and velocities exceeded the capacity of downgradient storm water conveyances, some degree of flooding could occur. However, the Location Hydraulics Study, December 2001 indicates that the existing storm drainage system could accommodate flows from each of the proposed alternatives, therefore there is no further discussion of mitigation or design measures. Construction-period erosion of stockpiled materials, if improperly protected and stabilized, is a potential impact of the project.
- Create or substantially contribute to runoff water that would exceed the capacity of existing or planned storm water drainage systems or provide substantial additional sources of polluted runoff.
- Alter the course or flow of flood waters within the 100-year flood hazard area.

  There is no floodplain mapping for the site.[45] No documented historic flooding problems have been reported in the literature reviewed for this study. Any impacts associated with alteration of flood waters would be considered less than significant; therefore, there is no further discussion of mitigation or design measures.
- Place structures or other improvements susceptible to flooding within a 100-year flood hazard zone as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard map.

  There is no floodplain mapping for the site. No documented historic flooding problems have been reported in the literature reviewed for this study. Any impacts associated with placement of improvements in a storm-related floodplain would be considered less than significant; therefore, there is no further discussion of mitigation or design measures.
- Expose people or property to water-related hazards such as flooding, or inundation by seiche, tsunami, sea level rise, mud flows, or dam or levee failure.

[45] A floodplain delineation has not been prepared for the site. Neither the City nor the Presidio has participated in the Federal Emergency Management Agency's flood insurance program, and therefore floodplains have not been mapped by FEMA.

Flooding could occur locally if drainage inlets were to become blocked during substantial precipitation events. In addition, the project could be susceptible to coastal flooding from tsunamis, extreme high tides, and/or sea level rise.

- Substantially damage, disrupt, or remove designated unique geologic and/or subsurface hydrology resources.

  The bluffs south of Crissy Field are designated as unique geologic and subsurface hydrologic resources in the Draft Implementation Plan (2001). Construction of a tunnel segment through these bluffs would result in removal of a portion of a designated unique resource.

4.2 TEMPORARY CONSTRUCTION-RELATED EFFECTS

4.2.1 Managing Effluent Associated with Construction Dewatering

Construction of any of the build alternatives would require excavation below the groundwater level (e.g., tunnel construction, excavation for pile caps at bridge foundations). Typical construction practices require pumping of groundwater to dewater excavations below the groundwater level.

The most substantial excavation would occur under the Presidio Parkway Alternative (Alternative 5) during excavation for the tunnel through the bluff area north of the cemetery. Based on groundwater level data collected during the preliminary geotechnical investigation, it is estimated that the groundwater table is approximately two to three meters (6 to 9 feet) above the bottom of the proposed tunnel excavation elevation (although seasonal variation is likely). This potential condition warrants the use of a shoring system that would minimize groundwater intrusion into the below ground work area. One potential type of shoring system that could be used to construct the tunnel segment through the bluffs where groundwater inflows would likely be relatively low would include secant[46] piles in the soils and the thin layer of Colma Formation and shotcrete[47] and dowels or soldier piles[48] and lagging in the bedrock. However, this does not preclude the use of other types of temporary shoring systems (i.e., interlocking sheetpiles) that are structurally sound and minimize groundwater intrusion. With an appropriate temporary shoring system in place, strip drains would be installed during excavation to permanently convey groundwater around the tunnel. Dewatering would occur for the duration of the excavation and tunnel construction process, approximately one to two years. Potential temporary and long-term impacts associated with the disruption of fracture flow to the bluff face where important plant communities are further described below under Potential Alteration to Hydrogeology in the Vicinity of Bluffs and in the Natural Environment Study for this project.

Four hazardous materials sites under investigation and/or remediation by the Trust are located within approximately 500 feet of the proposed tunnel location:[49] Sewer Lift Station No. 1, Building 662 Area, Building 669 Area, and the Building 633 firing range. Of these sites, only Sewer Lift Station No. 1 is considered to have the potential for groundwater impacts. As the lift station is located north of, and hydraulically downgradient of, the proposed tunnel location, contaminants from this site would not be

[46] Secant piles are piles (vertical holes filled with concrete) placed side by side. One pile cuts into the adjacent pile, so the two are in direct contact with each other. Secant piles can be placed in a series, each cut into the adjacent pile, forming a wall. The walls can be made in a circular or rectangular pattern and hold back the soil when the inside is excavated.

[47] Shotcrete is mortar or concrete conveyed through a hose and pneumatically projected at high velocity onto a surface. Shotcrete used in conjunction with dowels or rock bolts (steel bolts drilled and cemented or mechanically fastened into the rock face) can be an effective shoring system for excavations in rock.

[48] The soldier pile and lagging shoring system consists of a series of steel I-beams that are placed vertically in the ground before excavation begins. As the excavation proceeds downward, the exposed earth walls between the piles are sheeted with boards or other suitable materials. The allowable excavation that can take place before the operation must be stopped and sheeted depends on the soil type. In sandy soils the sheeting must be nearly continuous.

[49] Erler & Kalinowski, Inc., 2003.

expected to affect dewatering operations. Additional information regarding hazardous materials sites is provided in the Waste and Hazardous Materials Technical Memorandum.

Although existing groundwater quality data do not indicate that groundwater in the vicinity of the bluffs tunnel is contaminated, it is possible that unidentified contaminants are present. If contaminants were present in dewatering effluent at levels that could cause environmental harm, a significant impact could occur. Potential impacts to the public or project workers are described in the Waste and Hazardous Materials Technical Memorandum. No indirect or cumulative effects associated with discharge of effluent are expected if current regulations are followed.

Mitigation Measure (No-Build)

None required.

Mitigation Measure (Replace and Widen, Presidio Parkway)

An effluent management plan would be prepared by the project proponent that would characterize the quality of groundwater in the vicinity of the dewatering operations (prior to initiation of dewatering), address permitting of the discharge, include specific management measures to ensure that uncontrolled runoff (which could impact the environment) does not occur, and detail the means of coordination with the appropriate regulating agencies.

The discharge of groundwater to the sanitary sewer system would be required to comply with the San Francisco Public Utilities Commission (PUC) pretreatment standards and other requirements for discharge to the City's sewer system. Such a discharge may require the Southeast Water Pollution Control Plant to accommodate a temporary and very minor additional pollutant load (only for the build alternatives). Prior to discharge of the dewatering effluent to the Presidio sanitary sewer system, an approval for discharge would be required from the Presidio Trust Utilities Department. However, the discharge of relatively clean groundwater to sanitary sewer systems is generally discouraged since it takes treatment capacity that is better dedicated to the treatment of domestic sewage and industrial wastes. Discharge to the storm sewer system (and eventually to the Bay) or directly to the Bay would be addressed by the Caltrans Statewide Permit, which incorporates the performance requirements and other technical provisions of the Construction General Permit. In exceptional cases, the Regional Water Quality Control Board may require a separate NPDES permit for the dewatering discharge.

Representatives from the Trust, NPS, and/or the Southeast Water Pollution Control Plant in coordination with the Region 2 RWQCB would determine whether the discharges were acceptable[50] and, if not, evaluate on-site treatment options to reduce contaminants to acceptable levels. If the dewatering effluent does not meet the requirements for sewer discharge, provisions for other off-site treatment/disposal or on-site treatment should be made. These permit requirements, if appropriately enforced, would reduce the potential impact of disposal of contaminated groundwater into the combined sewer system and the local storm drain system to a less-than-significant level.

4.2.2 Degradation of Runoff Quality during Construction

The build alternatives would involve roadway construction, including excavation, grading, stockpiling of soil, and reconstruction of existing facilities involving removal and replacement of earthen materials. It is possible for runoff generated during rainstorms at the site to result in erosion of exposed soil. Sediment transported by runoff could cause sedimentation in downstream drainages and/or the sewer system. The accumulation of sediment could result in blockage of flows, potentially resulting in localized ponding or flooding and potentially adverse effects on aquatic habitat. In addition, it is possible that suspended sediment could affect

[50] The determination would be made by evaluating the characteristics of the proposed waste discharge with the provisions of the existing waste discharge permit (Order No. 158170) held by the Presidio.

aquatic biota in receiving waters. However, required provisions within the existing Caltrans permit provide mitigation for sedimentation during construction.

Under existing conditions, the majority of runoff generated from the project site flows to the Bay (either directly or through Crissy Marsh) through storm water sewers or as overland flow, particularly during large storms. During construction, sediment could be transported by the runoff and discharged into the Bay, resulting in water quality degradation.

As noted in Section 3.6.1, the terms for coverage under the Caltrans permit require that a SWPPP be developed and implemented for the project during construction to reduce the potential for adverse effects of erosion and sedimentation. Typical contract specifications require that Caltrans, through their construction contractors, provide temporary site drainage controls and source and sediment controls to prevent and minimize soil erosion. Construction storm water pollution prevention measures (referred to as BMPs) are focused at specific areas within each construction area to prevent sewer system backup or flow damage to property. The SWPPP is required to identify any potential pollutant sources that may affect the quality of the runoff and identify, construct, and implement BMPs to reduce pollutants in storm water discharges from a construction site.

In general SWPPPs include the following types of measures to reduce pollutants in runoff water during construction:

- At a minimum, BMPs should include practices to minimize the contact of construction materials, equipment, and maintenance supplies (e.g., fuels, lubricants, paints, solvents, adhesives) with storm water. The SWPPP should specify properly designed storage areas that keep these materials protected from rain and run-on from adjacent drainage.
- An important component of the storm water quality protection effort is the knowledge of the site supervisors and workers. To educate on-site personnel and maintain awareness of the importance of storm water quality protection, site supervisors should conduct regular tailgate meetings to discuss pollution prevention. The frequency of the meetings and required personnel attendance list should be documented in the SWPPP.
- The SWPPP should specify a monitoring program to be implemented by the construction site supervisor, and must include both dry and wet weather inspections.
- BMPs designed to reduce erosion of exposed soil may include, but are not limited to: soil stabilization controls, watering for dust control, perimeter silt fences, placement of rice straw bales, and sediment basins. The potential for erosion is generally increased if grading and earth disturbance is performed during the rainy season as disturbed soil can be exposed to rainfall and storm runoff. If grading must be conducted during the rainy season, the primary BMPs selected should focus on erosion control, that is, keeping sediment on the site. End-of-pipe sediment control measures (e.g., basins and traps) should be used only as secondary measures. Soil stabilization (source control) should be the primary choice for controlling sediment deposition and erosion. As such, appropriate use of temporary soil stabilizers and covers should be applied and implemented in coordination with construction activities. Coordinated stabilization will minimize the amount of open disturbed areas at any one time and provide continuous stabilization throughout the winter season. If seeding is to be used, all seed mixes and placement methodologies must be approved by the Trust and/or NPS resources staff. Entry and egress from the construction site should be carefully controlled to minimize off-site tracking of sediment. Vehicle and equipment wash-down facilities should be designed to be accessible and functional during both dry and wet conditions.

The NPS and the Trust are responsible for managing numerous habitat resource issues within the Presidio and should be involved in the preparation and/or review of the SWPPP to ensure that the highest level of protection is provided for existing resources. No indirect effects associated with the control of runoff during construction of the build alternatives have been identified. No cumulative effects of construction phase runoff are expected if current regulations are enforced.

Mitigation Measure (No-Build)

None required.

Mitigation Measure (Replace and Widen, Presidio Parkway)

In a coordinated effort with Caltrans, the project proponent will submit the SWPPP for the construction activities to the Trust and NPS for review and comment. Otherwise, compliance with existing regulations and programs would adequately mitigate this potential impact.

4.3 PERMANENT OPERATIONAL EFFECTS

4.3.1 Potential Increase in Urban Runoff Pollutant Load

The operation of roadways results in the discharge of contaminants to the environment that can be transported by runoff away from the roadways and new and/or modified ramps. These pollutants could reach receiving waters and potentially increase the incremental pollutant load discharged to the Bay. Pollutants associated with roadways include metals and petroleum hydrocarbons contained in fuels and lubricants and pollutants associated with wear of tires and brake pads (e.g., particulate matter and metals).

Under the existing condition, the total amount of impervious area (the catchment area) of the project-related Doyle Drive is approximately 41,800 square meters (450,000 square feet).[51] This area would not change under the No Build Alternative. Under the Replace and Widen Alternative, the area of the Doyle Drive catchment would increase to 66,000 square meters (710,000 square feet). Under the Parkway Alternative, the area would also increase, but only slightly relative to the No Build to 45,200 square meters (486,300 square feet). The Parkway Alternative would result in less of an impervious area increase because of the two tunnel segments, which would be covered with an adequate soil profile to provide infiltration of precipitation (areas over the tunnels would not be considered impervious).[52] The Parkway Alternative would result in the reduction of total pollutant loading associated with the roadway (relative to the No Build and Replace and Widen alternatives) since approximately 45 percent of the roadway under the Parkway Alternative would be in tunnel segments and therefore not subject to stormwater runoff.[53]

It should be noted that the project does not include additional traffic capacity, and therefore it would not be expected that the pollutant load would increase under any of the alternatives. The total area of the catchment is not the determining factor when considering the pollutant load. The vehicle traffic volume is the most important factor, and for this project the traffic volume will stay the same as the existing condition under each of the alternatives. Regardless, new or major Caltrans reconstruction roadway projects must consider treatment of storm water runoff, as specified under Regional Water Quality Control Board Order 99-06-DWQ. As a means of implementing Order 99-06-DWQ, Caltrans has prepared a Storm Water Management Plan (SWMP),[54] which is regularly revised and updated (at the time of this writing, the current SWMP is the May 2003 SWMP). The plan includes three main components:

- The Project Development Storm Water Management Program, which includes the Design Storm Water Management Program and the Construction Storm Water Management Program;
- The Maintenance Storm Water Management Program; and
- The Training and Public Education Program.

[51] As measured between stations 7 and 27 (excluding offramps and onramps).
[52] As stated in section F.3 of the Regional Board Order 99 – 06 – DWQ "At a minimum, a consideration of structural controls for water quality improvement shall be included in the design of any new construction or major reconstruction or repair projects."
[53] This assumes that any residual water collected within the tunnel during storms or during washdown activities is contained and treated, as described in Mitigation Measure 4.3.1.
[54] Caltrans Statewide Storm Water Management Plan, May 2003.

Implementation of the SWMP requires that pollution prevention and control measures be incorporated into the project design. All projects must be evaluated for conformance to the provisions in the SWMP. For non-exempt projects, a consideration process is undertaken to determine the feasibility for incorporating minimum design elements with respect to water quality concerns, including: 1) minimizing impervious surfaces, 2) preventing downstream erosion, 3) stabilizing disturbed soil areas, and 4) maximizing vegetated surfaces. In addition, the Order (RWQCB Order 99-06-DWQ) requires that permanent control measures be considered for new major construction projects.

In general, the potential for impacts associated with urban pollutant loading is reduced as the portion of tunnelized roadway increases. Pollutants deposited on the roadway within a tunnel would not be subject to direct precipitation and entrainment in runoff (although some water will be carried into the tunnel on cars during storms). The volume of storm water that is collected in the tunnel sumps would be of much lesser volume than that of a similar sized aboveground roadway, but would be expected to contain relatively high concentrations of urban pollutants. The lesser volume of water allows greater flexibility and efficiency for potential treatment options, prior to discharge.

Each of the alternatives includes an elevated structure over the Tennessee Hollow corridor. At some time in the future, the Tennessee Hollow corridor may be completely restored and include open intertidal waters and/or riparian habitat in the vicinity of Doyle Drive. Direct discharge of roadway runoff to the Tennessee Hollow system should include consideration for the ultimate development of the site below the elevated structure. The discharge of roadway runoff to intertidal waters should consider runoff treatment prior to discharge to the maximum extent practicable. No indirect or cumulative effects associated with increased pollutant loading are expected if the following mitigation is implemented.

