Developments Protecting Water Quality

A Guidebook of Site Design Examples

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

April 2004

Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Campbell • Cupertino • Los Altos • Los Altos Hills • Los Gatos • Milpitas • Monte Sereno • Mountain View • Palo Alto
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Developments Protecting Water Quality

A Guidebook of Site Design Examples

Prepared by:
EOA, Inc.

April 2004

CREDITS

This document was prepared by the Santa Clara Valley Urban Runoff Pollution Prevention Program (Program) for use by the Program Co-permittees, other local agencies, and the land development community. The Program expresses its appreciation to all those who contributed to this document.

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EOA, Inc., as the Program management consultant, coordinated and compiled the information, took photographs (most photographs were taken by Wendy Edde or Carina Chen unless otherwise noted) and was responsible for the overall preparation of this document.

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Acronyms and Abbreviations

BASMAA	Bay Area Stormwater Management Agencies Association
CO	Commercial
DCIA	Directly Connected Impervious Area
LEED	Leadership in Energy & Environmental Design
HVAC	Heating, Venting, and Air Conditioning
MF	Multi-Family Residences
MU	Mixed Use Residential/Commercial
PA	Public Areas
PROGRAM	Santa Clara Valley Urban Runoff Pollution Prevention Program
REGIONAL BOARD	San Francisco Bay Regional Water Quality Control Board
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SF	Single Family Residences
USGBC	United States Green Building Council

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Site Design Examples

SECTION I

Introduction

BACKGROUND

On October 17, 2001, the San Francisco Bay Regional Water Quality Control Board (Regional Board) adopted Order 01-119, amending the Santa Clara Valley Urban Runoff Pollution Prevention Program's (Program's) Permit Provision C.3. (New and Redevelopment Requirements). Per Provision C.3.j of the permit, the Co-permittees[1] recently reviewed their local design standards and guidance for opportunities to make revisions that would help reduce impacts to water quality. The Co-permittees must revise and fully implement their standards and guidance by September 15, 2004. For more information on permit requirements, see the Program's *C.3. Stormwater Handbook*.

This Guidebook has been created as part of the effort to encourage the use of site design measures that benefit water quality in project designs. It is intended to serve as a reference during the conceptual design and review stage and to be used by both project applicants and municipal staff. This document provides examples of innovative site design elements, primarily in the Santa Clara Valley. In some instances, exceptional sites outside of the Santa Clara Valley but within the greater Bay Area are also used to illustrate the wide variety of techniques that are available.

SITE PLANNING CONCEPTS

Site design measures integrate basic stormwater management and hydrologic concepts into site planning to create developments that mitigate their impact on stormwater quality. Examples include working with the natural topography of a site, clustering the development on the least sensitive portions of a site while protecting sensitive areas, and using design techniques to minimize impervious surface area and infiltrate runoff. This document presents examples of site designs that incorporate the following approaches.

Protect Sensitive Areas from Encroachment

This concept includes such techniques as ensuring adequate protective setbacks from creeks, wetlands, and riparian areas; preserving significant trees and native or significant vegetation to protect soil structure, increase soil permeability and reduce the volume and velocity of rainwater runoff; and avoiding construction on and disturbance of erosive soils and slopes, such as steep or large continuous slopes, soils high in silt or fine sand, or soils lacking vegetative cover.

[1] The Co-permittees are the thirteen (13) Cities and Towns together with Santa Clara County and the Santa Clara Valley Water District that share a common permit to discharge storm water to South San Francisco Bay. (Refer to Credits for a full listing of the Co-permittees.)

Minimize Impervious Surface Area

❖ *Street and right-of-way widths*

Streets make up about 25% of a development's total land area, and street pavement makes the largest contribution to a site's impervious land coverage. Designing streets with less surface area by reducing widths, incorporating parking pullouts, or using permeable pavements for low use or parking areas can protect water quality while preserving the street's primary function. (BASMAA, 1999)

Fire department requirements for minimum street widths and cul-de-sac radii can conflict with better site design goals. In addition, street and parking areas need to be designed to withstand the impacts of heavy load vehicles (i.e., fire, garbage and delivery trucks). For these reasons, the fire department should be included in the development of design standards to ensure safety while allowing measures such as narrow streets, alternative turnarounds, and permeable pavement such as turf block.

❖ *Cluster or infill development*

Clustering high density development on a portion of the site while preserving high quality open space elsewhere on the site can improve overall watershed health. Although the densely developed area has a high percentage of impervious land coverage, the total impervious area is reduced and land disturbance is minimized. (BASMAA, 1999)

❖ *Parking lots*

Parking lots make up a large portion of land use and are constructed mostly of impervious pavement. Some municipal zoning codes and standards mandate that parking exceed the usual parking demand. (BASMAA, 1999) In order to provide adequate, but not excessive parking supply, site design features such as overflow parking and landscaped reserve areas can be used. Also, curb cuts allowing drainage into swales and landscaping; trees; and permeable pavement materials can be installed in order to reduce and treat parking lot runoff.

Use Drainage as a Design Element

Landscaping combined with site engineering (grading and drainage) can improve stormwater quality. Runoff draining to landscaping can to be filtered by biota and infiltrated into the soil. Site design features that can be included are areas that drain to a detention basin; streets and parking lots draining to vegetated and rocky swales, biofilters (vegetated channels), vegetated cul-de-sacs or turnarounds; and roof downspouts that drain to landscaping ("disconnected downspouts"). Disconnecting impervious surface areas (i.e., allowing runoff to drain to pervious surfaces in between impervious surfaces) reduces the velocity and amount of water, lowers downstream peak flows and reduces flood and erosion potential.

Promote Alternatives to Automobiles

Automobiles are a major source of water pollution. Designing sites that promote a variety of transportation alternatives has the potential to reduce automobile trips. Design examples are provided that promote bicycling, walking, carpooling, and mass transit.

ADDITIONAL RESOURCES

For more detailed descriptions and guidelines on these topics, refer to the Bay Area Stormwater Management Agencies Association's (BASMAA's) *Start at the Source Manual* (1999) and its companion document *Using Site Design Techniques to Meet Development Standards for Stormwater Quality* (2003) (available at the Program's website www.scvurppp.org). Of substantial benefit to project proponents, using site design techniques to help meet the requirements of Provision C.3. can also result in fewer or smaller-sized treatment controls required and a corresponding savings in the operation and maintenance costs over the life of the project. Additional information regarding stormwater quality-friendly site designs is available on the Program's website and in the Program's *C.3. Stormwater Handbook*.

CONTENTS OF MANUAL

This document provides examples of local site design measures that control storm water quality impacts. The examples are organized into Sections II through VII, based on type of development. For each site, the design examples provide the location, features with pictures, cost information and lessons learned (where available), and contact information. Contacts were asked for additional information including construction and maintenance costs and considerations, project size and completion date. This information is provided where available.

Section I contains the background and introduction to the Santa Clara Valley Urban Runoff Pollution Prevention Program's Guidebook of Site Design Examples.

Section II focuses on single-family residences, where many site design techniques can be integrated for maximum effectiveness.

Section III focuses on multi-family residences. For the purposes of this document, the distinguishing factor between single- and multi- family houses is that in the latter, the residences share adjoining walls.

Section IV focuses on mixed-use developments, generally high density residential units combined with commercial businesses.

Section V focuses on commercial and industrial developments. This section is divided into campus/industrial parks and other areas. Generally campus/industrial parks are on large sites dedicated for one or more businesses and include common areas that provide opportunities for features that can improve water quality.

Section VI focuses on projects that are on publicly owned and managed land. These include greenbelts, bike paths to parks, and public buildings.

Section VII includes two indices to assist the user in locating: 1) particular site design techniques illustrated in this document; and 2) all the examples within a specific municipality.

REFERENCES

Bay Area Stormwater Management Agencies Association, *Start at the Source*, 1999.

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Site Design Examples

SECTION II

Single Family Residences

Basking Ridge
SF-1

Site Location:
Basking Ridge Avenue
San Jose, CA

Features:
- Two detention ponds
- Wetland vegetation
- Parking pullouts and narrower streets

Stormwater Benefits:
- Natural treatment of runoff
- Reduced velocity of flows
- Reduced impervious surface area

Photograph courtesy of Sheila Tucker (BASMAA)

Parking pullouts allow narrower streets that require less land area and provide more space for trees and grass. These landscaped areas reduce the volume and velocity of rainwater and maximize infiltration. Properties on narrow streets with tree-lined landscapes typically have higher property values. The use of narrow streets also reduces construction costs.

