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SOUTH ACCESS TO THE GOLDEN GATE BRIDGE

DOYLE DRIVE

DOYLE DRIVE REPLACEMENT PROJECT

Stormwater Drainage Report

February 2009

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California Department of Transportation District 4

Doyle Drive Replacement Project

Stormwater Drainage

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This report takes into account the particular instructions and requirements of our client.
It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Job number 131558

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1 Introduction

1.1 Purpose

The purpose of this report is to determine the onsite and off-site drainage characteristics within the tributary area of the proposed Doyle Drive Project located in the City of San Francisco.

This report will determine the peak flows from a 25-year and 100-year storm event for the project area, prepare a drainage concept plan in accordance with Caltrans guidelines, and determine additional required drainage facilities. The approach will be as follows:

1. Establish the tributary area.

2. Perform hydrologic computations using the Rational Method for onsite areas and TR-55 for offsite areas.

3. Prepare a drainage concept plan for onsite and offsite areas.

1.2 Project Description

The project is approximately 1.5 linear miles and is the southern approach of Route 101 to the Golden Gate Bridge. Built in 1936, Doyle Drive is a critical link for traveling to and from the San Francisco Peninsula and the North Bay.

The project extends, on the west, from the Golden Gate Bridge Toll Plaza to Broderick Street on the east, and includes access to Richardson Avenue, Gorgas Avenue and Marina Boulevard. On the eastern end of the project area, access to Doyle Drive is provided via two approaches. The first approach is at the intersection of Marina Boulevard and Lyon Street The second at the intersection of Richardson Avenue and Lyon Street. Access is also provided at Veterans Boulevard (Route 1) approximately one mile west of the Marina Boulevard approach.

The new facility will consist of two 11-foot lanes and one 12 foot outside lane in each direction with 10-foot outer shoulder and 4-foot wide inner shoulder. The southbound direction will include 11-foot auxiliary lane from the Park Presidio Interchange to the Girard Road exit ramp.

The total roadway width will be 105.3 feet. The median will vary in width. The width of the proposed landscaped median will vary from 16 feet to 41 feet.

To minimize impacts to the Presidio Trust land, the footprint of the new facility will not extend excessively beyond the footprint of the existing facility east of the Park Presidio Interchange.

A viaduct 1,279-foot in length will be constructed between the Park Presidio Interchange and the San Francisco National Cemetery. The height of the high-viaduct will vary from 66 to 115 feet above the ground surface. Shallow cut-and-cover tunnels will extend 853 feet past the cemetery to east of Battery Blaney. The facility will then continue towards the Main Post at-grade with a wide heavily landscaped median. A retaining wall between 13 to 26 feet high will be constructed along the south side of the facility between the Battery and Main Post tunnels. A landscaped berm will be constructed along the north side of the facility to deter pedestrian traffic from the proposed facility.