Mitigation Measure (No-Build)

None required.

Stormwater Treatment Alternatives (Replace and Widen, Presidio Parkway)

The setting of the project inside a national park requires special consideration be given to treatment of stormwater runoff. The following treatment alternatives are favored for implementation to eliminate or reduce pollutants in runoff from the proposed roadway. Measure 4.3.1 is the preferred alternative. This alternative is considered to provide maximum protection to resources within the National Park setting and may result in less land requirements needed for installing treatment controls.

4.3.1-a

Stormwater runoff from the proposed roadway, including washdown water and incidental runoff from within the tunnels (Presidio Parkway alternative only), shall be collected and discharged to the existing sanitary sewer system. This runoff would then be treated at the City and County of San Francisco wastewater treatment facility.

Alternatively, if 4.3.1-a is determined to be infeasible, the following alternative shall be implemented:

4.3.1-b

Runoff from the new roadway would be treated prior to discharge to surface waters, to the extent feasible, at or near the new structure. Caltrans shall coordinate with the Trust and NPS during the permanent treatment control (best management practices (BMP)) selection process. The selected build alternative will incorporate, to the maximum extent practicable (MEP), the treatment of roadway pollutants in runoff prior to discharge to any surface water systems. In accordance with the Caltrans Storm Water Management Plan (SWMP), Caltrans will design, construct, and maintain BMPs to treat stormwater runoff from the new roadway associated with this project. It is acknowledged that frequent small storms, which over the long-term carry the substantial quantity of total pollutant load, would be the focus of the treatment BMPs. Most

modern well-designed runoff treatment systems include bypass features that allow the safe passage of larger untreated storm flows.

Based on the physical constraints along the alignment, it will be challenging to identify feasible treatment controls that are effective in the removal of specific pollutants. Caltrans shall conform to the requirements of its SWMP to incorporate treatment controls and during the design phase will use Caltrans-approved BMPs to treat roadway runoff to the MEP. Caltrans-approved BMPs include 1) land-based biofiltration, detention and infiltration treatments that employ filtering medium in combination with vegetation to filter and treat stormwater and 2) "in-line" structural BMPs such as media filters and multi-chamber treatment trains that treat concentrated runoff. The structural BMPs typically require less area for installation and are more maintenance intensive. The complete list of Caltrans-approved BMPs, including a brief description of each BMP is included in Appendix D. If none of the approved BMPs appear feasible, the NPS and Presidio Trust will work cooperatively with Caltrans to develop other mitigation measures for stormwater treatment.

Washdown water (and any incidental stormwater runoff) collected from within the tunnels (Presidio Parkway alternative only) should be discharged to the sanitary sewer system. If discharge to the sanitary sewer system is infeasible, this water shall be collected and hauled off-site for treatment and disposal.

Caltrans shall collaborate with the NPS and Presidio Trust to develop feasible measures for implementation. If more than one type of Caltrans-approved BMP is determined to meet the MEP requirement, Caltrans shall select the preferred BMP in consultation with the NPS and Presidio Trust.

Relative to the existing condition, Doyle Drive stormwater runoff currently is discharged to existing drainage facilities without treatment, the build alternatives, with the inclusion of some form of treatment controls, are expected to provide a net benefit to stormwater runoff quality and the quality of receiving waters.

4.3.2 Potential Flooding of Roadway and/or Tunnel

The low-lying portions of the alignment, particularly in the area of the Main Post, could be subject to infrequent flooding events caused by tsunami wave run-up and/or extreme high tides. Expected inundation levels associated with these flooding events could be exacerbated over time with expected sea level rise because sea level rise incrementally increases the base level to which wave elevation would be added.

Any roadways or tunnels below 3.2 meters (10.5 feet) NAVD[55] could be inundated during the 100-year tsunami wave run-up event [by the year 2050, the inundation elevation is expected to rise incrementally to 3.35 meters (11 feet) NAVD]. Based on review of available topographic data,[56] it appears that the existing surface elevations in the vicinity of the Main Post are near or below an elevation of 3.35 meters (11 feet) NAVD. Therefore, if the roadway were to be constructed at grade without flood protection features, it is possible that the roadway could be inundated one or more times during the operational life of the project. Only the Presidio Parkway Alternative would place roadways at or near grade (the No-Build and Replace and Widen alternatives have elevated roadways through the low-lying Main Post area). No indirect or cumulative effects associated with flooding are expected. Given this potential for tidal-related flooding where water surges up into the storm drainage system, the ability to implement effective treatment controls within specific areas of the project may be less infeasible.

[55] Predicted wave run-up elevations vary from 2.5 meters (8.2 feet) in the western portion of the site to 2.4 meters (7.8 feet) in the eastern portion. The predicted elevation in the eastern portion of the site [2.4 meters (7.8 feet)] was selected for use in this analysis because the existing ground surface in the eastern portion of the alignment is low-lying and susceptible to flooding, whereas n the western portion of the alignment it is at elevations that are not susceptible to coastal flooding hazards.

[56] Parsons Brinckerhoff, 2001, topographic map of Doyle Drive corridor, contour interval 0.5 meter, written communication with Bruce Abelli-Amen of BASELINE, 19 March.

Mitigation Measure (No-Build, Replace and Widen)

None required.

Mitigation Measure (Presidio Parkway)

The Presidio Parkway Alternative shall include flood protection for the low portions of the roadway at:

- the eastern portal of the Main Post tunnel;
- the depressed roadway segment north of the Gorgas warehouses;
- the depressed segment of Girard Road.

The flood protection features shall consist of either landscaped berms or barrier structures with crests greater than 3.35 meters (11 feet) NAVD. Properly designed and constructed flood protection structures would reduce this potential impact to a less-than-significant level.

4.3.3 Potential Alteration to Hydrogeology in the Vicinity of Bluffs

The PTMP includes planning principles that would guide the Trust's management of Area B. The section on Geologic Resources under Principle 8 includes the following statement:

"The Presidio contains some fragile geologic and soil resources, including the Colma formation dunes, and the serpentine outcrops and bluffs at Inspiration Point and south of Crissy Field. The Presidio Trust would protect and monitor unique geologic and subsurface hydrologic resources and functions..."

It is certain that construction of a tunnel upgradient of the bluffs (as is proposed by the Presidio Parkway Alternative) would result in removal of a portion of the geologic materials that comprise a designated resource. Therefore, in accordance with the criteria established in the significance criteria section, the removal of these materials is considered a significant impact.[57] Since the removal of the subsurface materials is a required activity for tunnel construction, the impact is significant and unavoidable (for the Presidio Parkway Alternative only).

It is possible that the tunnel can be constructed so that disruption of groundwater flow around the tunnel is minimized. However, even minor alterations to the groundwater flow pattern to the bluffs could have indirect impacts on the biotic resources on the bluffs.

Surface and/or near surface water occurs at various locations on and at the base of the bluffs (north of the cemetery) year-round. It is possible that construction and operation of a tunnel upgradient of the bluffs could alter or disrupt groundwater flow to the bluffs, potentially impacting existing plants that rely on emergent groundwater. Year-round wet conditions at the bluffs must be supported by a continuous source of groundwater. It is likely that groundwater upgradient of the top of the bluffs is replenished by a combination of infiltration of rainfall during the rainy season and year-round infiltration of irrigation water at the cemetery and other Presidio facilities.[58] The dune sands that underlie most of the area in the vicinity of the cemetery would be expected to maintain a relatively high infiltration capacity, potentially allowing deep infiltration of a substantial amount of rainfall and irrigation water. The majority of the water that infiltrates beyond the root zone would be expected to migrate downward under gravity drainage and soil capillary forces to the groundwater table.

[57] The significance criteria referred to states that an adverse effect would occur if the project were to: "Substantially damage, disrupt, or remove designated unique geologic and/or subsurface hydrologic resources."

[58] The main water supply line to the irrigation system of the National Cemetery is not metered (Fitzgerald, 2001). Based on published data on turf grass irrigation requirements in the vicinity and typical irrigation efficiency, it is estimated that irrigation may account for approximately 25 percent of groundwater recharge from surface infiltration within the boundaries of the cemetery (infiltration of precipitation would account for the other 75 percent).

Based on the boring log for geotechnical boring GB-5 installed in January 2001 (Figure 4), depth to first groundwater along the alignment at the top of the bluffs is below the dune sand, occurring at a depth of approximately 8 meters (26 feet) below the ground surface in the Colma Formation. Under existing conditions, groundwater flows from the Colma Formation to the sheared Franciscan bedrock that comprises the bluffs. The boring logs for GB-5 and GB-6 (Figure 4) indicate that Franciscan in this area is composed of intensely weathered fine-grained sandstone, siltstone, and metasedimentary rock. Groundwater flow in the Franciscan is expected to be dominated by flow in the fractures (the actual competent rocks have a relatively low permeability). The fracture pattern within the Franciscan unit has not been defined, but is expected to be extremely complex. Based on the proposed location and depth of the tunnel, portions of the tunnel may be constructed at or near the contact between the Franciscan and the Colma formations (Figure 5).

Groundwater conveyance to the fractures could be disrupted if the water table was substantially lowered and/or the fractures were somehow sealed. The area that would be disturbed by the tunnel would be considered a source area for groundwater flow to the bluffs [the bluffs are more than 90 meters (300 feet) from the proposed tunnel location]. Fractures receive groundwater input in the area of the proposed tunnel and deliver it to the bluffs.

Tunnel construction in this area would include placement of discrete high-permeability strip drains consisting of fabricated geocomposite cores within a filter fabric around the tunnel box. Groundwater would be intercepted on the upstream (south) side of the tunnel and flow through the strip drains to discharge at locations outside the northern sidewall of the tunnel. The strip drains would be placed against the exposed rock before the concrete box is poured and would follow the exposed trace of the planar water-bearing fractures and fissures. No lateral migration of water along the tunnel would be expected to occur because the strip drains would be the only high-permeability pathway; the tunnel box would be reconnected to the geologic formation with concrete and/or low permeability backfill. Any fractures that are receiving groundwater under existing conditions and delivering the water to the bluffs would be expected to continue to receive groundwater flow from the strip drains around the tunnel and/or the undisturbed formation below the tunnel (Figure 5). The strip drains would be expected to convey a similar quantity of groundwater to the bluffs that the existing fractured bedrock formation delivers. However, the flow and volume in specific fractures may be altered. It should be noted that construction of the tunnel may increase flow to the seeps on the bluffs by increasing deep infiltration in the location of the existing Doyle Drive roadway. Replacement of the existing surface segment of Doyle Drive with a tunnel could result in the removal of a substantial amount of impervious cover and an increase in infiltration, potentially raising the groundwater table locally. Raising the water table would steepen groundwater flow gradient and deliver more water to the bluffs.

It may be possible that an increase or decrease in flow within specific bedrock fractures could result in an indirect impact to biotic resources on the entire bluff face. Potential impacts and associated mitigation measures for potential impacts to the biotic resources on the bluff face are included in the Natural Environment Study (NES) for this project. No cumulative impacts associated with groundwater flow in the bluffs have been identified.

Mitigation Measure (No-Build, Replace and Widen)

None required (no tunnel segment through the bluff area).

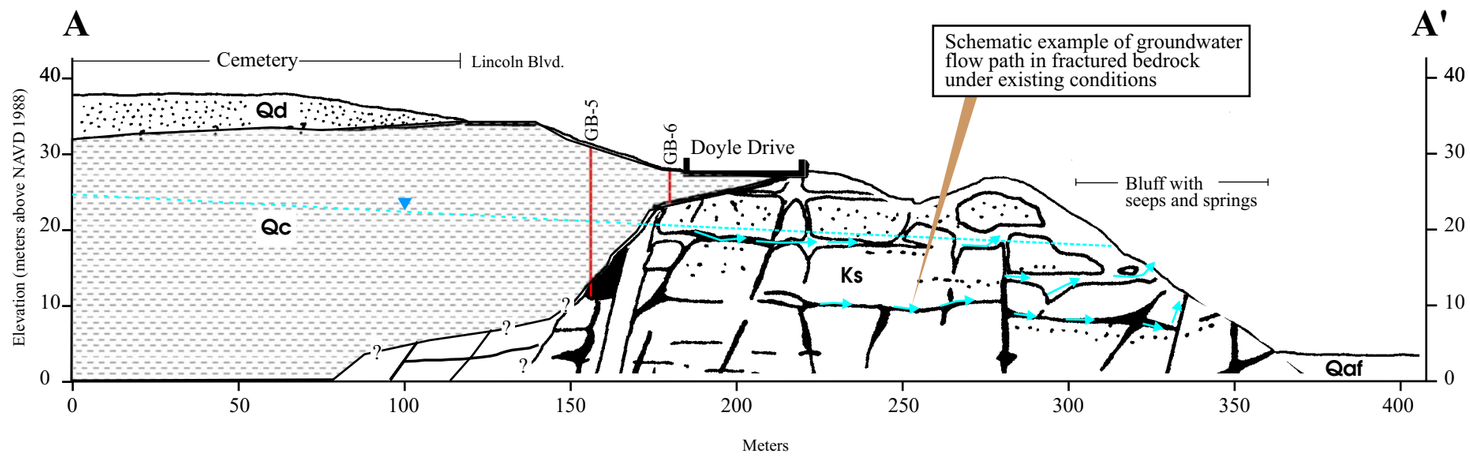
Mitigation Measure (Presidio Parkway Alternative)

No additional mitigation is available for the direct impact (the removal of a portion of a designated resource) and it remains significant, unavoidable, and adverse even after all project-proposed mitigation. The indirect impact (the potential change in groundwater flow in fractures resulting in adverse effects to the local plant communities) is a potential impact to biotic resources and is discussed in the NES.

GEOLOGIC CROSS-SECTION SHOWING GROUNDWATER FLOW CONDITIONS IN THE VICINITY OF THE BLUFFS

Figure 5

EXISTING:



Legend

GB-6 Geotechnical boring location

Groundwater flow in bedrock fractures

Groundwater potentiometric surface approximate, and could have substantial variability due to differential pressure in discrete fractures

Geologic Units:

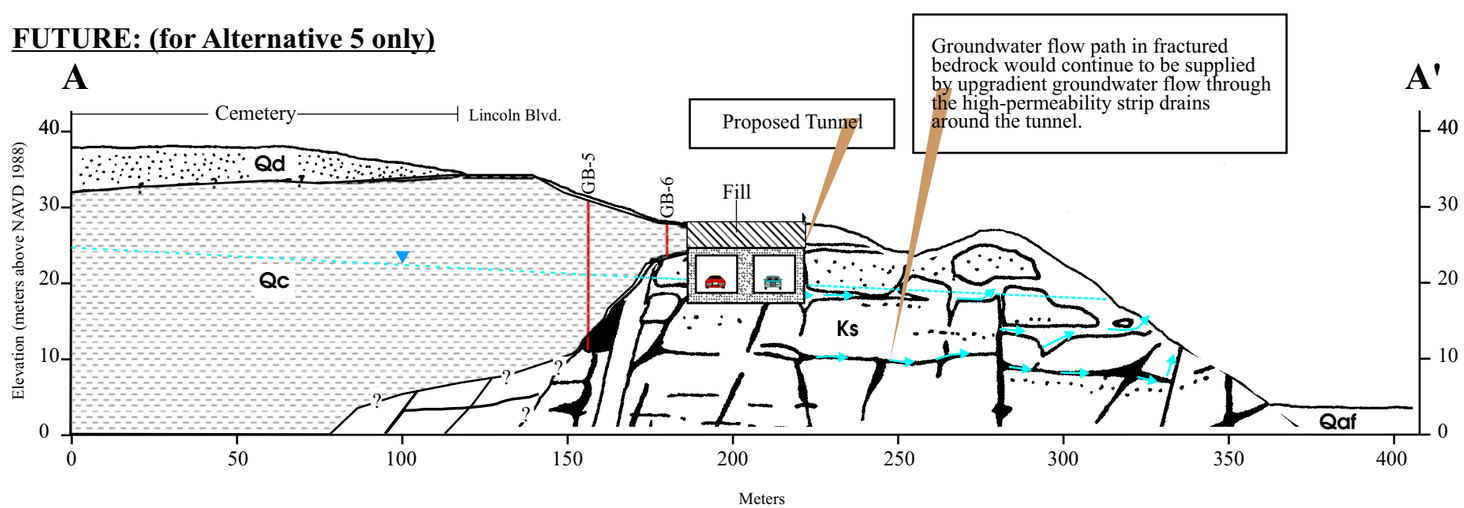
Qaf Artificial Fill

Qd Dune Sand

Qc Colma Formation

Ks Sheared Rocks, undifferentiated (Franciscan Formation)

FUTURE: (for Alternative 5 only)



Refer to Figure 4 for geologic cross-section location.

