3 Watershed Hydrology and System Hydraulics

3.1 Watershed Description

The Vista Grande Watershed includes portions of Daly City as well as portions of unincorporated San Mateo County. The watershed encompasses an area of approximately 2.5 square miles (Figure 3.1). The approximate boundaries of the watershed are formed by: the City and County of San Francisco to the north, Colma Creek to the east and south, and the Pacific Ocean to the west. Stormwater flows from the watershed are collected by three main culverts: a 24-inch-diameter culvert, a 60-inch-diameter culvert, and a 7-foot by 6-foot box culvert. These three culverts discharge into the Vista Grande Canal, which starts near the intersection of Lake Merced Boulevard and John Muir Drive. Flows in this canal continue to the west along John Muir Drive where they are diverted into the existing Vista Grande Outfall Tunnel. The tunnel discharges to the Pacific Ocean through an existing outfall structure at Fort Funston, located in the Golden Gate National Recreation Area (GGNRA).

The watershed predominantly consists of urban runoff from three distinct drainage basins. The runoff is collected in the three existing drainage culverts described above. Figure 3.1 shows the entire Vista Grande Watershed and its three sub-basins.

3.2 Preliminary Design Criteria

Based on past planning, the City has selected a design storm event with a 4-hour duration and a 25-year recurrence interval (RMC, 2006). This design event results in an estimated peak stormwater flow of 1,500 cubic feet per second (cfs), including base flows, and an accumulation of approximately 43 million gallons.

Stormwater modeling being performed by others has not yet produced a final storm hydrograph for the design storm. A storm hydrograph is a graph showing water flow with respect to time. It is made up of two components: base flow and surface runoff. Base flow is that rainfall which seeps into the soil and moves laterally to the storm drains and the canal, reaching the canal after several hours or days. Surface runoff is the rainfall that travels overland and is transported through storm drain facilities to the canal. It also includes the rainfall that is deposited directly on the canal. Brown and Caldwell developed a synthetic hydrograph based on the design storm event flow and accumulation. It is shown in Figure 3.2. For planning and design purposes the synthetic hydrograph is considered suitable, but it is not recommended for final design. Before further development of the tunnel or stormwater detention designs, the hydrologic analysis should be updated to reflect the anticipated future upper watershed hydrology and stormwater system configuration.

Brown and Caldwell assumed that the peak stormwater flow would most likely occur following a series of rain storms, which would saturate the watershed and leave excess base flow with nowhere to go. Absent any data from past studies, Brown and Caldwell assumed a base flow of 5 cubic feet per second associated with a saturated watershed. Such a base flow represents only about 0.3 percent of the peak flow and about 1.3 percent of the total runoff during the storm event. Brown and Caldwell considers a base flow of this magnitude to be reasonable based on the characteristics of this watershed. Base flow will be determined more accurately when the stormwater modeling efforts are completed.

In addition, Brown and Caldwell also analyzed the potential impacts of storing runoff in either retention basins or storage tanks. Retention basins and storage tanks can be used to store stormwater until the storm has passed, reducing the peak stormwater flow and allowing a smaller outfall tunnel and/or conduit to discharge the flow. Following the storm, screened stormwater can be returned to the stormwater system or serve as a resource for stormwater re-use. Table 3.1 indicates the relationship between outfall tunnel capacity and retention basin capacity.

In February 2004, a major storm caused extensive flooding in the downstream portions of the Vista Grande watershed. This storm event has been referred to as a 100-year-storm[1]. For such events (i.e., those exceeding the 25-year design storm), the City could consider approaching the City and County of San Francisco to inquire about opportunities to discharge higher flows using San Francisco's existing Outfall Tunnel.

