



SAN FRANCISCO PUBLIC UTILITIES COMMISSION

SUNSET SWALES PARKING LOT STORMWATER RETROFIT Project Summary – May 10, 2007

LOCATION	Eastern shore of Lake Merced, southwest San Francisco, at the intersection of Sunset and Lake Merced Boulevards
PROJECT TYPE	Stormwater management retrofit of existing parking lot
TECHNOLOGY	Infiltration basins and vegetated swales
BENEFITS	The project is capturing runoff from 3.5 acres of impermeable surfaces that would have otherwise flowed untreated into Lake Merced. Additionally, it is improving the visual appearance of the lake and parklands through the addition of native plantings and public art.
COSTS	The cost of the project was approximately \$288,300.00, which is roughly \$1.87 per square foot of impervious area managed.
CONSTRUCTED	January 2006 to March 2007
MAINTENANCE	The San Francisco Public Utilities Commission (SFPUC) maintains the project with contract work performed by Earth Stewards. For further information or questions, contact the Wastewater Enterprise at 415-554-3289. (Information current 4/2007).

Features:

This project takes advantage of the unique opportunity to test new landscape-based stormwater management techniques in San Francisco. As a demonstration project, it tests best practices for Low Impact Design (LID) that will assist the SFPUC in the development of future projects in other locations. Using vegetated swales and infiltration basins, these features are intended to delay, capture, and purify water that otherwise would flow directly into Lake Merced, demonstrating how stormwater can recharge groundwater reserves at the same time.

Background

Stormwater Management Overview:

The city of San Francisco has begun to prioritize LID as a method of stormwater management. It is investigating, testing and implementing projects that treat stormwater at the source rather than at the outflow. Methods involved in these solutions increase infiltration, retention, and detention, slowing or stopping the flow of stormwater before it enters natural waterways, such as lakes, streams, or the San Francisco Bay. It also has the potential to decrease the load on municipal water treatment facilities.

Goals:

The main goals of the Sunset Swales stormwater retrofit were to:

- Enhance the parkland qualities of the areas surrounding the Lake Merced watershed by converting impervious paved surfaces into pervious, vegetated areas;
- Test bio-climatically appropriate plantings for stormwater management in San Francisco;

- Design new vegetated areas as a demonstration project for stormwater Best Management Practices (BMPs); and
- Create an attractive, garden setting for a San Francisco Arts Commission statue of Juan Bautista de Anza.

Project team:

The project was constructed in partnership with the San Francisco Public Utilities Commission (SFPUC) and the City of San Francisco Department of Public Works (DPW). The SFPUC is responsible for the continued ownership and maintenance of the project and has a contract with Earth Stewards, a non-profit job-training program, to perform the necessary maintenance tasks.

Site Summary:

The Sunset Swales parking lot borders the eastern shoreline of Lake Merced, in the southwest corner of San Francisco, California. The lake is an important natural habitat for many animal species and is a critical location along the Pacific Flyway for migrating birds. Lake Merced is a major regional recreation venue, popular for biking, fishing, boating and appreciating wildlife. It is composed of four interconnected freshwater lakes. The Sunset Swales parking lot is located at the confluence of the North Lake and East Lake. The parking lot is slightly U-shaped and was built on a small peninsula on the north side of the lake. Lake Merced Boulevard edges the parking lot on the northeast side. Sunset Boulevard intersects with Lake Merced Boulevard at the northwestern entrance to the parking lot. The parking lot is approximately 3.5 acres and measures roughly 400 feet by 400 feet.