Doyle Drive
San Francisco, California

BASELINE

D:\Graphics\Y0239-03\Hydro\Figure 5 Geologic Cross-Section .cdr 9/3/04

4.3.4 Potential Alteration to Groundwater Hydrogeology in the Vicinity of Tennessee Hollow

The Doyle Drive alignment crosses the Tennessee Hollow watershed at the transitional boundary between the uplands to the south and the location of the pre-development deltaic/estuary system to the north. Several of the previously proposed alternatives for Doyle Drive (now withdrawn from consideration as part of the feasibility screening process) included a subsurface tunnel segment in the vicinity of Tennessee Hollow. It is possible that specific groundwater flow patterns exist in this area that are important to the existing Crissy Field wetland and/or would be beneficial to the restoration of the Tennessee Hollow drainage. The previously proposed subsurface tunnel in this area was considered a potentially problematic structure in a complex hydrogeologic environment.

Since the subsurface tunnel in the vicinity of Tennessee Hollow is not an element of any of the alternatives being carried forward, the hydrogeologic investigation and analysis conducted to evaluate potential impacts to surface and groundwater systems associated with the this tunnel are not presented here. Background information and the results of those studies are included in BASELINE's July 2002 Hydrology and Water Resources Technical Report, Doyle Drive Environmental Design Study.

The alternatives being carried forward would not be expected to cause any substantial permanent disruption to the groundwater system in the vicinity of Tennessee Hollow since the roadway in this area would be essentially unchanged from a hydrogeologic perspective (i.e., similar to existing conditions for the No-Build and Replace and Widen alternatives or a low causeway for the Presidio Parkway Alternative). No indirect or cumulative effects are expected.

Mitigation Measure (No-Build, Replace and Widen, Presidio Parkway)

None required.

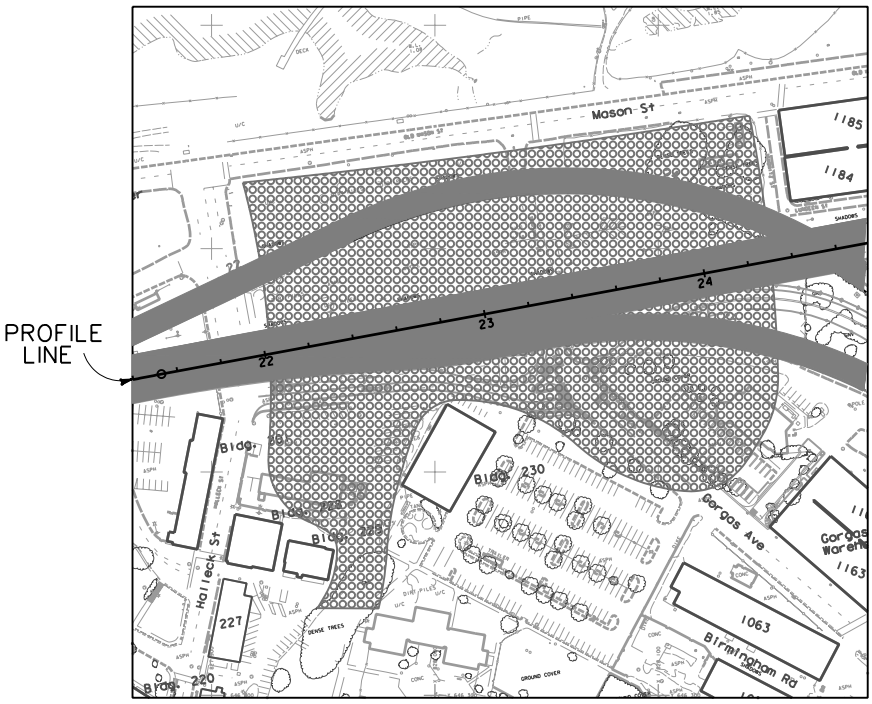
4.3.5 Constraints for Future Tennessee Hollow Crossing Restoration

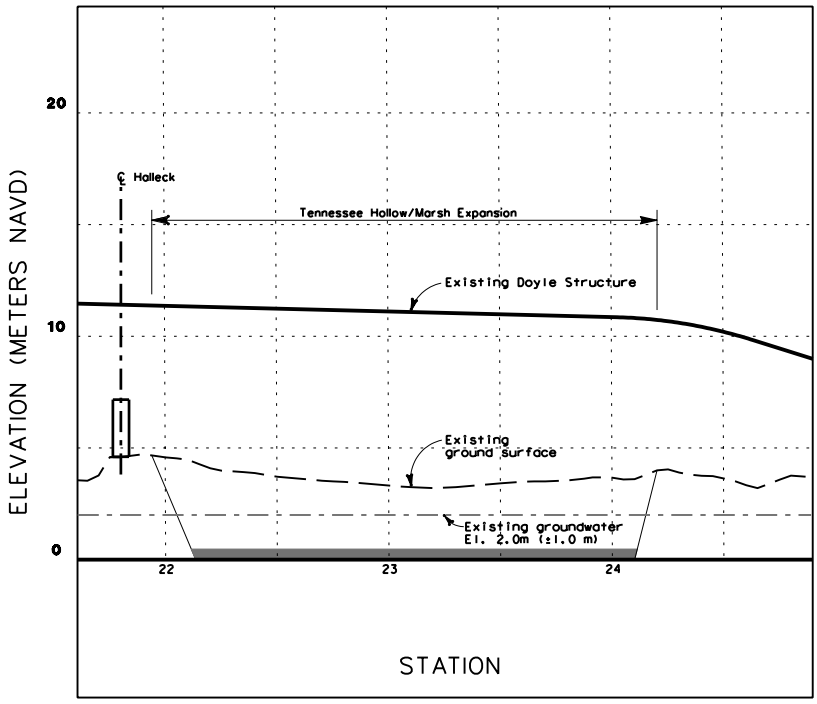
Among the most challenging issues that the selected alternative must address is the crossing over Tennessee Hollow or an expanded Crissy Marsh. The NPS and the Trust support substantial restoration of Tennessee Hollow from a largely culverted drainage to an open creek channel with an associated riparian corridor and salt water marsh capable of supporting habitat occupation and movement. The NPS and Presidio Trust are also pursuing expansion of Crissy Marsh to enhance hydrologic and ecologic function.

The current alternatives all include an elevated structure in the vicinity of Tennessee Hollow. Therefore, the only remaining constraints to the hydrologic restoration of Tennessee Hollow and/or Crissy Marsh are associated with physical constraints of the elevated structures (i.e., the elevation of the bottom of the roadbed, the foundation abutments, and the eastern and western returns to grade).

The No-Build and Replace and Widen alternatives include essentially no constraints associated with the bottom of the roadbed (at an elevation greater than 10 meters [31 feet] NAVD) or return to grade structures at the east or west (to both the east and west the roadway returns to surface grade well away from the Tennessee Hollow corridor) (Figures 6a, 6b). The bottom of the causeway with the Presidio Parkway Alternative is lower in the vicinity of Tennessee Hollow, ranging from about two to six meters (6.3 to 18.8 feet) NAVD.

The existing grade in the vicinity of Tennessee Hollow is at about 3.0 meters NAVD. However, the restored Tennessee Hollow creek bottom or Crissy Marsh is expected to be at an elevation of approximately zero meter (zero foot) NAVD. Approximately 80 meters (250 feet) of the bottom of the Tennessee Hollow Causeway is above the existing ground surface elevation and therefore could be considered as a location for the Tennessee Hollow crossing of the roadway alignment (Figure 6c). The lateral distance should be considered a minimum available width for the Tennessee Hollow crossing since any lowering of surface



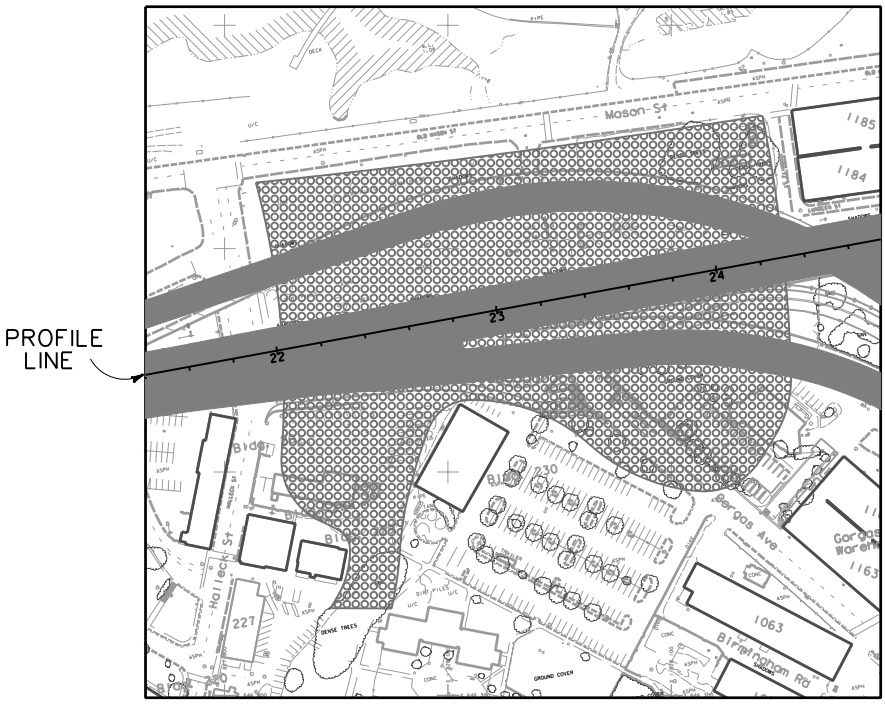


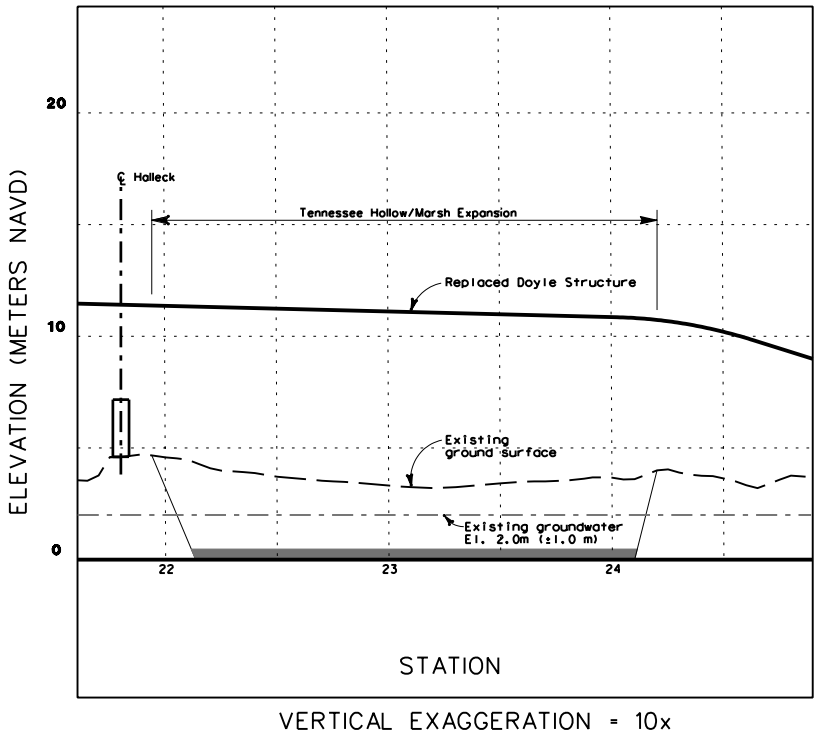
VERTICAL EXAGGERATION = 10x

Constraints East: Mason St. & Gorgas Ave Warehouses; West: Halleck St. Existing Piers for viaduct will be incorporated in project.

Source of groundwater elevation data: Ullensvang, 2001; Kamman Hydrology and Engineering, 2003, boring log for HGB-3 in Appendix C of this report.

PB PARSONS BRINCKERHOFF 303 Second St., Suite 700N, San Francisco, CA 94107	**Doyle Drive Tennessee Hollow/ Marsh Expansion** **Crossing Opportunities & Constraints** **Alternative 1 - No Build**	**Figure** **6a**



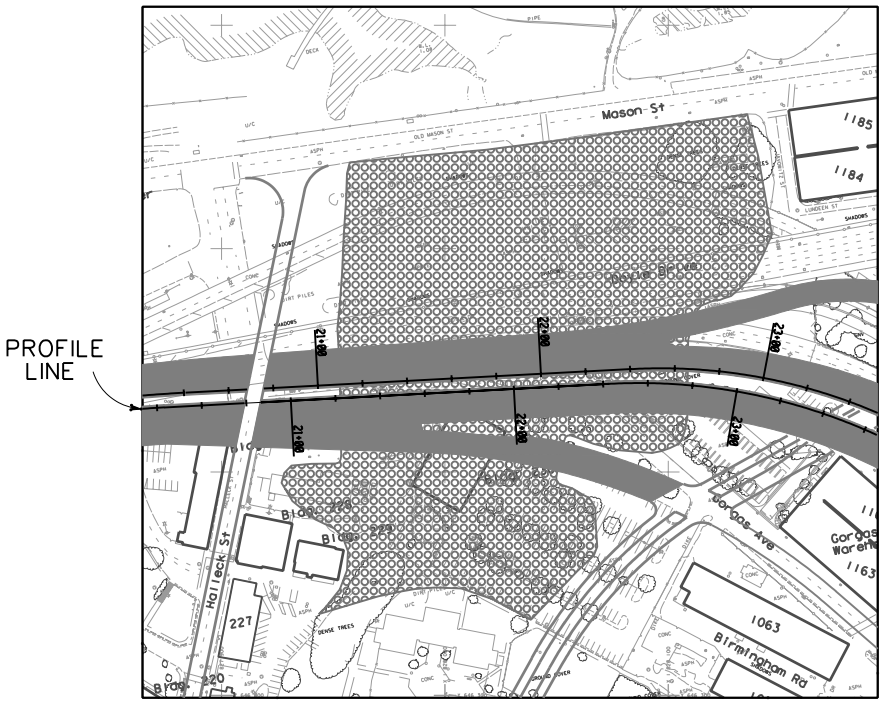


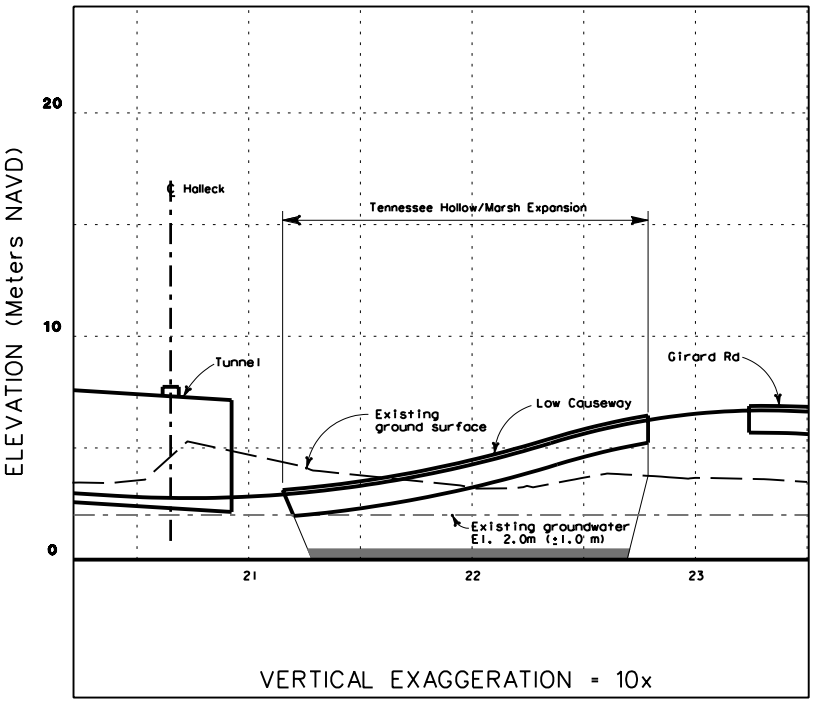
VERTICAL EXAGGERATION = 10x

Constraints East: Mason St. & Gorgas Ave. Warehouses; West: Halleck St. New Piers for viaduct will be incorporated in project.