Photograph courtesy of Sheila Tucker (BASMAA)

Stormwater runoff is directed into the detention pond which temporarily holds the water, allowing for settling of sediments and pollutant removal to occur. The system releases runoff slowly to reduce downstream peak flows.

Photograph courtesy of Sheila Tucker (BASMAA)

Wetland vegetation helps to remove dissolved metals and nutrients. A walking trail bordering the pond on Dana Court demonstrates how a stormwater treatment device can benefit the environment and be attractive, thereby enhancing the neighborhood character.

Municipal Contact:
Jenny Nusbaum
City of San Jose
(408) 277-4576
Jenny.Nusbaum@sanjoseca.gov

Site Contact:
Phil Alne
Shea Homes
(925) 245-3600

Note: Some text courtesy of Sheila Tucker (BASMAA)

Dana Street
SF-2

Site Location:
235 & 239 Dana Street
Mountain View, CA

Feature:

- Shared driveway
- Flared driveway

Stormwater Benefit:

- Reduced impervious surface area

These two (2) houses share a driveway leading towards a shared garage area. This reduces the amount of impervious surface area required per home. The driveway is also flared – allowing for a wider area for parking than the single-lane entrance/exit way.

Municipal Contact:
Eric Anderson
City of Mountain View
(650) 903-6225
Eric.Anderson@ci.mtnview.ca.us

Shelley Avenue 1
SF-3

Site Location:
63 & 65 Shelley Avenue
Campbell, CA

Feature:
- Shared driveway serving multiple houses

Stormwater Benefits:
- Reduced impervious surface area

Two (2) single-family houses share a driveway. Shared driveways reduce the amount of impervious surface required per home, especially when houses are set back far from the street. Shared driveways are often used for hillside developments but can be incorporated into many subdivisions.

Municipal Contact:
Geoff Bradley
City of Campbell
(408) 866-4140

Ortega Avenue
SF-4

Site Location:

North End of Ortega Avenue (adjacent to railroad tracks)
Mountain View, CA

Features:

- Landscaped parking and turnaround area located at the end of a dead end street

Stormwater Benefit:

- Reduced impervious surface area

Landscaping, including a street tree, is provided in a center island where there is also an area for parking. The design allows adequate room for a turnaround, providing easier access for fire and other service vehicles.

This is an alternative view of the turnaround, as you would approach it if driving.

Other Opportunities:

- To improve the site design from a stormwater quality perspective, the island could have been designed to accept runoff from the street through such features as concave landscaping with pavement protection, curb cuts, and grading the street to drain to the island.

Municipal Contact:
Eric Anderson
City of Mountain View
(650) 903-6225
Eric.Anderson@ci.mtnview.ca.us

Bourbon Court
SF-5

Site Location:

South End of Bourbon Court
Mountain View, CA

Features:

- Landscaped recreational and turnaround area in a cul-de-sac

Stormwater Benefit:

- Reduced impervious surface area

Landscaping around this center island allows for some infiltration to occur while allowing easier access for public service vehicles such as fire and garbage trucks. Also within the island is a recreational area with a pool and associated facilities for nearby residents.

Other Opportunities:

- To improve the site design from a stormwater quality perspective, the island could have been designed to accept runoff from the street through such features as concave landscaping with pavement protection, curb cuts, and grading the street to drain to the island.

Municipal Contact:
Eric Anderson
City of Mountain View
(650) 903-6225
Eric.Anderson@ci.mtnview.ca.us

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Site Design Examples

SECTION III

Multi-Family Residences

Communications Hill/Helzer Ranch
MF-1

Site Location:
3000 Narvaez Avenue
San Jose, CA

Features:

- Landscaped areas provide detention for floods and stormwater
- Downspouts disconnected
- Higher density housing

Stormwater Benefit:

- Reduced impervious surface area
- Reduced directly-connected impervious area (DCIA)
- Natural treatment of runoff
- Reduced velocity runoff

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Rooftop runoff drains through downspouts to landscaping for treatment and infiltration.

Photograph courtesy of Jenny Nusbaum (City of San Jose)

This large grassy swale provides area for runoff to percolate into the soil, reduce downstream peak flows, and to receive treatment via settling and filtration.

Communications Hill/Helzer Ranch
MF-1 (cont.)

Photograph courtesy of Jenny Nusbaum (City of San Jose)

This outdoor space for the community to enjoy also acts as a detention basin for stormwater.

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Infiltration is allowed to occur in this detention basin before entering the drainage system.

Municipal Contact:
Jenny Nusbaum
City of San Jose
(408) 277-4576
Jenny.Nusbaum@sanjoseca.gov

Site Contact:
Matt Steinle
Development Director
(408) 993-2908

Los Padres and Homestead Condominiums
MF-2

Site Location:
Los Padres and Homestead Road
Santa Clara, CA

Features:
- Turf block fire lanes are used for fire access
- Narrow 20-foot wide streets
- Higher density housing

Stormwater Benefit:
- Reduced impervious surface area.

Fire access is marked where the fire truck can drive up over the curb across the turf block to access this housing development.

Close-up picture shows the concrete turf block matrix not covered in grass.

Signs clearly posted in order to prevent people from blocking access to the turf block fire lanes in emergencies.

Los Padres and Homestead Condominiums
MF-2 (cont.)

The narrow streets within the complex provide only 20 feet of access, thereby reducing the amount of impervious surface area. With this narrow access, any parked vehicles can impede fire access. Red curb paint and signs can be used to denote fire lanes throughout complexes. (This driver remained in his vehicle.)

Municipal Contact:
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City of Santa Clara
(408) 615-2456
jsilva@ci.santa-clara.ca.us

Fire Department Contact:
Steve Silva
Santa Clara Fire Department
(408) 615-4978
ssilva@ci.santa-clara.ca.us

Stanford West
MF-3

Site Location:
700 Clark Way (off Sand Hill Road)
Palo Alto, CA

Features:

- Apartment development was planned with cul-de-sacs, but redesigned to use a grid system
- Area dedicated as a covered car wash area plumbed to the sanitary sewer
- Detention basin on the east end that also serves as a recreational playing field

Photograph courtesy of Joe Teresi (City of Palo Alto)

This covered car-washing area drains water to the sanitary sewer system. This prevents car wash water, soap, and pollutants from entering storm drains.

Stormwater Benefit:

- Washwater treatment
- Natural treatment of runoff in recreational area
- Reduced velocity of flows discharged to nearby creek
- Transportation-related pollution reduction (grid street system reduces vehicle miles traveled)

Photograph courtesy of Joe Teresi (City of Palo Alto)

A recreational play field also serves as a detention basin for runoff. The detention basin temporarily holds runoff, allowing for settling, infiltration and pollutant removal to occur, such as allowing fine sediments to settle out. The system releases runoff slowly to reduce downstream peak flows.

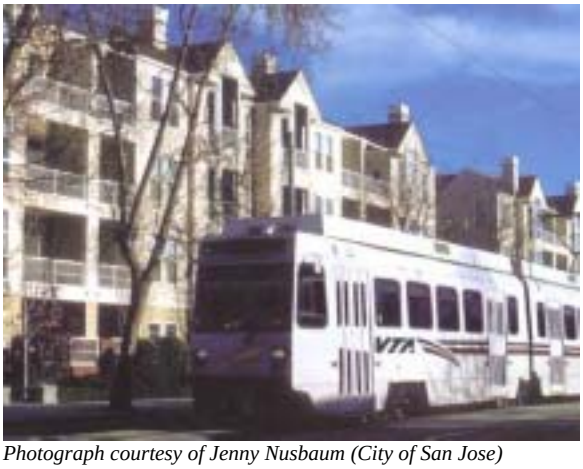
Municipal Contact:
Joe Teresi
City of Palo Alto
(650) 329-2129
Joe_teresi@cityofpaloalto.org

Site Contact:
Dave Richwood
Brian-Kangas-Foulk
(408) 467-9100
drichwood@bkf.com

Ryland Mews
Transit-Oriented Development Corridor
MF-4

Site Location:
4115 North 2nd Street
San Jose, CA

Features:
- High density housing near First Street Light Rail Line
- Located near downtown
- Disconnected downspouts drain to landscaping
- Multi-story buildings reduce the building footprint



Photograph courtesy of Jenny Nusbaum (City of San Jose)

Light Rail runs nearby, promoting the use of alternative transportation. Motor vehicles can be the sources of metals, oil, and grease which can be harmful to aquatic organisms and, in high enough quantities, can contaminate drinking water supplies. (BASMAA, 1999) Using alternate transportation can reduce the amount of these pollutants from entering waterways.

