Chapter 4 Alternatives Considered

This chapter presents a series of alternatives that were considered to meet the study goal of resolving flooding issues along Vista Grande canal, as well as solving flooding within the Vista Grande watershed. Many of the alternatives evaluated for the Vista Grande Watershed Study were identified in previous studies including the Vista Grande Storm Sewer Draft Report (Kennedy/Jenks, 1983), Vista Grande Diversion Feasibility Evaluation (CH2M Hill, 2001) and Vista Grande Stormwater Drainage Basin Hydraulic Capacity Evaluation (CH2M Hill, 2001). Each of these studies is discussed in more detail in Chapter 3, Previous Studies. This watershed study reviewed the alternatives previously analyzed from a watershed perspective by looking at how potential upstream improvements might impact downstream improvements, and evaluating land availability and site constraints of the alternatives. Through this approach, the benefits and limitations of each alternative are identified. This Vista Grande Watershed Study also develops planning level cost estimates (in December 2005 dollars) for each of the alternatives. Note that the cost estimates presented in Chapter 4 may differ slightly to those presented in Chapter 5, Preliminary Program Recommendations. Planning level costs were developed in Chapter 4 to serve as a basis for comparison between the Alternatives Considered and to determine the most desirable alternatives. The preliminary program components presented in Chapter 5 were developed further and include more detailed planning level cost estimates.

This chapter summarizes the long-term upstream and downstream alternatives evaluated for the watershed study. These summaries are followed by a discussion of the comparison of alternatives and the preliminary long-term components recommended for further assessment in the Vista Grande Watershed Study. Finally, this section includes a discussion of potential interim solutions evaluated for the watershed study.

4.1 Upstream Alternatives

Upstream alternatives are those that are considered in the upstream portion of the Vista Grande watershed in Daly City. Upstream alternatives are intended to provide benefit to localized flooding issues, and in some cases, hydraulic benefit to flooding conditions at Vista Grande canal as well. Upstream alternatives considered include:

- Storm Drain Improvements
- Regional Detention Storage
- Local Detention Storage
- Best Management Practices

4.1.1 Storm Drain Improvements

This alternative would include a series of collection system improvements to replace or enlarge storm drain pipes that do not have sufficient capacity to convey the 10-year design storm flows. Studies done by both Kennedy/Jenks (1983) and CH2M Hill (2002) identified that some improvements of the storm drain improvements were necessary. As analyzed for the Vista Grande Watershed Study, it is assumed that storm drain improvements would be implemented to provide conveyance for the 10-year storm event. The 10-year recurrence interval has become a standard for storm drain design for most cities in California because it provides a balance between level of service and affordability. In order to fully define the extent and location of the required storm drain improvements in the Vista Grande drainage area a storm drain master planning process would be required.

Planning Level Capital Cost Estimate

The planning level cost estimate for storm drain improvements to provide 10-year level of protection for the Vista Grande drainage basin is between $25,000,000 and $35,000,000. Because storm drain master

planning has not yet been completed, this estimate is based on preliminary modeling conducted by CH2M Hill (2002) and comparison of proportional costs for storm drain improvements planned in several other Bay Area cities, including the City of Palo Alto, City of Gilroy, City of Milpitas, and the City of Livermore.

Benefits

Implementation of storm drain improvements for the 10-year design storm will increase the capacity of the existing storm drain system to eliminate flooding for the design storm event. Reducing flooding in upstream locations will benefit public safety and reduce the potential for flood damage to public and private property.

Limitations

Implementing storm drain improvements will allow more water to be conveyed downstream. As such, storm drain improvements must be implemented after downstream improvements are in place so that problems at Vista Grande canal are not exacerbated.

4.1.2 Regional Detention Storage

The concept of upstream detention storage was analyzed in the Vista Grande Stormwater Drainage Basin Hydraulic Capacity Evaluation (CH2M Hill, 2002). The study looked at the potential to implement a series of upstream detention basins in Daly City to alleviate regional flooding issues along interceptors throughout the watershed and at the Vista Grande canal and tunnel. The four upstream basin locations examined as part of the study are shown in Figure 4-1. Basins would essentially be underground, reinforced concrete reservoirs, as shown in Figure 4-2. As part of the CH2M Hill study, each of the basin locations was modeled to assess the benefit on flooding on interceptors throughout the system and at the Vista Grande canal and tunnel. It is important to note that the modeling conducted as part of the study assumed that 330 cfs would be diverted from the canal to Lake Merced (CH2M Hill, 2002.) The locations, volume and cost of the four detention basin locations are summarized in Table 4-1 and each is further discussed below.

Figure 4-1 Location of detention basins modeled in the Vista Grande Hydraulic Capacity Evaluation (CH2M Hill, 2002)

Figure 4-2 Example of underground reservoir construction

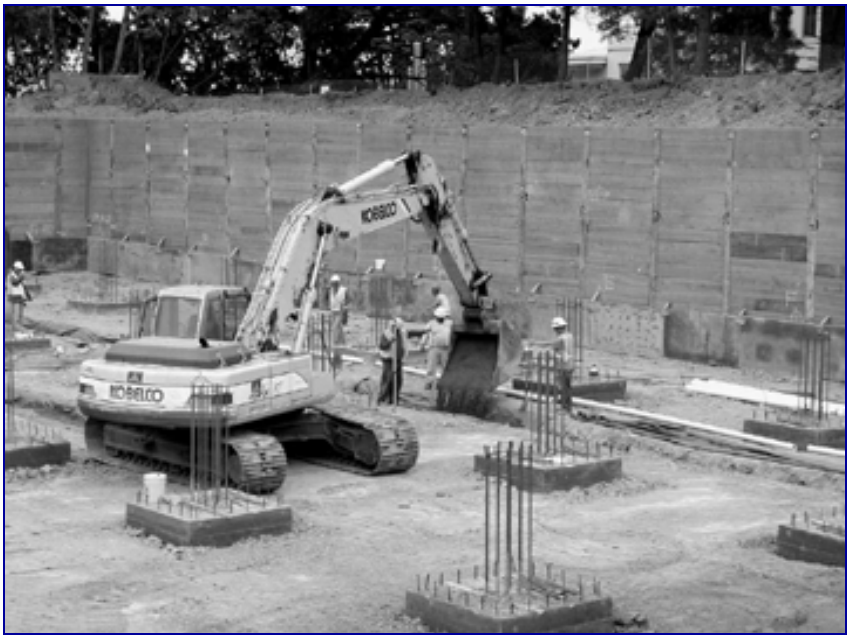


Table 4-1 Summary of Detention Basins Studied in the Vista Grande Hydraulic Capacity Evaluation (CH2M Hill, 2002)

Detention Basin Location	Storage Volume	Planning Level Capital Cost Estimate
Interstate-280 (I-280) Cloverleaf	1.6 MG	$6,200,000
Lake Merced Golf Club (LMGC)	4.3 MG	$16,800,000
Westlake Shopping Center	35.7 MG	$139,200,000
Park Plaza Drive	13.8 MG	$53,800,000

Detention Basin at I-280 Cloverleaf

A detention basin at the I-280 Cloverleaf, as shown in Figure 4-3, would have a volume of 1.6 million gallons, with a depth of 12 feet and diameter of 150 feet. Flows from 1-280 and an area east of I-280 would enter the basin through a 48 inch pipeline and would exit the basin through a 24 inch pipeline. The objective of the basin would be to minimize surcharging and flooding along downstream interceptors.

Figure 4-3 I-280 Detention Basin Location

Planning Level Capital Cost Estimate

The planning level cost estimate for the I-280 Cloverleaf detention basin is $6,200,000, as shown in Table 4-2. This estimate assumes an underground detention basin with a unit cost of $3.00/gallon.

Table 4-2 Planning Level Cost Estimate for I-280 Cloverleaf Detention Basin

Item Description	Unit Cost [a]	Storage Volume	Total Cost
I-280 Cloverleaf Detention Basin	$3.00/gallon	1.6 MG	$4,800,000
Construction Cost Estimate			$4,800,000
Implementation (30% Allowance)			$1,400,000
Capital Cost Estimate			$6,200,000

a. Unit cost data for detention basins developed based on review of several capital cost estimates for similar basins around and Bay Area (as described in Appendix C) and estimated from SFPUC RW Master Plan (RMC, 2005.)

Benefits

Based on the SWMM modeling conducted by CH2M Hill (2002), the I-280 Cloverleaf detention basin would provide flow attenuation to minimize surcharging along John Daly Boulevard. There is a potential to construct the I-280 Basin such that stormwater may percolate through the bottom of the basins to groundwater recharge and, resulting in a water supply benefit. A preliminary analysis has shown that the I-280 Cloverleaf basin could provide an approximate average annual recharge benefit of 26 acre-feet per year (ac-ft/yr) (Yates, 2005) at a cost of approximately $22,000 per acre foot.

Limitations

The main limitation of the I-280 Cloverleaf detention basin is that it does not mitigate flooding at the Vista Grande canal and tunnel unless 330 cfs can be diverted from the canal to Lake Merced (CH2M Hill,

2002.) This alternative has a relatively high cost, which limits the feasibility of water supply benefits of the basin. This alternative would require extensive coordination with Caltrans for construction and maintenance activities. Additionally, there is risk associated with using storage for flood protection. To mitigate this risk, the basin would have to be operated so that water could be evacuated from the basin in preparation for upcoming storm events. Water would likely have to be pumped out of the basin, which would further limit water supply benefits.

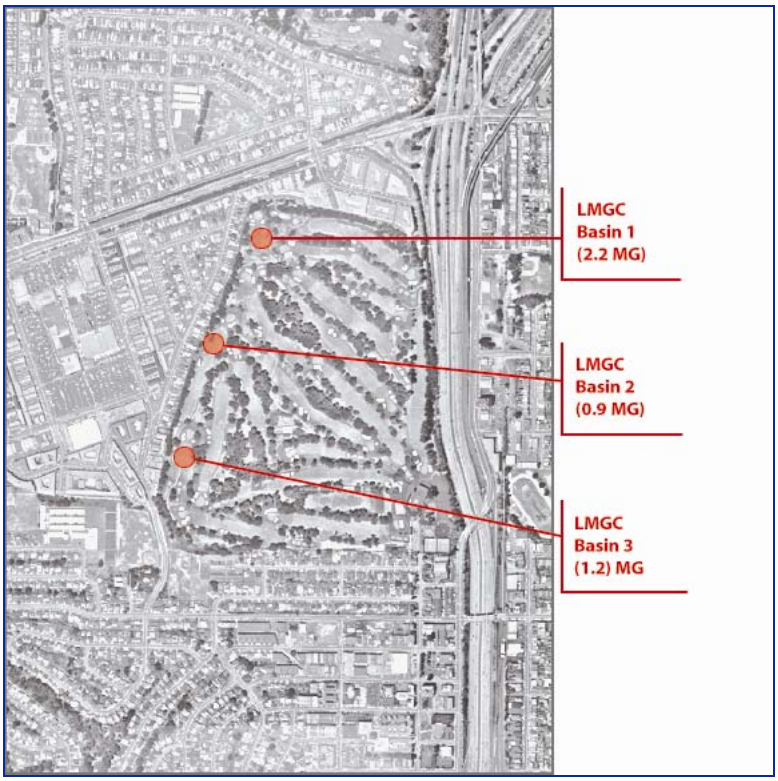
Detention Basin at Lake Merced Golf Club (LMGC)

As described in the Vista Grande Stormwater Drainage Basin Hydraulic Capacity Evaluation (CH2M Hill, 2002), this alternative would include implementation of three detention basins at the LMGC, as shown in Figure 4-4:

- Basin 1, which would be located at the par three on the northern edge of the golf course, would be 10 feet deep and 95 feet in diameter and store approximately 2.2 MG
- Basin 2, located on the western edge of the golf course, would store approximately 0.9 MG
- Basin 3, located in the south west area of the course, would store approximately 11.2 MG.