3.3 Preliminary Hydrologic Evaluation

As discussed above, the Vista Grande watershed is comprised of three drainage sub-basins routing stormwater flows to separate stormwater culverts. The estimated 43 million gallons generated by the design storm is divided among three drainage basins in the following manner:

- Sub-Basin No. 1 is approximately 397 acres (0.6 square miles) and produces approximately 10 million gallons, which are routed to the 60-inch-diameter culvert line.
- Sub-Basin No. 2 is approximately 118 acres (0.2 square miles) and produces approximately 3 million gallons, which are routed to the 24-inch-diameter culvert line; and,
- Sub-Basin No. 3 is approximately 1,175 acres (1.8 square miles) and produces approximately 30 million gallons, which are routed to the 7-foot by 6-foot box culvert line.

The culverts converge at the Vista Grande Canal inlet and discharge into the canal as indicated schematically on Figure 3.3. For reference purposes only, the three sub-basin culverts are referred to by their diameters at their discharge point into the Vista Grande Canal. In January 1987, the City added a parallel 72-inch-diameter, 150-foot-long culvert adjacent to the box culvert to improve flow characteristics. The 72-inch-diameter culvert does not increase the flow capacity of the system.

The City and others have previously evaluated the hydraulic capacities of the major stormwater collection conduits. The existing Vista Grande Outfall Structure, located on the beach beneath the GGNRA, is capable of discharging 170 cfs. The reported capacities of the existing Vista Grande Tunnel and Vista Grande Canal are about 170 cfs and 500 cfs, respectively. Figure A.2 presents existing facilities and as-built designs of the Existing Vista Grande Canal, Tunnel, and Outfall Structure.

3.4 Water Quality Improvements

A trash rack located at the existing Vista Grande Tunnel inlet prevents large debris (larger than approximately 6-inches by 24-inches) from entering the tunnel, but unfortunately garbage and smaller debris can pass through the trash rack and be released onto the beach and into the ocean. City employees and volunteers have been called upon to clean up debris on the beach following moderate storm events.

The water quality of the stormwater discharged at the ocean can be improved through additional debris screening. When selecting a debris screening system, the following should be considered: maximum acceptable debris size and configuration, debris quantities, peak and average water flow, maximum permissible water velocity through the screening media, available space and depth, debris removal

[1] "Daly City Chided for Flood Plans," *Oakland Tribune*, September 21, 2006.

methods, and operations and maintenance of the screening system. Debris screening capabilities can be integrated into the project features by using a gross solids removal device, an inclined screen, or a conventional trash rack and trashrake.

3.4.1 Gross Solids Removal Device

Provisions to screen trash, debris, and flotables from the stormwater flows could be included in a linear radial gross solids removal device located at the inlet to the Vista Grande Canal or stormwater detention basins. The linear screening device could screen out suspended solids larger than 5 mm (approximately 3/8-inch) in diameter, and the device would maintain the desired flow capacity provided the screens are note more than 25% full.

A manifold of linear radial gross solids removal devices, Figure 3.4, may provide a low-maintenance approach for debris screening. In this approach, stormwater would enter the manifold and pass through the louvers into the tunnel inlet. Debris would need to be removed several times each year through access hatches in the top of the screens using a vacuum truck depending on the amount of rainfall and the number of storms.

3.4.2 Inclined Screen

Similar to the screening device described above, an inclined screen device is a below-grade structure. Water and debris flowing into the structure are separated as the water falls through an inclined screen or bar rack and the debris rolls off the screen into a collection basin. The inclined screen openings may be sized to screen out debris of various dimensions.

Multiple debris screening chambers could be used in combination with stormwater detention structures. Figure 3.5 shows a conceptual view of an inclined screening chamber. Debris could be monitored frequently, and removed once or several times per year through access hatches in the top of the screens using a vacuum truck.

3.4.3 Trash Rack and Trashrake

Conventional approaches to debris screening include exterior inclined trash racks. Water flows horizontally through the space between the bars and debris is caught on the bar rack. The space between bars is sized to limit the size of material that passes the trash rack. In heavy debris situations where manual debris removal is difficult, an automatic trashrake can detect the accumulation of debris and rake the material free of the trash rack. Debris is deposited on the operating deck or into a debris box, and later removed.

A trash rack could be used on this project at the entrance to the existing tunnel or a new tunnel inlet. Figures 3.6A and 3.6B show a typical canal trash rack, trashrake, and debris conveyor.