STANDARD URBAN STORM WATER MITIGATION PLAN (SUSMP)

FOR

TORRANCE SHOPPING CENTER

19330 HAWTHORNE BLVD.

TORRANCE, CA

Prepared for

19330 HAWTHORNE LLC.
915 Wilshire Blvd., Suite 2200
Los Angeles, CA 90017
Steve Shaul, Senior Manager, Investment
(213) 553-2200

Prepared By:

DRC ENGINEERING, INC.
160 South Old Springs Road, Suite 210
Anaheim Hills, CA 92808
(714) 685-6860
Lawrence Mitchell Gates P.E., President

Project No. 10-257

January 20, 2012

OWNER'S CERTIFICATION

STANDARD URBAN STORMWATER MITIGATION PLAN (SUSMP) FOR TORRANCE SHOPPING CENTER

This Standard Urban Stormwater Mitigation Plan (SUSMP) has been prepared for Regency Centers by DRC Engineering, Inc. for the project site known as the Torrance Shopping Center, at 19330 Hawthorne Blvd., in the City of Torrance, County of Los Angeles, state of California. The SUSMP is intended to comply with the requirements of the City of Torrance, Public Works Department, Engineering Division, requiring the preparation of a Standard Urban Stormwater Mitigation Plan (SUSMP).

The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with the County's Manual for Standard Urban Stormwater Mitigation Plan (SUSMP) and the intent of the non-point source NPDES Permit for Waste Discharge Requirements for the County of Los Angeles, Los Angeles County Flood Control District and the incorporated Cities of Los Angeles County within the Los Angeles Region Stormwater Runoff Management Program. Once the undersigned transfers its interest in the property, its successors-in-interest shall bear the aforementioned responsibility to implement and amend the SUSMP. An appropriate number of approved and signed copies of this document shall be available on the subject site in perpetuity.

Signed: _____

Name: Steve Shaul

Title: Manager, Investments

Company: Regency Centers

Address: 915 Wilshire Boulevard, Suite 2200. Los Angeles, CA 90017

Telephone #: (213) 553-2270

Date: 2/1/12

STATEMENT OF UNDERSTANDING
STANDARD URBAN STORMWATER MITIGATION PLAN (SUSMP)
FOR TORRANCE SHOPPING CENTER

As the Civil Engineer of Record for the project, I have reviewed the 'Development Planning for Storm Water Management - A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), and have proposed the implementation of the permanent Best Management Practices (BMPs) applicable to effectively minimize the negative impacts of the project's stormwater runoff. The selected BMPs will be installed per the approved plans and as recommended by the product manufacturer as applicable.

Signed: _____

Name: Lawrence Mitchell Gates, P.E

Title: President

Company: DRC Engineering, Inc

Address: 160 South Old Springs Road, Suite 210

Telephone #: (714) 685-6860

Date: _____

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Section 100 Discretionary Permit(s) and Water Quality Conditions

INTRODUCTION

In accordance with the General Permit issued under the National Pollutant Discharge Elimination System (NPDES) and adopted by the California State Water Resources Control Board (CSWRCB) in August 1999 (CAS000002), this Standard Urban Stormwater Mitigation Plan has been developed to meet the following objectives:

- Identify pollutant sources that could affect the quality of storm water discharges.
- Identify non-storm water discharges.
- Identify, construct, and implement Best Management Practices (BMPs) to reduce pollutants in storm water discharges from the site after construction.
- Develop a maintenance schedule for BMPs designed to reduce or eliminate pollutants after construction is completed (post-construction BMPs).

Preparation of this Standard Urban Stormwater Mitigation Plan (SUSMP) is required by the City of Torrance and shall comply with the Los Angeles County Storm Water Program supplementing the Standard Urban Stormwater Mitigation Plan (SUSMP) and the Report of Waste Discharge (ROWD) adopted by the County of Los Angeles. The Program, SUSMP, and ROWD are part of a countywide storm water pollution control effort adopted to comply with the National Pollution Discharge Elimination System (NPDES) General Permit adopted by the California State Water Resources Control Board.

The objective of this SUSMP is to identify pollutant sources associated with business operations that may affect the quality of discharges of storm water from the site and to specify storm water pollution prevention measures to reduce potential pollutant discharges. These prevention measures are referred to as Best Management Practices or BMPs. Non-Structural BMPs include such practices as spill prevention, outdoor loading/unloading, waste handling and disposal, and drainage system maintenance. Structural BMPs may include infiltration trenches/basins, grass swales, proprietary control measures, and similar mechanisms as deemed appropriate.

Section 200 Project Description

PROJECT INFORMATION

Owner:	Regency Centers
Site Address:	19330 Hawthorne Blvd, Torrance, CA
City/State	Los Angeles, California
Project Area:	8.5± acres
Proposed Use:	Commercial

LOCATION

As shown on the Location Map in Attachment A, the project site is located in the City of Torrance, County of Los Angeles, State of California. The site is situated on the east side of Hawthorne Boulevard, south of the intersection of 190th Street and Hawthorne Boulevard.

SITE PLAN

The Torrance Shopping Center is an existing 8.5 acre shopping area located within a larger shopping center, and is bounded to the north and east by existing industrial uses, to the west by Hawthorne Boulevard and residential areas, and to the south by an existing shopping center. The shopping center consists of one large retail tenant, paved drive aisles and parking, and landscaped areas. One new building pad is proposed, and the demising of the one large building into three tenant spaces. One driveway apron modification is proposed along Hawthorne Boulevard. The disturbed area is approximately 2.9 acres, including the interior of the existing tenant space.

All solid and liquid waste will be handled and disposed of with caution, ensuring that no waste generated on the site will pollute storm water. There will be no activities associated with vehicle or equipment fueling, maintenance, or repair on the site. The only routinely conducted outdoor activities will include the loading and unloading of materials, which will be conducted only at the loading docks and other designated loading/unloading areas. No other routinely conducted outdoor activities will be performed onsite. Materials that will be delivered to the site on a regular basis include food/beverage items, miscellaneous goods, and products necessary for the daily operation of business. There will be no outdoor storage of materials.

Landscaping will be located around the parking areas and buildings. Plants with similar and low irrigation requirements will be chosen for efficient irrigation purposes.

All paved areas will be used for drive aisles, parking areas, and pedestrian walkways. As shown on the Site Plan and SUSMP Exhibit in Attachment A, a portion of the proposed pavement will implement the use of a vegetated swale, and other areas will utilize a dry well installation to mitigation runoff quality, and infiltrate runoff into the ground. Refer to Section 500 of this SUSMP for entities that will be responsible for implementing each BMP.

Section 300 Site Description

WATERSHED

RWQCB: Los Angeles Regional Water Quality Control Board
320 W. 4th Street, Suite 200, Los Angeles, CA 90013

SITE INFORMATION

Site Address:	19330 Hawthorne Boulevard
City/State:	Torrance, California
Soil Types:	Alluvial deposit, generally silty sand and sandy silt with gravel.
Hydrologic Concerns:	None
Pollutants of Concern:	None
Receiving Waters:	

DRAINAGE PATTERN

Existing Condition

Runoff from the westerly portion of the site drains toward Hawthorne Boulevard and into an existing underground storm drain. Runoff from the roof and easterly portion of the site drain into an existing paved open channel along the easterly boundary of the project site flowing southerly.

Proposed Condition

The proposed site will discharge to the same locations as in the existing condition. Prior to leaving the site, runoff will be passed through either a vegetated swale or a dry well for quality treatment in infiltration volume. The volume of water to be treated/infiltrated will be in accordance with the SUSMP requirement to mitigate the first ¾" of a rainfall event.

Section 400 Best Management Practices (BMPs)

SOURCE CONTROL BMPS

The following tables show source control BMPs (routine non-structural and routine structural) included in this project and those that were not included.

Routine Non-Structural BMPs

BMP	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
SC-10	Non-Stormwater Discharges	X		
SC-11	Spill Prevention, Control and Cleanup		X	This BMP refers to sites in which hazardous materials are being used, handled, or stored in type and quantity subject to regulation under Division 20, Chapter 6.95 of the California Health and Safety Code. Therefore this BMP is not applicable to this site.
SC-20	Vehicle and Equipment Fueling		X	No vehicle and equipment fueling onsite.
SC-21	Vehicle and Equipment Cleaning		X	No vehicle and equipment cleaning onsite.
SC-22	Vehicle and Equipment Repair		X	No vehicle and equipment repairing onsite.
SC-30	Outdoor Loading/Unloading	X		
SC-31	Outdoor Liquid Container Storage		X	Outdoor storage of liquids is not expected.
SC-32	Outdoor Equipment Operations		X	Outdoor storage of equipment is not expected.
SC-33	Outdoor Storage of Raw Materials	X		Outdoor garden center to have merchandise within outdoor designated area of building.
SC-34	Waste Handling and Disposal	X		
SC-35	Safer Alternative Products	X		
SC-40	Contaminated or Erodible Areas		X	Contaminated areas are not expected.
SC-41	Building & Grounds Maintenance	X		
SC-42	Building Repair and Construction	X		
SC-43	Parking/Storage Area Maintenance	X		
SC-44	Drainage System Maintenance	X		

Routine Structural BMPs

BMP	Name	Check One		If not applicable, state brief reason
		Included	Not Applicable	
SD-10	Site Design and Landscape Planning	X		
SD-11	Roof Runoff Controls		X	Not applicable for this site.
SD-12	Efficient Irrigation	X		
SD-13	Storm Drain Signage	X		
SD-20	Pervious Pavements		X	
SD-21	Alternative Building Material		X	Alternative building material is not applicable. Project is proposing to replace minor areas of the parking area, landscaping, etc. with new parking and landscaped areas. In addition, alternative building materials that promote infiltration are not recommended for this site.
SD-30	Fueling Areas		X	No fueling areas onsite
SD-31	Maintenance Bays and Docks	X		
SD-32	Trash Enclosures	X	X	No new trash enclosures proposed. Applies to existing facilities
SD-33	Vehicle Washing Areas		X	No vehicle washing onsite.
SD-34	Outdoor Material Storage Areas	X		Outdoor garden center to have merchandise within outdoor designated area of building.
SD-35	Outdoor Work Areas		X	Outdoor work is not expected.
SD-36	Outdoor Processing Areas		X	Outdoor processing is not expected.