The purpose of the basins would be to provide flow attenuation during storm events and mitigate flooding caused by downstream restrictions.

Figure 4-4 Location of LMGC Detention Basins



Planning Level Capital Cost Estimate

As shown in Table 4-3, the planning level cost estimate for the LMGC detention basins is $16,800,000. This estimate assumes underground covered detention basins with a unit cost of $3.00/gallon.

Table 4-3 Planning Level Cost Estimate for LMGC Detention Basins

Item Description	Unit Cost [a]	Storage Volume	Total Cost
Basin 1 – Northwestern edge of course	$3.00/gallon	2.2 MG	$6,600,000
Basin 2 – Western edge of course	$3.00/gallon	0.9 MG	$2,700,000
Basin 3 – Southwestern corner of course	$3.00/gallon	1.2 MG	$12,900,000
Construction Cost Estimate			$12,900,000
Implementation (30% Allowance)			$3,900,000
Capital Cost Estimate			$16,800,000

a. Unit cost data for detention basins developed based on review of several capital cost estimates for similar basins around and Bay Area (as described in Appendix C) and estimated from SFPUC RW Master Plan (RMC, 2005.)

Benefits

There is a potential to construct the LMGC basins such that stormwater may percolate through the bottom of the basins to provide a groundwater recharge benefit. A preliminary analysis shows that combined, the three LMGC basins could provide up to 36 ac-ft/yr of recharge benefit (Yates, 2005) at a cost of $42,000 per acre foot. SWMM modeling found that these basins provided a drastic reduction in surcharging along the upstream interceptors (CH2M Hill, 2002.)

Limitations

Modeling showed that, even with 330 cfs being diverted from the canal to Lake Merced, there would be no benefit to the hydraulic conditions at the Vista Grande canal after implementation of the LMGC detention basins (CH2M Hill, 2002.) The high unit cost of these detention basins is another major limitation and limits the feasibility of water supply benefits that could be achieved through groundwater recharge. Additionally, there is risk associated with using storage for flood protection. To mitigate this risk, the basin would have to be operated so that water could be evacuated from the basin in preparation for upcoming storms. Water would likely have to be pumped out of the basin at a significant energy cost. Pumping water out of the basin would also decrease potential groundwater recharge potential. Construction of these basins would need to be coordinated with the LMGC and would need to be constructed without modifying the existing golf course layout.

Detention Basin at Westlake Shopping Center

This large detention basin would be located under the western half of Westlake Shopping Center's south parking lot, as shown in Figure 4-5. The basin would be designed to have a capacity of 35.7 MG (CH2M Hill, 2002.) At a depth of 25 feet, this would require an area approximately 275 feet x 700 feet (equivalent to 16 Olympic size swimming pools.)

Figure 4-5 Location of Westlake Shopping Center Detention Basin

Planning Level Capital Cost Estimate

This planning level cost estimate of this basin is $139,200,000, as shown in Table 4-4. This estimate assumes construction of an underground covered detention basin with a unit cost of $3.00 per gallon.

Table 4-4 Planning Level Capital Cost Estimate for Westlake Shopping Center Detention Basin

Item Description	Unit Cost [a]	Storage Volume	Total Cost
Westlake Shopping Center Detention Basin	$3.00/gallon	35.7	$107,100,000
Construction Cost Estimate			$107,100,000
Implementation (30% Allowance)			$32,100,000
Capital Cost Estimate			$139,200,000

a. Unit cost data for detention basins developed based on review of several capital cost estimates for similar basins around and Bay Area (as described in Appendix C) and estimated from SFPUC RW Master Plan (RMC, 2005.)

Benefits

SWMM modeling found that the Westlake Shopping Center detention basin would alleviate surcharging in the Central Interceptor along Southgate Avenue (CH2M Hill, 2002.) The basin could also be constructed with a permeable bottom to enable groundwater recharge. A preliminary analysis of the groundwater recharge potential indicated that up to 316 acre feet could be recharged annually (Yates, 2005) at a cost of $40,000 per acre foot.

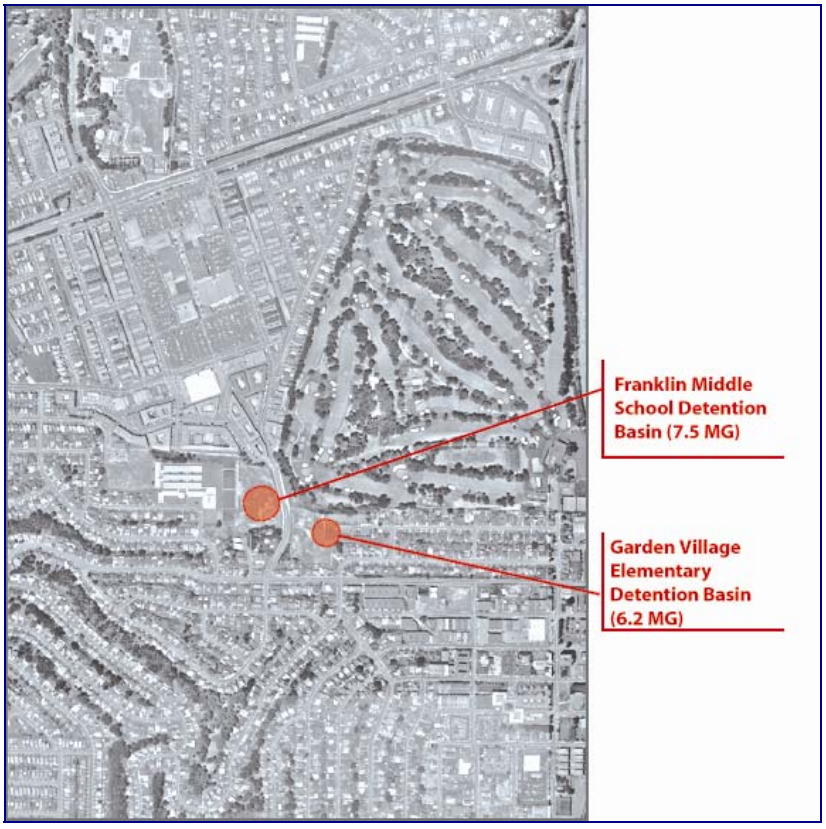
Limitations

The main limitation of the Westlake Shopping Center detention basin is that it would only mitigate flooding at the Vista Grande canal and tunnel for the 10-year, 4-hour storm event if 330 cfs is diverted from the canal to Lake Merced (CH2M Hill, 2002.) Additionally, the alternative has an extremely high capital cost. This high capital cost, which results in a high dollar per acre foot value for groundwater recharge, limits potential water supply benefit of this alternative. This detention basin would also require extensive coordination with the owner of the Westlake Shopping Center, which has recently undergone major renovations. Because of its size, there are extensive site constraints and land purchase could be required for implementation. Additionally, there is risk associated with using storage for flood protection. To mitigate this risk, the basin would have to be operated so that water could be evacuated from the basin in preparation for upcoming storms. Water would likely have to be pumped out of the basin at a significant energy cost. Pumping water out of the basin would also further decrease recharge potential and any resulting water supply benefits.

Park Plaza Drive Detention Basins

This alternative includes two detention basins on Park Plaza Drive, one at Garden Village Elementary School and one at Franklin Middle School, as shown in Figure 4-6. As modeled by CH2M Hill (2002) these basins would be below-grade basins with playing fields reinstalled on top. The basin on the east side of Park Plaza Drive at Garden Village Elementary would have a capacity of 6.3 million gallons and the basin on the west side of Park Plaza Drive at Franklin Middle School would have a capacity of 7.5 million gallons.

Figure 4-6 Park Plaza Drive Detention Basins



Planning Level Capital Cost Estimate

As shown in Table 4-5, the planning level cost estimate for the Park Plaza Drive basins is $53,800,000. This estimate is a based on a unit cost of $3.00 per gallon for underground, covered storage basins.

Table 4-5 Planning Level Cost Estimate for Park Plaza Drive Detention Basins

Item Description	Unit Cost [a]	Storage Volume	Total Cost
Garden Village Elementary Detention Basin	$3.00/gallon	6.3 MG	$18,900,000
Franklin Middle School Detention Basin	$3.00/gallon	7.5 MG	$22,500,000
Construction Cost Estimate			$41,400,000
Implementation (30% Allowance)			$12,400,000
Capital Cost Estimate			$53,800,000

a. Unit cost data for detention basins developed based on review of several capital cost estimates for similar basins around and Bay Area (as described in Appendix C) and estimated from SFPUC RW Master Plan (RMC, 2005.)

Benefits

The Park Plaza Drive detention basins could provide a water supply benefit if the bottoms of the detention basins were designed to allow for percolation to the groundwater basin. A preliminary analysis of the Franklin Middle School basin showed that the basin could provide an approximate annual recharge benefit of 316 ac-ft/yr (Yates, 2005) at a cost of $30,000 per acre foot.

Limitations

Due to hydraulic limitations and constructability issues, CH2M Hill (2002) recommended that the Garden Village Elementary basin be dropped from further consideration. SWMM modeling showed that the Franklin Middle School detention basin would mitigate flooding at the Vista Grande canal and tunnel for the 10-year, 4-hour storm event only if 330 cfs is diverted from the canal to Lake Merced (CH2M Hill, 2002.) This alternative also has a relatively high capital cost. This high capital costs, which results in a high dollar per acre foot value for groundwater recharge, limits the feasibility of the water supply benefit of this alternative. Implementation of these basins would require extensive coordination and long-term cooperation with the school district. Additionally, there is risk associated with using storage for flood protection. To mitigate this risk, the basin would have to be operated so that water could be evacuated from the basin in preparation for upcoming storms. Water would likely have to be pumped out of the basin at a significant energy cost. Pumping water out of the basin would also limit groundwater recharge potential.

4.1.3 Local Detention Storage

Local detention storage differs from the regional detention storage basins evaluated above in that it is designed to capture runoff from a smaller, localized drainage area such as a parking lot or within a neighborhood. Local detention storage is designed to alleviate localized flooding problems, as opposed to regional flooding issues, and can be implemented as part of, or in addition to, storm drain improvements. Local detention storage is often designed to store increased runoff from new developments in order to meet “no net increase” requirements in Phase II National Pollutant Discharge Elimination System (NPDES) stormwater permits. Some applications of local detention storage include:

- *Underground storage chambers such as those developed by CULTEC, Inc.* These chambers are generally intended to be used as replacements for large diameter pipe through subsurface detention of stormwater (CULTEC Inc., 2005.) A picture of CULTEC system is shown in Figure 4-7 Example of CULTEC Chambers (source: CULTEC, Inc., 2005).

- *Above ground storage to capture runoff from local neighborhoods.* Such storage often utilizes playing fields or parks that are specifically designed to retain runoff from newly developed neighborhoods, as shown in Figure 4-8 (personal communication, Spring Dineen, July 2005.)