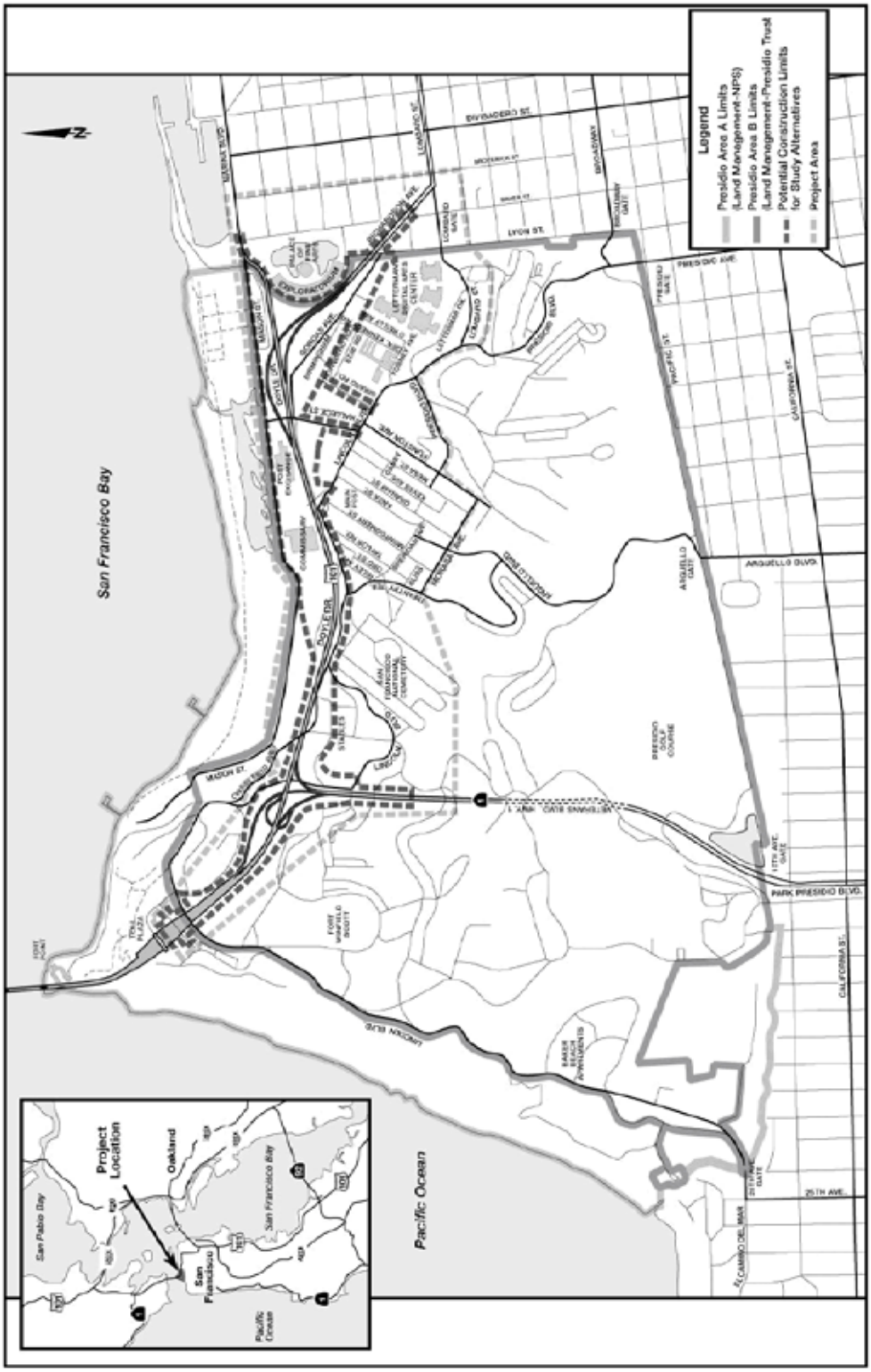

Figure 1 – Location Map

Figure 2 – Proposed Project Rendering

From Building 106 (Band Barracks) cut-and-cover tunnels up to approximately 1,020 linear feet will extend to east of Halleck Street. The facility will then rise slightly on a low causeway 394 feet long over the site of the proposed Tennessee Hollow restoration and then pass over Girard Road.

The low causeway will rise to approximately ten feet above the surrounding ground surface at its highest point. East of Girard Road the facility will return to existing grade north of the Gorgas warehouses and connect to Richardson Avenue. The proposed facility will provide a transition zone starting from the Main Post tunnel to reduce vehicle speeds when transitioning into the local road network.

The Park Presidio Interchange will be reconfigured to the south. The exit ramp from southbound Doyle Drive to southbound Veterans Boulevard will be replaced with standard exit ramp geometry and widened to two lanes. The loop of the northbound Doyle Drive exit ramp to southbound Veterans Boulevard will be improved to provide standard exit ramp geometry. The northbound Veterans Boulevard connection to northbound Doyle Drive will be realigned to provide standard compliant entrance ramp geometry. The northbound Veterans Boulevard connection to southbound Doyle Drive will be reconstructed in a similar configuration as the existing directional ramp with improved sight lines, and exit/entrance geometry.

East of the new Letterman garage, Gorgas Avenue is a one-way street with a signalized intersection at Richardson Avenue. North of Richardson Avenue, Lyon Street will remain in its existing configuration to provide access to Palace Drive. The surface parking spaces will be reconfigured to maintain the existing parking supply in the area and improve pedestrian access between the Presidio and the Palace of Fine Arts. Retaining walls will be required at the Park Presidio Interchange to accommodate the reconstruction of the ramps. Retaining walls will also be required in the eastern end of the alignment primarily along the extended Girard Road. Fences will be required along the edge of the at-grade portions of the roadway to restrict pedestrian access onto the roadway.

2 Hydrologic Analysis

2.1 Onsite Drainage

The existing drainage system consists of drainage inlets that collect flow from the roadway. The inlets then convey runoff through downspouts to the adjacent ground where it surface drains into the Presidio collection system.

The Presidio drainage system outfalls to San Francisco Bay. The existing system is offers no water quality treatment for the flow draining from the roadway. The proposed scheme will treat the runoff in agreement with the conditions of the project.

The preliminary onsite drainage system was designed by modeling the system in StormCad (V8 XM) which uses the Rational Method to calculate peak flows. This study only represents a 30% design effort therefore actual inlet locations were not modeled. Inlets will be modeled in a future design iteration. As a simplification, the actual sheds were modeled where inlets will be required but one general collection node was used instead of separate inlets on either side of the crowned roadway surface. This provided for an accurate calculation of the overall peak flow and simplified the creation of the computer model.

As the roadway and bridge design advances the proposed model will be updated to reflect the actual inlet locations. Sheds were drawn assuming that inlet spacing would not exceed 300 feet. See Appendix A for the shed maps and Appendix D for the proposed system layout.

A Caltrans Type D-1 inlet was modeled for the bridge structure (high viaduct) inlets and a Type GO inlet was modeled for all other locations. If the bridge design limits the size of the allowable drainage inlet the model will have to be adjusted to reflect this. The inlets were modeled with sufficient inlet capacity, which assumes the inlet has adequate capacity to capture 100% of the shed flow without any bypass.

StormCad utilizes the rational method to calculate peak flows. The water quality, 25-year, and 100-year event were modeled using the methods prescribed the California Department of Transportation Highway Design Manual. For this initial iteration of design, only the onsite system was modeled. The proposed system from the Stormwater Best Management Practices (BMP) areas to the sea outfalls was not modeled. Conceptual connectivity was shown and modeled but this area of analysis is likely to be covered in the next design iteration.

2.2 Runoff Coefficient

The on-site area consists of mainly pavement. The runoff coefficient was assumed to be 0.95. As the roadway is predominantly elevated above the adjacent ground, there is negligible offsite areas that contribute to the analyzed area.