SITE DESIGN BMPS

The following table shows site design BMPs that are included in this project. A description of each BMP follows:

Site Design BMPs

Technique	Included?		Brief Description of Method
	Yes	No	
Minimize Impervious Area/Maximize Permeability (C-Factor Reduction)	X		Inclusion of landscaped areas and buffers in site design; minimized use of impervious surfaces in landscape design; sidewalks/parking lot aisles designed to minimal widths necessary while maintaining walkable environment.
Minimize Directly Connected Impervious Areas (DCIAs) (C-Factor Reduction)	X		Inclusion of landscaped areas and buffers in site design to minimize directly connected impervious area. Landscape areas are planned as shown on the SUSMP Exhibit in Attachment A.
Create Reduced or "Zero Discharge" Areas (Runoff Volume Reduction)		X	
Conserve Natural Areas (C-Factor Reduction)		X	

TREATMENT BMPS

The following table shows treatment BMPs that are included in this project. A description of each BMP follows:

Treatment BMPs

Identifier	Name	Included?		If not applicable, state brief reason
		Yes	No	
MP-51	Vortex Separator		X	Not practical / Existing Site Constraints
MP-52	Drain Inserts		X	Pre-Treatment for Infiltration Basins
TC-10	Infiltration Trench		X	Not practical / Existing Site Constraints
TC-11	Infiltration Basin	X		Maxwell Plus Dry Well / Open Bottom Catch Basin
TC-12	Retention/Irrigation		X	Not practical / Existing Site Constraints
TC-20	Wet Pond		X	Not practical / Existing Site Constraints
TC-21	Constructed Wetland		X	Not practical / Existing Site Constraints
TC-22	Extended Detention Basin		X	Not practical / Existing Site Constraints
TC-30	Vegetated Swale	X		Located parallel to Hawthorne Boulevard, within 12' landscape setback area. Runs the length of the project frontage along Hawthorne.
TC-31	Vegetated Buffer Strip		X	Not practical / Existing Site Constraints
TC-32	Bioretention		X	Not practical / Existing Site Constraints
TC-40	Media Filter		X	Not practical / Existing Site Constraints
TC-50	Water Quality Inlet		X	Not practical / Existing Site Constraints
TC-60	Multiple Systems		X	Not practical / Existing Site Constraints

Section 500 Inspection/Maintenance Responsibility for BMPs

RESPONSIBLE PARTIES

The Owner of the property and its successors and assigns, is responsible for implementation of this SUSMP for the onsite areas (paved lots, landscaping, drainage devices, etc.). The Owner may employ construction managers, general contractors, subcontractors and property managers to assist in implementing, monitoring and reporting the BMPs outlined in this SUSMP for operating facilities to ensure compliance with the provisions of SUSMP including storm water control permitting requirements for new developments.

SITE INSPECTIONS

- *Quarterly Post-Construction Inspection.*

Conduct quarterly inspections of the onsite catch basins to assure that they are clean and unobstructed. Remove debris buildup as necessary. Inspect roof and retaining wall drain inlets and outlets for any obstructions.

- *Pre-Storm Inspection.*

Inspect the storm drain catch basins to make sure they are clear and will function properly. Examine other onsite surface flow channels and swales that convey storm runoff and remove any debris that may block the flow path.

- *Post-Storm Inspection.*

Check the catch basin inlets. Look for any ponded water around the site and determine the cause. Look for surface erosion, particularly on steep slopes. Take corrective actions as necessary.

REPORTING

- *Inspection Records.*

The Owner shall be responsible for completing and maintaining inspection reports that include the date of the inspection, the name of the person who performed the inspection, the observations made, and any actions taken. The Owner will be responsible for completing and maintaining inspection reports of their activities. Records shall be maintained for three years. The records shall be available for inspection upon request of the City Engineer, Regional Water Control Board, or the designated City Representative.

See the BMP Maintenance Responsibility/Frequency Matrix in this section for details on the party responsible for each BMP and the frequency of action with respect to that BMP.

MAINTENANCE REQUIREMENTS

Maintenance and cleaning of BMPs shall be in accordance with the manufacturer's recommendations. At a minimum, BMPs should be inspected and maintained once prior to the rainy season, once during the rainy season, and once after the rainy season.

DRY WELL MAINTENANCE

Maintenance and cleaning of the Maxwell Plus shall be in accordance with the manufacturer's recommendations, but not less than three times a year. Maintenance shall occur at a minimum once prior to the rainy season (generally accepted as October 1st through April 30th), once during the rainy season, and once after the rainy season. Maintenance shall include inspection of the units, removal of accumulated sediment and floatables, vacuum removal of the collected materials if necessary. See the manufacturer's recommendations for maintenance.

VEGETATED SWALE MAINTENANCE

Maintenance shall occur at a minimum once prior to the rainy season (generally accepted as October 1st through April 30th), once during the rainy season, and once after the rainy season. Maintenance shall include removal of accumulated debris and removal of any collected sediment and obstruction in the swale flow path or in the grated inlets.

REVISION TO THE SUSMP

Revisions to the SUSMP in the event of a substantial change to the project due to construction modifications or uses at the site will be the responsibility of the Property Owner. Modifications to the SUSMP may be necessary if project changes result in a potential increase in pollutant discharge to storm water or if inspection and monitoring indicates that existing BMPs are ineffective. The Property Owner shall secure the services of the firm that prepared the original SUSMP or other qualified persons to make any appropriate changes, additions or deletions. Any revisions shall require approval by the local government that has jurisdiction over the subject property.

POST CONSTRUCTION BMPS
MAINTENANCE RESPONSIBILITY/FREQUENCY MATRIX
TORRANCE SHOPPING CENTER - COUNTY OF LOS ANGELES

BEST MANAGEMENT PRACTICES (BMPs)	INSPECTION FREQUENCY (All controls)	MAINTENANCE/REPAIR PROGRAM
SC-10 Non-Storm Water Discharges	Ongoing. See BMP SC-10 in Attachment C.	■ Responsible Party: *Regency Centers* ■ Orientation shall be given to employee.
SC-30 Outdoor Loading/Unloading	Daily management of operation. Check the loading docks daily for trash and debris. Pick up trash and debris upon detection. Spills and broken containers shall be cleaned immediately upon occurrence. See BMP SC-30 in Attachment C.	■ Responsible Party: *Regency Centers* ■ Make repairs as necessary, depends on the age of the facility. ■ Check loading and unloading equipment for leaks and regular broom dry-sweeping of area.
SC-33 Outdoor Storage of Raw Materials	Daily management of operation. Make sure materials properly covered and measures to prevent materials from being transported off site are in place. See BMP SC-33 in Attachment C.	■ Responsible Party: *Regency Centers*
SC-34 Waste Handling & Disposal	Daily management of operation. Trash dumpster pickup shall be a minimum of once per week. See BMP SC-34 in Attachment C.	■ Responsible Party: *Regency Centers*
SC-35 Safer Alternative Products	Daily management of operation. See BMP SC-35 in Attachment C for recommended "safer alternative products" applicable to individual uses/activities.	■ Responsible Party: *Regency Centers*
SC-41 Building & Grounds Maintenance	Perform landscape and parking lot maintenance on weekly basis to remove trash and debris. See BMP SC-41 in Attachment C.	■ Responsible Party: *Regency Centers*, through Grounds and Maintenance personnel.
SC-42 Building Repair & Construction	When applicable (when buildings being repaired, painted, etc.) See BMP SC-42 in Attachment C for stormwater protection measures applicable to individual building repair/maintenance activities.	■ Responsible Party: *Regency Centers*