Figure 4-7 Example of CULTEC Chambers (source: CULTEC, Inc., 2005)

Figure 4-8 Use of park for detention of storm flows (Source: Clark County Regional Flood Control District, Las Vegas, NV.)

Benefits

Local storage approaches are most applicable to comply with "no net increase" requirements found in Phase II NPDES permits and can be utilized to reduce localized flooding in small areas or neighborhoods. The use of local storage can reduce the need for storm drain upgrades in the area where it is cost effective to implement. Local storage can also provide water quality improvements through settlement, and can potentially provide groundwater recharge benefits if designed to allow stormwater to infiltrate into the groundwater basin.

Limitations

The primary limitation of local storage is that these smaller scale storage alternatives are not designed to solve watershed-wide flooding problems. Additionally, it is difficult and expensive to site local storage facilities in already developed areas such as Daly City, and is therefore, often most compatible with new developments or redevelopment.

4.1.4 Best Management Practices (BMPs)

A BMP is a program or device used to reduce stormwater runoff to storm drains and /or improve the quality of stormwater runoff. Non structural BMPs include activities such as development of stormwater pollution prevention plans, street sweeping, public outreach programs, and workshops. Structural BMPs may include devices such as swales, curbless gutters, or porous pavement. The implementation of different types BMPs is required for municipalities to meet their stormwater NPDES permits. Daly City's stormwater and BMP requirements are regulated under a countywide permit for San Mateo County. A countywide stormwater management program, called the San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP) was as created to coordinate implementation and compliance with NPDES permits, and partnerships between STOPPP members to implement stormwater-related activities and BMPs. Daly City is a member of STOPPP, and as such, currently implements BMPs in compliance with the San Mateo Countywide NPDES permit, and in coordination with STOPPP.

Benefits

BMPs help reduce the quantity of stormwater entering the storm drain system, and help improve stormwater quality. Under the countywide NPDES permit, BMPs are also required for some new development and redevelopment projects. As such, BMPs are generally designed to help municipalities meet "no net increase" requirements of new developments and re-developments in NPDES permits.

Limitations

The primary limitation of BMPs is that they are designed to address incremental increases in stormwater, but are not designed to solve regional flooding problems. BMPs can be more difficult to implement in already developed areas such as Daly City, and would likely be implemented over a long period of time as redevelopment occurs.

4.2 Downstream Alternatives

Downstream alternatives are those alternatives designed to address flooding and stormwater flows at the Vista Grande canal through storage, conveyance, or diversion to Lake Merced. Downstream alternatives analyzed in the Vista Grande Watershed Study include:

- Direct discharge to Lake Merced
- Detention Basin at Vista Grande Canal
- Detention Basin at Impound Lake
- Constructed Wetlands at Impound Lake
- Structural Control Followed by Treatment Wetlands
- Constructed Wetlands at Vista Grande Canal
- New Parallel Tunnel
- New Tunnel South of County Line

4.2.1 Direct Discharge to Lake Merced

Direct discharge of excess stormwater from Vista Grande canal to Lake Merced was investigated by Kennedy/Jenks (1983) and was further reviewed by CH2M Hill (2001). As developed by Kennedy/Jenks,

excess stormwater from the canal would be discharged to Lake Merced through a series of 5 to 11 overflow structures across John Muir Drive to Impound and South Lake. This alternative would include no treatment with the exception trash racks. Since the Kennedy/Jenks report was developed, the City of San Francisco combined sewer structure has been constructed under John Muir Drive between South Lake and Vista Grande canal. Therefore, if implemented today, the direct diversion alternative would have a design similar to one of the Interim Solution alternatives analyzed as part of this watershed study:

- Diversion to Impound Lake, which could include four-48 inch pipes from the canal to Impound Lake
- Diversion to South Lake would include 440 feet of 2'x5' box culverts under John Muir Drive and over the combined sewer structure.

Further description and schematics of these Interim Solutions can be found in Section 4.4 and Appendix D.

Direct discharge was the alternative recommended by Kennedy/Jenks in 1983 because it was the least cost alternative, but with the caveat that CCSF and environmental approvals would be required. Since 1983, there have been changes in the way stormwater is regulated. Specifically, the 1987 amendments to the Clean Water Act established phased NPDES permit requirements for municipal stormwater discharges. Such changes make implementation of this alternative much more difficult. For this reason, and other limitations as described below, CH2M Hill recommended that direct discharge no be pursed as an alternative (CH2M Hill, 2002.)

Planning Level Cost Estimate

The planning level cost estimates for the direct diversion alternative range from $2,100,000 to $10,700,000 and are based on cost estimates developed for Interim Solutions diversion alternatives analyzed as part of the Vista Grande Watershed Study. Additional information on these cost estimates is provided in Appendix D.

Benefits

The direct diversion alternatives alternative would be the least cost alternative.

Limitations

Vista Grande stormwater introduced to Lake Merced would be untreated and would present challenging water quality permitting requirements. Discharge of stormwater to Lake Merced, which is typically high in nutrients, coliform, and other contaminants could negatively impact the quality of Lake Merced if not treated before diversion. Due to these water quality constraints and regulatory requirements, direct diversion is not considered a feasible long-term solution. Additionally, implementation of this alternative would require armoring of the banks near the outlet of discharge structures, disturbing Lake Merced wetland habitat, which could present significant permitting and require extensive mitigation for disturbed habitat.

4.2.2 Detention Basin at Vista Grande Canal

A storage basin along Vista Grande canal was originally suggested by Kennedy/Jenks (1983) and further evaluated in the Vista Grande Diversion Feasibility Study (CH2M Hill, 2001). As shown in Figure 4-9 and Figure 4-10, this basin would be implemented by expanding Vista Grande canal along John Muir Drive for approximately 3,600 feet from the upstream end of the canal to the tunnel entrance. The basin would vary in width from 140 to 230 feet for the first 200 feet of the basin, and then narrow to approximately 30 feet wide for the remaining portion of the basin to the tunnel (resulting in an average width of 25 feet.) With a 10 foot depth, the basin could store up to 38 MG. Additionally, the basin could be designed with a pervious bottom to encourage infiltration to the groundwater basin. As designed, the

basin would store flows until they can be discharged by gravity through the Vista Grande tunnel or diverted to treatment and Lake Merced.

Figure 4-9 Location of Vista Grande Detention Basin

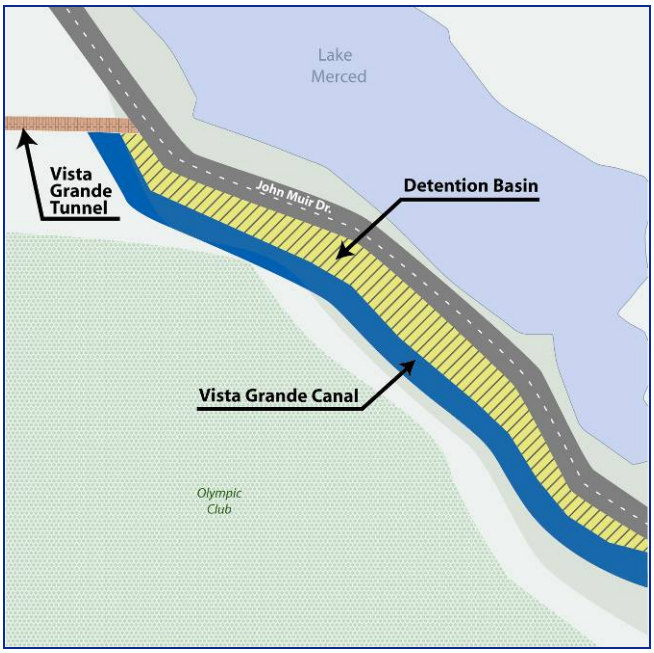
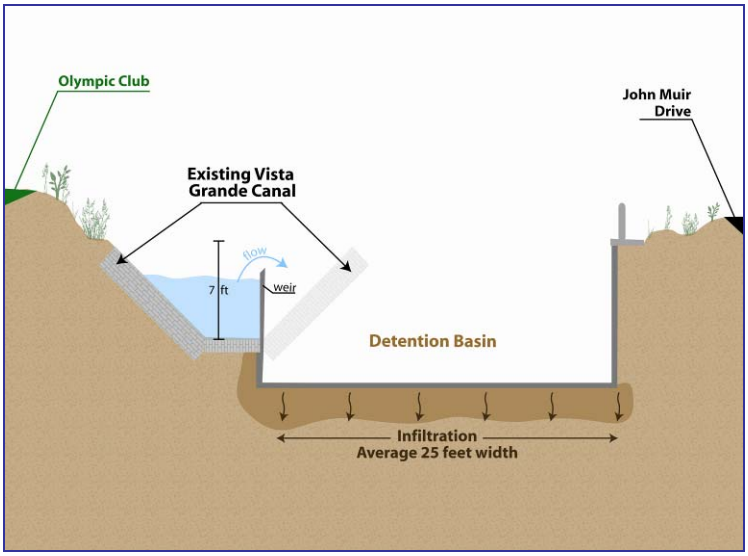


Figure 4-10 Conceptual Cross Sectional View of Vista Grande Detention Basin



Planning Level Capital Cost Estimate

The planning level cost estimate for the Vista Grande Detention Basin is estimated at $148,200,000 as presented in Table 4-6. The cost estimate assumes that the basin is an uncovered, reinforced concrete detention basin with a cost of $2.50 per gallon to construct.

Table 4-6 Planning Level Cost Estimate for Vista Grande Detention Basin

Item Description	Unit Cost[a]	Quantity	Total Cost
Vista Grande Detention Basin	$2.50/gal[a]	38 MG	$95,000,000
Construction Cost Estimate			$95,000,000
Implementation (30% Allowance)			$28,500,000
Capital Cost Estimate			$123,500,000

a. Unit cost data for detention basins developed based on review of several capital cost estimates for similar basins around and Bay Area (as described in Appendix C) and estimated from SFPUC RW Master Plan (RMC, 2005.); lower unit cost accounts for uncovered detention basin construction.

Benefits

The Vista Grande Detention Basin would provide flow equalization for discharge through the tunnel, reducing tunnel and outfall capacity improvement needs. A basin at Vista Grande canal could also provide equalization for stormwater flows that are diverted to Lake Merced through treatment, reducing the required size of treatment facilities. If constructed with a permeable bottom, the basin could also allow for recharge to the groundwater basin, potentially providing some water supply benefits. Detention basins also provide limited water quality treatment through settling and coliform die off.

Limitations

The primary limitation of the Vista Grande Detention Basin is that it would need to be implemented in combination with upstream storage or tunnel and outfall capacity improvements. This is because site constraints limit the volume of the basin to 38 MG, which is not sufficient to store flood projected flows from the 10-year design storm event. Additionally, potential reliability issues associated with the existing tunnel would need to be evaluated. Another major limitation of the Vista Grande Detention Basin is constructability. The existing site is approximately 10 to 12 acres and lies between on Olympic Club and John Muir Drive. The storage basin would lie within feet of John Muir Drive, presenting potential safety issues for traffic, and its construction and resulting impact to the golf course, including aesthetics, would need to be coordinated with the Olympic Club. Additionally, there would be conflicts with existing utilities including Daly City 30 inch sewer line, a sewer line running across Vista Grande canal from the Olympic Club, and other above ground utilities. Relocation of these utilities would need to be addressed as part of the project. Finally, the risk associated with using storage for flood protection would need to be considered in the operation of the basin so that the basin is ready to capture flood flows, especially for multiple storm events.