Site Selection:

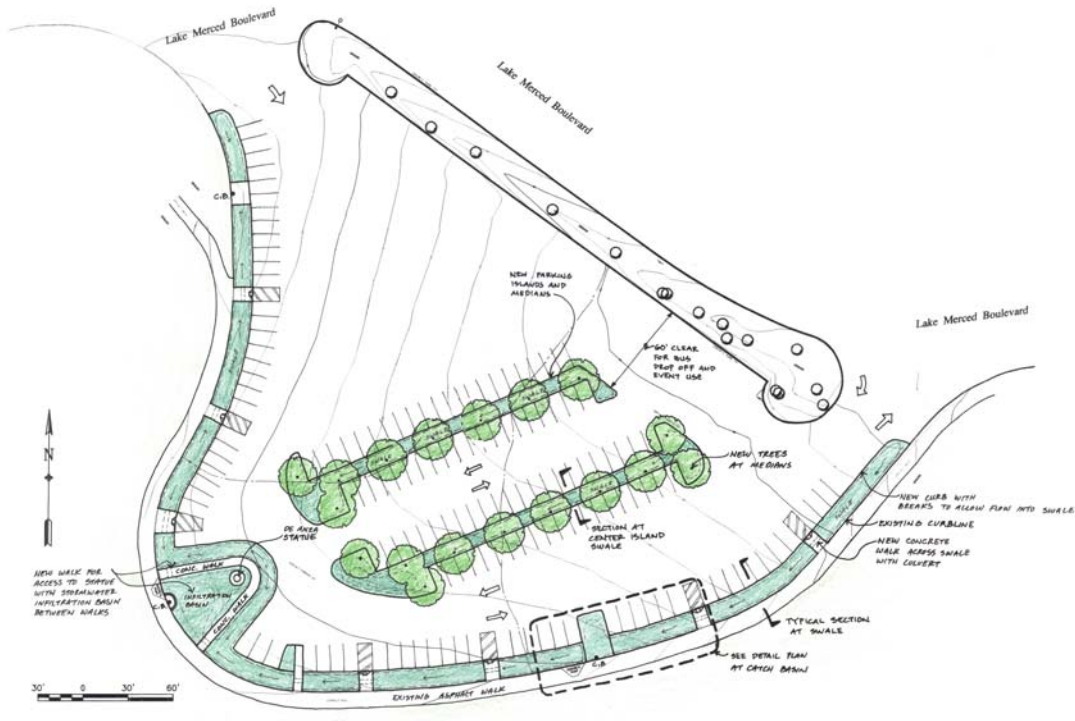
The Sunset Swales parking lot was chosen for its proximity to San Francisco’s largest natural surface water body. Additionally, it is not part of the city’s combined stormwater system, which means that without stormwater management, untreated water flows off paved surfaces directly into the lake. In order to assure high water quality for all of the users of Lake Merced, this project delays and purifies the stormwater that leaves paved surfaces adjacent to the lake.

The pre-construction conditions of the site facilitated the development of a successful project. The gentle slope of the site enabled the uncomplicated incorporation of swales into the design. The parking lot was already slated to be the site for a new piece of public art – a statue of Juan Bautista de Anza. The desired location of the statue was accommodated within the stormwater landscape design, allowing the new planting to

showcase the art piece. After stormwater modifications and addition of planted medians, only 10% of the parking spaces on the site were lost. The project also maintained public access to the lake.

Overview of system:

Sunset Circle Parking Lot Plan



The Sunset Swales project includes two types of stormwater management methods: vegetated swales and infiltration basins. These two systems work together to capture and purify the water that drains off the paved parking area. Vegetated swales were designed to capture stormwater runoff from the parking lot paving and convey it to small infiltration basins at the low end of each swale. Swales in the parking lot islands each have ‘bulb-out’ areas at their ends that serve this purpose. Breaks in the concrete curbs that define the parking islands allow surface runoff to enter the swales at controlled points. The swales along the perimeter of the parking lot also have breaks in the parking lot-side curbing to allow stormwater into the perimeter swales. With the exception of the far western section of the perimeter swale, the runoff captured along the parking lot edges is conveyed towards the larger infiltration basin.

The infiltration basins reduce and delay stormwater flows by capturing and holding runoff. They also allow stormwater to percolate into the soil, recharging groundwater and postponing or completely bypassing drainage into on-site catch basins. There are three infiltration basins included in the design. The main infiltration basin is

located near the Juan Bautista de Anza statue, and two smaller infiltration basins are located at the western (low) ends of the two parking lot islands.

Summary of Work Schedule

The project was initiated in January 2006. The construction phase of the project was completed in the following fall. Maintenance will be ongoing following the completion of the construction. The following is a summary of the major events in the project time line.