POST CONSTRUCTION BMPS
MAINTENANCE RESPONSIBILITY/FREQUENCY MATRIX
TORRANCE SHOPPING CENTER - COUNTY OF LOS ANGELES

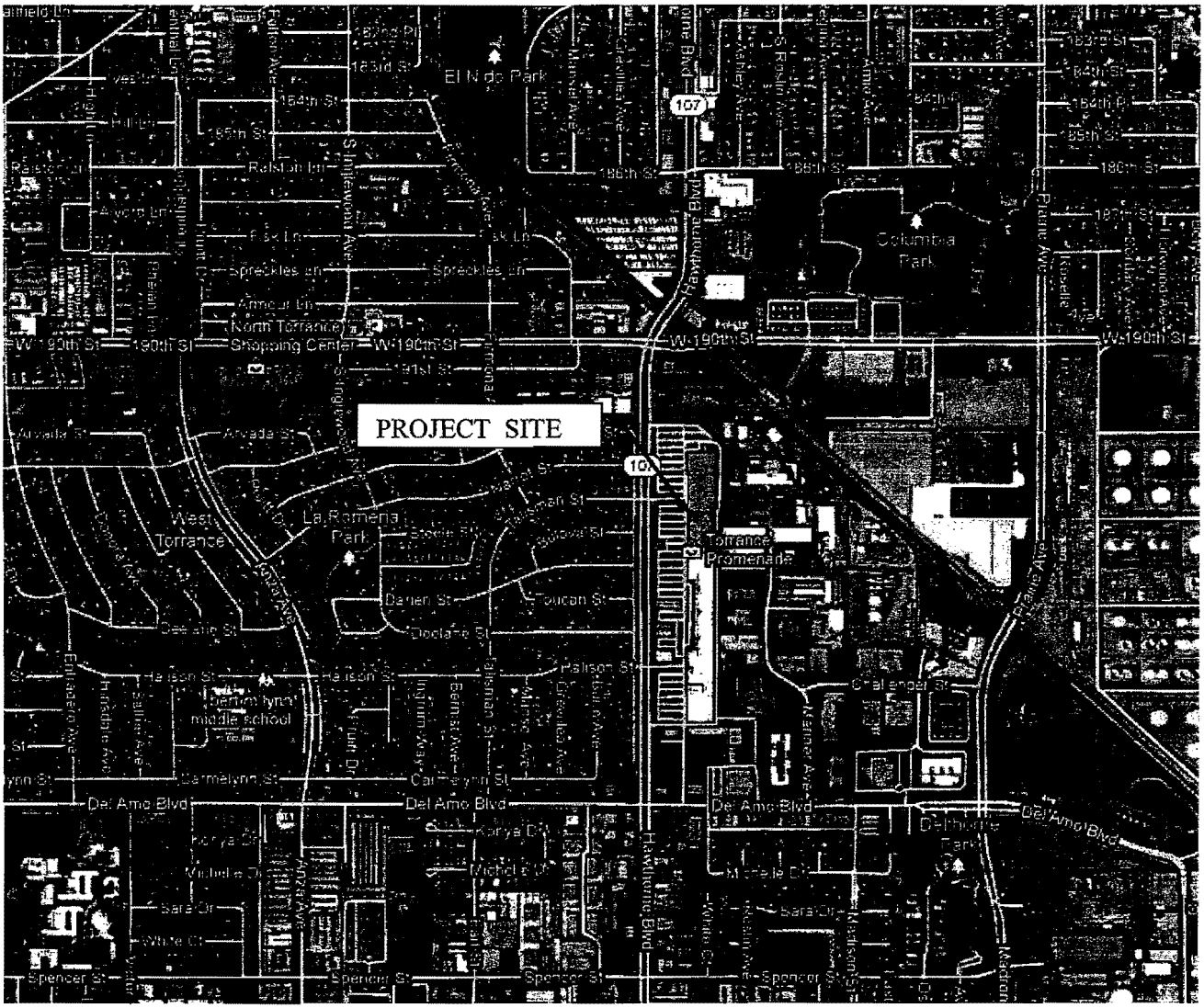
BEST MANAGEMENT PRACTICES (BMPs)	INSPECTION FREQUENCY (All controls)	MAINTENANCE/REPAIR PROGRAM
SC-43 Parking/Storage Area Maintenance	The parking lot shall be swept on a weekly basis to remove trash and debris. See BMP SC-43 in Attachment C.	■ Responsible Party: *Regency Centers*, through Grounds and Maintenance personnel.
SC-44 Drainage System Maintenance	Check drainage system equipment (catch basins, filters, etc.) a minimum of 3 times per year. Remove obstructions that block flow paths and clean filters and inlets as necessary. See BMP SC-44 in Attachment C.	■ Responsible Party: *Regency Centers*
SD-10 Site Design and Landscape Planning	Choose vegetation with minimum water and fertilizer needs. Inspect irrigation equipment (sensors, timers, irrigation heads, etc.) on a monthly basis for proper operation. Adjust sensors, timers, irrigation heads as necessary to avoid over or under watering of vegetation and excessive runoff from landscaped areas. Repair leaks when necessary. See BMP SD-10 in Attachment C.	■ Responsible Party: *Regency Centers*
SD-12 Efficient Irrigation	Inspect irrigation equipment (sensors, timers, irrigation heads, etc.) on a monthly basis for proper operation. Adjust sensors, timers, irrigation heads as necessary to avoid over or under watering of vegetation and excessive runoff from landscaped areas. Repair leaks when necessary. See BMP SD-12 in Attachment C.	■ Responsible Party: *Regency Centers*, through Landscape Maintenance contracts and grounds maintenance personnel. *Regency Centers* is responsible for the common areas.
SD-13 Storm Drain Signage	Catch basins shall be stenciled with the Phrase "No Dumping, Drains to Ocean" or equally effective phrase to alter the public of the destination of storm water. The storm drain stencils shall be inspected a minimum of 3 times per year for legibility and re-stenciled as necessary to maintain legibility. See BMP SD-13 in Attachment C.	■ Responsible Party: *Regency Centers*

POST CONSTRUCTION BMPS
MAINTENANCE RESPONSIBILITY/FREQUENCY MATRIX
TORRANCE SHOPPING CENTER – COUNTY OF LOS ANGELES

BEST MANAGEMENT PRACTICES (BMPs)	INSPECTION FREQUENCY (All controls)	MAINTENANCE/REPAIR PROGRAM
SD-31 Maintenance Bays and Docks	Daily basis for trash and debris. Perform regular sweeping and remove broken containers and leaking containers.	■ Responsible Party: ■ *Regency Centers*
SD-32 Trash Storage Areas	Daily management of operation. Loose trash to be picked up. Dumpster lids to remain closed. Dumpsters not to overflow. Trash pick up a minimum of once a week and when dumpsters are full	■ Responsible Party: ■ *Regency Centers*
SD-34 Outdoor Material Storage Areas	Daily management of operation. Make sure materials properly covered and measures to prevent materials from being transported off site are in place. See BMP SC-33 in Attachment C.	■ Responsible Party: ■ *Regency Centers*
Maxwell Plus Dry Well	Schedule 3 annual inspections with one at the beginning, one at the end, and one during the wet season to identify potential problems per manufacturer's specifications and recommendations.	■ Responsible Party: *Regency Centers*
Vegetated Swale	Schedule 3 annual inspections with one at the beginning, one at the end, and one during the wet season to identify potential problems.	■ Responsible Party: *Regency Centers*

Attachment A Location Map and SUSMP Exhibit

FIGURE 1A: LOCATION MAP



Attachment C Educational Materials Included

The following is a list of the educational materials that pertain to City of Los Angeles and Los Angeles County.

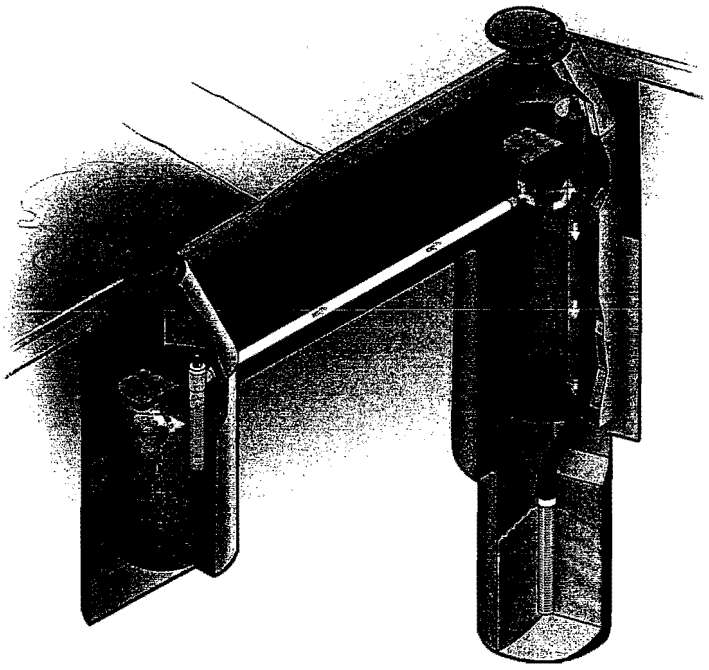
- After the Storm - A Citizen's Guide to Understanding Stormwater
- Protecting Water Quality from Urban Runoff
- Preventing Pollution through Efficient Water Use
- BMP Fact Sheets

MaxWell Plus DRAINAGE SYSTEM

Product Information and Design Features

TORRENT RESOURCES

The ***MaxWell® Plus,*** as manufactured and installed exclusively by Torrent Resources Incorporated, is the industry standard for draining large paved surfaces, nuisance water and other demanding applications. This patented system incorporates state-of-the-art pre-treatment technology.



THE ULTIMATE IN DESIGN

Since 1974, nearly 60,000 MaxWell® Systems have proven their value as a cost-effective solution in a wide variety of drainage applications. They are accepted by state and municipal agencies and are a standard detail in numerous drainage manuals. Many municipalities have recognized the inherent benefits of the MaxWell Plus and now require it for drainage of all paved surfaces.

SUPERIOR PRE-TREATMENT

Industry research, together with Torrent Resources' own experience, have shown that initial storm drainage flows have the greatest impact on system performance. This "first flush" occurs during the first few minutes of runoff, and carries the majority of sediment and debris. Larger paved surfaces or connecting pipes from catch basins, underground storage, etc. can also generate high peak

s which may strain system function. In addition, nuisance water flows require controlled processing separate from normal storm runoff demands.

In the ***MaxWell® Plus,*** preliminary treatment is provided through collection and separation in deep large-volume settling chambers. The standard MaxWell Plus System has over 2,500 gallons of capacity to contain sediment and debris carried by incoming water. Floating trash, paper, pavement oil, etc. are effectively stopped by the **PureFlo™** Debris Shields in each chamber. These shielding devices are equipped with an effective screen to filter suspended material and are vented to prevent siphoning of floating surface debris as the system drains.

EFFECTIVE PROCESSING

Incoming water from the surface grated inlets or connecting pipes is received in the Primary Settling Chamber where silt and other heavy particles settle to the bottom. A PureFlo Debris Shield ensures containment by trapping floating debris and pavement oil. The pre-treated flow is then regulated to a design rate of up to 0.25cfs and directed to a Secondary Settling Chamber. The settling and containment process is repeated, thereby effectively achieving controlled, uniform treatment. The system is drained as water rises under the PureFlo Debris Shield and spills into the top of the overflow pipe. The drainage assembly returns the cleaned water into the surrounding soil through the **FloFast™** Drainage Screen.

ABSORBENT TECHNOLOGY

Both MaxWell Plus settling chambers are equipped with absorbent sponges to provide prompt removal of pavement oils. These floating pillow-like devices are 100% water repellent and literally wick petrochemical compounds from the water. Each sponge has a capacity of up to 128 ounces to accommodate effective, long-term treatment. The absorbent is completely inert and will safely remove runoff constituents down to rainbow sheens that are typically no more than one molecule thick.

SECURITY FEATURES

MaxWell Plus Systems include bolted, theft-deterrent, cast iron gratings and covers as standard security features. Special inset castings which are resistant to loosening from accidental impact are available for use in landscaped applications. Machined mating surfaces and "Storm Water Only" wording are standard.

THE MAXWELL FIVE-YEAR WARRANTY

Innovative engineering, quality materials and exacting construction are standard with every MaxWell System designed, manufactured and installed by Torrent Resources Incorporated. The MaxWell Drainage Systems Warranty is the best in the industry and guarantees against failures due to workmanship or materials for a period of five years from date of completion.