Stormwater Benefits:
- Reduced impervious surface area
- Reduced directly-connected impervious area (DCIA)
- Transportation-related pollution reduction

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Open space surrounding high density housing allows residents to enjoy the outdoors (e.g., grass and trees) and also provides good drainage areas.

Ryland Mews
Transit-Oriented Development Corridor
MF-4 (cont.)

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Rooftop runoff drains through downspouts to landscaping where it has the opportunity to be filtered by plant material and infiltrate into the soil. Disconnecting impervious surface area reduces the speed and amount of water which can result in benefits such as lower peak flows downstream and reduced flood and erosion potential.

Municipal Contact:
Jenny Nusbaum
City of San Jose
(408) 277-4576
Jenny.Nusbaum@sanjoseca.gov

Site Contact:
Dan Sell
Barry Swenson Builder
(408) 983-6338
dsell@barryswensonbuilder.com

Blossom River Apartments
MF-5

Site Location:
1000 Blossom River Way
San Jose, CA

Features:
- High density residential area
- Rocky swale

Stormwater Benefits:
- Reduced impervious surface
- Natural treatment of runoff
- Reduced velocity of runoff
- Reduced directly-connected impervious area (DCIA)

Photograph courtesy of Mike Campbell (RBF Consulting)

Runoff enters the rocky swale from the parking lot and is filtered before entering the storm drain.

Photograph courtesy of Mike Campbell (RBF Consulting)

Turf landscaping around the rocky swale provides an area for infiltration Multi-story buildings reduce the building footprint.

Municipal Contact:
Jenny Nusbaum
City of San Jose
(408) 277-4576
Jenny.Nusbaum@sanjoseca.gov

Le Mirador Senior Housing
MF-6

Site Location:
1191 Coleman Road
San Jose, CA

Features:
- High density multi-story senior housing area
- Vegetative swale

Stormwater Benefits:
- Reduced impervious surface area
- Natural treatment of runoff
- Reduced velocity of runoff
- Reduced directly-connected impervious area (DCIA)

Before

Photograph courtesy of Mike Campbell (RBF Consulting)

This photo illustrates the swale when plant growth was hindered by the native clay soil. The parking lot is graded to drain to the swale.

After

Photograph courtesy of Mike Campbell (RBF Consulting)

The densely landscaped vegetative swale was made possible by replacing the native clay soil with sandy loam soil.

Lessons Learned:
- Over 2 feet of the native clay soil was replaced with sandy loam, which improved growth and infiltration.

Municipal Contact:
Jenny Nusbaum
City of San Jose
(408) 277-4576

801 Homestead
MF-7

Site Location:
801 to 827 Homestead Road
Santa Clara, CA

Features:
- Narrow shared driveway
- "Tucked under" parking reduces the building footprint
- Street trees

Stormwater Benefits:
- Reduced impervious surface area
- Reduced volume and velocity of runoff

Because the long, narrow, dead-end driveway, exceeds the maximum 150 feet required for fire truck access, fire sprinklers were installed in the rear units to provide additional response time.

Municipal Contact:
Judith Silva
City of Santa Clara
(408) 615-2456
jsilva@ci.santa-clara.ca.us

Fire Department Contact:
Steve Silva
Santa Clara Fire Department
(408) 615-4978
ssilva@ci.santa-clara.ca.us

Shelley Avenue 2
MF-8

Site Location:

Shelley Avenue near White Oaks Avenue
Campbell, CA

Feature:

- "Tucked under" parking reduces the building footprint
- Shared driveway

Stormwater Benefit:

- Reduced impervious surface area

This site features "tucked under" parking for multi-family houses. This design reduces the impervious surface area per unit by reducing the building footprint. More land would be required if the parking garages were separate, not underneath the living areas.

Municipal Contact:
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City of Campbell
(408) 866-2747
lynnp@ci.campbell.ca.us

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Site Design Examples

SECTION IV

Mixed Use Residential/Commercial

The Crossings
MU-1

Site Location:

2255 Showers Drive
Mountain View, CA

Features:

- High density (multi-story) housing with reduced building footprints integrated with commercial areas
- Located near mass transit including bus lines and CalTrain station
- Disconnected downspouts drain into landscaping
- Turf block fire lanes
- Landscaped center of driving circle

Stormwater Benefits:

- Transportation-related pollutant reduction
- Reduced impervious surface area
- Reduced velocity of runoff
- Reduced directly-connected impervious area (DCIA)
- Natural treatment of runoff

"The Crossings" is conveniently located across the street from the San Antonio CalTrain Rail Station.

Turf block fire lane provides access during emergencies. The bollards can be removed for emergency access.

The Crossings
MU-1 (cont.)

Multi-story housing reduces the building footprint and, thus, impervious surface area. Rooftop runoff drains into landscaping rather than directly to the storm drain system.

This rain gutter drains into landscaping reducing the amount of directly-connected impervious area (DCIA).

Drive around circle has a landscaped island, providing an area for infiltration.

The Crossings is located within walking distance to major commercial areas for groceries and other shopping needs, thereby reducing the need for auto use.

The Crossings
MU-1 (cont.)

Mixed use commercial businesses located within the Crossings encourage residents to walk to shops thereby reducing the reliance on motor vehicles.

Municipal Contact:
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Site Contact:
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Designer Contact:
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Other Opportunities:

- To improve the site design from a stormwater quality perspective, the island could have been designed to accept runoff from the street through such features as concave landscaping with pavement protection, curb cuts, and grading the street to drain to the island.

Santana Row
MU-2

Site Location:
360 South Winchester Blvd.
San Jose, CA

Features:

- Mixed-use high-density housing and regional commercial
- Encourages pedestrian activity and public use of outdoor space
- Preserved mature trees in redevelopment areas
- Use of multi-story buildings reduces building footprints
- Street trees

Stormwater Benefits:

- Transportation-related pollutant reduction
- Reduce impervious surface area
- Reduce volume and velocity of runoff

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Mixed-use, high-density multi-story housing combined with commercial areas, provide access to conveniences without the need to drive. Street trees have many benefits, including stormwater management.

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Shops conveniently located below housing units promote pedestrian activity.

Santana Row
MU-2 (cont.)

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Trees in place before redevelopment were maintained for the new residents to enjoy. Trees reduce the volume and velocity of rainwater.

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North Park
MU-3

Site Location:

155 & 175 River Oaks Parkway & 3491 Zanker Road
San Jose, CA

Features:

- High density housing near North First Street Light Rail Line
- Encourages pedestrian activity and public use of outdoor space
- Multi-story building reduces the building footprints

Stormwater Benefits:

- Reduced impervious surface area
- Transportation-related pollutant reduction

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Open space surrounding high density housing for residents to enjoy also provides good drainage areas.

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Commercial areas conveniently located below housing units promote pedestrian activity.

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Multi-story buildings reduce the amount of impervious surface.

North Park
MU-3 (cont.)

Photograph courtesy of Jenny Nusbaum (City of San Jose)

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Amader@irvinecompany.com

Light rail runs within walking distance, conveniently located behind the park and adjacent to housing.

Other Opportunities:

- Disconnected downspouts could have been drained to landscaping to break up directly connected impervious area.

SECTION V

Commercial

Agilent – Palo Alto
CO-1

Site Location:
395 Page Mill Road
Palo Alto, CA

Features:
- Detention basin with native vegetation along banks
- Parking lot vegetated swales
- Roof downspouts draining to landscaping
- Promotes alternative transportation by providing bike racks and lockers, an onsite bus stop, and carpool/vanpool parking
- Structured parking lot (2 levels with top level draining to rock filter bed).

The detention basin, known as "The Swale" by Agilent employees, provides stormwater collection and treatment for the parking areas, visual amenities for employees, and a visual buffer for the neighboring residential community.

Stormwater Benefits:
- Reduced impervious surface area
- Natural treatment of runoff
- Reduced volume and velocity of runoff
- Reduced transportation related pollutants
- Reduced directly-connected impervious area (DCIA)

The parking lot is graded to drain into vegetated swales, shown here, and the detention basin.

Storm drains from the parking lot enter the detention basin through drains like this one.

The detention basin has two outlets to protect against localized flooding and to ensure that the basin drains within 72 hours for vector control.

Bike racks and showers encourage employees to bike to work. Additional bike lockers and a bus stop are located at the Page Mill Road entrance.