Sourca of groundwater elevation data: Ullensvang 2001; Kamman Hydrology and Engineering, 2003, boring log for HGB-3 in Appendix C of this report.

PB PARSONS BRINCKERHOFF 303 Second St., Suite 700N, San Francisco, CA 94107	**Doyle Drive Tennessee Hollow/ Marsh Expansion** **Crossing Opportunities & Constraints** **Alternative 2 - Replace and Widen**	**Figure** **6b**





Note: All required flood protection features would be outside the shown expansion opportunity area.

Constraints East: Depressed segment of Girard Rd.
West: Reconstructed Halleck St. (in a modified location).

Source of groundwater elevation data: Ullensvang, 2001; Kamman Hydrology and Engineering, 2003, boring log for HGB-3 in Appendix C of this report.

PB PARSONS BRINCKERHOFF 303 Second St., Suite 700N, San Francisco, CA 94107	**Doyle Drive Tennessee Hollow/ Marsh Expansion Crossing Opportunities & Constraints** **Alternative 5 - Presidio Parkway**	**Figure 6c**

grade associated with the creek restoration would widen the lateral width. The lateral constraints to an expanded Crissy Marsh are shown on Figures 6a-6c.

From a hydraulic and hydrologic perspective, the flows of Tennessee Hollow could be adequately accommodated in a channel under the low causeway. Similarly, an expanded Crissy Marsh could be accommodated under a low causeway. However, it is acknowledged that the low causeway would result in potential impacts to biological resources associated with shading (potential shading impacts are evaluated in the NES).

The No-Build Alternative would continue to be supported by the existing foundation abutments that are located approximately every ten meters (31 feet) along the alignment. The lateral spacing of abutments under the Replace and Widen and Presidio Parkway alternatives would increase to about 32 meters (100 feet). Therefore, under the build alternatives, constraints, if any, associated with abutments would be reduced.

No indirect or cumulative effects associated with hydrology and the restoration of Tennessee Hollow and/or Crissy Marsh have been identified.

Mitigation Measure (No-Build, Replace and Widen)

None required. The location of the existing structure does not pose any hydrologic constraint to the restoration of Tennessee Hollow or Crissy Marsh.

Mitigation Measure (Presidio Parkway)

None available. The depressed segment of Girard Road presents a lateral constraint to the east for an expanded Crissy Marsh. The reconstructed Halleck Street is an existing constraint to the west and therefore the project would not result in a new constraint relative to the existing condition.

4.3.6 Alteration of Surface and Near-Surface Hydrology at the Main Post Tunnel

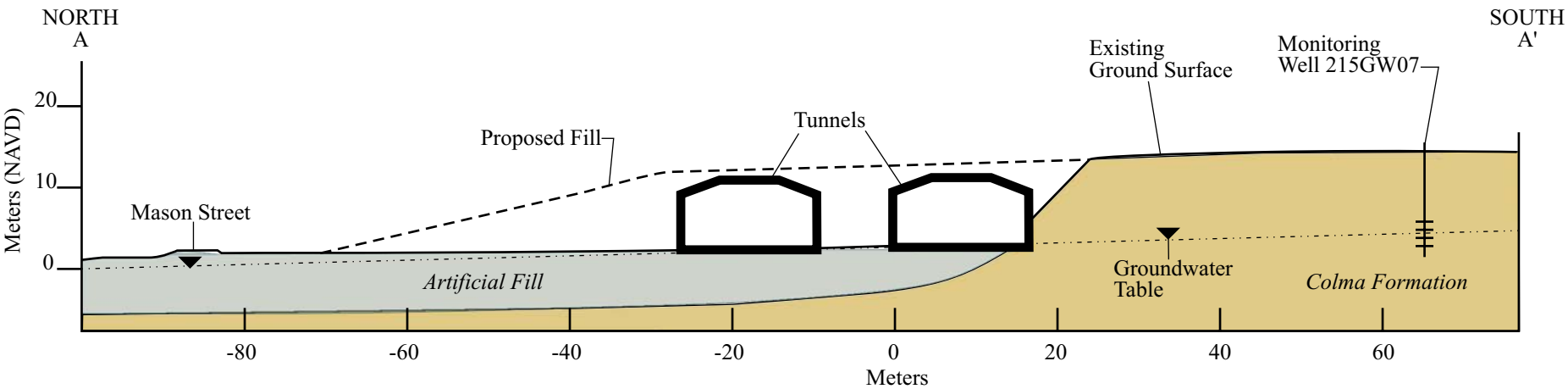
The Main Post Tunnel (which consists of two adjacent tunnels at similar elevations, one for each direction of traffic) would approximately follow the alignment of the existing Doyle Drive. The elevation of the roadway in the tunnel (ranging from about 2 to 4 meters [6.6 to 13 feet] NAVD) would be substantially lower than the elevation of the existing Doyle Drive road surface (11 to 12 meters [36 to 39 feet]). The base of the tunnel box would be placed about one meter below the existing ground surface, with the top of the tunnels ranging from about 10 to 12 meters (33 to 39 feet) NAVD (Figure 7).

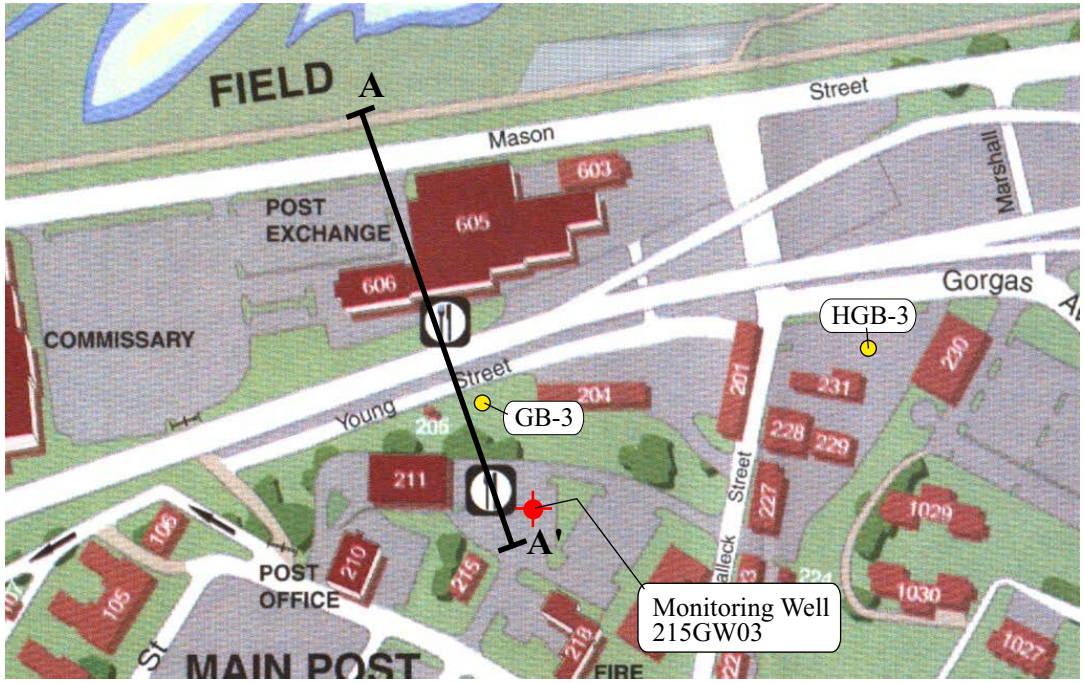
Fill would be placed between the existing bluff face and the south wall of the Main Post tunnel, essentially extending the plateau that supports Building 211 to the north. Up to two meters of fill would be placed on the top of the tunnel. Fill would also be placed on the north side of the tunnel, creating a slope from the top of the box down to existing grade along Mason Street (in the approximate location of the Commissary building) (Figure 7).

The concern has been raised that, if groundwater migrates into the fill (which under current conditions is open air) and backs up against the lower portion of the south tunnel wall, excessively moist conditions could occur on the south side. If this were to occur, excessive moisture could occur at the surface, potentially causing problems with drainage and vegetation management. In addition, it is possible that the fill on top of the tunnel box and on the downgradient (north) side of the tunnel box could become excessively dry due to lack of upgradient recharge and distance from a groundwater source.

MAIN POST TUNNEL SCHEMATIC CROSS SECTION

Figure 7





Doyle Drive
San Francisco, California

BASELINE

D:\Graphics\Y0239-03\Hydro\Figure 7 .cdr 9/2/04

Based on the measured groundwater levels in monitoring wells near Building 211 and 215,[59] it appears that the elevation of the water table in this vicinity is approximately 4.5 meters (15 feet) NAVD. Groundwater levels would be expected to be lower toward the bluff (in the downgradient direction), probably about 4.0 meters (13 feet) NAVD.[60] The elevation of the existing ground surface at the bottom of the bluff is about 4.0 meters (13 feet) NAVD. This indicates that, under normal conditions, seeps on the bluff face would not be expected. Therefore, no substantial contact between groundwater and the new fill between the bluff and the south side of the tunnel box is likely to occur, and rising groundwater levels in the fill upgradient of the tunnel would not occur. It is possible that, during stormy wet periods, regionally elevated groundwater levels could cause the water table in the vicinity of the tunnel to rise and come into contact with the tunnel. However, the tunnel box would be constructed with a permeable gravel envelope and/or strip drains around the box and water would be easily transmitted to the downgradient side under the tunnel. The passage of groundwater under the tunnel through permanent drainage features would minimize the potential for rising groundwater on the north side of the tunnel to occur.

Fill soils on top of the tunnel box would not be directly underlain by a groundwater table, and therefore would expected to be seasonally dry. If this area is being considered for revegetation, this moisture condition may pose a vegetation management challenge that may require special plant selection and/or irrigation. This potential challenge is further discussed in the NES.

The fill prism north of the tunnel would likely develop a similar soil moisture profile as has developed in the existing Colma formation bluff materials (composed of weakly consolidated fine- to medium-grained sands with intermittent clay layers) in the vicinity of buildings 211 and 215. The maximum depth to groundwater in the new sloping fill prism on the north side of the tunnel would be about the same or less than the existing conditions on the top of the bluff. Therefore, no new adverse soil moisture conditions, relative to existing conditions in the vicinity, are likely to occur on the north side of the tunnel.

It has been reported that there are freshwater seeps along the south shore of Crissy Marsh and that there is some concern that the Main Post tunnel might affect the flow of these seeps.[61] Based on the local hydrogeology and the proposed location/depth of the tunnel, it does not appear likely that the tunnel would affect the seeps. Geologic logs of borings installed in the surface of the low terrace near Building 204 (GB-3 and HGB-3) indicate that the upper six meters (20 feet) is composed of a heterogeneous mixture of soft to slightly compact clay, silt, sand, and gravel. If the freshwater flow to the seeps originates in the upper water-bearing zone, groundwater would continue to flow unobstructed under the tunnel box and continue to feed the seeps.

It is possible that the water feeding the seeps originates in a deeper confined water-bearing zone. However, the boring logs for GB-3 and HGB-3 show no indication of a hydrologically confining layer in the upper zone. The first unit that could act as a confining layer is a dense silty fine sand at a depth of about six meters (20 feet). None of the foundation types being considered to support the essentially at-grade base of the proposed tunnel structure would exceed a depth of six meters (20 feet) and therefore would not be expected to disrupt any confining layers that may feed the seeps.

In summary, no significant hydrologic impacts associated with the transport of surface water or groundwater around the proposed Main Post tunnel are expected. It is possible that challenges associated with revegetation of the top of the tunnel could be encountered. This potential issue is further discussed in the NES.

[59] Water levels for wells 215GW02 and 215GW03 as summarized by Kamman Hydrology & Engineering, 2003.
[60] Regional gradients as measured in the Presidio Trust Building 231/207 contaminant investigations are about 0.013 (Ullensvang, 2001). Since the bluff is about 40 meters (130 feet) from the monitoring wells, under regional gradients, the groundwater elevation at the bluff would be expected to be about 4.0 meters (13 feet) NAVD.
[61] Ward, Kristen, 2004, National Park Service, written communication with Bruce Abelli-Amen of BASELINE Environmental Consulting, 27 August.

Mitigation Measure (No-Build, Replace and Widen, Presidio Parkway)

None required.

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APPENDIX A

Data for Conversion of Datums at the Presidio

(NGVD 1929 to NAVD 1988)

and Location Map for Benchmarks Used

PB\Doyle Drive 99-08-052

NAVD 88 Elevation Ties to NGVD 29 Bench Marks

BM Name	NAVD88 (m)	NGVD29 (ft)	NGVD29 (m)	(NAVD88-NGVD29) Datum Diff. (m)	Datum Diff (ft)
Tidal 175	4.1776	11.539	3.5171	0.6605	2.1670
Tidal 174	5.0277	13.829	4.2151	0.8126	2.6660
Clark	4.2490	11.224	3.4211	0.8279	2.7163
Clark RM 2	4.2362	11.181	3.4080	0.8282	2.7173
Tidal 181	4.0032	10.440	3.1821	0.8211	2.6938
Tidal 180	3.9876	10.397	3.1690	0.8186	2.6857
Tidal 176	4.8326	13.136	4.0039	0.8287	2.7190
N 813	3.3781	8.363	2.5490	0.8291	2.7200
54 (U.S.E.D.)	3.3734	8.481	2.5850	0.7884	2.5866

Post-it® Fax Note 7671

Date 3/20	# of pages ▶ 1
To BRUCE	From ED
Co./Dept. BASELINE	Co. CHAUDHARY
Phone #	Phone # 255-2729
Fax # 742-5271	Fax #

Note: This table was prepared by Chaudhary and Associates (the surveyor for the Doyle Drive Reconstruction project) by running level lines between published NGVD and NAVD benchmarks.