Project Schedule:

Date	Action
<i>Oct. - Dec. 2005</i>	Completed conceptual design Site surveyed GIS analysis of drainage area Swale Designed
<i>January 2006</i>	Presented design to the Lake Merced Task Force
<i>Jan-March 2006</i>	Design finalized Plant palette selected
<i>March - Sep. 2006</i>	Most construction completed
<i>December 2006</i>	Irrigation installed and oak trees planted
<i>March – April 2007</i>	Planting completed

References:

The planning and design process relied on previously constructed precedents and technical publications as references. Several built projects in the city of Portland, Oregon were looked to as examples of success, specifically including the design of SW 12th Avenue Green Street.¹ Reference documents that were used and available to the public online were: Portland’s Green Streets documents available from the Bureau of Environmental Services; the Bay Area Stormwater Management Agencies Association 1999 publication *Start at the Source: Design Guidance Manual for Stormwater Quality Protection*² by Tom Richman and Associates; the 2005 Alameda Countywide Clean Water Program document *Protecting Water Quality in Development Projects: A Guidebook of Post-Construction BMP Examples*;³ and the Caltrans document *Design of Biofiltration Swales and Strips*.⁴ Also used and available to American Society of

¹ <http://www.portlandonline.com/bes/index.cfm?c=34598&a=148539>

² Tom Richman and Associates for Bay Area Stormwater Management Agencies Association “Start at the Source: Design Guidance Manual for Stormwater Quality Protection,” 1999. http://www.scvurppp-w2k.com/basmaa_satsm.htm

³ Alameda Countywide Clean Water Program, “Protecting Water Quality in Development Projects: A Guidebook of Post-Construction BMP Examples” 2005. http://www.cleanwaterprogram.org/uploads/ACCWP_Site_Design_Guidebook_final.pdf

⁴ Carol Forest, “Design Of Biofiltration Swales And Strips.” PowerPoint presentation, August 14, 2002. <http://www.dot.ca.gov/hq/oppd/stormwtr/treatment/3-Bioswales.ppt>



Photos from Construction

Landscaping:

All the plants selected for the swales are primarily natives and should be climatically appropriate for the site. They were selected based on low water requirements in the dry season and tolerance to seasonal inundation. Also, because most are native to the region, they will support local habitat and not become invasive in the delicate Lake Merced natural ecosystem. The San Francisco Recreation and Park Department Natural Areas Program that is active in the restoration of native plant communities at Lake Merced was consulted in the plant selection. Permanent irrigation on the site is provided by a pressurized water source that maintenance crews release with a hose periodically during regular visits.

Most of the plants used in the retrofit were grown by an organization called Earth Stewards. The Earth Stewards was formed in 2004 as a partnership between the Garden Project (an at-risk youth training program) and the SFPUC. Earth Stewards provides plants and landscaping services to the SFPUC at several of their sites, including the Sunset Parking Lot Swales. The services and supplies that Earth Stewards provided include: growing and installing plants (except for oaks), weeding, and watering. The plants were grown from seeds or from cuttings as appropriate, depending on the species. While the site was under construction, the plants were maintained in the Garden Project's facilities. Earth Stewards will continue to weed and water the site as long as funding is available (guaranteed through June 2008). They will also continue to maintain a stock of replacement plants in case any plants at the project site die, are eaten by wildlife, or uprooted or damaged by visitors to the site. A native plant expert has also been providing additional consulting services to the Garden Project. In some cases, plants were also acquired from other vendors.

Most of the plants were spaced using a triangular spacing method at 18-24 inches on center. A few larger shrubs were planted at 3-feet on center.