Agilent encourages employees to carpool by providing designated car/van pool areas. Reducing vehicle trips traveled reduces the amount of pollutants such as hydrocarbons and brake pad dust released to the environment.

Runoff from this parking structure drains to the filter bed, described below. The two-story parking structure allows for roughly twice the number of vehicles for the same area of a typical surface parking lot, while allowing enough room on-site for the detention basin.

The runoff drains from the top of the parking structure to this rock filter bed for treatment and then to the storm drain system via the detention basin.

This rocky swale is used to slow and treat rooftop runoff before draining to the storm drain. A minimum two percent (2%) slope away from the building protects the building foundation from water damage.

Storm drains are clearly labeled with an educational “no dumping” message.

The detention basin collects water from the parking lot. The concrete edging protects the asphalt from water damage while the bumper stops help prevent cars from traveling over the vegetated swales.

Agilent – Palo Alto
CO-1 (cont.)

Lessons Learned:

- The irrigation heads originally installed for the retention basin caused some ponding for greater than 72 hours until they were modified to target areas requiring water. The local vector control agency brought mosquito fish for mosquito control while the irrigation challenge was being diagnosed and addressed.
- During the rainy cloudy days, the water in the parking lot catch basins may take longer than 72 hours to drain. Maintenance staff must periodically clean debris from catch basins.
- The detention basin has also served as a useful indicator for irrigation leaks for sprinklers within the parking lot biofilter landscaping. When maintenance staff sees ponded water in the detention basin during a dry spell, they investigate for potential leaks.
- The landscape service provider must carefully control the scheduling of irrigation system to prevent overwatering and water build up in the detention basin.
- Shredded bark was installed initially along the detention basin banks to hold the soils without clogging the system until vegetation became established.
- The site designer highly recommends checking after the first rain to make sure the entire system is working correctly. For the roof downspouts, the rainwater initially started pooling behind the header boards at the bottom of the roof downspouts. Notches cut in the header board ensure proper drainage away from building with a minimum 2% slope.
- Maintenance costs and effort are comparable to that for typical landscaping according to Agilent maintenance staff.

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(650) 752-5226
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(650) 752-5409

Pacific Shores Center
CO-2

Site Location:
1500 Seaport Boulevard
Redwood City, CA

Features:

- Multi-purpose detention basin and playing fields
- Second detention basin with cobble bottom
- Parking lot vegetated swales
- 3 miles of paved trails that are an extension of the Bay Trail

Stormwater Benefits:

- Reduced amount of impervious surface area
- Natural treatment of runoff
- Reduced volume and velocity of runoff
- Reduced directly-connected impervious area (DCIA)

This athletic field also serves as a detention basin. The basin is designed to fill up to a four-foot depth and drain within eight (8) hours.

Pacific Shores Center
CO-2 (cont.)

Photograph taken from: http://www.pacificshores.com/

This photograph offers an aerial view of baseball fields and detention basin.

Photograph taken from: http://www.pacificshores.com/

The multi-story buildings allow for vast landscaping that helps reduce the amount of runoff from the site.

Photograph taken from: http://www.pacificshores.com/

Aerial view of Pacific Shores Center shows an ideal area to enjoy the Bay Trail.

Parking lot dividers are used as infiltration areas with vegetated swales and trees. Boulders are used to prevent automobile encroachment across the swale.

The parking lot is graded to drain to these vegetated swales, planted with vegetation and trees. The swales were excavated and backfilled with imported sandy loam soil to increase porosity, and constructed with perforated sub-drains. The concrete strip protects the asphalt from water damage. This image was taken prior to grass establishment.

Pacific Shores Center
CO-2 (cont.)

Photograph courtesy of Bill Southard (DES, Architects and Engineers)

Cobbles along this detention basin run for several hundred feet to prevent channeling during high runoff.

Photograph courtesy of Bill Southard (DES, Architects and Engineers)

This photo shows the vegetated swale after the native vegetation has grown in.

Lessons Learned:

- Trees planted with only two (2) stakes for support in sandy loam soil within the vegetated swales blew over during a windstorm prior to root establishment. Using three (3) stakes per tree are now recommended.

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Agilent – Santa Clara
CO-3

Site Location:
5301 Stevens Creek Boulevard
Santa Clara, CA

Features:
- Roof garden
- Disconnected downspouts

Stormwater Benefits:
- Reduced impervious surface area
- Reduced volume and velocity of runoff

Large areas of vegetation are located on top of the second floor of the office building.

Photograph above courtesy of Scott Sidlow (Agilent).

The roof garden is located on the second floor of the Agilent building.

Trees are planted as part of the roof gardens.

Agilent – Santa Clara
CO-3 (cont.)

Rooftop runoff is directed to drain through the vegetation.

Exhaust vents for HVAC* systems are integrated into roof garden areas.

*HVAC = heating, venting, and air conditioning

Photograph above courtesy of Scott Sidlow (Agilent)

Another view of the roof garden shows a large shady tree that can reduce rainfall velocity and runoff.

Agilent – Santa Clara
CO-3 (cont.)

Lessons Learned:

- Leakage occurred due to roots penetrating the roof membranes, however after patching the barriers underneath the garden, leakage was prevented.
- The membrane integrity was also compromised by heavy vehicle traffic (for deliveries to the café on the roof garden level). The amount of deliveries was minimized to prevent more leaks.

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SGI/Google
CO-4

Site Location:
1600 Amphitheater Parkway
Mountain View, CA

Features:
- Green roof – entire ground level of complex including landscaped area is built above an underground parking lot
- Permeable pavement
- Native vegetation
- Multi-story buildings reduce building footprint
- Bike racks promote bicycle commuting

Stormwater Features:
- Reduced building footprint
- Natural treatment of runoff
- Transportation-related pollutant reduction
- Reduced velocity of runoff
- Reduced impervious surface area

The parking lot can be seen below the turf on the level above.

This tree in the parking lot grows up through an opening in the roof garden area. Trees and other vegetation help reduce the volume and velocity of rainwater.

This grassy rooftop area planted with trees reduces and provides some natural treatment of runoff.

SGI/Google
CO-4 (cont.)

Permeable pavement is used in this courtyard.

Permeable pavement and landscaped areas fill the courtyard on top of the parking structure.

Bike racks promote alternative transportation, perhaps providing easy access to other buildings on the campus.

Turf and gravel surrounds this pathway, providing an area for infiltration to occur.

SGI/Google
CO-4 (cont.)

Permeable pavement and native vegetation surround this multi-story complex.

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Site Contact:
Goldman Sachs Group, Inc.
(212) 902-4014

Stanford University Medical Center
CO-5

Site Location:
300 Pasteur Drive
Palo Alto, CA

Features:

- Roof garden above parking structure
- Street trees
- Native vegetation

Stormwater Benefits:

- Reduced impervious surfaces
- Natural treatment of runoff
- Reduces volume and velocity of runoff

Photograph courtesy of Joe Teresi (City of Palo Alto)

From this angle, it is possible to see the parking structure beneath the roof garden.

Photograph courtesy of Joe Teresi (City of Palo Alto)

This roof garden provides not only aesthetic benefits, but also a large area for stormwater infiltration to occur.

Photograph courtesy of Joe Teresi (City of Palo Alto)

At the end of the pathway, trees line the nearby street. The trees and the rooftop vegetation reduce the volume and velocity of stormwater runoff while providing for some natural treatment.

University Medical Center
CO-5 (cont.)

Photograph courtesy of Joe Teresi (City of Palo Alto)

The roof garden uses only one type of vegetation, which facilitates maintenance.

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(831) 659-3820
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Gap Corporate Headquarters
CO-6

Photograph courtesy of Paul Kephart (Rana Creek Habitat Restoration)

Aerial view of the building's roof garden shows the vegetative areas planted on top of the building made to appear like rolling hills.

Location:

901 Cherry Avenue
San Bruno, CA
Completed 1997
195,000 sq. ft.

Costs:

- Roof garden: approx. $24/sq.ft. ($1.6 million)[2]
- Total cost for building ~ $60 million

Stormwater Benefits:

- Reduced impervious surface area
- Natural treatment of runoff
- Reduced volume and velocity of runoff

Features:

- 69,000 sq. ft. green roof blends in with surrounding hillside grasslands
- Native grasses and wildflowers
- Natural day lighting
- Raised floor for individually-controlled air delivery
- Preserved grove of native oaks
- 2nd most energy-efficient building in California (exceeds requirements by 30%)
- Received a Green Roofs Award of Excellence in 2003.