Manufactured and Installed Exclusively by Torrent Resources Incorporated

Please see reverse side for additional information

U.S. Patent No. 4,923,330

Attachment B

Maxwell Plus Dry Well Detail


r the Storm
A Citizen's Guide to
Understanding Stormwater
WHEN IT RAINS

Education Materials:

AFTER THE STORM– A CITIZEN'S GUIDE TO UNDERSTANDING STORMWATER

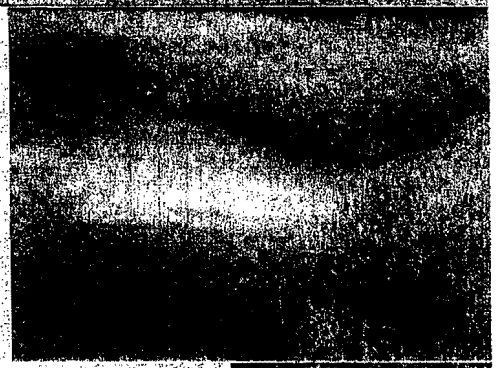
What is stormwater runoff?

Stormwater runoff occurs when precipitation from rain or snowmelt flows over the ground. Impervious surfaces like driveways, sidewalks, and streets prevent stormwater from naturally soaking into the ground.

Why is stormwater runoff a problem?

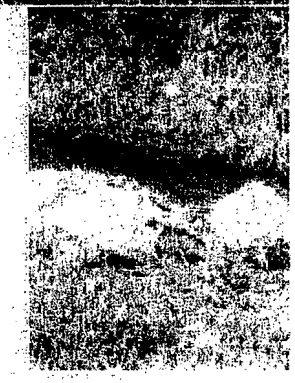
Stormwater can pick up debris, chemicals, dirt, and other pollutants and flow into a storm sewer system or directly to a lake, stream, river, wetland, or coastal water. Anything that enters a storm sewer system is discharged untreated into the waterbodies we use for swimming, fishing, and providing drinking water.

The effects of pollution

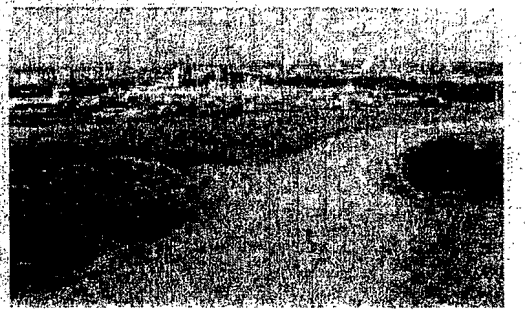


Polluted stormwater runoff can have many adverse effects on plants, fish, animals, and people.

- Sediment can cloud the water and make it difficult or impossible for aquatic plants to grow. Sediment also can destroy aquatic habitats.
- Excess nutrients can cause algae blooms. When algae die, they sink to the bottom and decompose in a process that removes oxygen from the water. Fish and other aquatic organisms can't exist in water with low dissolved oxygen levels.
- Bacteria and other pathogens can wash into swimming areas and create health hazards, often making beach closures necessary.

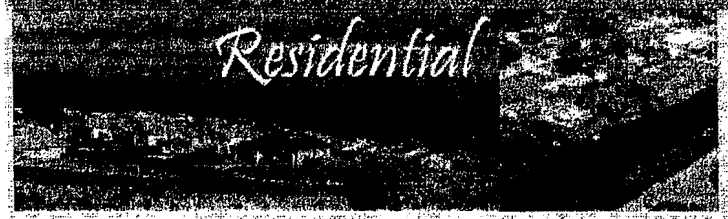


- Debris—plastic bags, six-pack rings, bottles, and cigarette butts—washed into waterbodies can choke, suffocate, or disable aquatic life like ducks, fish, turtles, and birds.
- Household hazardous wastes like insecticides, pesticides, paint, solvents, used motor oil, and other auto fluids can poison aquatic life. Land animals and people can become sick or die from eating diseased fish and shellfish or ingesting polluted water.
- Polluted stormwater often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.



Stormwater Pollution Solutions

Residential



Recycle or properly dispose of household products that contain chemicals, such as insecticides, pesticides, paint, solvents, and used motor oil and other auto fluids. Don't pour them onto the ground or into storm drains.

Lawn care

Excess fertilizers and pesticides applied to lawns and gardens wash off and pollute streams. In addition, yard clippings and leaves can wash into storm drains and contribute nutrients and organic matter to streams.

- Don't overwater your lawn. Consider using a soaker hose instead of a sprinkler.
- Use pesticides and fertilizers sparingly. When use is necessary, use these chemicals in the recommended amounts. Use organic mulch or safer pest control methods whenever possible.
- Compost or mulch yard waste. Don't leave it in the street or sweep it into storm drains or streams.
- Cover piles of dirt or mulch being used in landscaping projects.

Auto care

Washing your car and degreasing auto parts at home can send detergents and other contaminants through the storm sewer system. Dumping automotive fluids into storm drains has the same result as dumping the materials directly into a waterbody.

- Use a commercial car wash that treats or recycles its wastewater, or wash your car on your yard so the water infiltrates into the ground.
- Repair leaks and dispose of used auto fluids and batteries at designated drop-off or recycling locations.

Septic systems

Leaking and poorly maintained septic systems release nutrients and pathogens (bacteria and viruses) that can be picked up by stormwater and discharged into nearby waterbodies. Pathogens can cause public health problems and environmental concerns.

- Inspect your system every 3 years and pump your tank as necessary (every 3 to 5 years).
- Don't dispose of household hazardous waste in sinks or toilets.

Pet waste

Pet waste can be a major source of bacteria and excess nutrients in local waters.

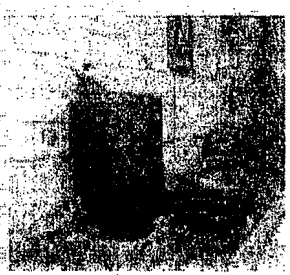
- When walking your pet, remember to pick up the waste and dispose of it properly. Flushing pet waste is the best disposal method. Leaving pet waste on the ground increases public health risks by allowing harmful bacteria and nutrients to wash into the storm drain and eventually into local waterbodies.

Education is essential to changing people's behavior. Signs and markers near storm drains warn residents that pollutants entering the drains will be carried untreated into a local waterbody.

Residential landscaping

Permeable Pavement—Traditional concrete and asphalt don't allow water to soak into the ground. Instead these surfaces rely on storm drains to divert unwanted water. Permeable pavement systems allow rain and snowmelt to soak through, decreasing stormwater runoff.

Rain Barrels—You can collect rainwater from rooftops in mosquito-proof containers. The water can be used later on lawn or garden areas.



Rain Gardens and Grassy Swales—Specially designed areas planted with native plants can provide natural places for rainwater to collect and soak into the ground. Rain from rooftop areas or paved areas can be diverted into these areas rather than into storm drains.

Vegetated Filter Strips—Filter strips are areas of native grass or plants created along roadways or streams. They trap the pollutants stormwater picks up as it flows across driveways and streets.

Commercial

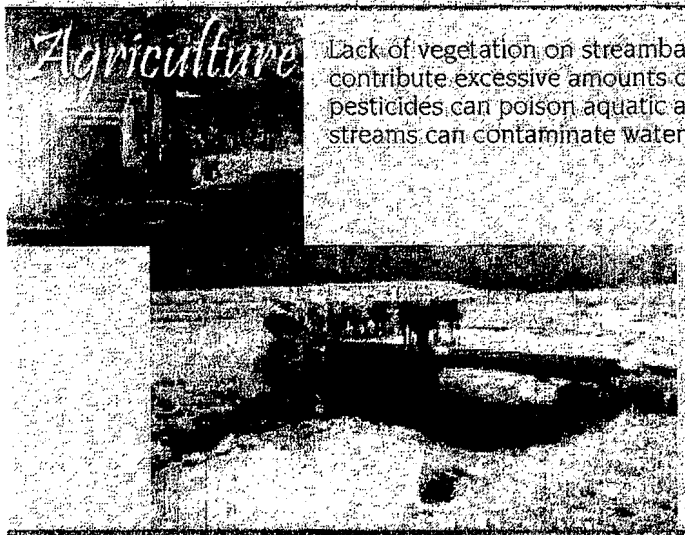
Dirt, oil, and debris that collect in parking lots and paved areas can be washed into the storm sewer system and eventually enter local waterbodies.

- Sweep up litter and debris from sidewalks, driveways and parking lots, especially around storm drains.
- Cover grease storage and dumpsters and keep them clean to avoid leaks.
- Report any chemical spill to the local hazardous waste cleanup team. They'll know the best way to keep spills from harming the environment.

Eros controls that aren't maintained can cause excessive amounts of sediment and debris to be carried into the stormwater system. Construction vehicles can leak fuel, oil, and other harmful fluids that can be picked up by stormwater and deposited into local waterbodies.

- Divert stormwater away from disturbed or exposed areas of the construction site.
- Install silt fences, vehicle mud removal areas, vegetative cover, and other sediment and erosion controls and properly maintain them, especially after rainstorms.
- Prevent soil erosion by minimizing disturbed areas during construction projects, and seed and mulch bare areas as soon as possible.

Construction



Agriculture

Lack of vegetation on streambanks can lead to erosion. Overgrazed pastures can also contribute excessive amounts of sediment to local waterbodies. Excess fertilizers and pesticides can poison aquatic animals and lead to destructive algae blooms. Livestock in streams can contaminate waterways with bacteria, making them unsafe for human contact.

- Keep livestock away from streambanks and provide them a water source away from waterbodies.
- Store and apply manure away from waterbodies and in accordance with a nutrient management plan.
- Vegetate riparian areas along waterways.
- Rotate animal grazing to prevent soil erosion in fields.
- Apply fertilizers and pesticides according to label instructions to save money and minimize pollution.