5
6
7
8
TO MARIN COUNTY AND THE REDWOOD EMPIRE
Tidal 175
Tidal 174
Clark
Clark RM 2
Tidal 180
Tidal 181
Tidal 176
N 813
54 (USED)
FT. POINT NATIONAL HISTORIC SITE
ST. FRANCIS YACHT CLUB
GOLDEN GATE YACHT CLUB
Marina Small Craft Harbor
GGNRA
East Harbor
West Harbor
MARINA GREEN
Gashouse Cove
FT. MASON CENTER
FORT
MARINA
JEFFERSON
GEORGE R. MOSCONE REC. CTR.
PALACE OF FINE ARTS
Lagoon
LINCOLN
CRISSY FIELD
PARADE GROUND
GATE
NATIONAL
SAN FRANCISCO NAT'L CEMETERY (MET. ADMIN.)
OLD MASON COMMISSARY
POST EXCHANGE
OFFICERS CLUB ADOBE BLDG. IN S.F.
LETTERMAN
PRESIDIO
LOMBARD
COMPLEX
RESIDIO
RECREATION
AREA
PRESIDIO GOLF COURSE
Mountain Lake
MOUNTAIN LAKE PARK
INSPIRATION POINT
WEST PACIFIC
CALIFORNIA
PINE
BUSH
GEARY
ALTA PLAZA PARK
HAMILTON REC. CENTER
KAISER PERMANENTE MED. CTR.
UNIVERSITY OF SAN FRANCISCO
UNIVERSITY OF S.F.
CITY COLLEGE (ADAMS)
ALAMO SQUARE
TURK
GOLDEN GATE
McALLISTER
FULTON
GROVE
HAYES
FELL
OAK
(PANHANDLE)
DE YOUNG MUSEUM
ASIAN ART MUSEUM
JAPANESE TEA GARDEN
CONCOURSE
NATURAL HISTORY MUSEUM
MORRISON PLANETARIUM
STEINHART AQUARIUM
CALIFORNIA ACADEMY OF SCIENCES
Lily Pond
TENNIS COURTS
HANDBALL COURTS
BIG REC
BALL FIELD
BOWLING GREENS
CHILDREN'S PLGD.
DR. CARROUSEL
POLICE STATION
KEZAR PAVILION
KEZAR STADIUM
PARK
ARBORETUM
CO. FAIR BLDG.
LUTHER KING JR. WAY
BUENA VISTA PARK
DUBOCE PARK
DUBOCE
RALPH K. DAVIES MED. CTR
14TH
HENRY
15TH
SUNSET TUNNEL PK.
CARL
HUGO
MASONIC
DIVISADERO
PRESIDIO
LINCOLN
BLVD.
101

APPENDIX B

Location of Monitoring Well 231GW15

Legend:

- Roadway
- 231 — Building and Number
- Fuel Distribution System (Unverified)
- Selected Water Line
- Removed Structure (except tanks)
- Fence
- Topographic Contour (Contour Interval: 5 ft.)
- Underground Storage Tank (R = removed)
- (R) — Underground Storage Tank (R = removed) (Size and orientation not representative)
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- Abandoned Monitoring Well (current status)
- Approximate Groundwater Flow Direction(s)

Notes: Horizontal Datum: NAD 27, CA State Plane Coordinates, Zone 3, feet

Vertical Datum: Presidio Lower Low Water (LLW)

0 30 60 feet

MONTGOMERY WATSON

PRESIDIO OF SAN FRANCISCO *CALIFORNIA*

BUILDING 231 AREA
SITE MAP

FIGURE 1

APPENDIX C

Geotechnical Boring Logs

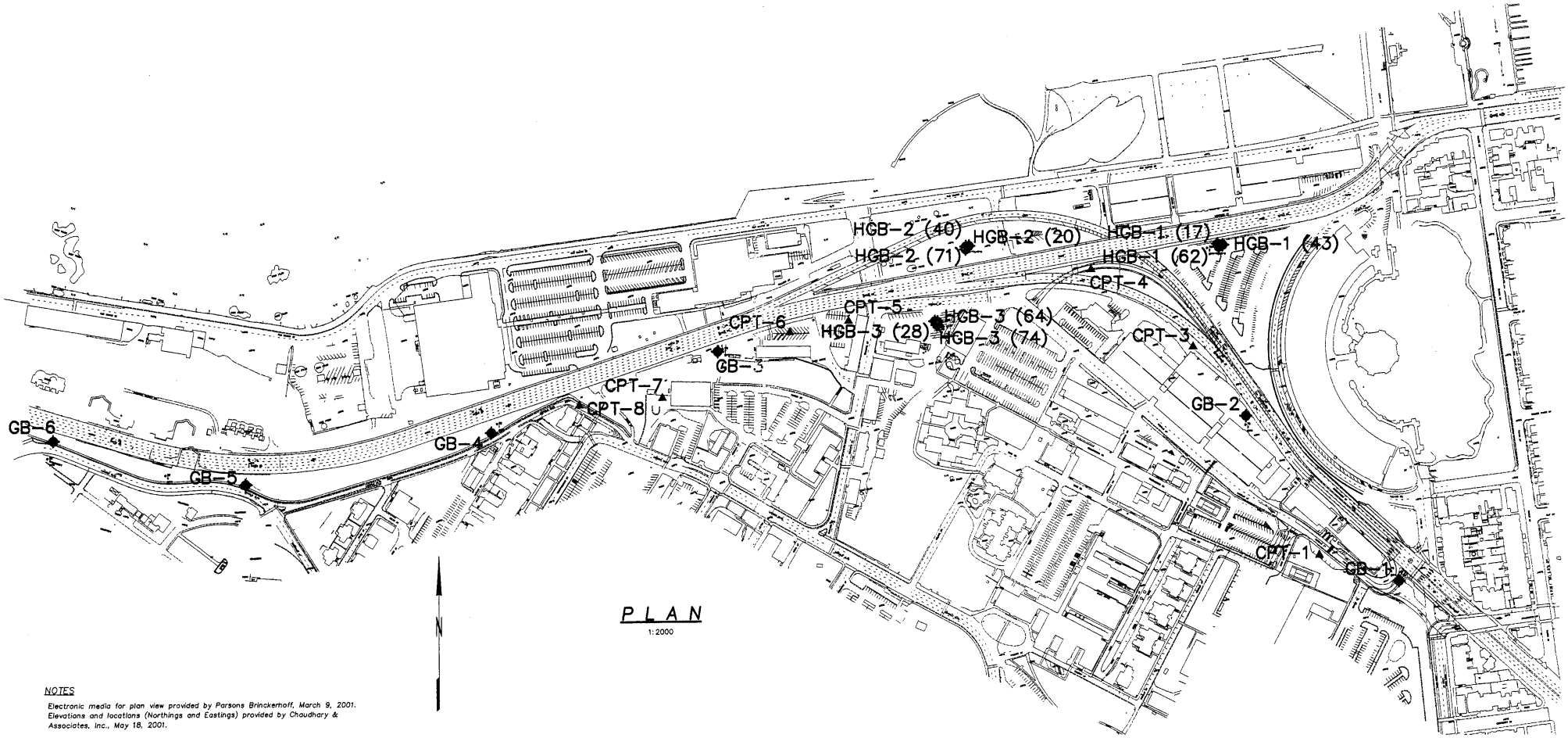
DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

Parsons Brinckerhoff
303 2nd Street, Suite 700N
San Francisco, CA 94107

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.



PLAN

1:2000

NOTES

Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001.
Elevations and locations (Northings and Eastings) provided by Chaudhary & Associates, Inc., May 18, 2001.

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE			

KP

DOYLE DRIVE RECONSTRUCTION PROJECT

LOG OF TEST BORINGS No. 1

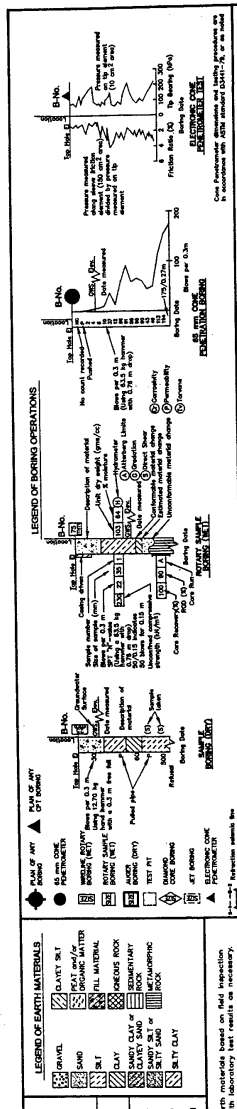
Taber Consultants Job No. 202/300/133 file id: 202300133q.dwg date: 05/24/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

CU
EA

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF



WEATHERING DESCRIPTORS

Modified from United States Bureau of Reclamation, Engineering Geology Field manual.

Descriptors	Diagnostic features: Chemical weathering–Discoloration and/or oxidation: Body of rock	Chemical weathering–Discoloration and/or oxidation: Fracture surfaces †	Mechanical weathering–Grain boundary conditions (disaggregation) primarily for granitics and some coarse-grained sediments	Texture and solutioning: Texture	Texture and solutioning: Solutioning	General characteristic (strength, excavation, etc.) §
Fresh	No discoloration, not oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No solutioning	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
Slightly weathered to fresh *						
Slightly weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull	Minor to complete discoloration or oxidation of most surfaces	No visible separation, intact (tight)	Preserved	Minor leaching of some soluble minerals may be noted	Hammer rings when crystalline rocks are struck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
Moderately to slightly weathered *						
Moderately weathered	Discoloration or oxidation extends from fractures usually throughout; Fe–Mg minerals are "rusty", feldspar crystals are "cloudy".	All fracture surfaces are discolored or oxidized	Partial separation of boundaries visible	Generally preserved	Soluble minerals may be mostly leached	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
Intensely to moderately weathered *						
Intensely weathered	Discoloration or oxidation throughout; all feldspars and Fe–Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation, see grain boundary conditions.	All fracture surfaces are discolored or oxidized, surfaces friable	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated	Texture altered by chemical disintegration (hydration, argillation)	Leaching of soluble minerals may be complete	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened. Usually common excavation.
Very intensely weathered *						
Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe–Mg minerals are completely altered to clay.		Complete separation of grain boundaries (disaggregated)	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete		Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes".

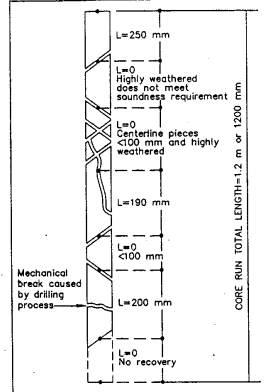
NOTE: This chart and its horizontal categories are more readily applied to rocks with feldspars and mafic minerals. Weathering in various sedimentary rocks, particularly limestones and poorly indurated sediments, will not always fit the categories established. This chart and weathering categories may have to be modified for particular site conditions or alterations such as hydrothermal effects; however, the basic framework and similar descriptors are to be used.

* Combination descriptors are permissible where equal distribution of both weathering characteristics are present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, dual descriptors should not be used where significant, identifiable zones can be delineated. When given as a range, only two adjacent terms may be combined (i.e., decomposed to slightly weathered or moderately weathered to fresh) are not acceptable.

† Does not include directional weathering along shears or faults and their associated features. For example, a shear zone that carried weathering to great depths into a fresh rock mass would not require the rock mass to be classified as weathered.

§ These are generalizations and should not be used as diagnostic features for weathering or excavation classification. These characteristics vary to a large extent based on naturally weak materials or cementation and type of excavation.

RQD LOGGING



$$RQD = \frac{\sum \text{Length of sound core >100 mm pieces}}{\text{Total core run length}}$$

$$RQD = \frac{250+190+100}{1200} \times 100\%$$

RQD= 53% (fair)

RQD (ROCK QUALITY DESIGNATION)	DESCRIPTION OF ROCK QUALITY
0 – 25%	VERY POOR
25 – 50%	POOR
50 – 75%	FAIR
75 – 90%	GOOD
90 – 100%	EXCELLENT

After Deere & Deere, 1989

FRACTURE DENSITY

Modified from United States Bureau of Reclamation, Engineering Geology Field manual.

FRACTURE DENSITY–Based on the spacing of all natural fractures in an exposure or core recovery lengths in boreholes; excludes mechanical breaks, shears, and shear zones; however, shear–distributed zones (fracturing outside the shear) are included. Descriptors for fracture density apply to all rock exposures such as tunnel walls, dozer trenches, outcrops, or foundation cut slopes and inverts, as well as borehole. Descriptive criteria presented below are based on borehole cores where lengths are measured along the core axis, for other exposures the criteria is distance measured between fractures (size of blocks).

UNFRACTURED (FD0): No fractures.

VERY SLIGHTLY FRACTURED (FD1): Core recovered mostly in lengths greater than 1 m.

SLIGHTLY TO VERY SLIGHTLY FRACTURED (FD2) "

SLIGHTLY FRACTURED (FD3): Core recovered mostly in lengths from 300 to 1000 mm, with few scattered lengths less than 300 mm or greater than 1000 mm.

MODERATELY TO SLIGHTLY FRACTURED (FD4) "

MODERATELY FRACTURED (FD5): Core recovered mostly in 100 to 300 mm lengths with most lengths about 200 mm.

INTENSELY TO MODERATELY FRACTURED (FD6) "

INTENSELY FRACTURED (FD7): Lengths average from 30 to 100 mm with scattered fragmented intervals. Core recovered mostly in lengths less than 100 mm.

VERY INTENSELY TO INTENSELY FRACTURED (FD8) "

VERY INTENSELY FRACTURED (FD9): Core recovered mostly as chips and fragments with a few scattered short core lengths.

* Combinations of fracture densities (e.g. very intensely to intensely fractured or moderately to slightly fractured) are used where equal distribution of both fracture density characteristics are present over a significant interval or exposure, or where characteristics are "in between" the descriptor definitions.

ROCK HARDNESS/STRENGTH DESCRIPTORS

Alphanumeric Descriptor	Descriptor	Criteria
H1	Extremely hard	Core, fragment, or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.
H2	Very hard	Can be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.
H3	Hard	Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.
H4	Moderately hard	Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow.
H5	Moderately soft	Can be grooved 1/16 inch (2 mm) deep by knife or sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.
H6	Soft	Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
H7	Very soft	Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

Any bedrock unit softer than H7, very soft, is to be described using ASTM D–2488 consistency descriptors.

NOTE: Although "sharp pick" is included in these definitions, descriptions of ability to be scratched, grooved or gouged by a knife is the preferred criteria.
Modified from United States Bureau of Reclamation, Engineering Geology Field manual.

Source: U.S. Department of Interior, Bureau of Reclamation "Engineering Geology Field Manual".