2.3 Rainfall Intensity (I)

2.3.1 Intensity-Duration Curve

In estimating the onsite peak discharges for this study, it was assumed that the maximum flow occurs when the duration of the rainfall is equal to the time of concentration. Rainfall intensity-duration curves for the 25-year and 100-year events were computed from the rainfall depths for the San Francisco City gage. The 25- and 100-year intensity-duration curves are provided in Appendix A.

2.4 Time of Concentration (Tc)

Time of concentration is defined as the time required for storm runoff to travel from the hydraulically most remote point of the drainage basin to the point of interest. Time of concentration is typically the cumulative sum of three travel times, including:

Sheet flow

Shallow concentrated flow

Channel flow

In many cases a minimum Tc has to be assumed as extremely short travel times will lead to calculated rainfall intensities that are overly conservative for design purposes. The Caltrans Hydraulic Design Manual recommends that a minimum Tc of 5 minutes be used for all-paved areas. A 5-minute time of concentration was therefore used for this conceptual analysis. A more detailed analysis of Tc will be performed for future submittals.

2.5 Tributary Drainage Area (A)

The On-site Hydrology Maps showing the delineated sub-basins are provided in Appendix A.

2.6 Onsite Watershed Results

The onsite shed area totaled approximately 25 acres. The total 25-year peak flow is 93 cfs (Appendix B). The complete StormCAD model results are as per Appendix E. The sub sheds were grouped into four main sheds (2, 5/6, 8/9, and 10) based on the proposed BMP treatment areas. The intent was to direct the runoff to the treatment area and then send it through subsurface conveyance to the Presidio system and to the San Francisco Bay outfalls.

Areas of the onsite roadway west of Girard Road may contribute area that generates flow towards the tunnel entrance as opposed to the Girard Road depression. Proposed plans for the Tennessee Hollow area include daylighting the existing culvert and restoring the stream area.

Due to the initial advice from the National Park Service, no flow (treated or untreated) is to enter the restored stream. There are two potential solutions to be considered for the onsite runoff; runoff could be routed back to Girard Road by coming off the elevated structure at some point and conveyed to the Girard Road pump station through subsurface pipes. Refinement of this concept will establish if this method is able to be implemented. The alternative is the onsite runoff could be collected at the tunnel entrance and routed to Mason Street where it could connect to the water quality treatment for BMP area 9. Finalization of the roadway geometry at Tennessee Hollow and adjacent ground will assist in selecting the preferred alternative.

2.7 System Outfalls

The Presidio drainage system at one time had approximately 12 sea outfalls. Arup PB Joint Venture was informed by their maintenance staff that only two are still functioning. The lines are both 30-inch in diameter. The first is located along Mason Street and Crissy Field and the second outfall is located further east where Mason Street becomes Marina Blvd (see Appendix F for the outfall locations). Arup PB Joint Venture had both outfalls television inspected.

The pipes appear to be in fair condition but there is a significant amount of silt and standing water in the pipes. The outfalls will not have sufficient capacity to convey the post project 25-year flows. The possible reasons for this are:

The existing outfalls are already undersized because of flow being rerouted to them due to obstructions and failures of the other outfalls.

Caltrans is requires the proposed system be designed for a 25-year event which exceeds what was used to design the existing system.

Even though there is existing onsite water flowing to Crissy Marsh, the National Park Service has advised that they do not believe the runoff can be treated to a level acceptable to discharge to the marsh. Consequently, project runoff is to be routed away from Crissy Marsh into one of the two functioning outfalls.

Considering the overall scenario, the two existing outfalls will need to be upsized or additional outfalls will need to be constructed. At this level of analysis the preferred alternative can not be identified. The current analysis assumed that the two outfalls have sufficient capacity due to being upsized. Appendix F shows a conceptual plan to connect the onsite drainage and BMP areas to the two existing sea outfalls. This proposal assumes new storm drain pipe to be constructed along Mason Street.

2.8 Pump Stations

The current drainage design will require three pump stations. One pump station will be located near low point of Girard Road. This will pump runoff from both Doyle Drive and Girard road and convey it to BMP area 10 at Mason Street. Here the flow will be treated and then a second pump station will be required to pump it to Outfall 2.

The existing Presidio drainage system along Mason Street appears to be relatively shallow; less than four feet below the existing ground surface. Consequently, whatever BMP type is selected for site 10, the outfall invert will be below grade of the existing drainage system necessitating an additional pump station. By having a higher head on the discharge flow the outfall will have more capacity with a specific tidal elevation than with just a gravity discharge.

The second pump station will be located along Mason Street west of BMP area 6 at Outfall 1. This pump station will be required to pump flow from the sheds for BMP areas 2, 5/6, and 8/9. As with Outfall 2, the existing drainage system is shallow. The proposed drainage pipes are expected to be below the existing system so a pump station will be required. Using either an Austin sand filter or Contech-type Stormvault, the depth of the outfall from the box would be lower than the existing drainage system.

3 Offsite Watershed

3.1 Approach

The US Department of Agriculture Natural Resources Conservation Service (NRCS) WinTR55 computer program was used to compute the 25- and 100- watershed runoff. WinTR-55 is a single-event rainfall-runoff small watershed hydrologic model. The model generates hydrographs from both urban and agricultural areas and at selected points along the stream system. Hydrographs are routed downstream through channels and/or reservoirs. Multiple subareas can be modeled within the watershed. Data required include dimensionless unithydrograph; storm data; rainfall distribution; and sub-area Data. The sub-area data includes subarea name, area, runoff curve number, and time of concentration (Appendix C).