Automotive Facilities

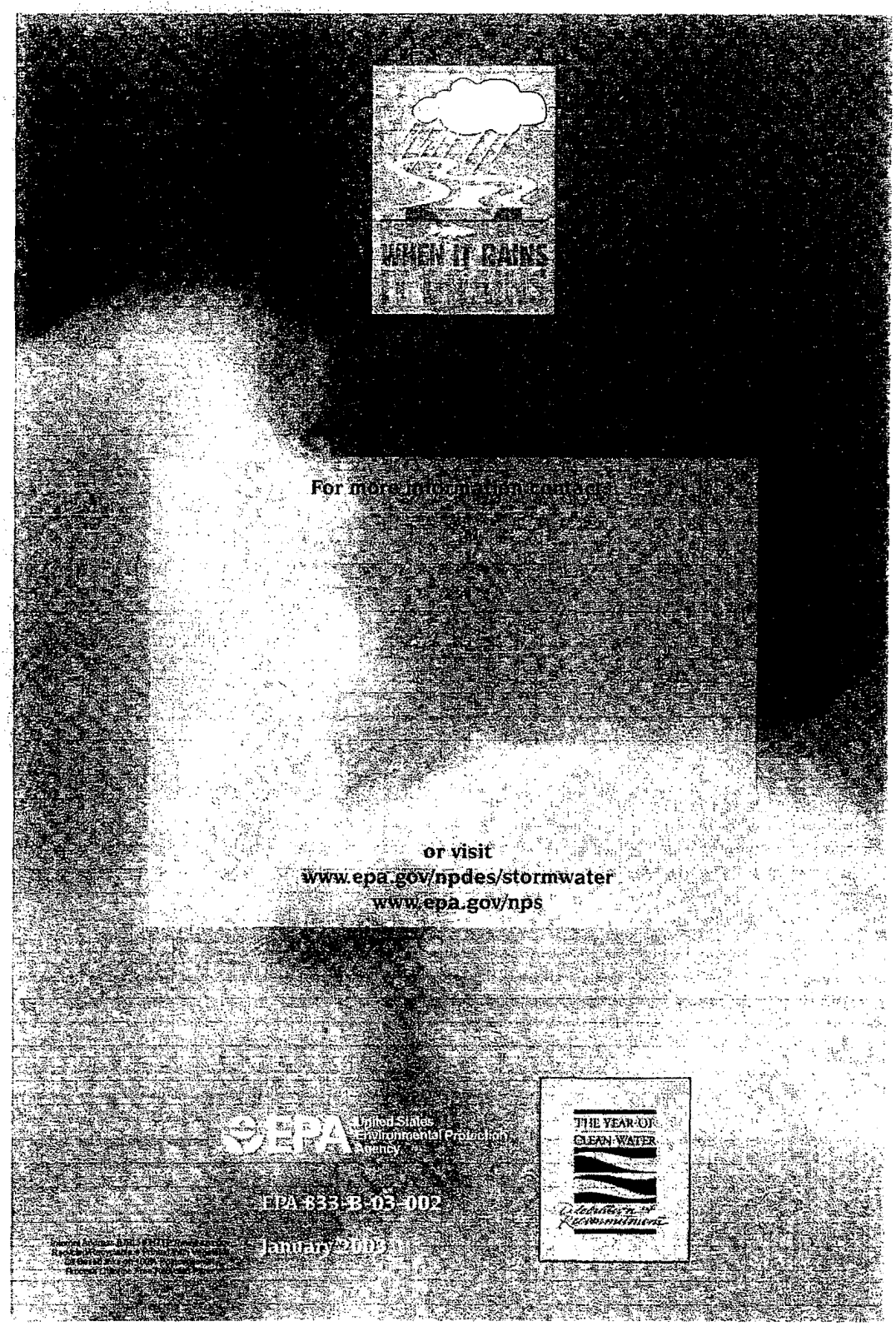
Uncovered fueling stations allow spills to be washed into storm drains. Cars waiting to be repaired can leak fuel, oil, and other harmful fluids that can be picked up by stormwater.

- Clean up spills immediately and properly dispose of cleanup materials.
- Provide cover over fueling stations and design or retrofit facilities for spill containment.
- Properly maintain fleet vehicles to prevent oil, gas, and other discharges from being washed into local waterbodies.
- Install and maintain oil/water separators.

Forestry

Improperly managed logging operations can result in erosion and sedimentation.

- Conduct preharvest planning to prevent erosion and lower costs.
- Use logging methods and equipment that minimize soil disturbance.
- Plan and design skid trails, yard areas, and truck access roads to minimize stream crossings and avoid disturbing the forest floor.
- Construct stream crossings so that they minimize erosion and physical changes to streams.
- Expedite revegetation of cleared areas.


WHEN IT RAINS
For more information contact
or visit
www.epa.gov/npdes/stormwater
www.epa.gov/nps
EPA
United States
Environmental Protection
Agency
THE YEAR OF
CLEAN WATER
EPA-833-B-03-002
January 2003

Education Materials:

PROTECTING WATER QUALITY FROM URBAN RUNOFF

EPA
United States Environmental Protection Agency

EPA 841-F-03-003

Protecting Water Quality *from* URBAN RUNOFF

Clean Water Is Everybody's Business

In urban and suburban areas, much of the land surface is covered by buildings and pavement, which do not allow rain and snowmelt to soak into the ground. Instead, most developed areas rely on storm drains to carry large amounts of runoff from roofs and paved areas to nearby waterways. The stormwater runoff carries pollutants such as oil, dirt, chemicals, and lawn fertilizers directly to streams and rivers, where they seriously harm water quality. To protect surface water quality and groundwater resources, development should be designed and built to minimize increases in runoff.

The most recent National Water Quality Inventory reports that runoff from urbanized areas is the leading source of water quality impairments to surveyed estuaries and the third-largest source of impairments to surveyed lakes.

Did you know that because of impervious surfaces like pavement and rooftops, a typical city block generates more than 5 times more runoff than a woodland area of the same size?

How Urbanized Areas Affect Water Quality

Increased Runoff

The porous and varied terrain of natural landscapes like forests, wetlands, and grasslands traps rainwater and snowmelt and allows them to filter slowly into the ground. In contrast, impervious (nonporous) surfaces like roads, parking lots, and rooftops prevent rain and snowmelt from infiltrating, or soaking, into the ground. Most of the rainfall and snowmelt remains above the surface, where it runs off rapidly in unnaturally large amounts.

Storm sewer systems concentrate runoff into smooth, straight conduits. This runoff gathers speed and erosional power as it travels underground. When this runoff leaves the storm drains and empties into a stream, its excessive volume and power blast out streambanks, damaging streamside vegetation and wiping out aquatic habitat. These increased storm flows carry sediment loads from construction sites and other denuded surfaces and eroded streambanks. They often carry higher water temperatures from streets, roof tops, and parking lots, which are harmful to the health and reproduction of aquatic life.

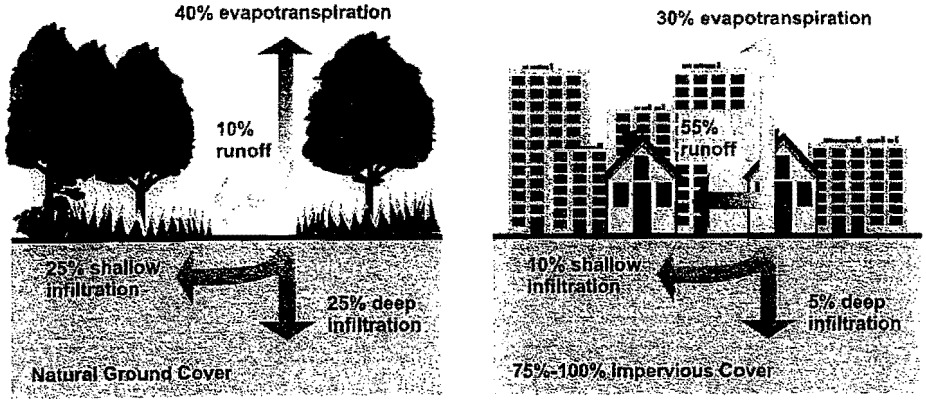
The loss of infiltration from urbanization may also cause profound groundwater changes. Although urbanization leads to great increases in flooding during and immediately after wet weather, in many instances it results in lower stream flows during dry weather. Many native fish and other aquatic life cannot survive when these conditions prevail.

Increased Pollutant Loads

Urbanization increases the variety and amount of pollutants carried into streams, rivers, and lakes. The pollutants include:

- Sediment
- Oil, grease, and toxic chemicals from motor vehicles
- Pesticides and nutrients from lawns and gardens
- Viruses, bacteria, and nutrients from pet waste and failing septic systems
- Road salts
- Heavy metals from roof shingles, motor vehicles, and other sources
- Thermal pollution from dark impervious surfaces such as streets and rooftops

These pollutants can harm fish and wildlife populations, kill native vegetation, foul drinking water supplies, and make recreational areas unsafe and unpleasant.



Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.

Managing Urban Runoff

What Homeowners Can Do

To decrease polluted runoff from paved surfaces, households can develop alternatives to areas traditionally covered by impervious surfaces. Porous pavement materials are available for driveways and sidewalks, and native vegetation and mulch can replace high maintenance grass lawns. Homeowners can use fertilizers sparingly and sweep driveways, sidewalks, and roads instead of using a hose. Instead of disposing of yard waste, they can use the materials to start a compost pile. And homeowners can learn to use Integrated Pest Management (IPM) to reduce dependence on harmful pesticides.

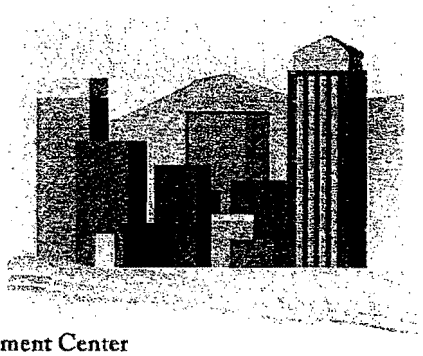
In addition, households can prevent polluted runoff by picking up after pets and using, storing, and disposing of chemicals properly. Drivers should check their cars for leaks and recycle their motor oil and antifreeze when these fluids are changed. Drivers can also avoid impacts from car wash runoff (e.g., detergents, grime, etc.) by using car wash facilities that do not generate runoff. Households served by septic systems should have them professionally inspected and pumped every 3 to 5 years. They should also practice water conservation measures to extend the life of their septic systems.

Controlling Impacts from New Development

Developers and city planners should attempt to control the volume of runoff from new development by using low impact development, structural controls, and pollution prevention strategies. Low impact development includes measures that conserve natural areas (particularly sensitive hydrologic areas like riparian buffers and infiltrable soils); reduce development impacts; and reduce site runoff rates by maximizing surface roughness, infiltration opportunities, and flow paths.