Caltrans Metric

DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

Parsons Brinckerhoff
303 2nd Street, Suite 700N
San Francisco, CA 94107

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NOTES

1. *Standard Penetration Tests (SPT) were performed in accordance with ASTM D 1586–84 using a safety hammer operated with cat–head, rope and pulley. Drill rodors were 1.61 inch diameter "A"–rods; sampler was driven without brass liners.*
2. *Rock classification according to Caltrans "Soil & Rock Logging Classification Manual (Field Guide)", August 1996.*
3. *Rock Quality Designation (RQD), Weathering, Rock Hardness/Strength, Bedding, and Fracture Density, as shown on this sheet, were used to describe all rock core from borings. Descriptors were determined in the field.*
4. *REC = Percent Core Recovery.*
5. *RQD = Percent Rock Quality Designation.*
6. *Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001.*

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	T. A. Krause & M. W. Heublein FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001		PROJECT ENGINEER

ENGINEERING GEOLOGY FIELD DESCRIPTORS

DOYLE DRIVE RECONSTRUCTION PROJECT

KP

LOG OF TEST BORINGS No. 2

SHEET

Taber Consultants Job No. 2D2/300/133 file id: 2D2300133r.dwg date: 03/22/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

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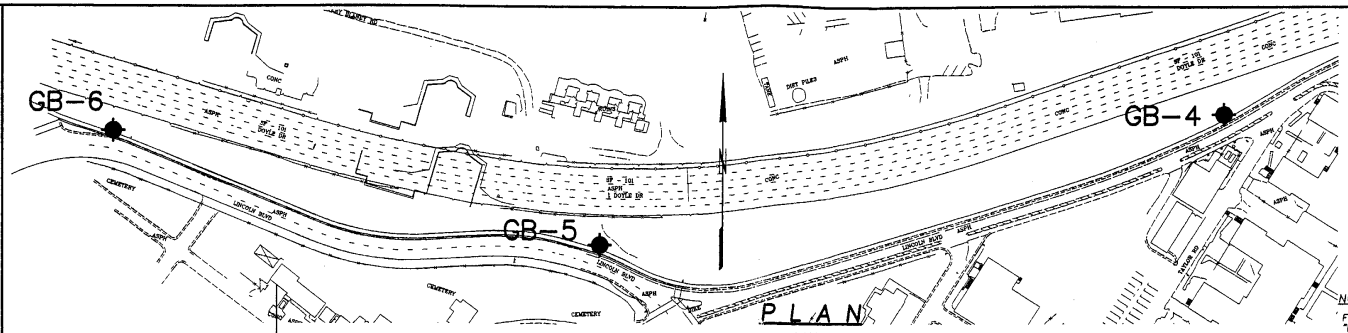
DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY)



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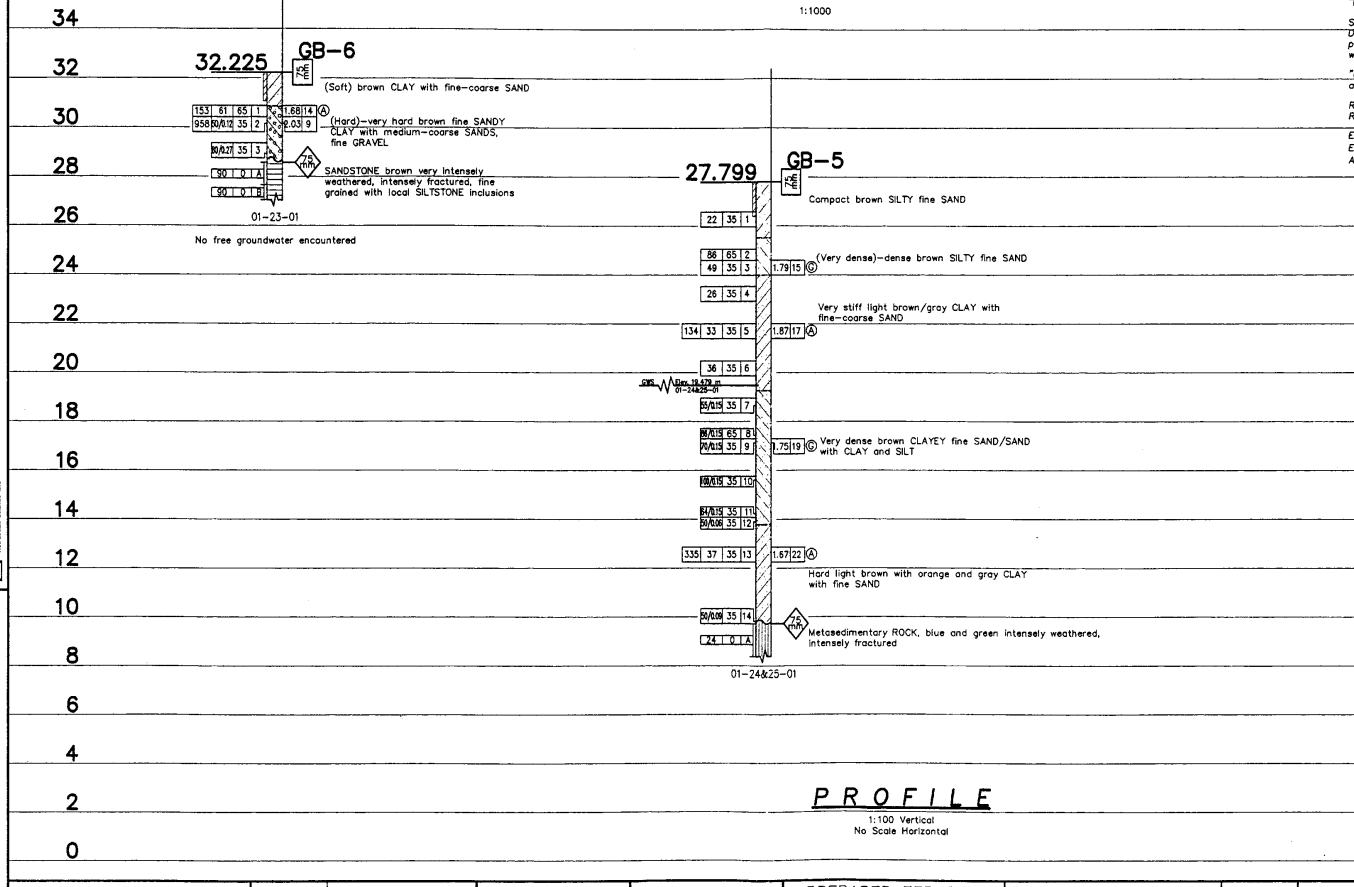

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No Scale Horizontal

Caltrans Metric

DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

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NOTES

Field classification of soils was in accordance with ASTM D 2488-93 "Description and Identification of Soils (Visual-Manual Procedure)".

Standard Penetration tests were performed in accordance with ASTM D 1586-84 using a safety hammer operated with cat-head, rope and pully. Drill rods were 41 mm diameter "A"-rods; sampler was driven with brass liners.

"65 mm sampler": ID=65 mm, OD=74 mm. Driven in same manner as SPT ("35 mm") sampler.

Rock Classification according to U.S. Department of Interior, Bureau of Reclamation "Engineering Geology Field Manual" (see Log of Test Borings No. 2).

Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001. Elevations and locations (Northings and Eastings) provided by Choudhary & Associates, Inc., May 18, 2001.

LEGEND OF BORING OPERATIONS

LEGEND OF EARTH MATERIALS

CONSISTENCY CLASSIFICATION FOR SOILS

NOTE: Visual classification of earth materials based on field inspection is confirmed or revised with laboratory test results as necessary.

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	M. W. Heublein FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	KP	DOYLE DRIVE RECONSTRUCTION PROJECT
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001					LOG OF TEST BORINGS No. 3

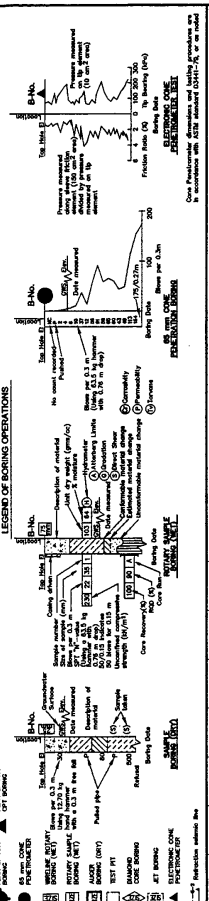
Taber Consultants Job No. 202/300/133 file id: 202300133a.dwg date: 05/24/01

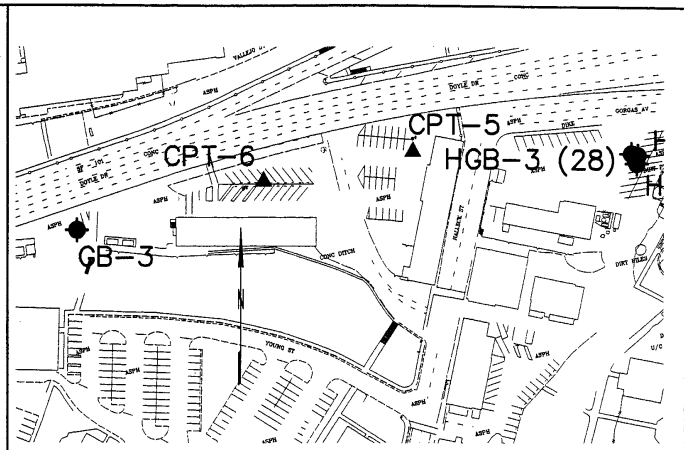
ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

CU EA

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF





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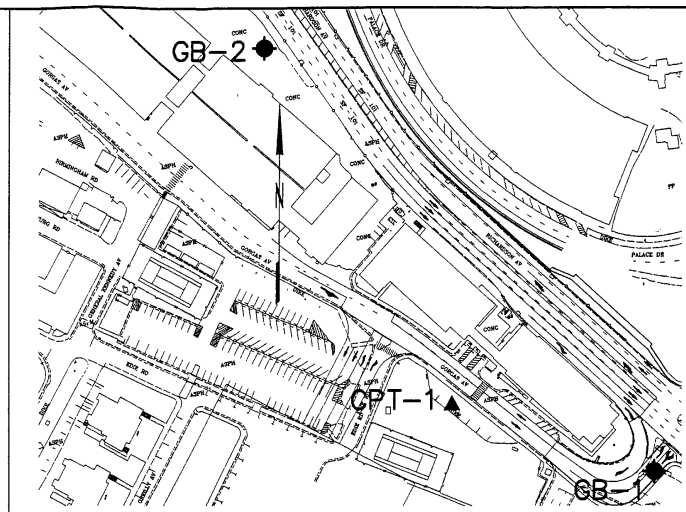

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Caltrans Metric

DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

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NOTES

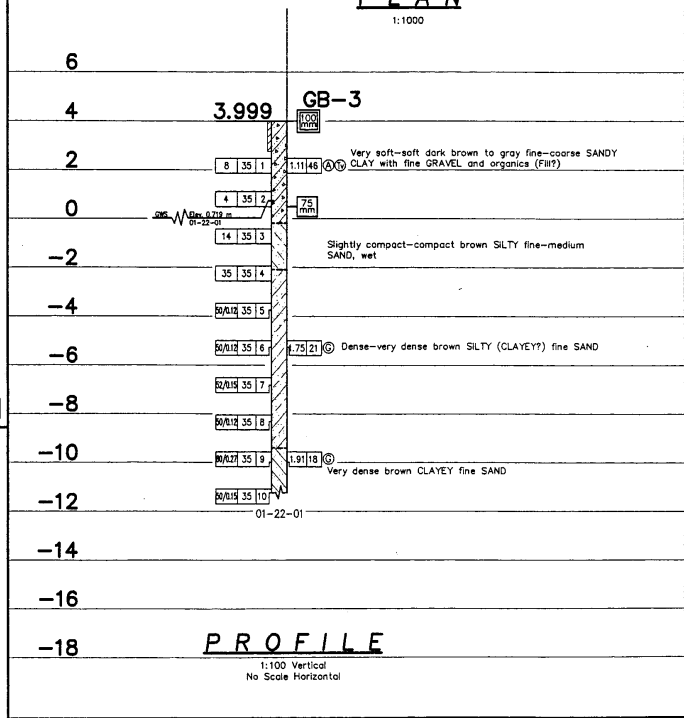
Field classification of soils was in accordance with ASTM D 2488-93 "Description and Identification of Soils (Visual-Manual Procedure)".

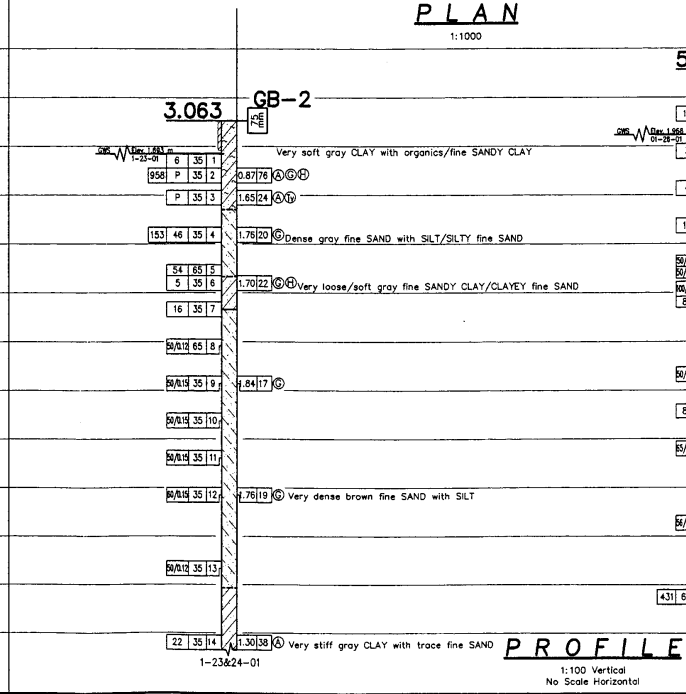
Standard Penetration tests were performed in accordance with ASTM D 1586-84 using a safety hammer operated with cat-head, rope and pully. Drill rods were 41 mm diameter "A"-rods; sampler was driven with brass liners.

"65 mm sampler": ID=65 mm, OD=74 mm. Driven in same manner as SPT ("35 mm") sampler.

Rock Classification according to U.S. Department of Interior, Bureau of Reclamation "Engineering Geology Field Manual" (see Log of Test Borings No. 2).

Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001. Elevations and locations (Northings and Eastings) provided by Chaudhary & Associates, Inc., May 18, 2001.





DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	M. W. Heublein FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001		

PROJECT ENGINEER

KP

DOYLE DRIVE RECONSTRUCTION PROJECT

LOG OF TEST BORINGS No. 4

Taber Consultants Job No. 2D2/300/133 file id: 2D230013 3aa.dwg date: 05/24/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

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EA

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REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF

DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

Caltrans Metric

REGISTERED CIVIL ENGINEER

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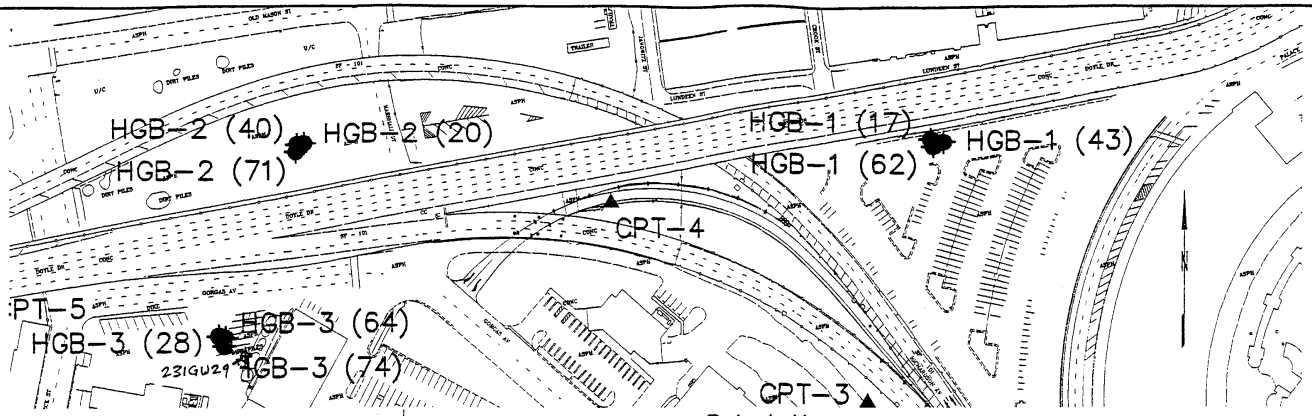

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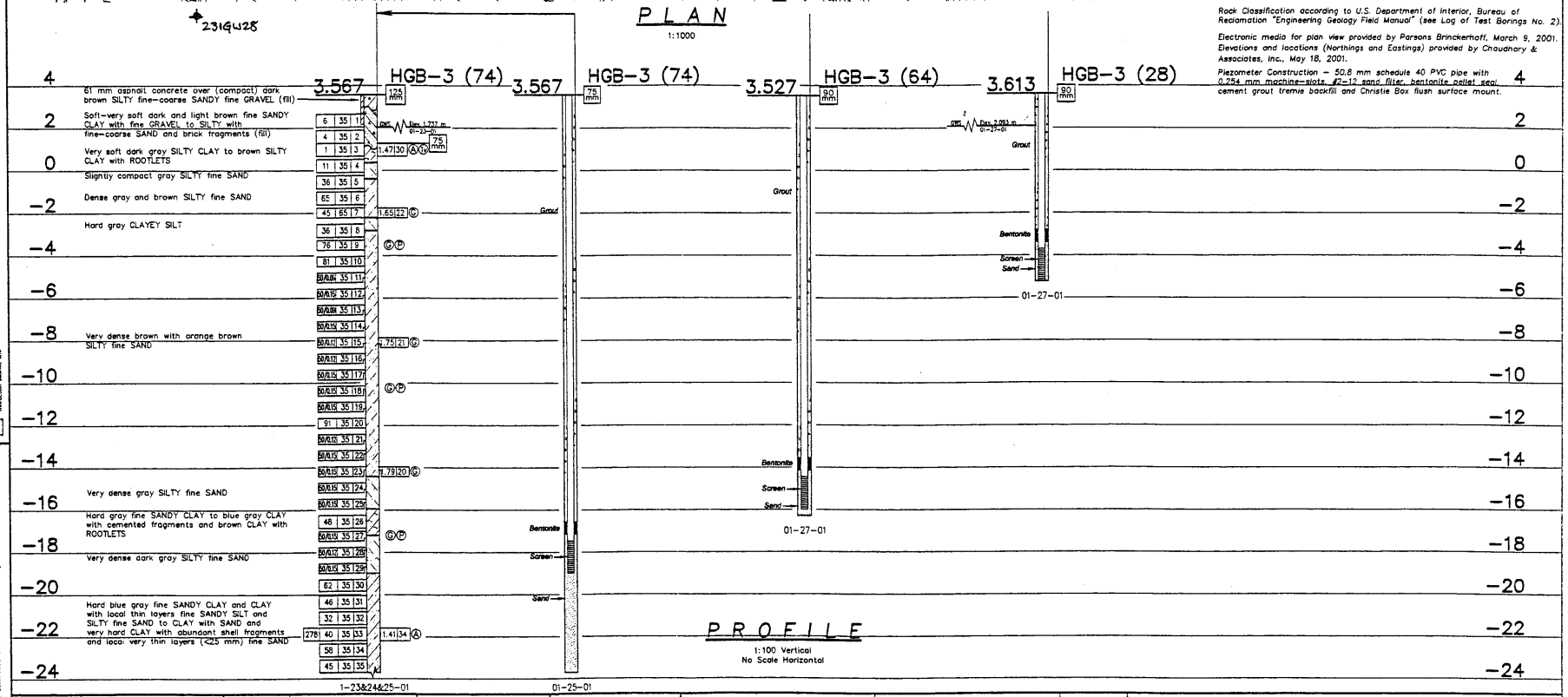

PROFILE

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No Scale Horizontal

NOTES

Field classification of soils was in accordance with ASTM D 2488-93 "Description and Identification of Soils (Visual-Manual Procedure)".

Standard Penetration tests were performed in accordance with ASTM D 1586-84 using a safety hammer operated with cat-head, rope and pully. Drill rods were 41 mm diameter "A"-rods; sampler was driven with brass liners.

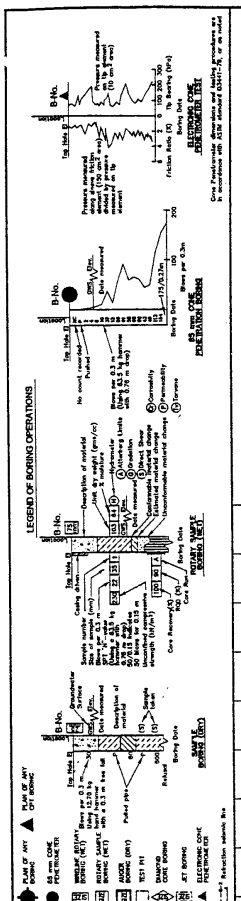
"65 mm sampler": ID=65 mm, OD=74 mm. Driven in same manner as SPT ("35 mm") sampler.

"50 mm sampler": ID=50 mm, OD=65 mm. Driven in same manner as SPT ("35 mm") sampler.

Rock Classification according to U.S. Department of Interior, Bureau of Reclamation "Engineering Geology Field Manual" (see Log of Test Borings No. 2).

Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001. Elevations and locations (Northings and Eastings) provided by Chaudnary & Associates, Inc., May 18, 2001.

Piezometer Construction - 50.8 mm schedule 40 PVC pipe with 0.254 mm machine-slots, #2-12 sand filter, bentonite pellet seal, cement grout tremie backfill and Christie Box flush surface mount.



DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	T. A. Krause & M. W. Heublein FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	KP	DOYLE DRIVE RECONSTRUCTION PROJECT
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001					LOG OF TEST BORINGS No. 7

Taber Consultants Job No. 2D2/300/133 file id: 2D23001336.dwg date: 05/24/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

CU EA

DISREGARD PRINTS BEARING EARLIER REVISION DATES

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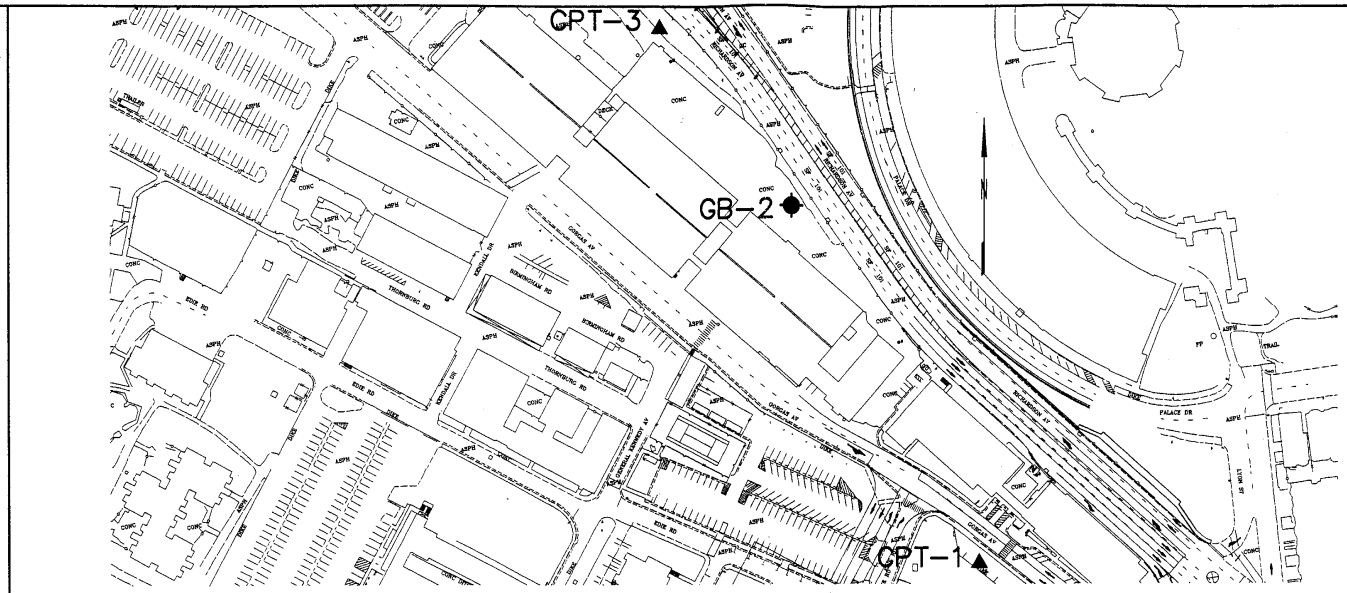

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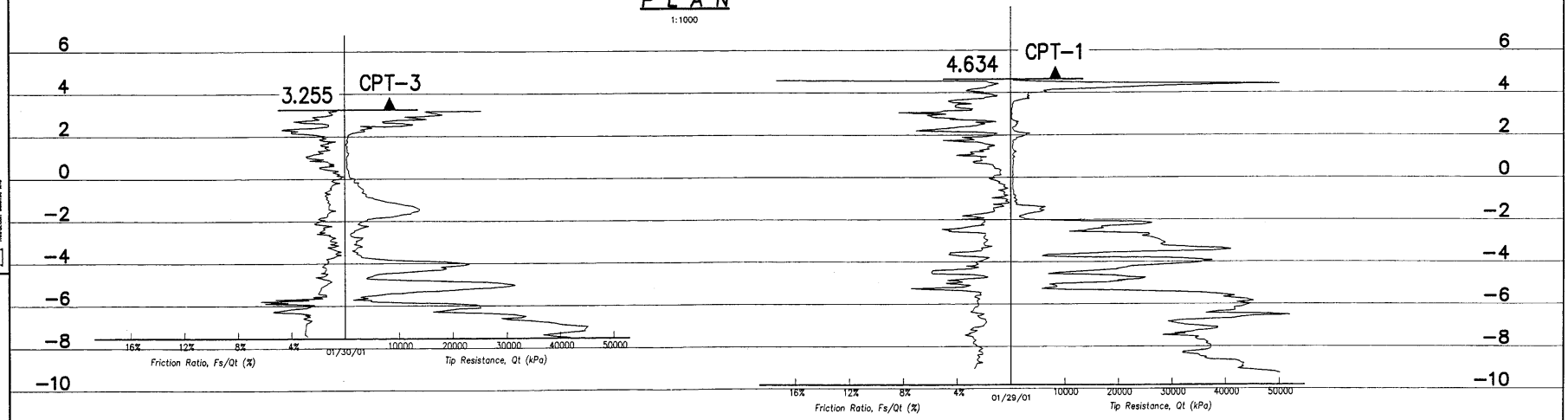

PROFILE

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DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

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NOTES

Electronic media for plan view provided by Parsons Brinckerhoff, March 9, 2001. Elevations and locations (Northings and Eastings) provided by Chaudhary & Associates, Inc., May 18, 2001.

CPT data reported for CPT-4 through CPT-8 was digitized from original metric data plot.

LEGEND OF BORING OPERATIONS

LEGEND OF EARTH MATERIALS

CONSISTENCY CLASSIFICATION FOR SOILS

NOTE: Visual classification of earth materials based on field inspection is confirmed or revised with laboratory test results as necessary.

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	T. d'Arcy FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	KP	DOYLE DRIVE RECONSTRUCTION PROJECT
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001					LOG OF TEST BORINGS No. 8

Taber Consultants Job No. 202/300/133 file id: 2D2300133s.dwg date: 05/24/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

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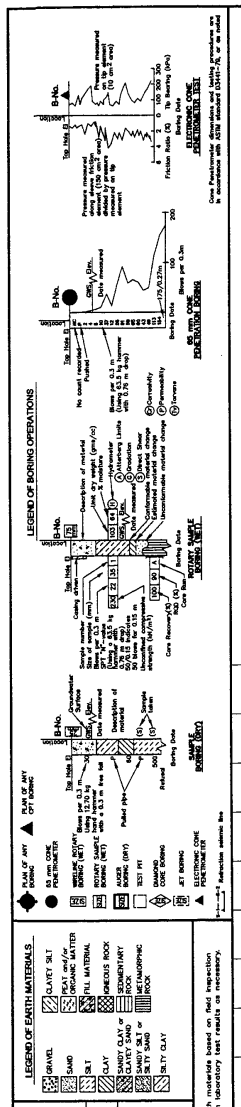
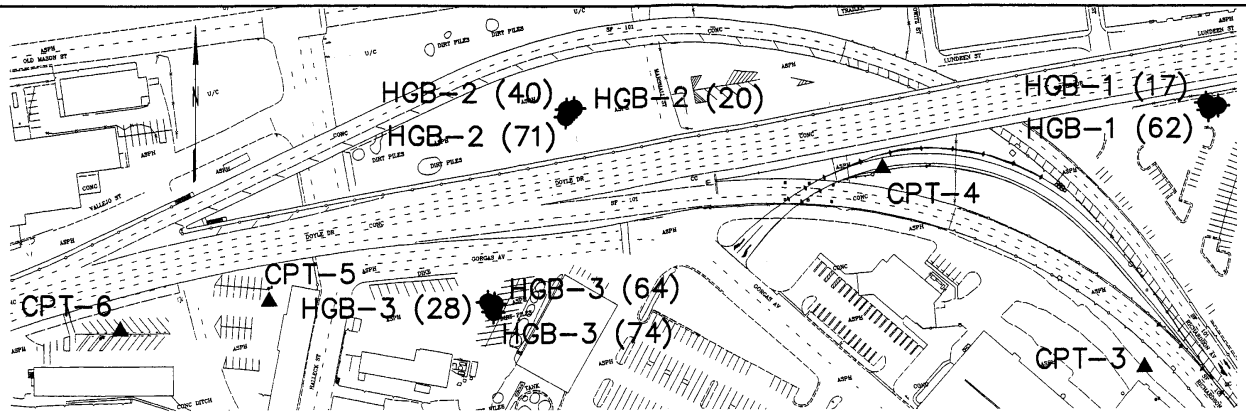
DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF





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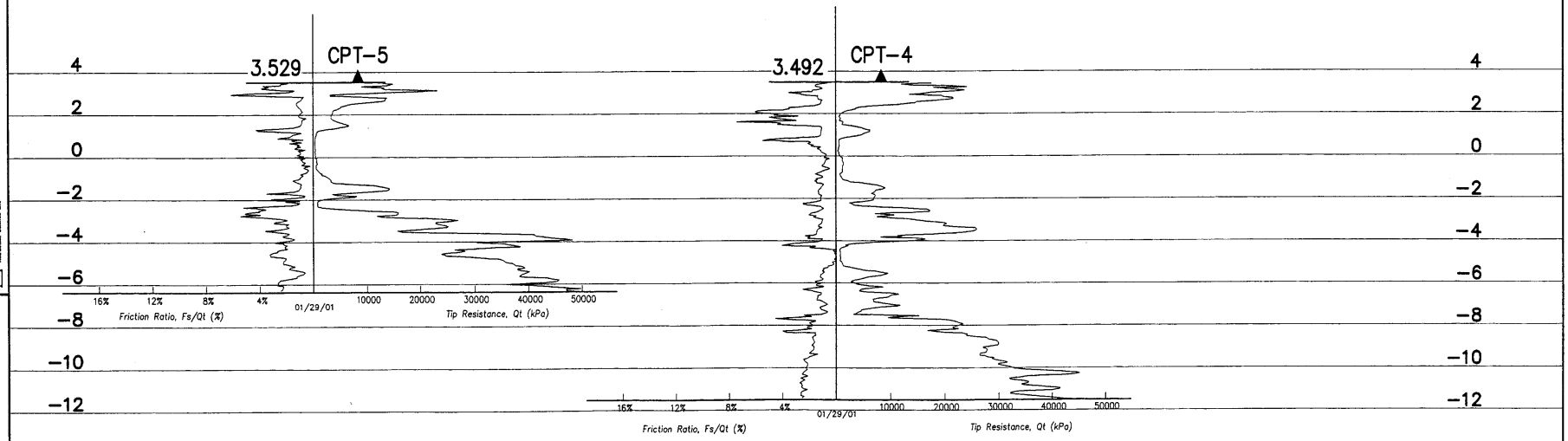