[2] Paul Kephart estimates that the costs for green roofs have dropped to roughly $8-11 per square foot in the United States (pers. comm., November 12, 2003).

Gap Corporate Headquarters
CO-6 (cont.)

Project Details:

- It is estimated that the roof garden captures and stores about 70% of the rainfall. Other benefits include better insulation of the building, reducing the costs of heating and cooling, and mitigating the "heat island effect."
- The roof irrigation system and annual mowing help mitigate fire risks. The roof is irrigated once per year and mowed by 10 gardeners armed with "weed eaters" in early July. The clippings are left on the roof to provide nutrients for the vegetation.
- The roof membrane has a 40-year warranty against leakage.
- GIS is used to map and manage the roof garden, allowing the building owner to index plants and locate utilities, such as water and electrical lines for maintenance purposes.
- The roof was planted using live plugs of six (6) different types of grasses (as opposed to hydroseeding or hand broadcasting) in six (6) inches of soil. The vegetation has grown to form a 5-inch mat of fibrous roots.

Lessons Learned:

- Gap estimates that the cost of the roof, HVAC, lighting, and other environmental features will be repaid in cost savings from reduced energy and maintenance bills within eight (8) years.
- The roof provides an effective acoustic barrier from the nearby San Francisco Airport.
- Cost-benefit study shows annual maintenance costs are about 70% of the costs for a conventional roof.

For more information, go to: http://www.bayareacouncil.org/bp/bestpractices/bp185.html

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Mechanical, Electrical and Structural Engineers:
Ove Arup and Partners USA
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Client and Project Manager:
Gap Inc. Corporate Architecture Department
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San Bruno, CA 94066

Architect of Record/Interior Design:
Gensler Architecture, Design & Planning Worldwide
600 California Street
San Francisco, CA 94108

Landscape Architect:
Hargreaves Associates

Yahoo! Inc.
CO-7

Site Location:
701 First Avenue
Sunnyvale, CA

Features:
- Rocky swales
- Multi-story buildings reduce building footprint
- Access to the Bay Trail open space area including parking available for visitors
- Permeable walkways

Stormwater Benefits:
- Natural treatment of runoff
- Reduced impervious surface area
- Reduced directly-connected impervious area (DCIA)

This rocky swale has a storm drain for excess flows.

Rocky swale with curb cuts allows for infiltration to occur.

Rectangular stones are used to create a rocky swale.

Yahoo! Inc.
CO-7 (cont.)

Pervious walkways used to minimize impervious surfaces.

On-site parking is provided for visitors to the Bay Trail (located behind the Yahoo! Campus).

This walkway slopes toward landscaped vegetation; with multi-story buildings in background.

Pervious walkways used between concrete sidewalks.

Yahoo! Inc.
CO-7 (cont.)

Curb cuts (see arrow) allow runoff to drain off parking lot into the vegetation.

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Juniper Networks
CO-8

Site Location:
1194 N. Mathilda Avenue
Sunnyvale, CA

Features:
- Multi-story buildings reduce building footprint
- Rocky swales and trees in parking lot
- Rooftop runoff drains to landscaping
- Promotes alternative transportation
- Permeable pavement
- Located buildings to protect existing heritage tree

Stormwater Benefits:
- Reduced impervious surface area
- Reduced transportation-related pollutants
- Natural treatment of runoff
- Reduced volume and velocity of runoff
- Reduced directly-connected impervious area (DCIA)

This pathway made of pervious pavers allows infiltration through the sand filled crevices. Also, these benches are provided on pervious surfaces.

Runoff from rooftop drains into landscaping reducing the directly-connected impervious area (DCIA).

Parking lot runoff drains through curb cuts and then filters through the rocky swale. Trees provide visual amenities as well as reduce the volume and velocity of runoff.

Juniper Networks
CO-8 (cont.)

The convenience of the Light Rail Station across the street encourages employees to take public transportation to work.

Charging stations allow employees with electric vehicles, like the Sparrow pictured here, to charge-up while at work.

Plenty of carpool parking encourages employees to share rides to work.

Covered bike racks are provided for employees who prefer to ride their bicycles to work.

Juniper Networks
CO-8 (cont.)

An existing oak tree was preserved in the development of this project.

Lessons Learned:

- During storms, ponding does occur in parking lots. This can be prevented through better design and construction of the rocky swales to ensure that the infiltration rate of the swale is fast enough to prevent ponding, or by adding a perforated drainage pipe for runoff overflow. It is also important that the site is graded properly to direct water toward the swale.

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Porter Drive
CO-9

Site Location:
3150 Porter Drive
Palo Alto, CA

Features:
- Vegetated swale
- Native vegetation

Stormwater Benefits:
- Natural treatment of runoff
- Reduced volume of runoff
- Reduced velocity of runoff
- Reduced pesticide requirements
- Reduced directly-connected impervious area (DCIA)

Photograph courtesy of Joe Teresi (City of Palo Alto)

The bioswale, shown before landscaping had fully matured, was planted using native vegetation along the banks. Check dams extend the retention time, allowing for additional infiltration (see arrows).

Photograph courtesy of Joe Teresi (City of Palo Alto)

The same bioswale, after landscaping has become established, appears natural and aesthetically pleasing.

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Brian Kangas Foulk
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Porter Drive
CO-9 (cont.)

Site Location:
3170 Porter Drive
Palo Alto, CA

Features:
- Pervious pavement
- Vegetated swale

Stormwater Benefits:
- Natural treatment of runoff
- Reduced impervious surface area
- Reduced directly-connected impervious area (DCIA)

Photograph courtesy of Joe Teresi (City of Palo Alto)

The parking area, adjacent to heritage oak trees, is made of permeable pavement which decreases the amount of impervious surface area at the site.

Photograph courtesy of Joe Teresi (City of Palo Alto)

The edges of the vegetated swale are flush with the parking lot, so that runoff can drain into the swale.

Photograph courtesy of Joe Teresi (City of Palo Alto)

This is a close-up photograph of the permeable pavers in the parking stalls.

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Porter Drive
CO-9 (cont.)

Site Location:
3180 Porter Drive
Palo Alto, CA

Features:
- Unit pavers of Ecostone on sand
- Vegetated swale

Cost of Ecostone Pavement:
- $9-15/s.f. for installation

Stormwater Benefits:
- Reduced impervious surface area

Photograph courtesy of Joe Teresi (City of Palo Alto)

This photo shows the construction of the permeable pavement in the parking area. The spaces between pavers are filled with sand instead of grouted, allowing infiltration through the pavement. The concrete border (see arrow) protects the asphalt from water damage.

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Hillview
CO-10

Site Location:
3300 Hillview
Palo Alto, CA

Features:
- Parking lot biofilters
- Commercial building courtyard with pervious pavement
- Courtyard also serves a buffer between multi-story building and the creek behind
- Section of parking lot drains to swale of native plants between courtyard and riparian area
- Buildings set back from riparian corridor

Stormwater Benefits:
- Reduced impervious surface area
- Natural treatment of runoff
- Reduced runoff velocity
- Setback from riparian corridor
- Reduced directly-connected impervious area (DCIA)

Pervious pathway placed through the courtyard allows easy access for visitors as well as drainage areas for stormwater. The creek runs behind the trees towards the back. Between the trees and the benches is a swale of native vegetation that treats water from the parking lot.

The parking lot design incorporates biofilters to filter and infiltrate runoff before entering the storm drain. Concrete edging protects the asphalt parking lot from water damage.

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Site Contact:
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Legacy Tech Park
CO-11

Site Location:

Gold Street and Hwy 237 (in Alviso)
San Jose, CA

Features:

- Vegetative swales
- Curb cuts
- Rock cobbles to prevent erosion

Stormwater Benefits:

- Natural treatment of runoff
- Reduced volume and velocity of runoff

Photograph courtesy of Mike Campbell (RBF Consulting)

Grassy swale drains toward storm drain after filtering runoff.

Photograph courtesy of Mike Campbell (RBF Consulting)

The vegetative swales at this site are one of San Jose's first examples in an industrial park, and are very well maintained.

Photograph courtesy of Mike Campbell (RBF Consulting)

Curb cuts allow runoff water to drain toward rock cobbles, then into the vegetated areas. The cobbles help prevent the runoff from eroding the soil and vegetation where the water runs from the parking lot into the swale.

Legacy Tech Park
CO-11 (cont.)