Controlling Impacts from Existing Development

Controlling runoff from existing urban areas is often more costly than controlling runoff from new developments. Economic efficiencies are often realized through approaches that target "hot spots" of runoff pollution or have multiple benefits, such as high-efficiency street sweeping (which addresses aesthetics, road safety, and water quality). Urban planners and others responsible for managing urban and suburban areas can first identify and implement pollution prevention strategies and examine source control opportunities. They should seek out priority pollutant reduction opportunities, then protect natural areas that help control runoff, and finally begin ecological restoration and retrofit activities to clean up degraded water bodies. Local governments are encouraged to take lead roles in public education efforts through public signage, storm drain marking, pollution prevention outreach campaigns, and partnerships with citizen groups and businesses. Citizens can help prioritize the clean-up strategies, volunteer to become involved in restoration efforts, and mark storm drains with approved "don't dump" messages.



Related Publications

Turn Your Home into a Stormwater Pollution Solution!
www.epa.gov/nps

This web site links to an EPA homeowner's guide to healthy habits for clean water that provides tips for better vehicle and garage care, lawn and garden techniques, home improvement, pet care, and more.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas
www.epa.gov/owow/nps/urbanmm

This technical guidance and reference document is useful to local, state, and tribal managers in implementing management programs for polluted runoff. Contains information on the best available, economically achievable means of reducing pollution of surface waters and groundwater from urban areas.

Onsite Wastewater Treatment System Resources
www.epa.gov/owm/onsite

This web site contains the latest brochures and other resources from EPA for managing onsite wastewater treatment systems (OWTS) such as conventional septic systems and alternative decentralized systems. These resources provide basic information to help individual homeowners, as well as detailed, up-to-date technical guidance of interest to local and state health departments.

Low Impact Development Center
www.lowimpactdevelopment.org

This center provides information on protecting the environment and water resources through integrated site design techniques that are intended to replicate preexisting hydrologic site conditions.

Stormwater Manager's Resource Center (SMRC)
www.stormwatercenter.net

Created and maintained by the Center for Watershed Protection, this resource center is designed specifically for stormwater practitioners, local government officials, and others that need technical assistance on stormwater management issues.

Strategies: Community Responses to Runoff Pollution
www.nrdc.org/water/pollution/storm/stoinx.asp

The Natural Resources Defense Council developed this interactive web document to explore some of the most effective strategies that communities are using around the nation to control urban runoff pollution. The document is also available in print form and as an interactive CD-ROM.

For More Information

U.S. Environmental Protection Agency
Nonpoint Source Control Branch (4503T)
1200 Pennsylvania Avenue, NW
Washington, DC 20460

www.epa.gov/nps

February 2003

Education Materials:

PREVENTING POLLUTION THROUGH EFFICIENT WATER USE

United States Environmental Protection Agency
20W-0002
July 1990
OW (WH-556)
OPPE (PM-222)

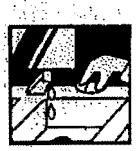
EPA

Preventing Pollution Through Efficient Water Use

EPA

For more information on what you and your community can do to use water more efficiently, contact:

U.S. Environmental Protection Agency
Office of Water
401 M Street, S.W.
Washington, D.C. 20460



For more information on pollution prevention programs at U.S. EPA, contact:

U.S. Environmental Protection Agency
Office of Pollution Prevention
401 M Street, S.W.
Washington, D.C. 20460

How Efficient Water Use Helps Prevent Pollution

Other Reasons to Use Water Wisely

What Individuals Can Do

What Communities Can Do

What Communities Can Do

A water supplier or wastewater system operator (public or private) has cost-effective options to process and deliver water more efficiently. A community can do the same, and can foster ways to use water wisely.

Not all of these steps are expensive. The best choices vary by region and by community; start by asking if these are appropriate where you live and work.

A Water Supplier or Wastewater Processor Can:

- ☞ Identify who uses water, and reduce unaccounted-for water use.
- ☞ Find and repair leaking pipes.
- ☞ Consider a new pricing scheme which encourages conservation.
- ☞ Reduce excess pressure in water lines.
- ☞ Explore the reuse of treated wastewater for uses other than drinking water.
- ☞ Charge hookup fees which encourage more efficient water use in new buildings.
- ☞ Build water efficiency into future demand projections, facility planning, and drought planning.

A Community Can:

- ☞ Adopt plumbing and building codes that require water-efficient equipment and practices.
- ☞ Adopt a water-efficient landscaping ordinance to reduce the water used for golf courses and commercial landscapes.
- ☞ Retrofit older buildings with water-efficient equipment, starting with public buildings.
- ☞ Reduce municipal water use for landscaping and other uses.
- ☞ Conduct a public education campaign.
- ☞ Require developers to build in water efficiency measures.

Other Reasons to Use Water Wisely

Preventing pollution is only one reason why using water efficiently makes sense. Here are a few more:

Money Saved

- Less water use results in fewer pumping and treatment costs.
- Saving money on water and wastewater operations frees money for meeting water quality, public health and water treatment goals.
- Water saved is also energy, and money, saved for you and your community.

Improved Reliability

- Water conservation provides a hedge against drought impacts.
- Improving water efficiency may be quicker and cheaper than developing a new supply.
- Reduced water use may extend the life of your water or wastewater facility.
- Reduced water use may increase the efficiency of wastewater treatment, and reduce overflows during storms.
- Communities which use water efficiently are better prepared to cope with effects of possible future climate change.

What Individuals Can Do

More efficient water use begins with individuals, in the home and place of work. Taking these and other steps, and encouraging others to do so, makes good economic as well as environmental sense.

In The Home

- Install a toilet dam or plastic bottle in your toilet tank.
- Install a water-efficient showerhead (2.5 gallons or less per minute).
- When you buy a new toilet, purchase a low flow model (1.6 gallons or less per flush).

Outdoors

- Water in the morning or evening, to minimize evaporation.
- Install a drip-irrigation watering system for valuable plants.
- Use drought-tolerant plants and grasses for landscaping, and reduce grass-covered areas.

At Work or School

- Adopt the same water-saving habits that are effective at home.
- Ask about installing water-efficient equipment and reducing outdoor water use.
- Encourage employers to explore the use of recycled "gray-water" or reclaimed wastewater.

How Efficient Water Use Helps Prevent Pollution

Using water more efficiently can help prevent pollution as well as protect and conserve our finite water resources. More efficient water use by you and your community has many other benefits.

Fewer Pollutants

- Using less water reduces the amount of wastewater discharged into our lakes, streams, rivers, and marine waters.
- The amount of pollutants wastewater carries can also be reduced, as treatment efficiency improves.
- Recycled process water can reduce pollutants from industry.
- More efficient irrigation can minimize runoff of agricultural pollutants and reduce the use of fertilizers and pesticides.

Protection of Aquatic Habitats

- Building fewer and smaller new water projects can help preserve wetlands, which naturally treat pollutants.
- Diverting less water preserves more streamflow to maintain a healthy aquatic environment.

Protection of Drinking Water Sources

- Less pumping of groundwater lowers the chance that pollutants will be drawn into a water supply well.
- With less water use, septic system performance can improve, reducing the risk of groundwater contamination.
- Highest quality water sources are preserved for drinking water by using treated wastewater for other uses.

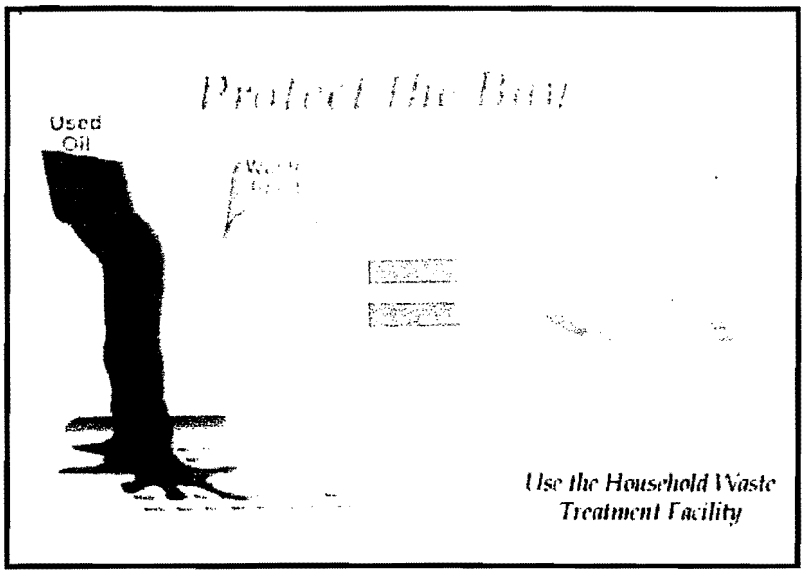
Energy Conservation

- Efficient water use means less power needed to pump and treat water and wastewater.
- Less water use reduces the amount of energy required for heating hot water.
- Less energy demand results in fewer harmful by-products from power plants.

Education Materials:

BMP FACT SHEETS

Non-Stormwater Discharges SC-10



Graphic by: Margie Winter

Objectives

- Contain
- Educate
- Reduce/Minimize

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Non-stormwater discharges are those flows that do not consist entirely of stormwater. For municipalities non-stormwater discharges present themselves in two situations. One is from fixed facilities owned and/or operated by the municipality. The other situation is non-stormwater discharges that are discovered during the normal operation of a field program. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain. These include uncontaminated groundwater and natural springs. There are also some non-stormwater discharges that typically do not contain pollutants and may be discharged to the storm drain with conditions. These include car washing, and surface cleaning. However, there are certain non-stormwater discharges that pose environmental concern. These discharges may originate from illegal dumping or from internal floor drains, appliances, industrial processes, sinks, and toilets that are connected to the nearby storm drainage system. These discharges (which may include: process waste waters, cooling waters, wash waters, and sanitary wastewater) can carry substances (such as paint, oil, fuel and other automotive fluids, chemicals and other pollutants) into storm drains. The ultimate goal is to effectively eliminate non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges.

Approach

The municipality must address non-stormwater discharges from its fixed facilities by assessing the types of non-stormwater discharges and implementing BMPs for the discharges determined to pose environmental concern. For field programs

CASQA
CALIFORNIA STORMWATER

the field staff must be trained to now what to look for regarding non-stormwater discharges and the procedures to follow in investigating the detected discharges.

Suggested Protocols

Fixed Facility

General

- Post "No Dumping" signs with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Landscaping and beautification efforts of hot spots might also discourage future dumping, as well as provide open space and increase property values.
- Lighting or barriers may also be needed to discourage future dumping.