3.2 Watershed Description

There are no stream gages in the watershed and the model could not be calibrated. In order to determine the accuracy of the results, the watershed was analyzed using U.S. Geological Survey regression equations for the central coast region of California.

The 100-year flow from the regression equation is within 2% of the values calculated in WinTR-55. The watershed consists of various land uses, including open space, residential, commercial, industrial, and institutional. The watershed was delineated on USGS quadrangle map (Figure 3).

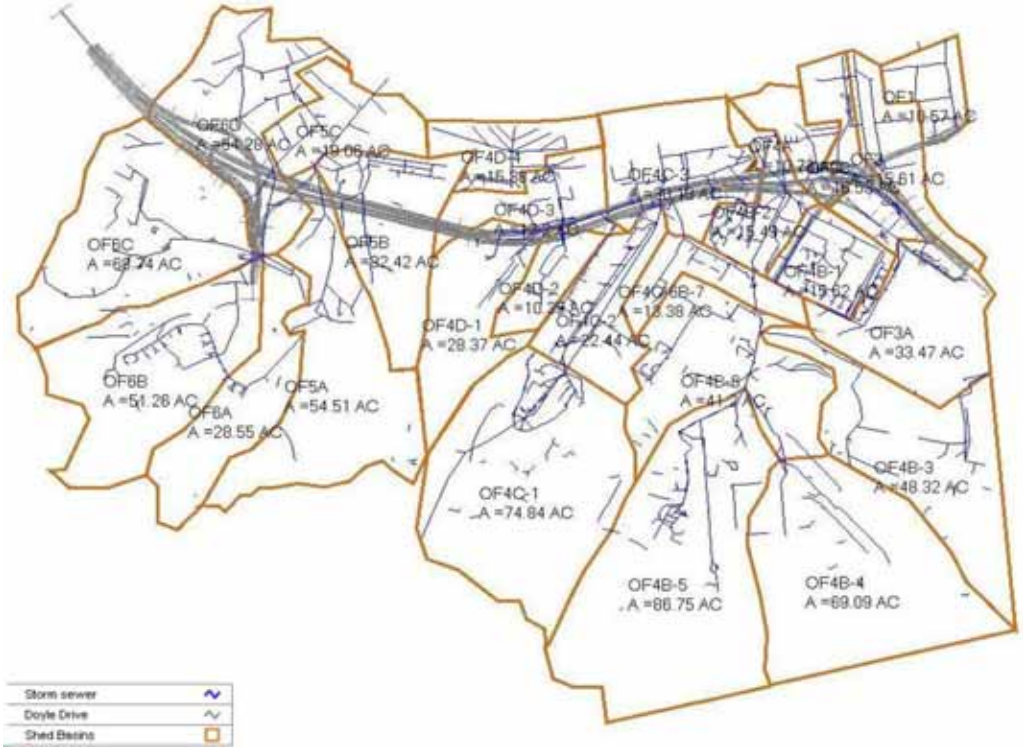

Figure 3 – Watershed map

There are not any creeks or streams that cross the current alignment of Doyle Drive. Most of the drainage in the urban areas occurs through the Presidio storm drain system in an underground pipe network and open channels along roads. The watershed is covered by

approximately 35 acres of impervious surfaces (i.e., roads, parking lots, and buildings) (Figure 4).

The rainfall gage for San Francisco City (over 116 years of data) was used for analyzing the runoff from the watershed. The rainfall data was obtained from the California Department of Water Resources website. The Natural Resource Conservation Service Hydrologic Soil Groups and curve number procedure were used to estimate rainfall infiltration.

The Battery Tunnel watershed is covered by Hydrologic Soil Groups A, B and D (Figure 5). Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. HSG A's generally have the lowest runoff potential and D's the highest.