PROFILE

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DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

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DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	T. d'Arcy FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	KP	DOYLE DRIVE RECONSTRUCTION PROJECT
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001					LOG OF TEST BORINGS No. 9

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

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EA

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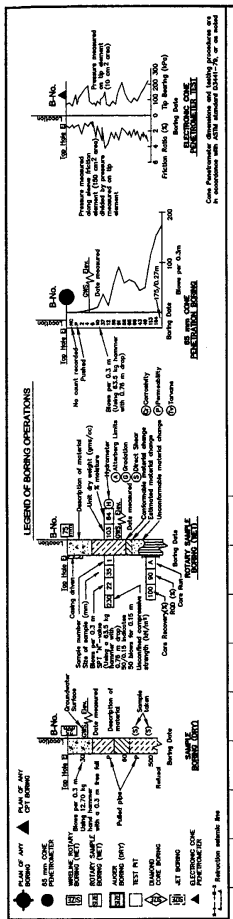
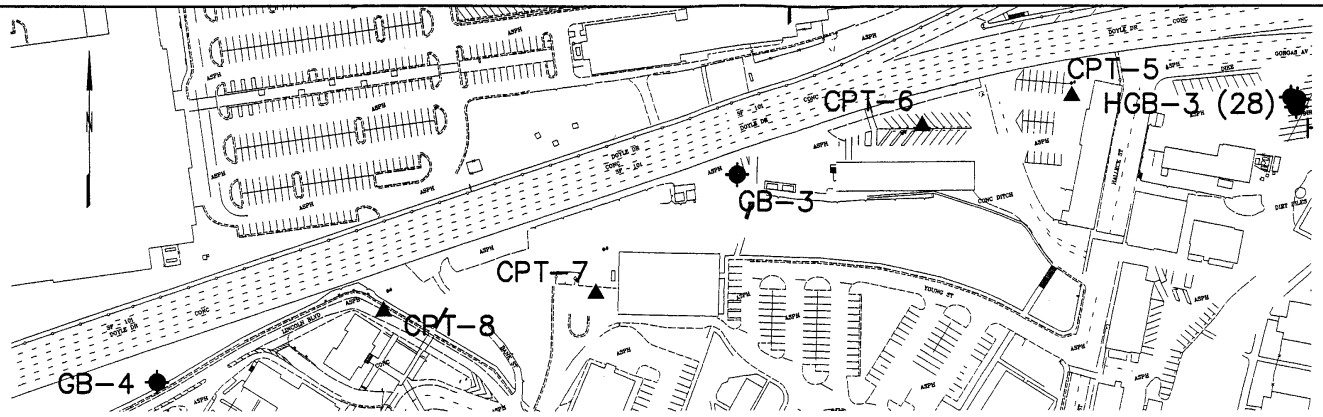
REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF

Taber Consultants Job No. 202/300/133 file id: 2D2300133t.dwg date: 05/24/01





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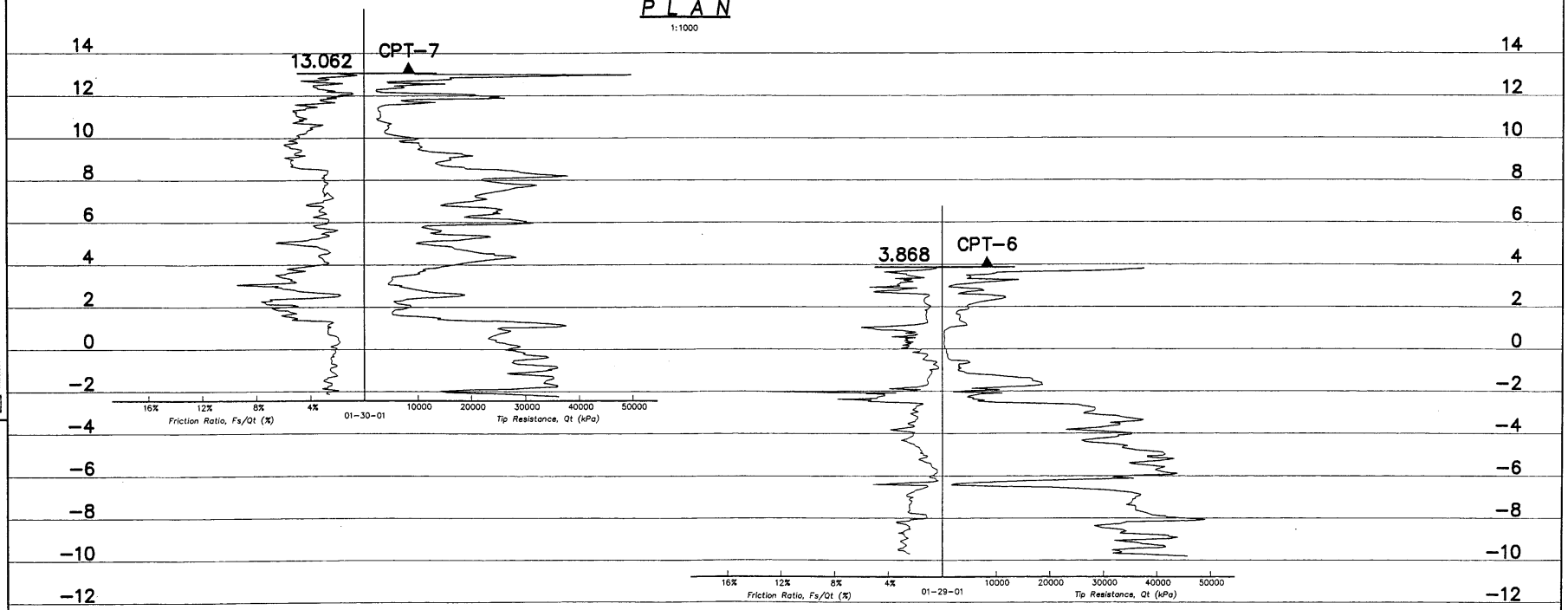

PROFILE

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DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

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CPT data reported for CPT-4 through CPT-8 was digitized from original metric data plot.

DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	T. d'Arcy FIELD INVESTIGATOR
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001

METRIC
"ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

PROJECT ENGINEER

KP

DOYLE DRIVE RECONSTRUCTION PROJECT

LOG OF TEST BORINGS No. 10

Taber Consultants Job No. 2D2/300/133 file id: 2D2300133u.dwg date: 05/24/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

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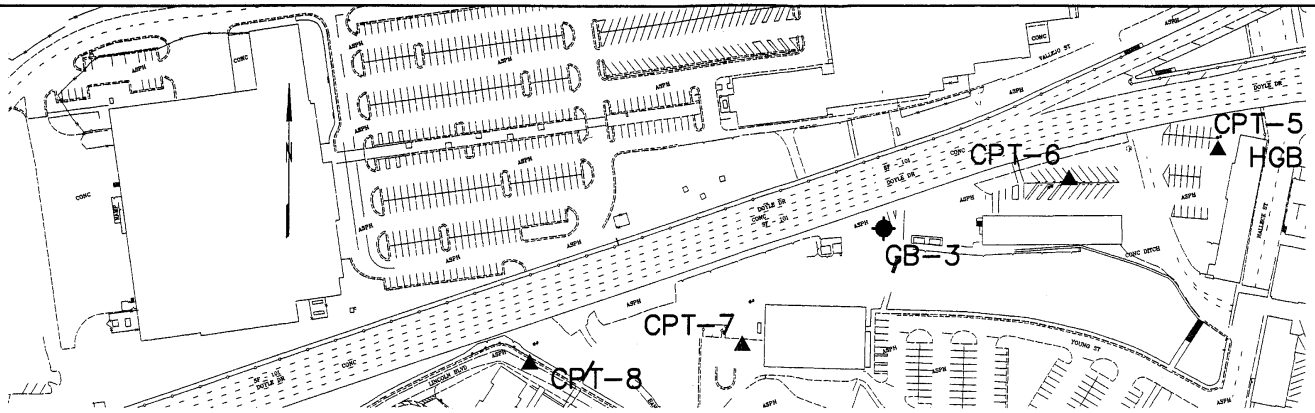
DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF



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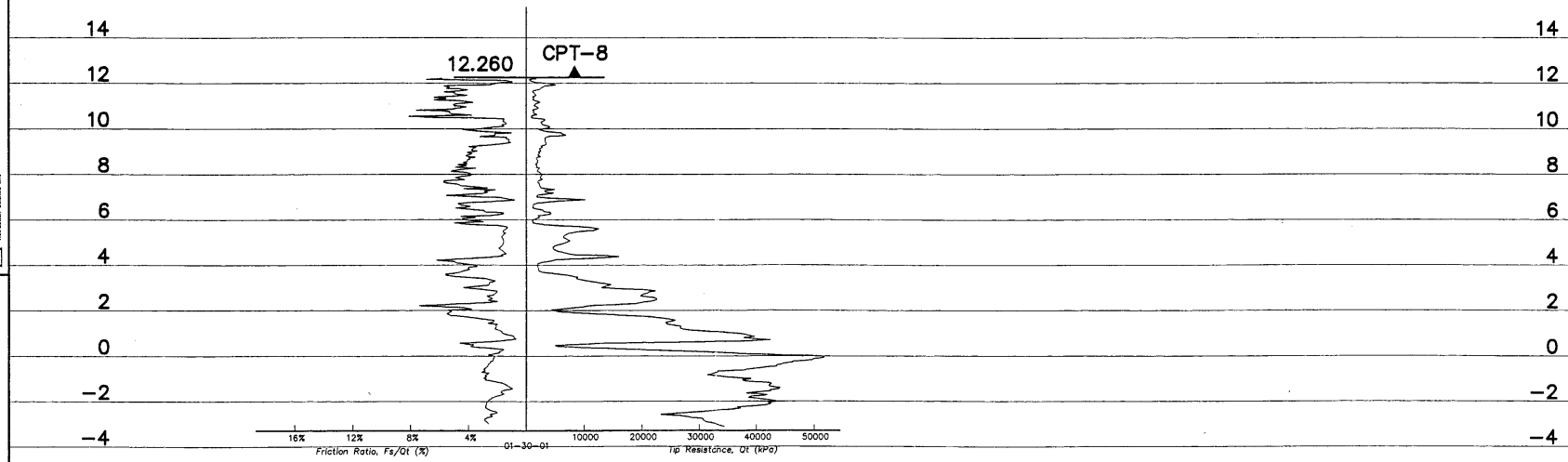

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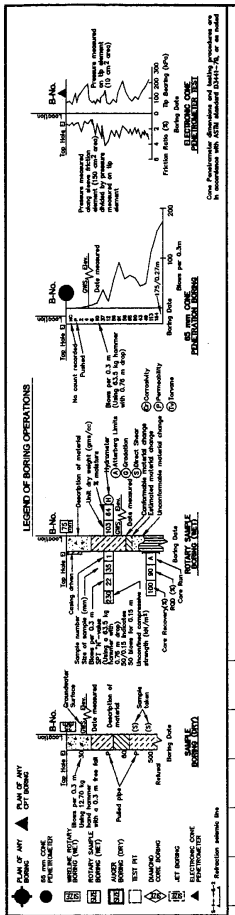

NOTE: Visual classification of earth materials based on field inspection is confirmed or revised with laboratory test results as necessary.

DIST.	COUNTY	ROUTE	KP TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

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DESIGN OVERSIGHT	DRAWN BY	M. D. Robertson	T. d'Arcy FIELD INVESTIGATOR	METRIC "ALL DIMENSIONS AND ELEVATIONS ARE IN METRIC (m)"	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	KP	DOYLE DRIVE RECONSTRUCTION PROJECT
SIGN OFF DATE	CHECKED BY	K. R. Dahl & M. W. Heublein	DATE January 2001					LOG OF TEST BORINGS No. 11

Taber Consultants Job No. 2D2/300/133 file id: 2D230013Jv.dwg date: 05/24/01

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 20 40 60 80

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DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF

APPENDIX D

Approved Caltrans BMPs

Appendix D

Approved Caltrans BMPs (excerpt from the SWMP, as modified by 5/28/04 memorandum: Notice of Revision to the Project Planning and Design Guidelines Based on the settlement negotiations of the District 7 Lawsuit

Biofiltration strips and swales are vegetated surfaces that remove pollutants by filtration through grass, sedimentation, sorption to soil or grass, and infiltration through the soil. Strips and swales are mainly effective at removing debris and solid particles, although some constituents are removed by sorption to the soil. Biofiltration swales are vegetated channels that receive directed flow and convey storm water. Biofiltration strips, also known as vegetated buffer strips, are vegetated sections of land over which storm water flows as overland sheet flow.

Biofiltration strips and swales are to be implemented at all sites to the extent that implementation is consistent with existing Caltrans policies, as described herein. In practice, this means maximizing the use of vegetation in the right-of-way wherever site conditions and climate allow vegetation to establish and where flow velocities are not high enough to cause scour.

Infiltration devices store runoff and allow it to infiltrate into the ground. Infiltration prevents pollutants in the captured runoff from reaching surface waters. In areas of high sediment loads, pretreatment may be required. Infiltration devices are required to meet the criteria in Appendix B. Infiltration devices should be considered wherever site conditions allow and the design water quality volume exceeds 123 cubic meters (0.1 acre-foot).

Detention devices are basins or tanks that temporarily detain runoff under quiescent conditions to allow particles to settle out. Detention devices should be considered when the design water quality volume is at least 123 cubic meters (0.1 acre-foot).

Traction sand traps should be considered at sites where traction sand or other traction-enhancing substances are commonly applied (at least once or twice a year) to the roadway.

Dry weather flow diversions to treat non-storm water flow may be feasible. They should only be considered if dry weather flow from Caltrans activities is persistent, or the result of an ongoing Caltrans activity. Additionally, dry weather diversions should only be considered if connection to a nearby sanitary sewer would not involve excessive measures to implement, and provided the local health department and the sanitary sewer authority are willing to allow the Department to connect to a nearby sanitary sewer.

Gross Solids Removal Devices (GSRDs) should be considered for areas where receiving waters are on the 303(d) list for trash or areas where TMDLs that require trash removal have been adopted.

Media Filters remove fine sediment, particulate-associated pollutants, and sometimes dissolved pollutants. The normal configuration of such a device consists of an initial sedimentation basin or vault followed by a filtering vault that is lined with a media.

Multi-Chamber Treatment Trains (MCTT) use three treatment mechanisms in three different chambers. These include a catch basin with a sump, a sedimentation chamber with tube settlers and sorbent pads, and a filtering chamber lined with media.

Wet Basins (constructed wetlands) are permanent pools of water designed to mimic naturally occurring wetlands. The main distinction between construction and natural wetlands is that constructed wetlands are placed in upland areas and are not subject to wetland protection regulations.