Photograph courtesy of Mike Campbell (RBF Consulting)

The curb cut allows runoff from the fire lane to enter the concave turf swale for natural treatment. The cobbles help prevent soil erosion.

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Pruneyard Towers
CO-12

Site Location:
1999 W. Campbell Avenue
Campbell, CA

Feature:
- Trees in structural soils

Stormwater Benefits:
- Reduced volume of runoff
- Reduced velocity of runoff

Photograph courtesy of Dave Dockter (City of Palo Alto)

Trees in structural soils frame the entrance to the Pruneridge Tower. These trees not only reduce the volume and velocity of rainwater, but the structural soil helps prevent pavement damage.

Photograph courtesy of Dave Dockter (City of Palo Alto)

A variety of top-dressing and landscape designs may be used. Colorful planting, irrigation and injection capability were built into this structural soil installation.

Pruneyard Towers
CO-12 (cont.)

Photograph courtesy of Dave Dockter (City of Palo Alto)

As an experiment, London plane trees from the same nursery and grow lot were planted in structural soil in 1999 (shown above) as well as in traditional tree pits (shown to the right). After 3.5 years, the trees above are over 30 feet tall providing more canopy to absorb the impact of and to collect rainwater.

Photograph courtesy of Dave Dockter (City of Palo Alto)

These trees are not yet 20 feet tall and are developing at a much slower rate.

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Santa Clara University
CO-13

Site Location:
500 El Camino Real
Santa Clara, CA

Features:
- Turf block fire lanes are used throughout the campus for fire access.
- A few streets have been diverted and replaced with landscaping. To maintain proper fire access, turf block fire lanes have been installed.
- Multi-story buildings reduce building footprint.

Stormwater Benefits:
- Reduced impervious surface area
- Reduced volume and velocity of runoff

Design Specifications:
- Turf block must withstand 76,000 pounds of gross weight and 20 feet in width for fire trucks (with risers)
- Maintenance performed by Santa Clara University (SCU)

Here the sidewalk and turf block with grass is used for fire access. The arrows point to concrete blocks that mark the extent of the turf block areas.

Concrete blocks mark the fire lanes throughout campus (also see photograph to left).

Santa Clara University
CO-13 (cont.)

This street used to extend directly through campus. Now the sidewalk and turf block is used for fire access while providing more areas for infiltration and aesthetic value.

Concrete blocks mark the turf block fire lane so that fire trucks can drive along the proper area without sinking. "No Parking" signs and red curbs help denote the fire lanes. Note that the nearest tree will need to be relocated to maintain the necessary width.

The fire lane here uses both the sidewalk and turf block for access. Bollards can be removed for emergency access.

Multi-story dormitories reduce the building footprint size and thereby decrease impervious surface area. Turf block allows emergency access to these dormitories.

Santa Clara University
CO-13 (cont.)

This street, which extended through the university, was redirected and replaced with turf block and sidewalks for fire access.

This sidewalk also provides emergency vehicle access. The fire lane continues on through the shrubs onto the turf block.

Lessons Learned:

- Periodic inspection of fire lanes and training is important to remind SCU staff not to place obstacles in fire lanes (e.g., trees, garbage bins, oversized shrubs).

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Middlebrook Gardens
CO-14

Site Location:

SE corner of W. Julian Street and Pleasant Street
San Jose, CA

Features:

- Office complex redeveloped from relocated and restored turn-of-the century homes from the surrounding neighborhood
- Project objective was to create zero runoff
- Multiple types of pervious pavements

Stormwater Benefits:

- Reduced impervious surface area
- Reduced volume of runoff

Photograph courtesy of Mike Campbell (RBF Consulting)

This walkway is constructed of decomposed granite, which promotes infiltration.

Photograph courtesy of Mike Campbell (RBF Consulting)

Brick courtyard is not grouted to allow runoff to seep through the bricks.

Photograph courtesy of Mike Campbell (RBF Consulting)

The parking lot is made completely of Gravel-Pave porous pavement, minimizing the amount of impervious surface onsite.

Middlebrook Gardens
CO-14 (cont.)

Photograph courtesy of Mike Campbell (RBF Consulting)

This is a close-up view of the Gravel-Pave driveway made up of a plastic framework of open cells (circles) filled with gravel.

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Landscaping Contact:
Middlebrook Gardens
76 Race Street, San Jose
(408) 292-9993

Residence Inn
CO-15

Site Location:
4460 El Camino Real
Los Altos, CA

Features:

- Turf block fire lane provides access for fire crews to the rear of the hotel.

Stormwater Benefits:

- Reduced impervious surface area.

Grass covers the turf block lane used for fire access, while reducing the overall impervious surface area for site.

Landscaping provides an aesthetically pleasing area for people to enjoy while also functioning as a fire lane.

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Site Contact:
General Hotel Information
Marriott's Residence Inn
(650) 559-7890
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Intel
CO-16

Site Locations:

2200 Mission College Boulevard
Santa Clara, CA

Features:

- Reserved landscaped parking
- Gravel reserved parking areas allow for infiltration to occur.
- Multi-story buildings and parking garages reduce building footprint

Stormwater Benefits:

- Reduced impervious surface area

A section of a 1996 Site Map shows area in which landscaping was used in a parking area being reserved for future potential growth.

The area indicated in the map (shown at left) has since been converted into these parking spaces that were developed when parking area renovations were required for terrorism safety precautions.

Intel
CO-16 (cont.)

This off-site gravel lot is designated for overflow parking and allows infiltration to occur during the rainy season.

Municipal Contact:
Judith Silva
City of Santa Clara
(408) 615-2456
jsilva@ci.santa-clara.ca.us

Designer Contact:
Ken Kay & Associates
Landscape Architecture and Urban Planning
(415) 956-4472
kenkay@kenkaysf.com

Site Contact:
Mark Pettinger
Intel
(408) 765-4970
mark.w.pettinger@intel.com

Lessons Learned:

- Reserved landscaped areas can be used as a mitigating tool to help assuage fiscal lender fears when proposing site designs with reduced parking ratios. Although this reserved area was ultimately converted to pavement, temporary benefits occurred while the area was landscaped, and might still be occurring if not for extenuating circumstances.

Opportunities Missed:

- When the parking area was renovated, permeable pavement could have been used for the outlying parking stalls.

SECTION VI

PUBLIC AREAS

Santa Clara Valley Water District Headquarters
PA-1

Site Location:
5700 Almaden Expressway
San Jose, CA

Features:
- Parking lot swales
- Rooftop downspouts drain to landscaping
- Multi-story building allows reduced building footprint

Stormwater Benefits:
- Reduced impervious surface area
- Reduced directly-connected impervious area (DCIA)
- Natural treatment of runoff

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Rooftop runoff drains to landscaping, breaking up directly-connected impervious area (DCIA).

Municipal Contact:
Jenny Nusbaum
City of San Jose
(408) 277-4576
Jenny.Nusbaum@sanjoseca.gov

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Multi-story building allows room for ample landscaping onsite for rooftop drainage and aesthetics.

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Vegetative swales within the parking lot collect drainage through curbside gaps. Concrete curb protects asphalt.

Site Contact:
Patrick Stanton
Santa Clara Valley Water District
(408) 265-2607 x2029
pstanton@valleywater.org

Swale Vegetation Contact:
Rick Austin
Vegetation Specialist
Santa Clara Valley Water District
(408) 265-2607 x3861

West Valley Branch Library
Green Building
PA-2

Site Location:

1243 San Tomas Aquino Road
San Jose, CA

Features:

- Green building based on United States Green Building Council and Leadership in Energy and Environmental Design rating
- Decomposed granite used for pedestrian paved areas

Stormwater Benefits:

- Reduced impervious surface area
- Reduced directly-connected impervious area (DCIA)
- Natural treatment of runoff

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Ample landscaping onsite allows for infiltration of rooftop drainage.

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Rooftop runoff drains to downspouts that drain to landscaping reducing directly-connected impervious areas (DCIA).

Photograph courtesy of Jenny Nusbaum (City of San Jose)

Pedestrian walkway created with decomposed granite.

Valley Branch Library
Green Building
PA-2 (cont.)

Site and Municipal Contact:
Domenic Onorato
City of San Jose
(408) 277-4777
Domenic.Onorato@sanjoseca.gov

This artichoke fountain serves as an aesthetic drainage conduit for rooftop runoff to the storm drain system.

Other Opportunities:

- Instead of leading directly to the storm drain system, fountains could be designed to recirculate the water, or to drain to landscaping surrounding the fountain to disconnect impervious surface areas.