Carex tumilicola, Berkeley Sedge



Iris douglasiana, Douglas Iris

Planting List:

The following plants were selected for planting in the swales:

Botanical Name	Common Name
<i>Achillea millefolium</i>	Common yarrow
<i>Agrostis exarata</i>	Bentgrass
<i>Aquilegia formosa</i>	Red flowering columbine
<i>Artemisia californica</i>	California sagebrush
<i>Artemisia douglasiana</i>	Mugwort
<i>Baccharis pilularis</i>	Coyote brush
<i>Bromus carinatus</i>	California brome
<i>Calamagrostis nutkaensis</i>	Pacific reed grass
<i>Carex praegracilis</i>	Field sedge
<i>Carex tumilicola</i>	Berkeley sedge
<i>Ceanothus "Joyce Coulter"</i>	Creeping mountain lilac
<i>Elymus glaucus</i>	Blue wild rye
<i>Festuca californica</i>	California fescue
<i>Festuca rubra</i>	Creeping native red fescue
<i>Juncus patens</i>	Blue spreading rush
<i>Juncus xiphioides</i>	Iris-leaved rush
<i>Hordeum brachyantherum</i>	Meadow barley salt
<i>Horkelia californica</i>	California horkelia
<i>Iris douglasiana</i>	Douglas iris
<i>Mimulus aurantiacus</i>	Sticky monkey flower
<i>Mimulus cardinalis</i>	Scarlet monkey flower
<i>Nasella pulchra</i>	Purple needle grass
<i>Ribes sanguineum v. glutinosum</i>	Currant
<i>Sisyrinchium californicum</i>	Yellow-eyed grass
<i>Stachys ajugoides</i>	Wood mint

Emergency Overflow:

Any overflows from the two smaller infiltration basins are directed into the larger infiltration basin that is located near the De Anza sculpture. As a back-up measure, the

larger infiltration basin is located near a catch basin to discharge any overflow runoff from the basin to the lake.

Cost

The entire cost of the project was \$288,300 for the fiscal years 2005 through 2007 including \$40,000 for the planting of oak trees and another \$18,000 for project over-run during 2006-2007. The Wastewater Enterprise of the San Francisco Public Utilities Commission contributed all the funds except \$9,000 of the project over-run. The cost of installing irrigation lines at the site, which was being carried out by the DPW, has not yet been accounted for.

In addition to those costs, the SFPUC Wastewater Enterprise contributed additional funds to the Garden Project for plant propagation and maintenance. Their services will continue through June 2008 but funding beyond that is still uncertain. Sunset Swales was funded as a one-time item and not given a continuous budget. For this reason, sources for the continued funding for maintenance through the Garden Project are not yet solidified.

Maintenance and Monitoring

The life of the swale can be indefinite if the proper maintenance is performed at a regular interval. The objective of maintenance is to preserve vegetation cover and hydrologic integrity of the swale. Monitoring and maintenance of the project is scheduled to begin as soon as construction is completed. This will be more intensive while the project is new and require less frequent effort as vegetation becomes established and problem areas are rectified.

Monitoring will include a continuing visual inspection and documentation of plant health, soil conditions including erosion, stability, areas of compaction or caking, clogging problems, and sediment accumulation in the basins and at the curb cuts. If the channel develops ruts or holes, it will be repaired utilizing a suitable soil that is properly tamped and seeded. During and immediately after rain events, stormwater ponding, and discharges to the outfalls will also be noted. The overall condition of the site and amenities including artwork, trash receptacles, pet waste stations, and signs will also be documented and deficiencies will be reported to the responsible agency. The original goal for monitoring the project is bi-weekly, during periods of dry weather, and during or immediately after six rain events for the first rainy season. The documentation will include a map noting deficiencies, digital photos corresponding to map annotation, and descriptions of deficiencies.

Sampling the water quality of stormwater discharges at the storm drain outfall where the De Anza installation is located will assess the efficiency of stormwater treatment of the facilities. This location is also where the initial sampling was performed. The pollutant removal efficiency shall be evaluated based on the pollutant loads discharged from the outfall comparing the before and after conditions. Wastewater Enterprise staff are performing the ongoing monitoring of stormwater quality and quantity. The goal of the monitoring is to achieve a clear understanding of how the project has performed over

time in order to best apply the successes and lessons learned to other projects in the future.

Regular maintenance will include litter removal, weeding, sediment removal from check dams and culvert inlets, reporting of erosion or other problems, vector control, re-vegetation, and repair of small-scale structural problems. These activities will occur two times per month for the first six months after planting is complete, then reducing to once per month during the rainy season and once every other month during the dry season or as needed depending on conditions noted in the visual monitoring activities.