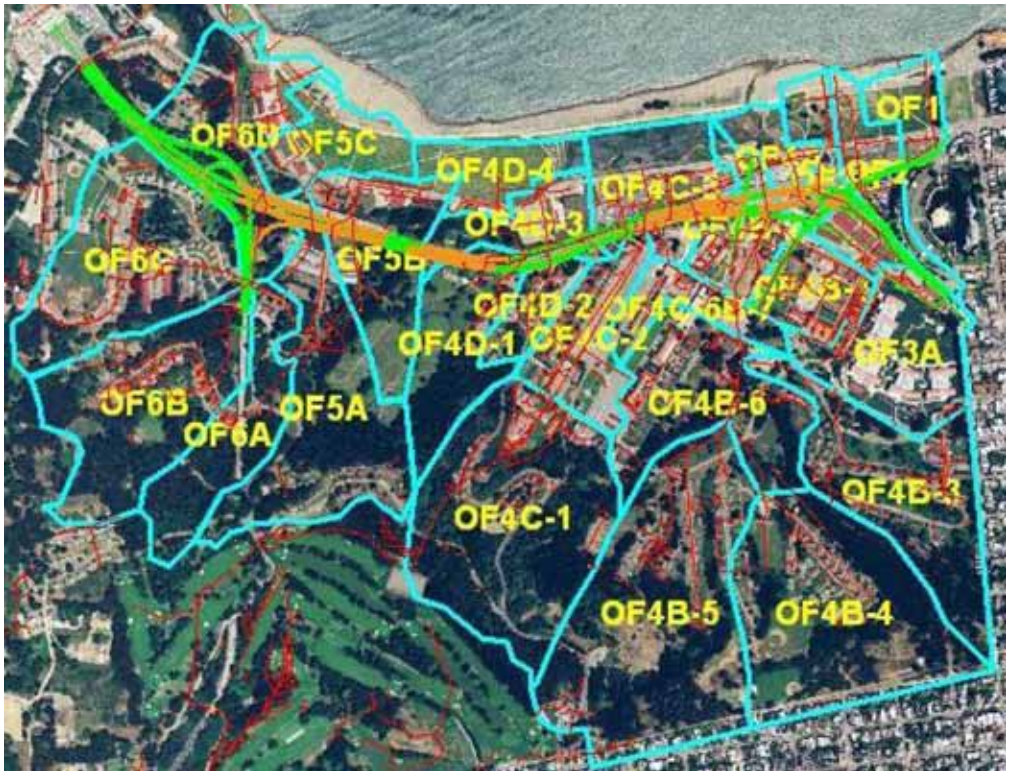

Figure 4 – Site Watershed Map

Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water andsoils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high watertable, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

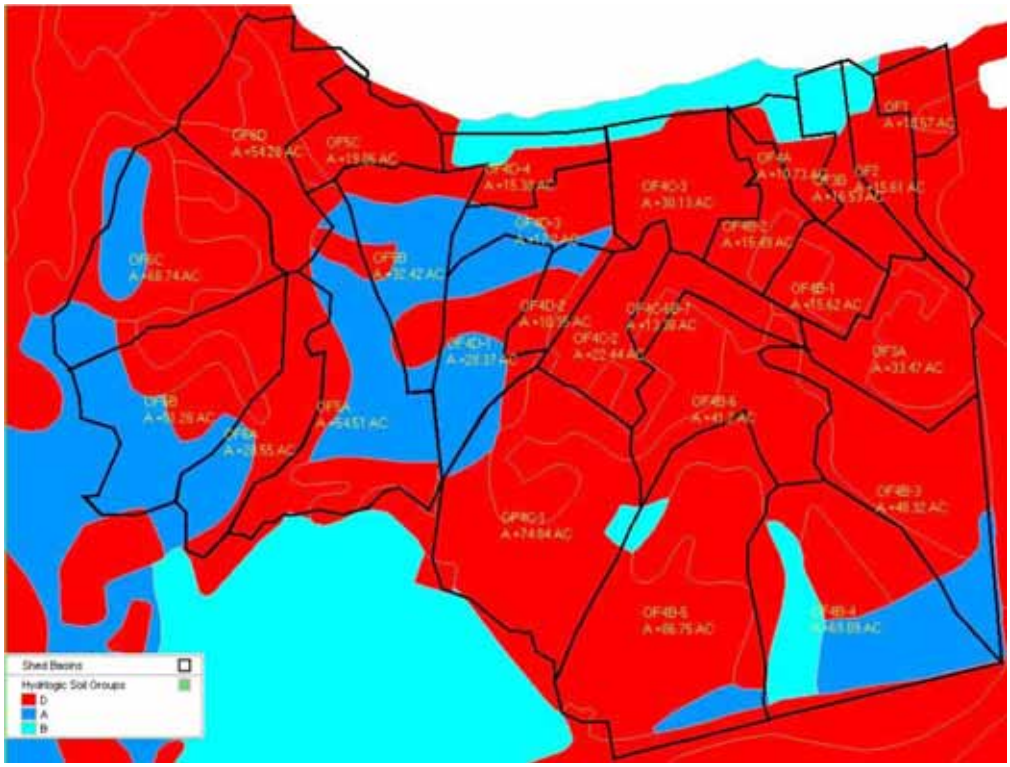

Figure 5 – Water Shed Basins

Excess runoff was transformed into flow hydrographs using the kinematic wave method. The kinematic wave method is designed principally for representing urban areas, although it can be used for undeveloped regions as well. It is a conceptual model that includes one or two representative planes. The same meteorologic boundary conditions are applied to each plane.

3.3 Offsite Watershed Results

Table 1 shows the existing 25-year and 100-year flows at the existing storm sewer outfalls assuming the outfalls are functioning and there is enough capacity in the storm sewer system to intercept the flows and convey them to the outfalls. A closed circuit video analysis indicates that only two of the outfalls in the San Francisco Bay are actually functioning.

A preliminary hydraulic analysis indicates that the storm sewer system does not have enough capacity at Doyle Drive to intercept and convey the 25- and 100-year flows. The excess flows will drain overland in local streets and open spaces to eventually reach the San Francisco Bay.

Outfall	Area	25-year	100-year	Remarks
OF1	10.6	17	22	Functioning Outfall
OF2	15.6	23	29	Outfall not functioning
OF3	50.0	58	76	Flows Pumped to OF1
OF4A	10.7	15	20	
OF4B	289.9	178	256	Tennessee Hollow
OF4C	129.4	116	161	
OF4D	71.8	89	116	West of Main Post Tunnel
OF5	106.0	40	64	Functioning Outfall Flows under High Viaduct
OF6	202.8	102	153	Outfall not functioning Flows under High Viaduct

Table 1 – Flows at Outfalls

4 Offsite Drainage Concept

There are no offsite areas that currently drain into Doyle Drive. The existing offsite flows cross Doyle Drive through the Presidio storm drainage system and surface runoff under the high and low viaducts. The offsite runoff will continue to cross Doyle Drive similar to existing conditions.