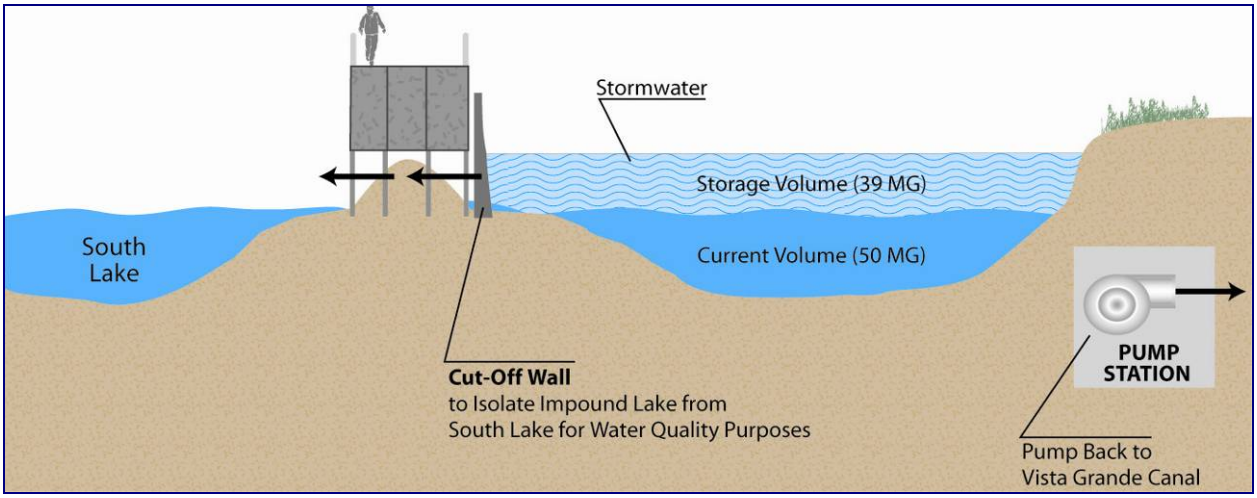
4.2.3 Detention Basin at Impound Lake

Impound Lake is a relatively small lake at the southernmost part of Lake Merced. At its current level (+4 SF city datum), Impound Lake is hydraulically isolated from South Lake by a sandy berm located beneath the viaduct that carries the CCSF combined sewer lines. If the level of Impound Lake is raised about 1 foot, the two lakes become hydraulically connected.

The concept of a detention basin at Impound Lake was initially evaluated by CH2M Hill (2001) and was further refined as part of this watershed study. A detention basin at Impound Lake would be implemented by diverting stormwater flows from Vista Grande canal to Impound Lake. Because direct diversion of stormwater to Lake Merced is not considered a long-term option, and the diversion of stormwater to Impound Lake would increase lake levels to a point where Impound Lake becomes hydraulically connected to the South Lake, the conceptual design of a detention basin at Impound Lake would require a cut off wall at the viaduct to isolate Impound Lake from South Lake for water quality purposes. Once there is adequate capacity in the tunnel, stormwater stored in Impound Lake would be pumped back to Vista Grande canal for discharged through the existing tunnel.

The current volume available for storage of stormwater in of Impound Lake is estimated at approximately 50 million gallons at water surface elevation (at +4 SF city datum) (EDAW, September 2004a). To maximize the volume available for storage of flood protection, this alternative would require that Impound Lake be drained prior to storm events, which would provide approximately 89 million gallons of storage (EDAW, September 2004a). A schematic of this alternative is shown in Figure 4-11. Implementing this alternative would require that Impound Lake be operated as a flood protection facility, as opposed to a natural lake.

Figure 4-11 Schematic of Detention Basin at Impound Lake



Planning Level Capital Cost Estimate

As shown in Table 4-7, the planning level capital cost estimate for the Impound Lake detention basin is $24,700,000. This cost estimate does not include mitigation costs for the loss of habitat that would be encountered by operating Impound Lake as a detention basin, which would likely be significant.

Table 4-7 Planning Level Cost Estimate for Detention Basin at Impound Lake

Item Description	Total Cost
Pump Station (300 cfs)	$3,000,000
Pipelines	$4,000,000
Cut Off Wall	$12,000,000
Construction Cost Estimate	$19,000,000
Implementation (30% Allowance)	$5,700,000
Capital Cost Estimate	$24,700,000

Benefits

The benefits of this alternative relate strictly to its potential for solving or reducing flooding problems at Vista Grande canal.

Limitations

There are several limitations of the Impound Lake detention basin alternative. The most significant limitation is the environmental impact, and associated permitting challenges, of draining Impound Lake prior to storm events to provide the required volume to retain storm flows. Draining Impound Lake and

operating it as a stormwater facility would have significant impacts to aquatic and wetland habitat of the lake. Impound Lake and its associated wetlands have been designated as a high priority for resource conservation by the San Francisco Natural Areas Program because the area supports significant habitat and species (SFRPD, 2005). Operating the lake as a detention basin would likely face significant stakeholder opposition.

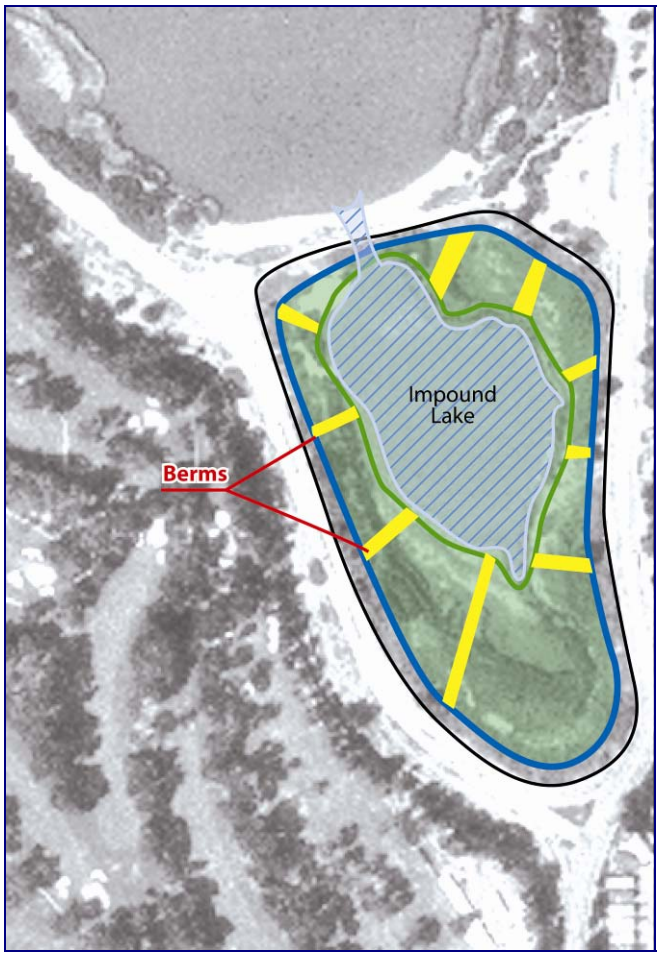
Another limitation of this alternative is that it would likely need to be done in combination with other flood protection improvements in order to provide adequate protection for the design storm event. Conservative estimates show that approximately 100 MG of storage would be required in Impound Lake to handle the 10-year storm if upstream storm drain improvements are implemented. However, as described above, Impound Lake could provide approximately 89 MG for storage of flood flows. Further modeling would need to be conducted to refine the required flows and storage volumes.

Additional limitations of this alternative include water quality impacts to Impound Lake, potential reliability issues with the existing tunnel, and addressing risk issues associated with operating detention basins for flood protection.

4.2.4 Constructed Wetlands at Impound Lake

The potential use of constructed wetlands to treat stormwater diversions to Impound Lake was investigated by CH2M Hill (2002) and was further refined for the Vista Grande Watershed Study, as shown in Figure 4-12. Implementation of constructed wetlands at Impound Lake would include conversion of existing wetlands areas at Impound Lake to several constructed wetlands treatment cells through grading, construction of berms, and replanting with wetland vegetation commonly used in treatment systems such as cattail (*Typha* sp.) and bulrush (*Scirpus* sp.). Approximately 13 to 20 acres of area would be available for treatment which would allow for between 2.5 to 4 cfs (approximately 1.7 to 2.6 mgd) to be treated assuming the wetlands were operated at 2 foot depth with a 5 day hydraulic residence time. Once treated, stormwater would be pumped into South Lake for lake level augmentation.

Figure 4-12 Schematic of Impound Lake Wetlands



Planning Level Capital Cost Estimate

The planning level cost estimate for the Impound Lake wetlands is approximately $14,200,000 to $21,800,000, depending on the number of acres of wetland constructed. This is based on a planning level cost of $840,000 per acre as shown in Table 4-8. It is important to note that this cost does not account for mitigation costs that would likely be required based on the acreage of existing wetland habitat at Impound Lake that would be lost or altered from implementation of this alternative.

Table 4-8 Impound Lake Planning Level Cost Estimate

Item Description	Unit Cost [a]	Quantity	Total Cost [b]
Constructed Wetlands at Impound Lake	$840,000/acre	13 to 20 acres	$10,900,000 to $16,800,000
Construction Cost Estimate			10,900,000 to $16,800,000
Implementation (30% Allowance)			$3,300,000 to $5,000,000
Capital Cost Estimate			$14,200,000 to $21,800,000

a. Unit cost data estimated from the Vista Grande Wetland cost estimate for the Vista Grande Watershed Study.
b. Costs are rounded to the closest $100,000.

Benefits

The Impound Lake wetlands concept would provide water of appropriate quality and quantity for augmentation of Lake Merced levels. In addition it could provide a water supply benefit by contributing to groundwater recharge.

Limitations

The primary limitation of the implementation of constructed wetlands at Impound Lake is that there is not enough land area available to provide treatment for the entire surcharge flow at the canal (assumed to be 510 cfs for a 10-year event if upstream storm drain improvements are not implemented.) In order to treat the entire 10-year flood flows with a hydraulic residence time of 5 days, approximately 2,500 acres of treatment wetlands would be required. Therefore, while the implementation of Impound Lake wetlands would provide for lake level augmentation and water quality benefits, it would not meet the flood protection objective of the Vista Grande Watershed Study. An additional limitation of treatment wetlands at Impound Lake is that it would require the replacement of existing natural wetlands with constructed and managed wetlands, which would present significant permitting challenges. Impound Lake is and its associated wetlands are have been designated as a high priority for resource conservation by the San Francisco Natural Areas Program because the area supports significant habitat and species (SFRPD, 2005). As such, there would likely be extensive stakeholder concerns and significant mitigation requirements with alternatives that alter the existing wetlands at Impound Lake.

4.2.5 Structural Control Followed by Treatment Wetlands

An alternative which combines structural control with treatment wetlands was identified as the preferred alternative in Vista Grande Stormwater Diversion Feasibility Evaluation (CH2M Hill, 2001). This alternative would first divert Vista Grande stormwater through four structural control units for initial water quality treatment that use screens in combination with vortex hydraulics to separate pollutants such as floatables, particles, suspended solids and oil and grease from the stormwater. Water would then flow from the structural control units to a total of 23 acres of treatment wetlands along the existing shoreline of Lake Merced, constructed along the majority of the south shoreline of South Lake and the entire shoreline of Impound Lake. The CH2M Hill study (2001) found that the combination of structural control and wetland treatment could meet water quality parameters for a flow of up to approximately 6 cfs.