Illicit Connections

- Locate discharges from the fixed facility drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- Use techniques such as smoke testing, dye testing and television camera inspection (as noted below) to verify physical connections.
- Isolate problem areas and plug illicit discharge points.

Visual Inspection and Inventory

- Inventory and inspect each discharge point during dry weather.
- Keep in mind that drainage from a storm event can continue for several days following the end of a storm and groundwater may infiltrate the underground stormwater collection system. Also, non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- Review the "as-built" piping schematic as a way to determine if there are any connections to the stormwater collection system.
- Inspect the path of floor drains in older buildings.

Smoke Testing

- Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two systems.

- During dry weather the stormwater collection system is filled with smoke and then traced to sources. The appearance of smoke at the base of a toilet indicates that there may be a connection between the sanitary and the stormwater system.

Dye Testing

- A dye test can be performed by simply releasing a dye into either your sanitary or process wastewater system and examining the discharge points from the stormwater collection system for discoloration.

TV Inspection of Storm Sewer

- TV Cameras can be employed to visually identify illicit connections to the fixed facility storm drain system.

Illegal Dumping

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- Clean up spills on paved surfaces with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.
- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.
- For larger spills, a private spill cleanup company or Hazmat team may be necessary.
- See fact sheet SC-11 Spill Prevention, Control, and Clean Up.

Field Program

General

- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially ones that involve more than one jurisdiction and those that are not classified as hazardous, which are often not responded to as effectively as they need to be.
- Stencil storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- See SC-74 Stormwater Drainage System Maintenance for additional information.

Field Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.
- During routine field program maintenance field staff should look for evidence of illegal discharges or illicit connection:
  - Is there evidence of spills such as paints, discoloring, etc.
  - Are there any odors associated with the drainage system
  - Record locations of apparent illegal discharges/illicit connections and notify appropriate investigating agency.
- If trained, conduct field investigation of non-stormwater discharges to determine whether they pose a threat to water quality.

Recommended Complaint Investigation Equipment

- Field Screening Analysis
  - pH paper or meter
  - Commercial stormwater pollutant screening kit that can detect for reactive phosphorus, nitrate nitrogen, ammonium nitrogen, specific conductance, and turbidity
  - Sample jars
  - Sample collection pole
  - A tool to remove access hole covers
- Laboratory Analysis
  - Sample cooler
  - Ice
  - Sample jars and labels
  - Chain of custody forms.
- Documentation
  - Camera
  - Notebook
  - Pens
  - Notice of Violation forms

- Educational materials

Reporting

- A database is useful for defining and tracking the magnitude and location of the problem.
- Report prohibited non-stormwater discharges observed during the course of normal daily activities so they can be investigated, contained and cleaned up or eliminated.
- Document that non-stormwater discharges have been eliminated by recording tests performed, methods used, dates of testing, and any onsite drainage points observed.
- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.

Enforcement

- Educate the responsible party if identified on the impacts of their actions, explain the stormwater requirements, and provide information regarding Best Management Practices (BMP), as appropriate. Initiate follow-up and/or enforcement procedures.
- If an illegal discharge is traced to a commercial, residential or industrial source, conduct the following activities or coordinate the following activities with the appropriate agency:
  - Contact the responsible party to discuss methods of eliminating the non-stormwater discharge, including disposal options, recycling, and possible discharge to the sanitary sewer (if within POTW limits).
  - Provide information regarding BMPs to the responsible party, where appropriate.
  - Begin enforcement procedures, if appropriate.
  - Continue inspection and follow-up activities until the illicit discharge activity has ceased.
- If an illegal discharge is traced to a commercial or industrial activity, coordinate information on the discharge with the jurisdiction's commercial and industrial facility inspection program.

Training

- Train technical staff to identify and document illegal dumping incidents.
- Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan.
- Train employees to identify non-stormwater discharges and report them to the appropriate departments.
- Train staff who have the authority to conduct surveillance and inspections, and write citations for those caught illegally dumping.

- Train municipal staff responsible for surveillance and inspection in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).
  - OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and federal OSHA 29 CFR 1910.146).
  - Procedural training (field screening, sampling, smoke/dye testing, TV inspection).
- Educate the identified responsible party on the impacts of his or her actions.

Spill Response and Prevention

- See SC-11 Spill Prevention Control and Clean Up

Other Considerations

- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The cost of fees for dumping at a proper waste disposal facility are often more than the fine for an illegal dumping offense, thereby discouraging people from complying with the law. The absence of routine or affordable pickup service for trash and recyclables in some communities also encourages illegal dumping. A lack of understanding regarding applicable laws or the inadequacy of existing laws may also contribute to the problem.
- Municipal codes should include sections prohibiting the discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.
- Many facilities do not have accurate, up-to-date schematic drawings.
- Can be difficult to locate illicit connections especially if there is groundwater infiltration.

Requirements

Costs

- Eliminating illicit connections can be expensive especially if structural modifications are required such re-plumbing cross connections under an existing slab.
- Minor cost to train field crews regarding the identification of non-stormwater discharges. The primary cost is for a fully integrated program to identify and eliminate illicit connections and illegal dumping. However, by combining with other municipal programs (i.e. pretreatment program) cost may be lowered.
- Municipal cost for containment and disposal may be borne by the discharger.

Maintenance

Not applicable

Supplemental Information

Further Detail of the BMP

What constitutes a "non-stormwater" discharge?

- Non-stormwater discharges are discharges not made up entirely of stormwater and include water used directly in the manufacturing process (process wastewater), air conditioning condensate and coolant, non-contact cooling water, cooling equipment condensate, outdoor secondary containment water, vehicle and equipment wash water, landscape irrigation, sink and drinking fountain wastewater, sanitary wastes, or other wastewaters.

Permit Requirements

- Current municipal NPDES permits require municipalities to effectively prohibit non-stormwater discharges unless authorized by a separate NPDES permit or allowed in accordance with the current NPDES permit conditions. Typically the current permits allow certain non-stormwater discharges in the storm drain system as long as the discharges are not significant sources of pollutants. In this context the following non-stormwater discharges are typically allowed:
  - Diverted stream flows;
  - Rising found waters;
  - Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20));
  - Uncontaminated pumped ground water;
  - Foundation drains;
  - Springs;
  - Water from crawl space pumps;
  - Footing drains;
  - Air conditioning condensation;
  - Flows from riparian habitats and wetlands;
  - Water line and hydrant flushing ;
  - Landscape irrigation;
  - Planned and unplanned discharges from potable water sources;
  - Irrigation water;
  - Individual residential car washing; and
  - Lawn watering.

SC-10 Non-Stormwater Discharges

Municipal facilities subject to industrial general permit requirements must include a certification that the stormwater collection system has been tested or evaluated for the presence of non-stormwater discharges. The state's General Industrial Stormwater Permit requires that non-stormwater discharges be eliminated prior to implementation of the facility's SWPPP.

Illegal Dumping

- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties

Outreach

One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people on the street who are aware of the problem and who have the tools to at least identify the incident, if not correct it. There we a number of ways of accomplishing this:

- Train municipal staff from all departments (public works, utilities, street cleaning, parks and recreation, industrial waste inspection, hazardous waste inspection, sewer maintenance) to recognize and report the incidents.
- Deputize municipal staff who may come into contact with illegal dumping with the authority to write illegal dumping tickets for offenders caught in the act (see below).
- Educate the public. As many as 3 out of 4 people do not understand that in most communities the storm drain does not go to the wastewater treatment plant. Unfortunately, with the heavy emphasis in recent years on public education about solid waste management, including recycling and household hazardous waste, the sewer system (both storm and sanitary) has been the likely recipient of cross-media transfers of waste.
- Provide the public with a mechanism for reporting incidents such as a hot line and/or door hanger (see below).
- Help areas where incidents occur more frequently set up environmental watch programs (like crime watch programs).
- Train volunteers to notice and report the presence and suspected source of an observed pollutant to the appropriate public agency.

What constitutes a "non-stormwater" discharge?

- Non-stormwater discharges are discharges not made up entirely of stormwater and include water used directly in the manufacturing process (process wastewater), air conditioning condensate and coolant, non-contact cooling water, cooling equipment condensate, outdoor secondary containment water, vehicle and equipment wash water, landscape irrigation, sink and drinking fountain wastewater, sanitary wastes, or other wastewaters.

Permit Requirements

- Current municipal NPDES permits require municipalities to effectively prohibit non-stormwater discharges unless authorized by a separate NPDES permit or allowed in accordance with the current NPDES permit conditions. Typically the current permits allow certain non-stormwater discharges in the storm drain system as long as the discharges are not significant sources of pollutants. In this context the following non-stormwater discharges are typically allowed:
  - Diverted stream flows;
  - Rising found waters;
  - Uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20));
  - Uncontaminated pumped ground water;
  - Foundation drains;
  - Springs;
  - Water from crawl space pumps;
  - Footing drains;
  - Air conditioning condensation;
  - Flows from riparian habitats and wetlands;
  - Water line and hydrant flushing ;
  - Landscape irrigation;
  - Planned and unplanned discharges from potable water sources;
  - Irrigation water;
  - Individual residential car washing; and
  - Lawn watering.

Municipal facilities subject to industrial general permit requirements must include a certification that the stormwater collection system has been tested or evaluated for the presence

of non-stormwater discharges. The state's General Industrial Stormwater Permit requires that non-stormwater discharges be eliminated prior to implementation of the facility's SWPPP.

Storm Drain Stenciling

- Stencil storm drain inlets with a message to prohibit illegal dumpings, especially in areas with waste handling facilities.
- Encourage public reporting of improper waste disposal by a HOTLINE number stenciled onto the storm drain inlet.
- See Supplemental Information section of this fact sheet for further detail on stenciling program approach.

Oil Recycling

- Contract collection and hauling of used oil to a private licensed used oil hauler/recycler.
- Comply with all applicable state and federal regulations regarding storage, handling, and transport of petroleum products.
- Create procedures for collection such as; collection locations and schedule, acceptable containers, and maximum amounts accepted.
- The California Integrated Waste Management Board has a Recycling Hotline, (800) 553-2962, that provides information and recycling locations for used oil.

Household Hazardous Waste

- Provide household hazardous waste (HHW) collection facilities. Several types of collection approaches are available including permanent, periodic, or mobile centers, curbside collection, or a combination of these systems.