The offsite runoff will not contribute to Doyle Drive runoff until after the Doyle runoff is treated in the proposed BMP's. The proposed condition will not impact the Presidio storm drainage system except for the area of the roadway between the High Viaduct and the Main Post Tunnel and the proposed depressed Girard Road area.

At these locations, it is expected that areas of storm drain network will be relocated. The storm drains at these locations are expected to convey the 25-year runoff and the pipe sizes are expected to remain unchanged.

4.1 Offsite Drainage

4.1.1 High Viaduct – End of Project to San Francisco National Cemetery

Existing offsite runoff south of Doyle Drive and west of Veterans Boulevard is intercepted by storm drains and conveyed east under Veterans Boulevard (Highway 1). The area is elevated to the north along Lincoln Boulevard and under Doyle Drive High Viaduct to San Francisco Bay (Figure 6). Between Veterans Boulevard and San Francisco National Cemetery, storm drains intercept and convey low flows south of Doyle Drive under the high Viaduct.

Flows in excess of the storm drain capacity are intercepted by an existing concrete lined channel along south of and paralleling Doyle Drive, local streets or just sheetflow under the high viaduct to the San Francisco Bay.

Future offsite runoff for this area will continue to be conveyed in a similar fashion. There are no offsite flows that will impact Doyle Drive between Veterans Boulevard and San Francisco National Cemetery.

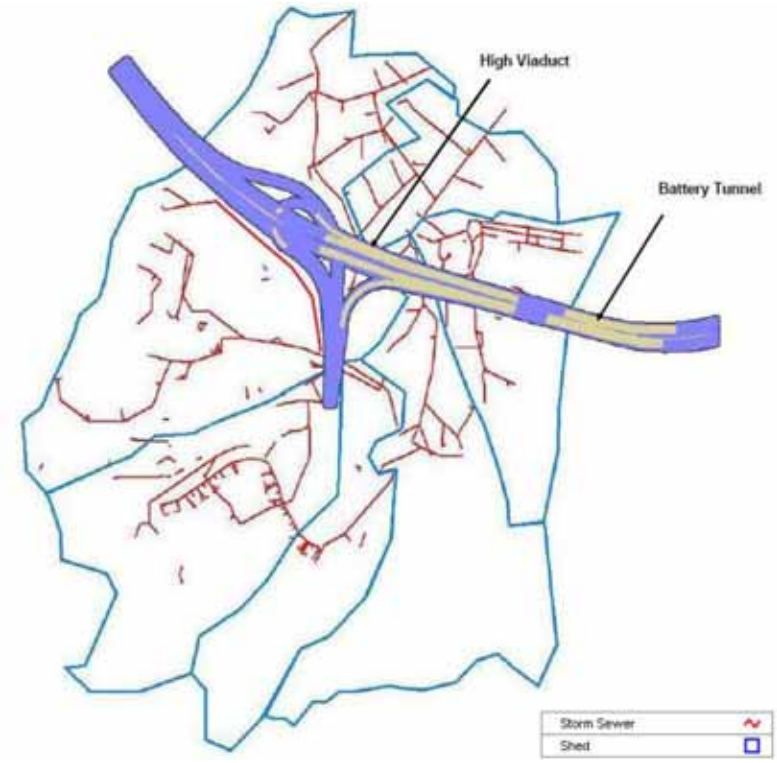

Figure 6 – Storm Drains between Battery Tunnel and Toll Booth

4.2 High Viaduct to Halleck Street

Existing offsite flows generated between the high viaduct and the proposed Halleck Street currently drain under Doyle Drive in a storm network that cross the roadway from south to north (Figure 7). The storm drains eventually outfall at Crissy marsh.

Flows in excess of the storm drain capacities are intercepted by local streets and eventually drain under Doyle Drive as surface runoff at the low viaduct. Under future conditions, Doyle Drive will be lowered and it will go into the proposed shallow cut-and-cover Battery Tunnels. The roadway will then continue towards the Main Post at-grade and then into the Main Post Tunnels to Halleck Street.

The existing storm drains will be relocated and lowered below the tunnels and the at-grade section of the roadway (Appendix G). Offsite runoff in excess of the storm drain capacities will flow across the Main Post Tunnel or sheetflow east to the proposed Tennessee Hollow Creek restoration area. In the areas where the storm drains do not have the capacity to convey the 25-year runoff, the existing curbs along the local streets and parking lots will direct the runoff away from Doyle Drive. The size of the existing storm drain network in this area will remain.