Planning Level Capital Cost Estimate

As shown in Table 4-9, the planning level cost estimate for this alternative is approximately $30,800,000. It is important to note that this cost does not account for mitigation costs that would likely be required based on the acreage of existing wetland habitat at South Lake or Impound that would be lost or altered from implementation of this alternative.

Table 4-9 Structural Control Followed By Treatment Wetlands Planning Level Cost Estimate

Item Description	Unit Cost [a]	Quantity	Total Cost [b]
Structural Control Units	$4,400,000	1	$4,400,000
Installation of Constructed Wetlands	$840,000/acre	23 acres	$19,300,000
Construction Cost Estimate			$23,700,000
Implementation (30% Allowance)			$7,100,000
Capital Cost Estimate			$30,800,000

a. CDS unit cost data from CH2M Hill (2001) and adjusted to 2005 dollars; wetlands unit cost data estimated from the Vista Grande Wetland cost estimate for the Vista Grande Watershed Study.
b. Costs are rounded to the closest $100,000.

Benefits

This alternative would provide lake level augmentation benefits by providing water of appropriate quality and quantity to Lake Merced Lake. In addition it could contribute to additional groundwater recharge.

Limitations

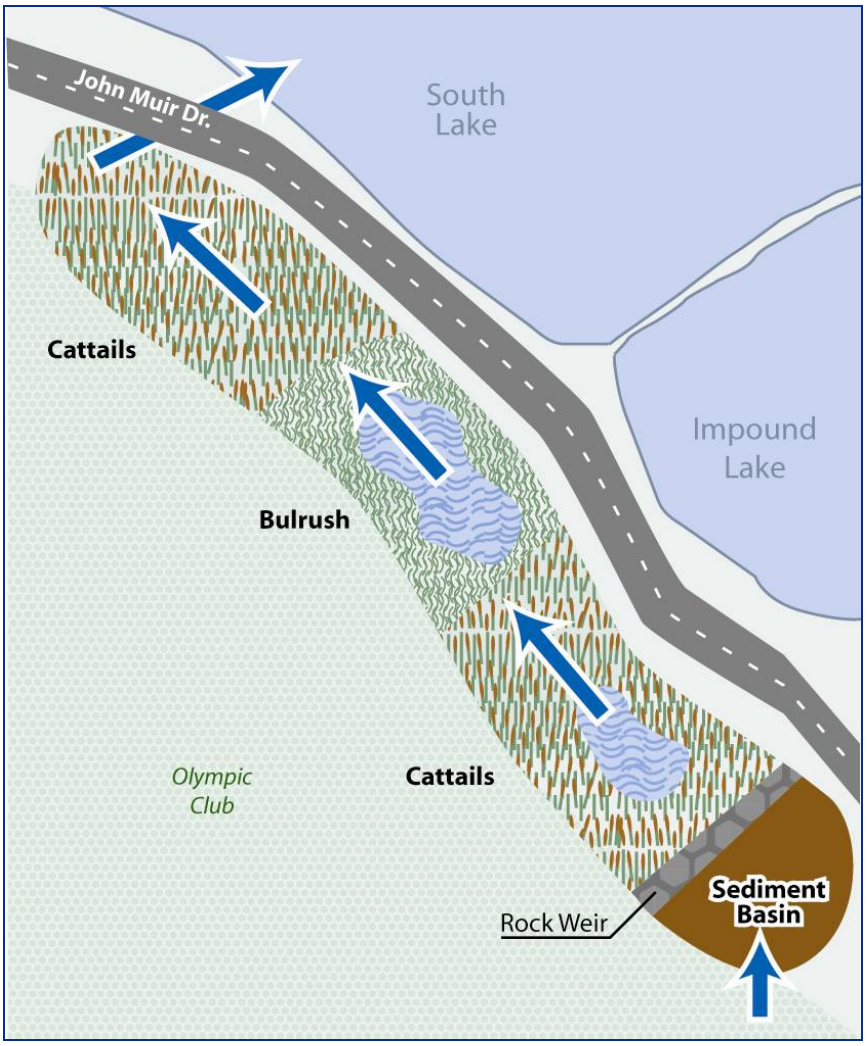
The primary limitation of this alternative is that there is not enough land area available to provide wetlands treatment for the entire flow expected for the 10-year design storm. As developed in the study (CH2M Hill, 2002), the alternative would only handle 6 cfs. Therefore, as developed, this alternative could not be considered a flood protection alternative.

Additionally, the stormwater treatment wetlands for the alternative would be created in existing wetland areas along both South Lake and Impound Lake, resulting in modifications of existing habitat areas which would present a number of significant permitting challenges. As described above, Impound Lake is and its associated wetlands have been designated as a high priority for resource conservation and there would likely be extensive stakeholder concerns and significant mitigation requirements with alternatives that alter the existing wetlands at Impound Lake.

4.2.6 Constructed Wetlands at Vista Grande Canal

Constructed wetlands at Vista Grande canal would be located at the site of the existing Vista Grande canal between the Olympic Club Golf Course and John Muir Drive, as shown in Figure 4-13. The wetlands would encompass approximately 8 acres of land with an effective treatment area of approximately 6.4 acres. One to two mgd of stormwater would be pumped into a settling basin prior to entering the wetland. Downstream of the settling basin, stormwater would flow by gravity into three consecutive cells, each of which would be approximately 1,100 feet long. Consecutive cells would be separated by a fifteen feet wide berm (top width), and connected by 8-inch pipelines. Water from one cell would overflow into the next cell when the water rises above two feet. Water from the third cell would then drain by gravity into South Lake via the Lake Merced overflow structure. An access road located on the north edge of the wetland, south of John Muir Drive, would provide maintenance access along the wetland cells and berms. A traffic barrier would be installed along the wetland, between the wetland and John Muir Drive.

Figure 4-13 Schematic of Constructed Wetlands at Vista Grande Canal



Planning Level Cost Estimate

The planning level cost estimate for the Vista Grande Wetland is $8,700,000, based on a unit cost of $840,000 per acre for treatment wetlands developed, as shown in Table 4-10.

Table 4-10 Vista Grande Wetland Cost Estimate

Item Description	Unit Cost[a]	Quantity	Total Cost [b]
Vista Grande Wetland	$840,000/acre	8 acres	$6,700,000
Construction Cost Estimate			$6,700,000
Implementation (30% Allowance)			$2,000,000
Capital Cost Estimate [c]			$8,700,000

a. Unit cost data based on detailed Vista Grande Wetland cost estimate.
b. Costs are rounded to the closest $100,000.
c. Note that the cost estimates presented in Chapter 4 may differ slightly to those presented in Chapter 5, Preliminary Program Recommendations. Planning level costs were developed in Chapter 4 to serve as a basis for comparison between the Alternatives Considered and to determine the most desirable alternatives. The preliminary program recommendations presented in Chapter 5 were developed further and include more detailed planning level cost estimates.

Benefits

The primary objective of the wetland is to supply water of an acceptable quantity to augment the water levels of Lake Merced. Providing approximately one to two mgd to Lake Merced could provide a maximum lake level increase of 8 feet (Geo/Resource Consultants, 1993). Providing water of appropriate quantity and quality for lake level enhancement meets one of the secondary objectives of the Vista Grande Watershed Study.

In addition, the wetland provides additional habitat for birds and wildlife adjacent to existing habitat along Lake Merced. It protects existing recreational activities and provides additional educational opportunities for school groups and the general public.

Limitations

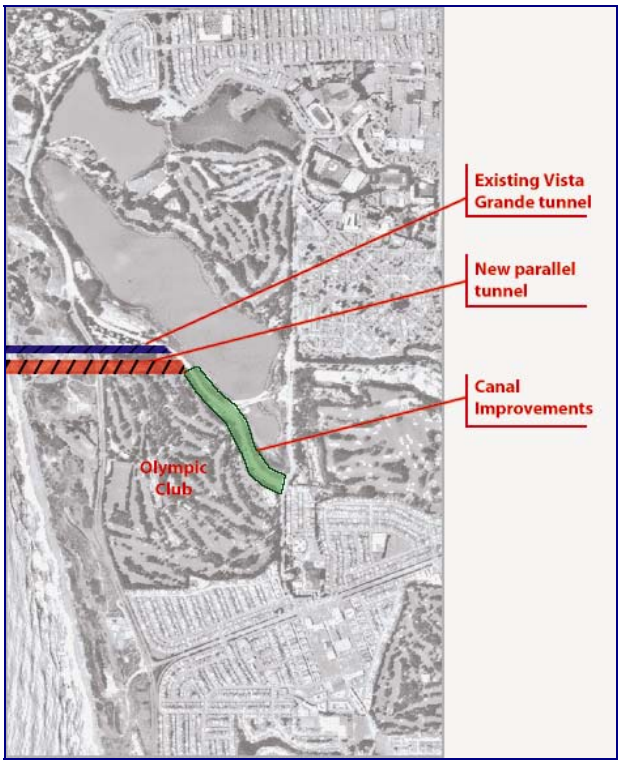
The primary limitation of the Vista Grande Wetland is that there is not enough land area available at the site to provide treatment for flood flows, and therefore, it does not provide flood protection benefits. Instead, it would treat a fraction of the stormwater runoff (1.0 to 2.0 mgd) to provide water supply to Lake Merced for lake level enhancement.

Conflicts with existing utilizes would need to be addressed including the Daly City 30” sewer line, a sewer line running across Vista Grande canal from the Olympic Club, and above ground utilities. Relocation of these utilities would need to be addressed as part of the project. The site for the Vista Grande Wetland is on property owned by the Olympic Club and its construction would require close coordination with, and possible land acquisition from, the Olympic Club. Additionally, because this alternative would require abandonment of the existing Vista Grande canal to maximize the land area available for treatment wetland development, this alternative would need to be constructed with a flood protection alternative that does not require the existing canal for stormwater conveyance.

4.2.7 New Parallel Tunnel

This alternative, which was examined in the Kennedy/Jenks study (1983), consists of a 3,500 foot long tunnel that is south of, and parallel to, the existing Vista Grande tunnel. The new parallel tunnel would extend westward from the Vista Grande canal about 500 feet upstream from the existing tunnel entrance (Kennedy/Jenks, 1983). The parallel tunnel would pass under the Olympic Club and would exit on the beach south of Fort Funston. This parallel tunnel also would require that the Vista Grande canal be enlarged to handle 1,300 cfs. A schematic of the new parallel tunnel location is shown in Figure 4-14

Figure 4-14 New Parallel Tunnel



Planning Level Cost Estimate

The planning level cost estimate for the new parallel tunnel is $52,260,000, as shown in Table 4-11.

Table 4-11 New Parallel Tunnel Cost Estimate

Item Description	Unit Cost [a]	Quantity	Total Cost
Enlargement of Vista Grande Canal	$3,000/foot	3,600 feet	$10,800,000
New Parallel Tunnel	$8,400/foot	3,500 feet	$29,400,000
Construction Cost Estimate			$40,200,000
Implementation (30% Allowance)			$12,100,000
Capital Cost Estimate			$52,260,000

a. Tunnel unit cost based on cost estimate developed for John Muir Drive alignment of the Tunnel South of County Line; canal enlargement unit cost estimated from Zone 7 Stream Management Master Plan cost estimating (RMC, 2005)

Benefits

This alternative would provide a reliable method to solve the flooding issues at Vista Grande canal. Additionally, the installation of a parallel tunnel would eliminate erosion and water quality impacts to Lake Merced that result from uncontrolled overflows at the canal. This tunnel would also alleviate public safety issues associated with overflows along John Muir Drive.