Palo Alto Trees and Structural Soils
PA-3

Site Location:
Various Locations
Palo Alto, CA

Features:
- Structural soils
- Street trees

Stormwater Benefits:
- Reduced volume and velocity of runoff

Costs:
- Majority of cost is to remove existing soil
- Approximately $30/cubic yard
- Cost savings for reduction in pavement maintenance
- Estimated savings of $7/tree yearly for stormwater runoff reduction

Structural Soil Components:
- 70-75% crushed granite stone
- 25-29% clay loam soil
- 0.03% hydrogel
- Other soil amendments

Photograph courtesy of Dave Dockter (City of Palo Alto)

Bryant Street: Roots growing in a planter strip eventually cause repetitive damage to hard surfaces such as the sidewalk near this tree related. Sidewalk repairs can cost a city hundreds of thousands of dollars per year.

Photograph courtesy of Dave Dockter (City of Palo Alto)

University Avenue: The use of structural soil allows the planting of large shade trees in narrow medians where the tree planting area would otherwise conflict with infrastructure. The large tree canopies reduce the amount of rainwater reaching the street. The trees absorb much of the force of the rainfall, allowing for reduced velocity of runoff entering the storm drain system. Reduced velocities can result in less stream erosion or scouring at the outfalls.

Photograph courtesy of Dave Dockter (City of Palo Alto)

999 Alma Street: A green-building technique using engineered structural soil under pavers encourages rapid growth of trees and roots with a minimum of damage to the parking lot.

Photograph courtesy of Dave Dockter (City of Palo Alto)

390 Lytton Avenue: On the surface, this appears as a typical planting pit. Below surface, over 1,200 cubic feet of Structural Urban Tree Soil Mix (per tree) will help large shade trees grow for at least 40 years. The structural soil allows the roots to grow down, protecting nearby pavement, and also infiltrates stormwater. The engineered soil provides enough strength for load-bearing surfaces such as the roadway and sidewalk pictures above.

Photograph courtesy of Dave Dockter (City of Palo Alto)

Hillview Avenue: A vegetated swale at the Tibco campus is surrounded by parking spaces with a new lattice base material, providing the young London plane and Chinese pistache trees a larger root growing volume.

Photograph courtesy of Dave Dockter (City of Palo Alto)

Stanford University: This 20-foot-wide pedestrian connector is lined with trees that should produce a long-term shade-covered canopy. The entire area is installed with structural soil to a 24” depth.

Palo Alto Trees and Structural Soils
PA-3 (cont.)

Lessons Learned:

- Trees with extensive root systems have damaged streets and sidewalks, costing cities a lot of money to repair. By installing structural soils, this can be prevented, because root systems can be directed to grow down and away from the pavement.
- Tree growth is limited by the amount of space the roots have to grow. Structured soils can be installed under the paved areas, creating a larger area for the roots to grow. This allows trees to grow to medium or large shade trees, improving aesthetics, as well as decreasing the amount and velocity of rainwater runoff.
- In the Alma Street example, although the parking lot trees are growing without problems related to the lot's infrastructure, there have been many replacements of tree guards due to automobile accidents. In the future, trees may be designed outside of the main parking areas, where the tree will may be better protected.
- Large trees, and evergreen trees provide better stormwater benefit than deciduous trees because most precipitation in the Santa Clara Valley occurs in the winter.
- Based on studies in Modesto, CA and coastal Southern California, the City of Palo Alto estimates it is receiving a stormwater benefit from reduced runoff of $7/tree annually for each of its 30,000 street trees, or $210,000 per year.

References:

Dockter, Dave, "Structured Soils for Improved Landscaping: Examples from the City of Palo Alto," SCVURPPP: Overcoming Hurdles to Using Better Site Designs Workshop. January 29, 2004.

Lii, Jane, "Palo Alto trades old ground for tony topsoil," San Jose Mercury News, July 24, 1999.

Municipal Contact:
Dave Dockter, Managing Arborist
City of Palo Alto
(650) 617-3145
dave.dockter@cityofpaloalto.org

North Bay Shore Area Project
PA-4

Site Location:
Off Stierlin Court (Private facility)
Mountain View, CA

Features:
- Multi-purpose flood control detention basin and athletic field

Stormwater Benefits:
- Reduced peak flows
- Natural treatment of runoff

Note:
- This site is adjacent to a City flood control basin and pump station and Stevens Creek.

Storm drain shown on the field.

Nearby office workers can enjoy picnic area.

Panoramic view of the athletic field that provides detention for the area.

Municipal Contact:
Eric Anderson
City of Mountain View
(650) 903-6225
Eric.Anderson@ci.mtnview.ca.us

Site Contact:
Equity Office
(408) 969-0346

Silver Creek Valley Road
PA-5

Site Location:

Silver Creek Valley Road between
Hwy. 101 and Hellyer Avenue
San Jose, CA

Features:

- Vegetative swales
- Street trees

Stormwater Benefits:

- Natural treatment of runoff
- Reduced volume and velocity of runoff
- Reduced directly-connected impervious area (DCIA)

Photograph courtesy of Mike Campbell (RBF Consulting)

This parking lot has curb cuts in order for the water to drain from the parking lot into the vegetative swale.

Photograph courtesy of Mike Campbell (RBF Consulting)

The street serving this industrial campus area is graded to drain to the swale, providing adequate slope for proper drainage. The flush concrete curb protects the asphalt from water damage.

Photograph courtesy of Mike Campbell (RBF Consulting)

When swales are designed to include trees, locating the trees on the banks of the swale, as shown in this photograph, is recommended. Otherwise, the trees may become over-saturated, or their roots may create high areas at the bottom of the swale that could impact the swale's performance.

Silver Creek Valley Road
PA-5 (cont.)

Photograph courtesy of Mike Campbell (RBF Consulting)

This is another grassy swale with street trees. Trees that maintain their canopies during the wet months provide greater stormwater benefit than deciduous trees.

Municipal Contact:
Jenny Nusbaum
City of San Jose
(408) 277-4576
Jenny.Nusbaum@sanjoseca.gov

Sand Hill Road
PA-6

Site Location:
Sand Hill Road
Palo Alto, CA

Features:
- Roadside bioswales
- Curb cuts

Stormwater Benefits:
- Natural treatment of runoff
- Reduced volume and velocity of runoff
- Reduced directly-connected impervious area (DCIA)

Construction Cost for Bioswale:*
- $80/linear foot for 4,000 linear ft. ($320,000 total)

Photograph courtesy of Joe Teresi (City of Palo Alto)

Designed swale shown before landscaping has fully grown in.

Photograph courtesy of Joe Teresi (City of Palo Alto)

Curbside gaps allow runoff to drain off street into the swale.

Photograph courtesy of Joe Teresi (City of Palo Alto)

Vegetation has grown in on the swale. Swale is wide enough that mowing and regular maintenance is not difficult.

* The street borders Stanford University, which paid for the improvements.

Sand Hill Road
PA-6 (cont.)

Photograph courtesy of Joe Teresi (City of Palo Alto)

Municipal Contact:
Joe Teresi
City of Palo Alto
(650) 329-2129
Joe.Teresi@cityofpaloalto.org

Designer Contact:
Dave Richwood
Brian-Kangas-Foulk
(408) 467-9100
drichwood@bkf.com

Storm drain inlet shown up close in swale.

Lessons Learned:

- Make curb cuts wider.
- The roadside bioswale is most useful for stretches of road without driveways that would interrupt the swale.

Baylands Parking Lot
PA-7

Site Location:

East end of Embarcadero Road
(Adjacent to PA Sailing Station)
Palo Alto, CA

Features:

- Bioswales
- Non-petroleum paving materials

Stormwater Benefits:

- Natural treatment of runoff
- Reduced directly-connected impervious area (DCIA)

Note:

- The bioswale was under construction at the time these photographs were taken (November 13, 2003).

The filtered runoff drains into this storm drain at the downstream end of the swale.

The bioswale surrounds the parking lot, providing runoff treatment before it drains to the storm drain.

Parking lot is graded so that runoff drains into the swale.