The city of San Francisco has an aggressive program to combat the spread of West Nile Virus. Soil infiltration rates at Sunset Swales are high. It is expected that water on the site will not remain long enough to support the breeding cycle of mosquitoes. Long-term ponding is founding during the regular maintenance and observation activities, the site will be added to the catch basin inspection program and regularly treated to prevent the spread of the disease.

Maintenance will be Managed by the PUC and carried out by Earth Stewards.

Lessons Learned

There are currently no data concerning the success of the project over time. As a pilot project, however, Sunset Swales has been successful in many ways. Because there was formerly no treatment of water running off the parking lot into Lake Merced, any new treatment is an improvement. Also, lessons that were learned through the process will help improve future stormwater management projects in San Francisco.

Since the completion of the project, the swales have discharged three times even though no storm events occurred that exceeded the planned capacity of the system. There are a few possible explanations for these discharges. First, the discharges could be the result of underestimating the size of the swales and basins.

Another possible explanation of the unexpected discharges could be that infiltration was decreased due to crusting of the soil surface. Fine silts and sediment from the runoff surfaces could flow into the swales and form a less-permeable, crusted surface. This problem has been observed in other stormwater management projects in Portland and repaired through the periodic scraping of the soil surface with rakes. This approach could be incorporated into the regular maintenance regime to increase infiltration.

So far, however, all discharges occurred prior to the installation of the plants. The roots of plants, once established, aid in the prevention of surface crusting of the soil, which decreases permeability. Planting was briefly delayed on the site due to the need to wait until both the oaks and the irrigation system were installed.

A surprise in the construction phase of the project could have also lead to unforeseen results. During the removal of the paving the sub-soils were found to be far deeper than

anticipated. All the sub soils needed to be removed to reach the native soils and achieve the expected infiltration rates. The additional fill needed to make up for the difference in depth added cost to the project. The highest quality soils could not be purchased while still staying within the budget. The soil that was used contained a large amount of weed seeds, which lead to other unforeseen post construction management issues. These problems could have been prevented with a preliminary soil bore to assess the depth of the soils and accurately estimate the costs of soils amendments.

During construction of the project, construction debris from a contractor was inappropriately stored on the sunset swales parking lot. Dust and debris from this material could have also negatively influenced the infiltration rates at the site.

Prepared by Leslie Webster, Student Design Trainee, San Francisco Public Utilities Commission

Appendix A: Calculation Specifics

Water Quality Flow

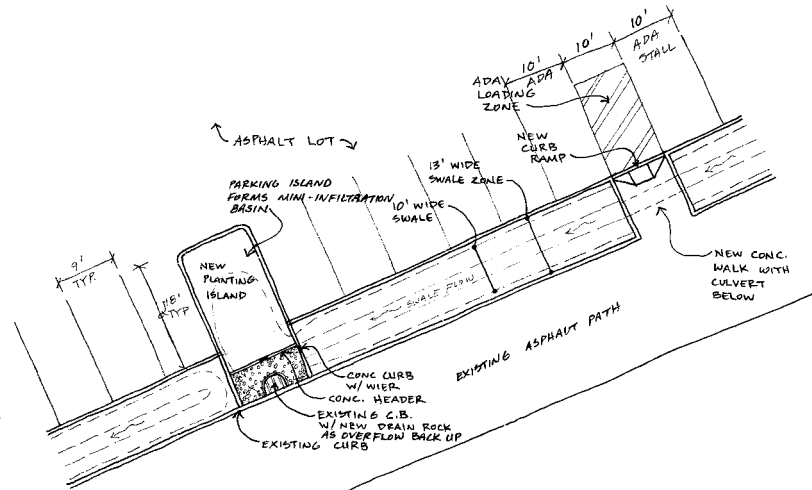
	Return period (years)	Q (cfs)	c	l (ft/sec)	a (f^2)	l (in/hr)	l(ft/sec)
WQF	0.25	0.48	0.98	8.61E-06	56,562	0.372	8.61111E-06
	0.25	0.38	0.98	8.61E-06	44,736	0.372	8.61111E-06
	0.25	0.45	0.98	8.61E-06	52,849	0.372	8.61111E-06
Q25	25	1.32	0.98	2.38E-05	56,562	1.03	2.38426E-05
	25	1.05	0.98	2.38E-05	44,736	1.03	2.38426E-05
	25	1.23	0.98	2.38E-05	52,849	1.03	2.38426E-05