Limitations

Constructability of a new parallel tunnel would need to be evaluated, as the tunnel would require a staging area of approximately 200 feet by 200 feet. This could require significant land acquisition and could impact activities on the Olympic Club golf course. Additionally, the required widening of the Vista

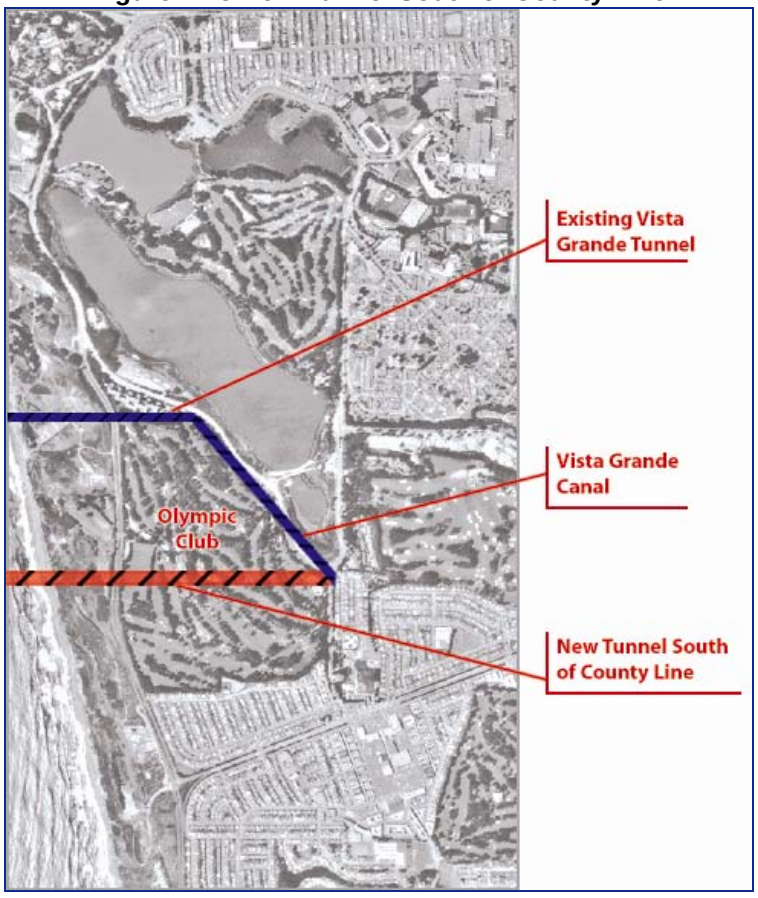
Grande canal for this alternative would also potentially require land acquisition of a portion of the Olympic Club golf course and would require significant coordination with the Olympic Club.

The installation of a parallel tunnel limits the opportunities for multiple benefits, unless it is implemented with wetlands treatment projects. Due to the canal improvements necessary as part of the parallel tunnel, this option would not be compatible with the Vista Grande Wetland alternative. A new parallel tunnel would require extensive environmental and permitting coordination.

4.2.8 New Tunnel South of County Line

This alternative, which was examined in the Kennedy/Jenks study (1983) and refined for the Vista Grande Watershed Study, consists of a tunnel that starts at the upstream end of the Vista Grande canal and runs under the Olympic Club to the beach below Fort Funston, as shown in Figure 4-15. Depending the on the alignment selected, the tunnel would range between 4,700 and 4,900 feet in length and would have an approximately 15 foot diameter, which could carry 25-year flows. Construction of a tunnel south of the County line would allow the existing Vista Grande canal to be abandoned. Such a tunnel could be constructed using a tunnel boring machine which operates primarily underground so there are minimal impacts on the surface to traffic and the surrounding community. Tunnel construction would be primarily visible only at the openings at each end of the tunnel.

Figure 4-15 New Tunnel South of County Line



Planning Level Cost Estimate

The planning level capital cost estimate for a 4,800 foot tunnel south of the County line is approximately $52,420,000, based on a tunnel unit cost of $8,400/foot, as shown in Table 4-12. The planning level cost estimate would vary depending on the exact alignment and length.

Table 4-12 Tunnel South of County Line Cost Estimate

Item Description	Unit Cost [a]	Quantity	Total Cost
New Tunnel	$8,400/foot	4,800 feet	$40,320,000
Construction Cost Estimate			$40,320,000
Implementation (30% Allowance)			$12,100,000
Capital Cost Estimate [b]			$52,420,000

a. Tunnel unit cost based on cost estimate developed for John Muir Drive alignment of the Tunnel South of County Line.
b. Note that the cost estimates presented in Chapter 4 may differ slightly to those presented in Chapter 5, Preliminary Program Recommendations. Planning level costs were developed in Chapter 4 to serve as a basis for comparison between the Alternatives Considered and to determine the most desirable alternatives. The preliminary program components presented in Chapter 5 were developed further and include more detailed planning level cost estimates.

Benefits

The Tunnel South of County Line will provide a reliable approach to flood protection to eliminate flooding at Vista Grande canal along John Muir Drive, and the associated damages and risk of stormwater overflows. The tunnel will be completely within Daly City and requires only a limited construction area. The tunnel bypasses the existing Vista Grande canal and allows the NSMCSD Wastewater Treatment Plant to use the existing tunnel for gravity flow of effluent.

Limitations

There are a number of implementation issues will need to be considered with construction of this alternative. The alignment for the tunnel, as currently portrayed, would run under private property (the Olympic Club Golf Course.) This would require and easement for the length of the tunnel under the Olympic Club and at the construction site. Access to the beach outlet for construction may require temporary right-of-way agreements from the Golden Gate National Recreation Area (GGNRA), the National Park Service (NPS), and the Olympic Club Golf Course.

A tunnel of this size would require extensive environmental and permitting issues including coordination with the California Coastal Commission (CCC), NPS, US Army Corps of Engineers (Corps), and the Regional Water Quality Control Board (RWQCB).

Construction of a new tunnel would cause impacts at the beach below Fort Funston related to increased stormwater discharges at the beach, which could result in water quality and erosion impacts, aesthetic impacts with the construction of a new outfall structure, and possible habitat impacts. These issues would need to be further studied as part of the implementation analysis of the tunnel.

The construction schedule assumes that the tunnel excavation would operate 24-hours a day during peak construction periods. While the majority of construction would be done in the tunnel itself and away from residential areas, noise, traffic control, and light containment measures, such as sound walls, may be necessary.

4.3 Alternatives Recommended for Further Evaluation

The alternatives discussed above were evaluated for their ability to meet the primary flood protection objective, as well as other benefits and limitations to determine which alternatives were most feasible for further evaluation in the Vista Grande Watershed Study. A summary table of the alternatives considered, cost estimates, flood protection benefits, other benefits, and limitations is shown in Table 4-13. The table also provides a discussion of why alternatives were, or were not, recommended for further analysis in the watershed study.

As presented in Table 4-13, the alternatives identified for further evaluation in the Vista Grande Watershed Study include the Tunnel South of County Line, Vista Grande Wetland, Storm Drain

Improvements and ongoing implementation of BMPs in compliance with the San Mateo Countywide NPDES permit. Each of these four components is further evaluated in Chapter 5. These four alternatives make up the preliminary program recommendations of the Vista Grande Watershed Study and are shown in Figure 4-16.

Table 4-13 Comparison of Long-Term Program Improvements [a]

Alternative	Description	Planning Level Capital Cost Estimate	Flood Protection Benefits and/or Limitations	Potential Benefits	Limitations	Recommended for Further Evaluation in Vista Grande Watershed Study
UPSTREAM ALTERNATIVES						
Storm Drain Improvements	Collection system improvements to replace or enlarge storm drain pipes that do not have sufficient capacity to convey the 10-year design storm	$25,000,000 to $35,000,000	Would eliminate upstream flooding for the 10-year design storm event. Must be implemented after downstream improvements are completed.	Increases public safety Reduces potential and frequency of property damage due to upstream flooding	Must be implemented after downstream improvements are in place	YES. Master planning should be done to determine the extent of upstream improvements necessary.
Regional Detention Storage at I-280 Cloverleaf	1.6MG detention basin to minimize surcharging and flooding along downstream interceptors Basin would be underground reinforced concrete structures	$6,200,000	Does not mitigate flooding at the Vista Grande canal and tunnel without 330 cfs diversion to Lake Merced Would provide flow attenuation to minimize surcharging along John Daly Boulevard	Could be designed to allow for potential groundwater recharge	Construction impacts on newly reconstructed cloverleaf High construction cost Risk associated with the use of storage for flood protection The need to pump water out of storage to provide capacity for flood water storage limits recharge potential.	NO. This alternative is not recommended for further evaluation due to its limited flood protection benefit, and high capital cost.
Regional Detention Storage at LMGC	Total of 4.3MG of detention storage in 3 storage basins. Basins would be underground, reinforced concrete structures	$16,800,000	No benefit to hydraulic conditions at Vista Grande canal Provides reduction in surcharging along upstream interceptors	Could be designed to allow for potential groundwater recharge	High construction cost Risk associated with the use of storage for flood protection The need to pump water out of storage to provide capacity for flood water storage limits recharge potential.	NO. This alternative is not recommended for further evaluation due to limited flood protection benefit, and high capital cost.
Regional Detention Storage at Westlake Shopping Center	35.7 MG of detention storage located under the southwest corner of the Westlake Shopping Center Basin would be underground, reinforced concrete structure	$139,200,000	Would not mitigate flooding at the Vista Grande canal unless 330 cfs of water was diverted to Lake Merced Would alleviate surcharging in the Central Interceptor along Southgate Avenue	Could be designed to allow for potential groundwater recharge	Site constraints and constructability issues Construction impacts on newly redeveloped shopping center High construction cost Risk associated with the use of storage for flood protection The need to pump water out of storage to provide capacity for flood water storage limits recharge potential.	NO. This alternative is not recommended for further evaluation due to limited flood protection benefit, high capital cost, and site constraints and constructability issues.
Regional Detention Storage at Park Plaza Drive	13.8 MG of detention storage in two basins along Park Plaza Drive (7.5MG at Franklin Middle School, 6.3 gallons at Garden View Elementary) Basins would be underground, reinforced concrete structures	$53,800,000	Garden View detention basin would not provide hydraulic benefit Franklin middle school basin would not mitigate flooding at the Vista Grande canal unless 330 cfs was diverted to Lake Merced	Basins could be designed to provide groundwater recharge	Extensive coordination with school district Construction and site constraints High construction cost Risk associated with the use of storage for flood protection The need to pump water out of storage to provide capacity for flood water storage limits recharge potential	NO. This alternative is not recommended for further evaluation due to limited flood protection benefit, high capital cost, and constructability issues.

a. Note that the cost estimates presented in Chapter 4 may differ slightly to those presented in Chapter 5, Preliminary Program Recommendations. Planning level costs were developed in Chapter 4 to serve as a basis for comparison between the Alternatives Considered and to determine the most desirable alternatives. The preliminary program components presented in Chapter 5 were developed further and include more detailed planning level cost estimates.