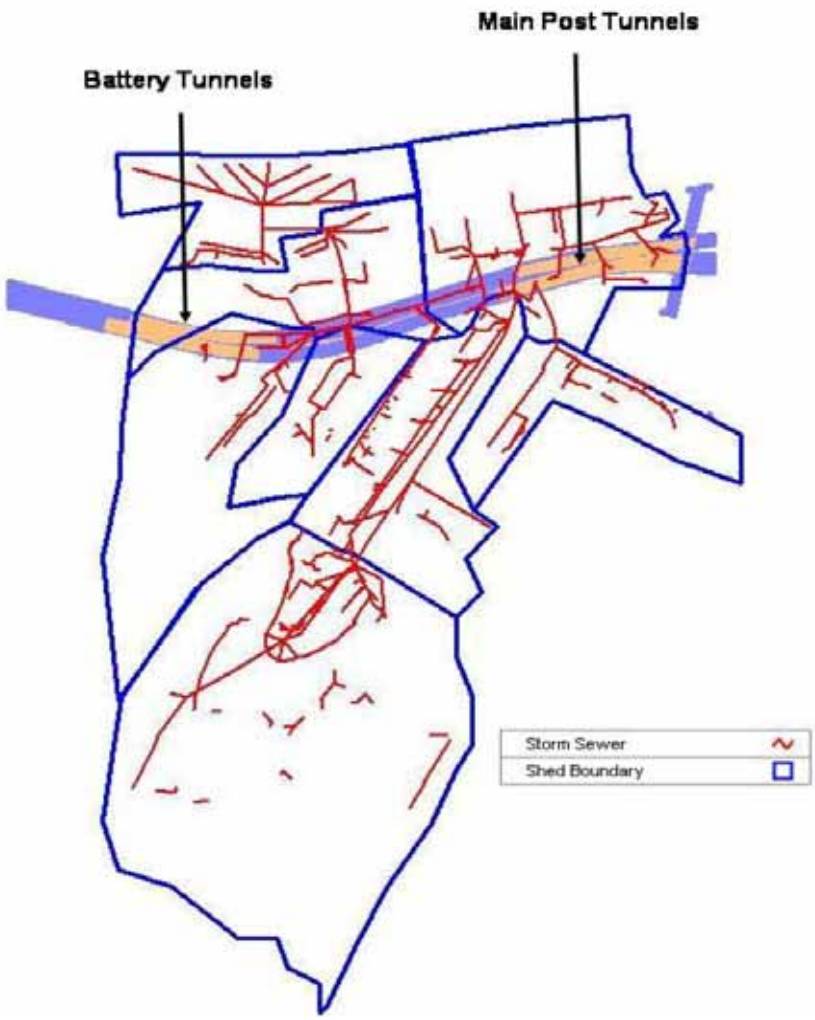

Figure 7 – Storm Drains between high Viaduct and Halleck Street

4.3 Low Causeway – Halleck Street to Girard Road

The Tennessee Hollow watershed consists of approximately 362 acres of various land uses, including open space, residential, commercial, industrial, and institutional. The Doyle Drive alignment between Halleck Street and Girard Road crosses the Tennessee Hollow drainage just south of Crissy Marsh. More than half of the existing creek system has been diverted into storm drains or lined concrete channels (Figure 9).

Portions of the Tennessee Hollow drainage system have been identified by the Trust and National Park Service (NPS) for future restoration to a natural stream and riparian corridor. A design consisting of a braided channel has been proposed for the restoration. The channel restoration will allow water from San Francisco Bay to flow upstream across Mason Street and Doyle Drive. A causeway is being proposed for Doyle Drive. The existing storm sewer under Doyle Drive is expected to be removed by the Presidio Trust.