Manning Equation

Rational method (Peak flow from storm event with intensity of .2 in/hr)

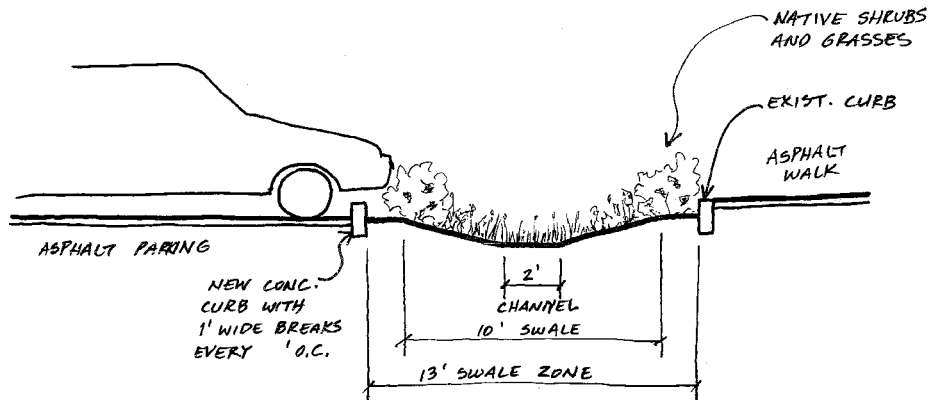
Q=CIA	Q (CFS)	C	I (in/hr)	A (f^2) (acres)	A (f^2)			
Drainage basin 1	0.23716	0.98	0.2	1.21	52849			
100 year	1.517824	0.98	1.28	1.21				
50	1.36367	0.98	1.15	1.21				
25	1.221374	0.98	1.03	1.21				
10	1.06722	0.98	0.9	1.21				
5	0.936782	0.98	0.79	1.21				
2	0.782628	0.98	0.66	1.21				
Drainage basin 2	0.19992	0.98	0.2	1.02	44736			
100 year	1.279488	0.98	1.28	1.02				
50	1.14954	0.98	1.15	1.02				
25	1.029588	0.98	1.03	1.02				
10	0.89964	0.98	0.9	1.02				
5	0.789684	0.98	0.79	1.02				
2	0.659736	0.98	0.66	1.02				
Drainage basin 3	0.25284	0.98	0.2	1.29	56562			
100 year	1.618176	0.98	1.28	1.29				
50	1.45383	0.98	1.15	1.29				
25	1.302126	0.98	1.03	1.29				
10	1.13778	0.98	0.9	1.29				
5	0.998718	0.98	0.79	1.29				
2	0.834372	0.98	0.66	1.29				
total volume	13.38709							
Manning Eq Q= Velocity (fps)	Area of trapezoid in section (flow)							
Qc = 1.49*R^2/3*S^1/2*A/n	Qc	1.49	R	2/3	S	1/2	A (ft)	n
Swale 1	0.471137	1.49	0.2108	0.666667	0.028	0.5	1.067	0.2
Swale 2	0.471137	1.49	0.2108	0.666667	0.028	0.5	1.067	0.2
Swale 3	0.471137	1.49	0.2108	0.666667	0.028	0.5	1.067	0.2

Appendix B: Detailed Plans and Sections



DETAIL PLAN AT CATCH BASIN AND ADA LOADING ZONE

12.18.05 SUNSET CIRCLE NOT TO SCALE
 CCSF DEPT. OF PUBLIC WORKS
 LANDSCAPE ARCHITECTURE



TYPICAL SECTION AT SWALE

12.18.05 SUNSET CIRCLE 1/4"=1'-0"
 CCSF DEPT. OF PUBLIC WORKS
 LANDSCAPE ARCHITECTURE