Alternative	Description	Planning Level Capital Cost Estimate	Flood Protection Benefits and/or Limitations	Potential Benefits	Limitations	Recommended for Further Evaluation in Vista Grande Watershed Study
Local Detention Storage	Storage of local overflows from small drainage areas through detention storage in parks or through technologies such as CULTEC.	n/a (Depends on location of size of facility; would be determined through modeling.)	Not designed to solve watershed wide flooding; most applicable to local flooding from new/re-developments	Applicable to "no net increase" requirements in Phase 2 NPDES permits for new or re-development projects Can reduce local storm drain size upgrades if cost effective Can provide for groundwater recharge Can provide water quality improvements	Difficult to site storage facilities in developed areas Large volumes of stormwater are very costly to store in an urbanized setting.	*NO.* This alternative should be evaluated for hydraulic benefit and cost effectiveness as part of a storm drain master plan; but is not recommended for further evaluation as a flood protection alternative in the watershed study.
Best Management Practices	BMPs are programs or devices that reduce stormwater runoff to storm drains BMPs are required as part of the Daly City Countywide NPDES permit.	n/a	Do not provide flood protection; more appropriate for smaller volumes of runoff	Can reduce quantity of stormwater from new developments and redeveloped areas Can provide water quality improvements Especially appropriate for small drainage areas and individual developments	Difficult to implement in an already developed area Implemented over a long period of time as redevelopment occurs	YES. Daly City is in compliance with BMPs as part of the San Mateo Countywide NPDES permit; ongoing compliance and implementation is component of the watershed study.
DOWNSTREAM ALTERNATIVES						
Direct Diversion	Direct diversion of stormwater from Vista Grande canal to Lake Merced without treatment Stormwater would be conveyed to Impound Lake or South Lake through diversion structures under John Muir Drive	$2,100,000 to $10,700,000	Would provide flood protection at Vista Grande canal	Lowest cost alternative	Considered infeasible as a permanent solution do to regulatory requirements Water quality impacts to Lake Merced	NO. Alternative dropped from further consideration due to incompatibility with regulatory requirements and water quality impacts to Lake Merced
Vista Grande Detention Basin	38 MG storage basin along Vista Grande canal adjacent to John Muir Drive Basin would be below grade, uncovered reinforced concrete structure	$123,500,000	Basin would not have capacity to store flood flows from the 10-year design storm event and would need to be done in combination with other alternatives Would provide flow attenuation for stormwater flows before discharge through Vista Grande tunnel or diversion to treatment/Lake Merced	Could be designed to provide groundwater recharge benefits Would provide limited water quality treatment through settling and coliform die off	Reliability issues associated with the existing canal and tunnel Site constraints Utility conflicts Risk associated with the use of storage for flood protection	NO. Alternative dropped from further consideration due to site constraints and volume limitations required for flood protection, and high capital cost

Alternative	Description	Planning Level Capital Cost Estimate	Flood Protection Benefits and/or Limitations	Potential Benefits	Limitations	Recommended for Further Evaluation in Vista Grande Watershed Study
Impound Lake Detention	Operate Impound Lake as a detention basin by draining lake before storm events and storing flows greater than 170 cfs in the lake After storm even, water would be pumped back to Vista Grande for drainage through the tunnel Approximately 89 MG available for storage	$24,700,000 (Cost does not include mitigation which would be significant for this alternative.)	Modeling would need to be done to determine if capacity available would store the flows for the design storm if upstream storm drain improvements were implemented	Provides limited water quality treatment through settling and coliform die-off	Requires draining of Impound Lake prior to storm events to provide required volume for flood flows, presenting significant environmental impact Would require isolation of Impound Lake from South Lake to protect Lake Merced water quality Potential reliability issues associated with the existing tunnel Significant impacts to Impound Lake aquatic and wetland habitat Water quality impacts to Impound Lake Alterations to existing wetlands will present significant permitting challenges Risk associated with the use of storage for flood protection Stakeholder concern	NO. Environmental impacts to Impound Lake aquatic and wetland habitat make this alternative infeasible.
Constructed Wetlands at Impound Lake	Divert up to 3 cfs (2 mgd) of stormwater from Vista Grande canal for treatment in constructed wetlands around Impound Lake Treated stormwater could be discharged to Lake Merced	$14,200,000 to $21,800,000 (Cost does not include mitigation which would be significant for this alternative.)	Would not provide flood protection benefit; not enough land area available to construct enough wetlands to treat flood flows	Provides water of appropriate quality and quantity for augmentation of Lake Merced lake levels Potential groundwater recharge	Would require removal of existing wetland habitat around Impound Lake and regarding of Impound Lake shoreline Significant permitting challenges associated with altering existing wetland habitat	NO. Impacts to Impound Lake aquatic and wetland habitat make this alternative infeasible.
Structural Control and Constructed Wetlands	Divert stormwater through structural control units to provide limited water quality treatment Stormwater would then flow through 23 acres of wetlands constructed along the south shoreline of South Lake and entire shoreline of Impound Lake After wetlands treatment water would be diverted to Lake Merced	$30,800,000 (Cost does not include mitigation which would be significant for this alternative.)	Would not provide flood protection benefit; not enough land area available to construct enough wetlands to treat flood flows	Provides water of appropriate quality for lake level enhancement of Lake Merced	Would require extensive alteration of existing wetlands along Impound Lake that are considered a high priority for conservation Would likely require significant permitting and mitigation	NO. Impacts to South Lake and Impound Lake habitat, combined with the lack of flood protection benefit, make this alternative infeasible.
Vista Grande Constructed Wetlands	Construction of 8 acres of wetlands at site of existing Vista Grande canal Divert approximately 2 to 3 cfs (1 mgd) of stormwater to wetlands After wetlands treatment, water would be diverted to Lake Merced	$8,700,000	Would not provide flood protection benefit	Provides water of appropriate quality and quantity for enhancement of Lake Merced lake levels Wetlands are constructed outside of existing wetland areas; increase wetland acreage at Lake Merced	Would need to be done in combination with Tunnel South of County Line alternative in order for existing canal to be abandoned for wetlands construction Utility conflicts will need to be addressed Land acquisition issues. Removal of approximately 50 trees.	YES. Compatible with Tunnel South of County Line alternative to provide multiple benefits; provides option for treatment of stormwater flows before diversion to Lake Merced for lake level enhancement; does not disturb existing wetland habitat.

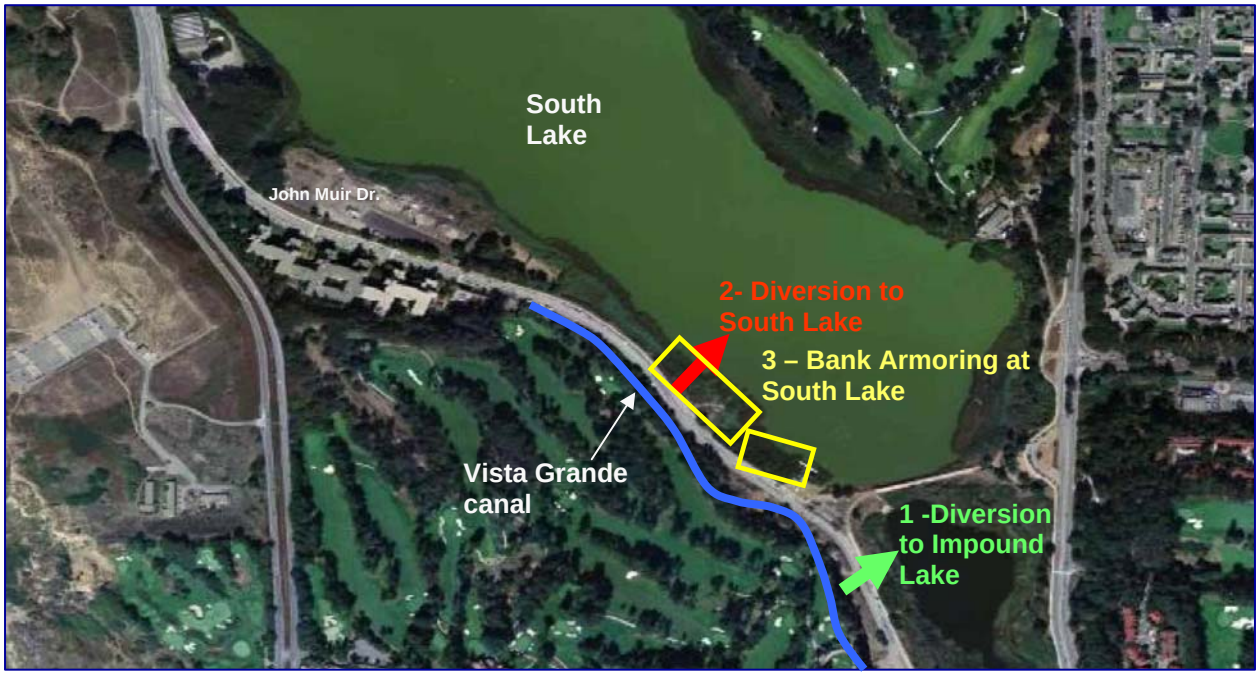
Alternative	Description	Planning Level Capital Cost Estimate	Flood Protection Benefits and/or Limitations	Potential Benefits	Limitations	Recommended for Further Evaluation in Vista Grande Watershed Study
New Parallel Tunnel	Construction of a 3,500 foot long tunnel parallel to the existing Vista Grande tunnel Would also require improvements along Vista Grande canal to convey the design storm to the new tunnel	$52,260,000	Would provide reliable flood protection at Vista Grande canal for the design storm	Eliminates erosion along Lake Merced resulting from overflows Protects Lake Merced water quality Eliminates public safety issues along John Muir Drive	Would require extensive permitting Would increase stormwater discharges to the beach below Fort Funston	NO. Alternative dropped for Tunnel South of County Line alternative which is less costly tunnel alternative, and does not require improvements to Vista Grande
Tunnel South of County Line	Construction of a 4,700 to 4,900 foot tunnel at the upstream end of Vista Grande canal Tunnel would be entirely within San Mateo County	$52,420,000 (Based on a 4,800 foot tunnel.)	Would provide reliable flood protection at Vista Grande canal for the design storm	Eliminates erosion along Lake Merced resulting from overflows Protects Lake Merced water quality Eliminates public safety issues along John Muir Drive Compatible with Vista Grande Wetland alternative	Would require extensive permitting Would increase stormwater discharges to the beach below Fort Funston	YES. This alternative provides reliable flood protection, is cost competitive, and is compatible with Vista Grande Wetland alternative for Lake Merced Lake Level enhancement.

Figure 4-16 Long-Term Program Components Recommended for Further Evaluation in the Vista Grande Watershed Study

4.4 Interim Solutions

Because the long-term program components would likely take 5 to 8 years to implement, several interim solutions for addressing overflows at Vista Grande canal were also investigated as part of this watershed study. The primary purpose of interim solutions would be to reduce the number of years of flooding impacts at Vista Grande canal, to address the immediate public safety issues along John Muir Drive, and reduce Lake Merced bank erosion and water quality impacts that result from overflows at the canal. To address overflows at the canal, interim solutions were designed to allow 170 cfs to flow through Vista Grande canal and tunnel, and divert 510 cfs of flow to Lake Merced in a controlled manner. A successful interim solution would solve flooding problems cost effectively, be compatible with the long-term program components, and would be capable of implementation in a relatively short period of time. As shown in Figure 4-17, three interim solutions were investigated: Diversion to Impound Lake, Diversion to South Lake, and Bank Armoring at South Lake. A detailed analysis of the interim solutions evaluated is provided in Appendix D and a summary of each solution and recommendations related to interim solutions is provided below.