Municipal Contact:
Joe Teresi
City of Palo Alto
(650) 329-2129
Joe.teresi@cityofpaloalto.org

Ulistac Natural Area (Guadalupe River) PA-8

Site Location:
Lick Mill Boulevard
at Tasman Drive
Santa Clara, CA

Features:

- Provides natural buffer area between the Guadalupe River and urbanized areas
- The City removed existing buildings to put in pocket parks and to restore natural preserve areas
- Provides habitat for flora and fauna
- Promotes community outdoor educational activities including volunteering with restoration efforts

Stormwater Benefits:

- Riparian buffer
- Reduced impervious surface area
- Open space benefits

Photograph courtesy of the Ulistac Natural Area Community Habitat Restoration Project

Trees and open space provide permeability for stormwater runoff, wildlife habitat, and a buffer area for the Guadalupe River.

Photograph courtesy of the Ulistac Natural Area Community Habitat Restoration Project

This 40-acre nature area, preserved on January 20, 1997, by the City of Santa Clara, attracts many birds.

Photograph courtesy of the Ulistac Natural Area Community Habitat Restoration Project

Wilcox High School students spend the day in the nature area and help with the restoration efforts by weeding.

Ulistac Natural Area
(Guadalupe River)
PA-8 (cont.)

Photograph courtesy of the Ulistac Natural Area Community Habitat Restoration Project

A bird sits on the vegetation at the Ulistac Natural Area, which once served as a pear orchard and golf course.

Municipal Contact:
Judith Silva
City of Santa Clara
(408) 615-2456
jsilva@ci.santa-clara.ca.us

Site Contact:
Kelly Crowley,
Outreach Coordinator
kcrowley@scu.edu
(408) 554-5419
http://www.scu.edu/envs/ulistac/

Saratoga Trails
PA-9

Site Locations:
Saratoga, CA

Features:
- Pedestrian and bike access trails created as part of subdivisions

Stormwater Benefits:
- Reduces transportation-related pollutants (promotes alternative transportation)
- Reduced impervious surface area
- Open space benefits

Photograph courtesy of Ann Welsh (City of Saratoga)

This trail is located on Prospect Road between Beauchamp Lane and Parker Ranch Road and provides open areas for pedestrians to enjoy.

Photograph courtesy of Ann Welsh (City of Saratoga)

This pathway located on Villa Oaks land east of the intersection with Deer Trail Court, provides access for people to hike or bike into the hills beyond the houses.

Municipal Contact:
Ann Welsh
City of Saratoga
(408) 868-1230
awelsh@saratoga.ca.us

San Tomas Aquino-Saratoga Creek Trail
PA-10

Site Location:

Sterling Boulevard at Barnhart
Cupertino, CA

Features:

- Pedestrian and bike bridge allows access

Stormwater Benefit:

- Reduced transportation-related pollutants

Notes:

- This section of the creek trail will eventually connect to the regional trail system.

The San Tomas Aquino-Saratoga Creek Trail allows for people to go for a walk or run near the creek.

The pathway provides access for locals to take advantage of the creek trail in their neighborhood. The trail promotes alternative transportation by providing convenient access for pedestrians and bicyclists.

Pathway leads to bridge that crosses creek to the San Tomas Aquino-Saratoga Creek Trail.

Municipal Contact:
Carmen Lynaugh
City of Cupertino
(408) 777-3354
carmenl@cupertino.org

Santa Cruz Avenue
PA-11

Site Location:

Santa Cruz Avenue
Los Gatos, CA

Features:

- Pedestrian activity
- Bike activity
- Bulbouts at crosswalks
- Street trees

Stormwater Benefits:

- Reduced transportation-related pollutant
- Reduced volume and velocity of runoff

Lessons Learned:

- Pedestrian vehicle accident rate has dropped significantly since the road was narrowed.

Among the many benefits of street trees are the reduction of the volume and velocity of stormwater runoff and aesthetic value.

Bulbouts at crosswalks encourage pedestrian activity by resulting in slower traffic speeds and by providing shorter distances across traffic lanes for improved pedestrian safety.

Bike lanes on streets adjacent to Santa Cruz Avenue help promote alternative transportation to the downtown area.

Municipal Contact:
Trish Duarte
Town of Los Gatos
(408) 399-5771
tduarte@losgatosca.gov

Bike Station Project
PA-12

Site Location:

Palo Alto Caltrain Station
95 University Avenue
Palo Alto, CA

Features:

- Promotes several modes of alternative transportation including bicycles, the Caltrain commuter rail, Santa Clara County and Sam Mateo County bus lines (SamTrans and VTA), Dumbarton Express, the Palo Alto Free Shuttle and Stanford University Marguerite shuttle lines.
- Attended bicycle parking– Free during regular business hours.
- Bicycle lockers for after-hours parking
- Bicycle repairs and sales
- Bicycles rentals – Offered by the hour for short commute trips or leisure rides.

Stormwater Benefits:

- Reduced transportation-related pollutants.

Photograph courtesy of Amanda Jones (City of Palo Alto)

Bike lockers store bikes, a service that is free during regular business hours. The Bike Station project currently serves about 50 commuters per day.

Photograph courtesy of Amanda Jones (City of Palo Alto)

The Bike Station provides not only free valet parking, but also coffee and bikes for sale.

Bike Station Project
PA-12 (cont.)

Photograph courtesy of Amanda Jones (City of Palo Alto)

The City of Palo Alto and its sponsors provide this service to local commuters.

Photograph courtesy of Amanda Jones (City of Palo Alto)

Commuters can take their bicycles on the Caltrain and bike from the Caltrain station to and from work and/or home.

Photograph courtesy of Amanda Jones (City of Palo Alto)

This Bike Station employee tags the bicycle for storage in the bike lockers, while the commuter takes an alternate mode of transportation to her destination.

Municipal Contact:
Amanda Jones
City of Palo Alto
(650) 329-2568
amanda.jones@cityofpaloalto.org

Site Contact:
Bike Station
(650) 327-9636 (Tel)
(650) 328-0323 (Fax)
http://www.bikestation.org

Bike Station Project
PA-12 (cont.)

Other:

- The City of Palo Alto also provides a $20/month benefit to encourage City of Palo Alto employees to ride bicycles to work, and provides bicycle education classes to the public.
- The City of Palo Alto Alternative Transportation Coordinator is available to consult, free of charge, with local employers and residents for all transportation demand management programs.

SECTION VII

INDEXES

INDEX
Site Design Examples by Best Management Practice

Better Site Design Techniques	Alternative Transportation - Carpool/Vanpool/Electric Vehicle	Alternative Transportation - Bicycling	Alternative Transportation - Pedestrian	Alternative Transportation - Public	Clearly Marked Storm Drain Inlets	Detention Basin	Disconnected Downspouts	Landscaped Cul-de-sac	Riparian/Bay Buffer Area	Reduced Building Footprint (Multi-story Buildings)	Narrow Streets	Native Plants	Open Space Areas	Permeable Pavement	Rocky Swale	Rooftop Landscaping/Green Roof	Minimize DCIA	Shared Driveway	Tree Preservation	Tuck Under Parking	Turf Block Fire Lane	Vegetative Swale/Biofilter	Other (Describe)	
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	CO-7	CO-2	CO-4	MF-4		CO-2	CO-8	SF-4	CO-10	CO-2	SF-1	CO-5	CO-8	CO-7	CO-7	CO-4	CO-2	SF-3	CO-12	MF-8	CO-15	CO-2	MF-3	Shared car wash area
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* This indicates the page number in *Start at the Source* that may provide additional information on the Site Design technique listed.

Site Design Examples by Municipality

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- **CO-12:** Pruneyard Towers
- **MF-8:** Shelley Avenue 2
- **SF-3:** Shelley Avenue 1

B. City of Cupertino
- **PA-10:** San Tomas Aquino-Saratoga Creek Trail

C. City of Los Altos
- **CO-15:** Residence Inn

D. Town of Los Gatos
- **PA-11:** Santa Cruz Avenue

E. City of Mountain View
- **CO-4:** SGI/Google
- **MU-1:** The Crossings
- **PA-4:** North Bay Shore Area Project
- **SF-2:** Dana Street
- **SF-4:** Ortega Avenue
- **SF-5:** Bourbon Court

F. City of Palo Alto
- **CO-1:** Agilent – Palo Alto
- **CO-5:** Stanford University Medical Center
- **CO-9:** Porter Drive
- **CO-10:** Hillview Avenue
- **MF-3:** Stanford West
- **PA-3:** Palo Alto Trees and Structural Soils
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- **PA-12:** Bike Station Project

G. City of San Jose
- **CO-11:** Legacy Tech Park
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H. City of Santa Clara
- **CO-3:** Agilent – Santa Clara
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I. City of Saratoga
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- **CO-2:** Pacific Shores Center
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