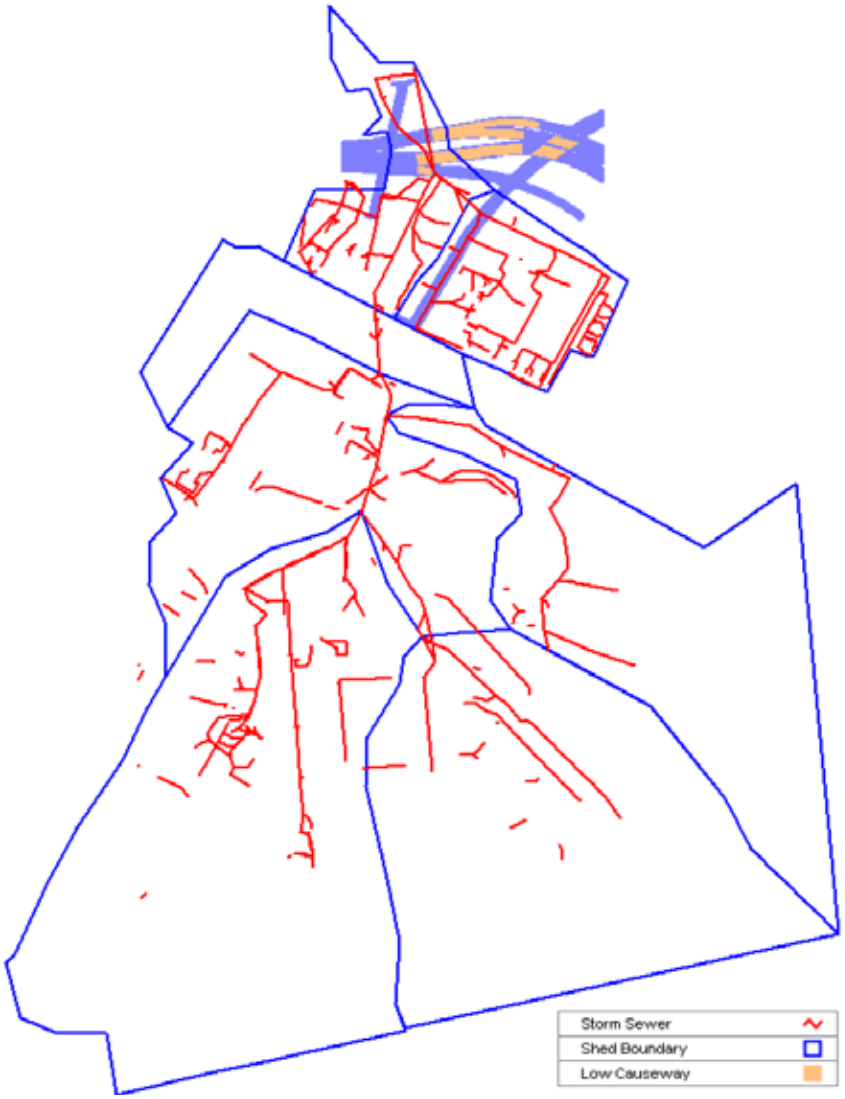

Figure 8 – Tennessee Hollow

4.4 Girard Road to Lyon Street

Under existing conditions, the offsite runoff is intercepted by the Presidio storm sewer system and drained under the existing low causeway (Figure 10). Under future conditions, the storm drains will be relocated to avoid the proposed Girard Road depressed area (Appendix D).

According to the project topographic map, Girard Road alignment at Doyle Drive is located on a knoll or local high point with flows draining away to the west and southeast. The flow to the west is currently drained by the Presidio storm drain system to Crissy Marsh.

The runoff from major storm events to the southeast ponds between Doyle Drive and the warehouses until it is able to get into the storm drain system. There will be no surface offsite flow to the proposed Girard Road depressed area.

The 42-inch storm drain pipe is proposed to be relocated The storm drain outfalls are currently out of service with the exception of the easternmost outfall. The flows to the out of service outfalls are being pumped to the only operating outfall.

It is understood that there are existing flooding problems in this area but addressing this falls outside the scope of the project and jurisdiction of the California Department of Transportation. It is assumed in this analysis that capacities of existing network not be decreased.

Figure 9 – Girard Road to Lyon Street

5 Water Quality

The project will provide a net benefit related to reduced runoff volumes due to a decrease in impervious area. The proposed concept increases open spaces and connectivity yielding a reduction of untreated runoff areas.

The BMP's will treat the runoff prior to discharge to the ultimate outfall points. Under the existing conditions, runoff from the Doyle Drive structure drains to Crissy Marsh and the San Francisco Bay without any treatment. Given the requirement for BMP's for the project, as well as the decrease in impervious surfaces, there will be an overall improvement in the quality of surface water quality discharging to San Francisco Bay.

The available water quality treatment options were selectively narrowed down to vegetated swales, Austin sand filter, and Contech-type Stormvault. Arup PB Joint Venture performed preliminary calculations to size all three of the alternatives for each of the four BMP sites in order to establish the most appropriate for the site (Appendix H). It is expected that as the design advances the appropriate options will be selected for each respective BMP site.

In order to size each of the three BMP alternatives it was necessary to calculate both the water quality flow (cfs) and the water quality volume (cf) for each shed. Some treatment options are designed based on flow while others are designed based on volume.

The water quality flow was calculated using the Rational method and a rainfall of 0.2 in/hour which is the value for Region 2 (San Francisco) in the Caltrans Storm Water Quality Handbook, section 2.4.2.2. The water quality volume was calculated using the Basin Sizer program version 1.46 for the Caltrans method with the Downtown San Francisco gage. This produced a water quality treatment unit basin storage volume of 0.7 inches for a 48-hour drawdown time (Appendix B).

6 Conclusion

Caltrans requires that all freeways drain adequately to safeguard the general public and therefore provide specific guidelines for storm water runoff conveyance. The proposed drainage facilities, in accordance with Caltrans design guidelines, will keep travel ways clear of storm water during a 25-year storm event.

There are no creeks, streams, open culverts or bridges that cross the current Doyle Drive alignment. The offsite drainage across Doyle Drive occurs through the Presidio storm drain system and as surface runoff under the high and low viaducts. Under the proposed conditions, the offsite flows will continue to drain under the High Viaduct and the Low Causeway in a similar fashion without obstruction.

The storm drains crossing Doyle Drive between the High Viaduct and the Main Post Tunnel will be lowered without impeding the 25-year runoff. The storm drain network will be relocated where necessary. Significant increase in pipe sizes is not anticipated.

The National Park Service has indicates that in order to accept runoff from Doyle Drive into Crissy Marsh, the runoff must be treated beyond the Regional Water Quality Control board requirements. Runoff from Doyle Drive should be kept separate from offsite flows and the runoff should be treated and discharged directly into San Francisco Bay. Three pump stations are proposed to discharge Doyle Drive runoff.

References

[1] *Caltrans Highway Design Manual*, Fifth Edition, California Department of Transportation, May 2001

[2] STORMCAD

[3] WinTR-55

[4] South Access to the Golden Gate Bridge, Doyle Drive FEIS/R

[5] Presidio of San Francisco Storm Water Management Plan, Dames & Moore, 1994

[6] ftp://ftp.water.ca.gov/users/dfmhydro/Rainfall Dept-Duration-Frequency/

Appendices

A. ONSITE SHED MAPS AND INTENSITY-DURATION CURVES
B. PEAK FLOW RESULTS (ONSITE)
C. OFFSITE HYDROLOGY CALCULATIONS
D. ONSITE DRAINAGE SYSTEM LAYOUT
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