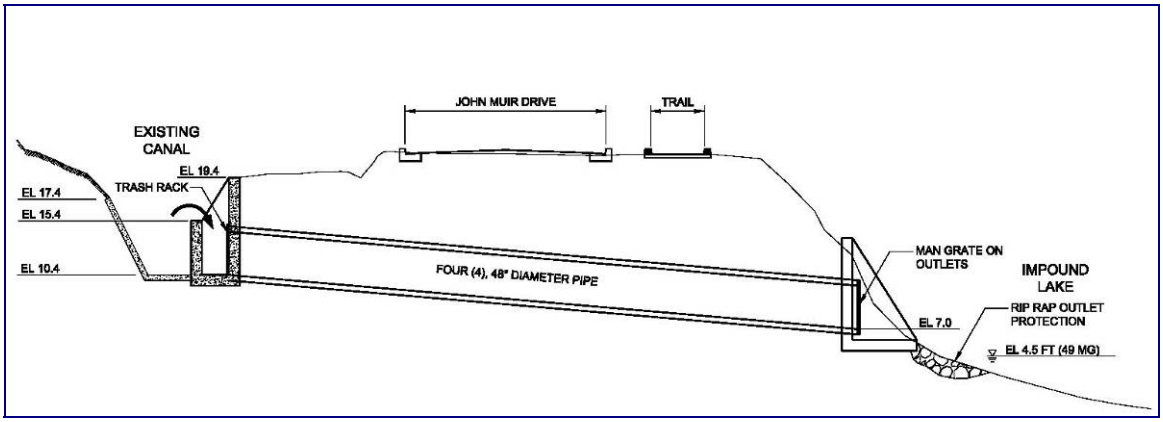
Figure 4-17 Location of Interim Solutions Examined for the Vista Grande Watershed Study



4.4.1 Diversion to Impound Lake

This interim solution would divert flow in excess of the tunnel capacity to Impound Lake via a concrete weir structure installed in Vista Grande canal, which includes four 48-inch diameter pipes under John Muir Drive and a concrete outfall at Impound Lake. The banks of Impound Lake would be lined with rip rap below the outlet structure to the normal lake level to prevent erosion. After implementation of a long-term solution, the rip rap would be removed and the banks would be restored. Figure 4-18 provides a schematic diagram of the facilities for this alternative.

Figure 4-18 Schematic of Impound Lake Diversion Interim Solution



Planning Level Capital Cost Estimate and Implementation Schedule

The planning level cost estimate for Diversion to Impound Lake is approximately $2,140,000. Details of the cost estimating analysis and implementation schedule are provided in Appendix D.

Implementation of this interim solution is expected to take approximately 3 years which includes time necessary for preparing permit applications, obtaining permit approval, design, bidding and construction. The permitting process is expected to take up to 2 years. If the permitting process began in early 2006, there would be four years of potential flooding along Vista Grande canal (winters of 2005/2006, 2006/2007, 2007/2008, and 2008/2009) before the project would be implemented.

Benefits

The Impound Lake Diversion interim solution addresses safety concerns and bank erosion issues by preventing the flooding of John Muir Drive during a 10-year storm event. This alternative requires a relatively low capital cost and the loss of habitat of 0.04 acres is considerably lower than the other interim solutions analyzed, requiring only 0.15 acres of mitigation based on an assumed 3:1 mitigation ration.

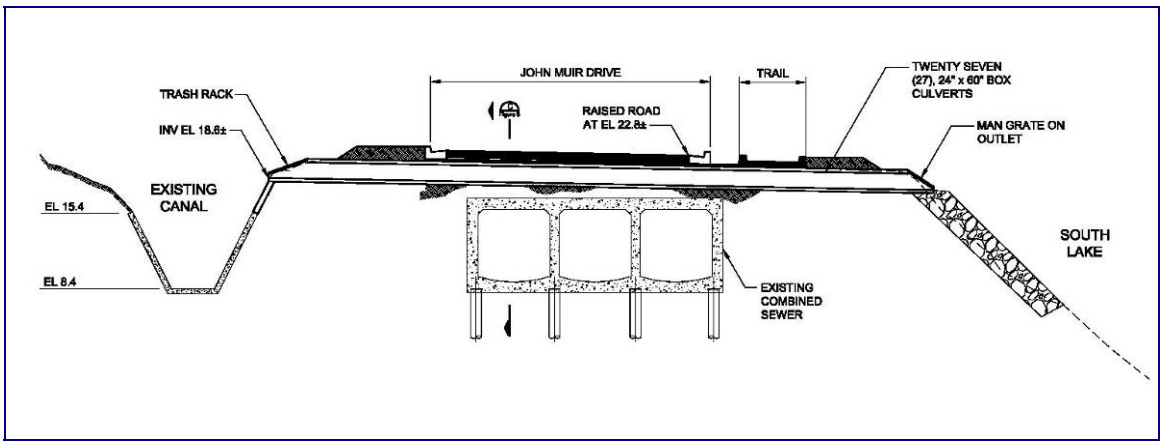
Limitations

This alternative would take approximately 3 to 3 ½ years to implement, which would mean up to four rainy seasons without flood protection if work began on the project in early 2006. There would be loss of a small amount of habitat at Impound Lake, but the wetland habitat at Impound Lake is high priority for conservation (SFRPD, 2005). The impacts of discharging stormwater with higher than ambient levels of coliforms, nutrients, and some metals and other pollutants will need to be addressed in the permitting and environmental compliance process. Additionally, this alternative is not compatible with the long-term solutions and therefore would be abandoned when a long-term solution is implemented.

4.4.2 Diversion to South Lake

The Diversion to South Lake interim solution would divert flow in excess of the tunnel capacity to South Lake via a concrete overflow structure installed in Vista Grande canal, 27 rows of 2 foot x 5 foot box culverts under John Muir Drive, and a concrete outlet structure at South Lake. To avoid conflict between the proposed box culverts and an existing 10 foot x 24 foot combined sewer box that runs under John Muir Drive, the road would have to be raised between 6 inches and 2.5 feet for a length of approximately 440 feet. The banks of South Lake below the outlet structure would be lined with rip rap to the normal lake level to prevent erosion. Figure 4-19 provides a schematic diagram of the required facilities for this alternative.

Figure 4-19 Schematic of South Lake Interim Solution



Planning Level Capital Cost and Implementation Schedule

The planning level capital cost estimate for the South Lake Diversion interim solution is $10,720,000. This alternative is more expensive to construct than the Impound Lake interim solution because of the

complications with conveying flows over the combined sewer structure that runs under John Muir Drive. Details of the cost estimating analysis and implementation schedule are provided in Appendix D.

Implementation of this interim solution is expected to take approximately 3 years, which includes time necessary for preparing permit applications, obtaining permit approval, design, bidding and construction. The permitting process is expected to take 18 months to two years. If the permitting process began in early 2006, there would be up to four years of potential flooding (winters of 2005/2006, 2006/2007, 2007/2008, and 2008/2009) before the project would be implemented.

Benefits

The South Lake Diversion interim solution would address safety concerns and bank erosion issues by preventing flooding of John Muir Drive during a 10-year storm event. This option would essentially allow water to go where it naturally goes today, but it would flow under the road in a controlled manner rather than over the road. This alternative avoids habitat disturbance to the wetlands around Impound Lake.

Limitations

The limitations of this alternative are significant. First, it would take approximately 3 years to implement this alternative, which means at least four rainy seasons without protecting the roadway or the banks, and without addressing public safety concerns. Second, the capital cost is very high and the facility would be abandoned when long-term solutions are in place. Finally, loss of habitat would be approximately 0.92 acres, which is a significant impact considering the quality of habitat surrounding Lake Merced. Mitigation would be required at a 3:1 ratio, or approximately 3 acres. As with all interim solutions, the impacts of discharging stormwater with higher than ambient levels of coliform, nutrients and some metals and other pollutants would need to be addressed in the environmental and compliance process.

4.4.3 Bank Armoring

Bank Armoring at South Lake would consist of installing vegetated rip-rap along the banks of South Lake where overflows presently occur. The width of rip rap would be approximately 300 feet along John Muir Drive and extend from the roadway to normal lake level. After implementation of a long-term solution, the rip rap would be removed and the banks would be restored.

Planning Level Capital Cost and Implementation Schedule

The planning level cost estimate for this interim solution is $3,570,000. This cost includes cost for bank restoration after the interim solution is removed and mitigation for wetland habitat destroyed through the installation of this interim solution. A detailed cost estimate and implantation schedule is provided in Appendix D.

Implementation of this alternative is expected to take approximately 2-1/2 years which accounts for the time necessary for preparing permit applications, obtaining permit approval, design, bidding and construction. The permitting process is expected to take 18 months to 2 years. If the permitting process began in early 2006, there would be up to three seasons of potential flooding (winters of 2005/2006, 2006/2007, and 2007/2008) before the project would be implemented

Benefits

Installing rip rap at South Lake addresses bank erosion issues related to flooding of John Muir Drive by protecting the soil from being washed away during an overflow. The cost of the project is in the same range as the Impound Lake Diversion, but significantly less than the South Lake Diversion. The implementation period for this alternative is one year shorter than other interim solution alternatives.

Limitations

A significant limitation with this alternative is that it does not address safety concerns associated with flooding of the roadway. The roadway will flood, as it does presently, during a 10-year storm event, posing a safety risk to motorists and pedestrians. This alternative would also require the largest loss of habitat of the three interim solutions examined. A total of 1.4 acres of habitat would be lost, which would require 4.2 acres of mitigation at a 3:1 ratio. As previously mentioned, the impacts of discharging stormwater with higher than ambient levels of coliform, nutrients and some metals and other pollutants would need to be addressed in the environmental and compliance process.

4.4.4 Recommendations Related to Interim Solutions

It is recommended that interim solutions are not further analyzed as part of the Vista Grande Watershed Study, and that the partner agencies do not proceed with implementation of an interim solution. There is a significant amount of time related to permitting activities associated with each of the interim solutions, resulting in a 2-1/2 to 3-1/2 year implementation schedule. With an assumed 5 to 8 year implementation schedule for the Tunnel South of County Line alternative recommended as part of the study, the interim solutions would provide only 2 to 4 years of flood protection before the long-term solution is implemented. Additionally, none of the interim solutions are compatible with the long-term program, so they would need to be removed once the long-term program is in place. Additionally, there is considerable expense associated with each interim solution with costs ranging between $2,100,000 and $10,700,000. Perhaps the most significant challenges associated with implementation of the interim solutions are the permitting and regulatory issues associated with the filling of 0.04 to 4.2 acres of wetlands along the shoreline of Lake Merced and the regulatory issues associated with creating a structure to discharge untreated stormwater into Lake Merced, as outlined under the Impound Lake and South Lake interim solution alternatives. As such, it is instead recommended that a traffic plan be developed to control traffic on John Muir Drive during storm events and that implementation activities associated with the long-term program be initiated as soon as possible.

Since interim solutions are not recommended as part of the watershed study, there may be potential for costs related to roadway and trail repairs associated with Vista Grande canal overflows until the long-term program components are implemented. Maintenance of the Vista Grande drainage system, especially the Vista Grande canal and the Vista Grande tunnel, will be essential in minimizing flooding damages until the long-term program is in place. This maintenance should include a pre-storm season walkthrough of the canal and adjacent areas to identify debris and other maintenance activities to be conducted prior to the storm season. Maintenance during storm events could be enhanced by installing a mechanical device to catch and remove debris to maintain flow through the canal and tunnel.