Training

- Train municipal employees and contractors in proper and consistent methods for waste disposal.
- Train municipal employees to recognize and report illegal dumping.
- Train employees and subcontractors in proper hazardous waste management.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Federal Regulations (RCRA, SARA, CERCLA) and state regulations exist regarding the disposal of hazardous waste.
- Municipalities are required to have a used oil recycling element and a HHW element within their integrated waste management plan.
- Significant liability issues are involved with the collection, handling, and disposal of HHW.

Examples

The City of Palo Alto has developed a public participation program for reporting dumping violations. When a concerned citizen or public employee encounters evidence of illegal dumping, a door hanger (similar in format to hotel "Do Not Disturb" signs) is placed on the front doors in the neighborhood. The door hanger notes that a violation has occurred in the neighborhood, informs the reader why illegal dumping is a problem, and notes that illegal dumping carries a significant financial penalty. Information is also provided on what citizens can do as well as contact numbers for more information or to report a violation.

The Port of Long Beach has a state of the art database incorporating storm drain infrastructure, potential pollutant sources, facility management practices, and a pollutant tracking system.

The State Department of Fish and Game has a hotline for reporting violations called CalTIP (1-800-952-5400). The phone number may be used to report any violation of a Fish and Game code (illegal dumping, poaching, etc.).

The California Department of Toxic Substances Control's Waste Alert Hotline, 1-800-69TOXIC, can be used to report hazardous waste violations.

References and Resources

http://www.stormwatercenter.net/

California's Nonpoint Source Program Plan http://www.co.clark.wa.us/pubworks/bmpman.pdf

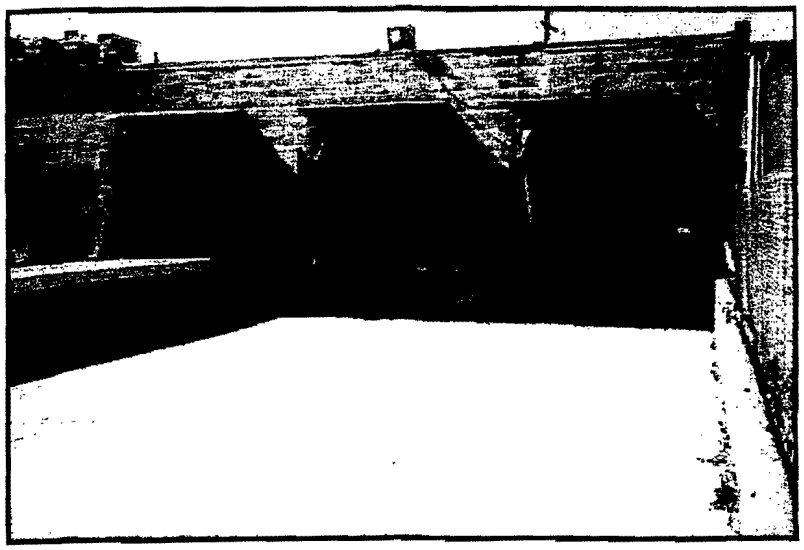
King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program,
http://www.ocwatersheds.com/stormwater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program
(http://www.projectcleanwater.org)

Santa Clara Valley Urban Runoff Pollution Prevention Program
http://www.scvurppp-w2k.com/pdf%20documents/PS_ICID.PDF

Outdoor Loading/Unloading SC-30



Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Description

The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by stormwater runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Loading and unloading of material may include package products, barrels, and bulk products. Implementation of the following protocols will prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials.

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Approach

Pollution Prevention

- Keep accurate maintenance logs to evaluate materials removed and improvements made.
- Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained.
- Limit exposure of materials with the potential to contaminate stormwater.
- Prevent stormwater runon.
- Regularly check equipment for leaks.

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Suggested Protocols

Loading and Unloading – General Guidelines

- Develop an operations plan that describes procedures for loading and/or unloading.
- Do not conduct loading and unloading during wet weather, whenever possible.
- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- A seal or door skirt between delivery vehicles and building can reduce or prevent exposure to rain.
- Design loading/unloading area to prevent stormwater runon which would include grading or berming the area, and positioning roof downspouts so they direct stormwater away from the loading/unloading areas.
- If feasible, load and unload all materials and equipment in covered areas such as building overhangs at loading docks.
- Load/unload only at designated loading areas.
- Use drip pans underneath hose and pipe connections and other leak-prone spots during liquid transfer operations, and when making and breaking connections. Several drip pans should be stored in a covered location near the liquid transfer area so that they are always available, yet protected from precipitation when not in use. Drip pans can be made specifically for railroad tracks. Drip pans must be cleaned periodically, and drip collected materials must be disposed of properly.
- Pave loading areas with concrete instead of asphalt.
- Avoid placing storm drains in the area.
- Grade and/or berm he loading/ unloading area to a drain that is connected to a dead-end sump.

Inspection

- Check loading and unloading equipment regularly for leaks, including valves, pumps, flanges and connections.
- Look for dust or fumes during loading or unloading operations.

Training

- Train employees (e.g. fork lift operators) and contractors on proper spill containment and cleanup.
- Employees trained in spill containment and cleanup should be present during the loading/unloading.
- Train employees in proper handling techniques during liquid transfers to avoid spills.

- Make sure forklift operators are properly trained on loading and unloading procedures.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Keep your spill prevention Control and countermeasure (SPCC) Plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Space, material characteristics and/or time limitations may preclude all transfers from being performed indoors or under cover.

Requirements

Costs

- Should be low except when covering a large loading/unloading area.

Maintenance

- Conduct regular inspections and make repairs as necessary. The frequency of repairs will depend on the age of the facility.
- Check loading and unloading equipment regularly for leaks.
- Regular broom dry-sweeping of area.
- Conduct major clean-out of loading and unloading area and sump prior to October 1 of each year.

Supplemental Information

Further Detail of the BMP

Special Circumstances for Indoor Loading/Unloading of Materials

As appropriate loading or unloading of liquids should occur indoors so that any spills that are not completely retained can be discharged to the sanitary sewer, treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements.

- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used:
  - The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.
  - Transfer area should be designed to prevent runon of stormwater from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce run-on.

- Transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer (if allowed). A positive control valve should be installed on the drain.

- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:

  - Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles, Use drip pans when making and breaking connections.

  - Drip pan systems should be installed between the rails to collect spillage from tank cars.

References and Resources

http://www.stormwatercenter.net/

King County - ftp://dnr.metrokc.gov/wlr/dss/spcm/Chapter%203.PDF

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) -
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Outdoor Storage of Raw Materials SC-33

Photo Credit: Geoff Brosseau

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Description

Raw materials, by-products, finished products, containers, and material storage areas exposed to rain and/or runoff can pollute stormwater. Stormwater can become contaminated when materials wash off or dissolve into water or are added to runoff by spills and leaks. Improper storage of these materials can result in accidental spills and the release of materials. To prevent or reduce the discharge of pollutants to stormwater from material delivery and storage, pollution prevention and source control measures must be implemented, such as minimizing the storage of hazardous materials on-site, enclosing or covering materials, storing materials in a designated area, installing secondary containment, conducting regular inspections, preventing stormwater run-on and runoff, and training employees and subcontractors.

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

Pollution Prevention

- Emphasize employee education for successful BMP implementation.
- Minimize inventory of raw materials.
- Keep an accurate, up-to-date inventory of the materials delivered and stored on-site.

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- Try to keep chemicals in their original containers and keep them well labeled.

Suggested Protocols

General

- Store all materials inside. If this is not feasible, then all outside storage areas should be covered with a roof and bermed or enclosed to prevent stormwater contact. At the very minimum, a temporary waterproof covering made of polyethylene, polypropylene or hypalon should be used over all materials stored outside.
- Cover and contain the stockpiles of raw materials to prevent stormwater from running into the covered piles. The covers must be in place at all times when work with the stockpiles is not occurring. (Applicable to small stockpiles only).
- Implement erosion control practices at the perimeter of your site and at any catch basins to prevent erosion of the stockpiled material off-site, if the stockpiles are so large that they cannot feasibly be covered and contained.
- Keep liquids in a designated area on a paved impervious surface within a secondary containment.
- Keep outdoor storage containers in good condition.
- Minimize stormwater run-on by enclosing the area or building a berm around it.
- Keep storage areas clean and dry.
- Slope paved areas should be sloped in a manner that minimize pooling of water on the site, particularly with materials that may leach pollutants into stormwater and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5% is recommended.
- Secure drums stored in an area where unauthorized persons may gain access to prevent accidental spillage, pilferage, or any unauthorized use.
- Cover wood products treated with chromated copper arsenate, ammonical copper zinc arsenate, creosote, or pentachlorophenol with tarps or store indoors.

Raw Material Containment

- Curbing should be placed along the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of stormwater from the stockpile areas.
- Tanks should be bermed or surrounded by a secondary containment system.
- The area inside the curb should slope to a drain. Liquids should be drained to the sanitary sewer if available. The drain must have a positive control such as a lock, valve, or plug to prevent release of contaminated liquids.
- Accumulated stormwater in petroleum storage areas should be passed through an oil/water separator.

Inspection

- Conduct regular inspections of storage areas so that leaks and spills are detected as soon as possible.
- Check berms, curbing, containment for repair and patching.

Training

- Train employees well in proper material storage.
- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.

Other Considerations

- Storage sheds often must meet building and fire code requirements. Storage of reactive, ignitable, or flammable liquids must comply with the Uniform Fire Code and the National Electric Code.
- Space limitations may preclude storing some materials indoors.
- Some municipalities require that secondary containment areas (regardless of size) be connected to the sanitary sewer, prohibiting any hard connections to the storm drain. Storage sheds often must meet building and fire code requirements.
- The local fire district must be consulted for limitations on clearance of roof covers over containers used to store flammable materials.

Requirements

Costs

Costs will vary depending on the size of the facility and the necessary controls. They should be low except where large areas may have to be covered.

Maintenance

- Accurate and up-to-date inventories should be kept of all stored materials.
- Berms and curbs may require periodic repair and patching.
- Parking lots or other surfaces near bulk materials storage areas should be swept periodically to remove debris blown or washed from storage areas.
- Sweep paved storage areas regularly for collection and disposal of loose solid materials, do not hose down the area to a storm drain or conveyance ditch.

- Keep outdoor storage areas in good condition (e.g., repair roofs, floors, etc., to limit releases to runoff).

Supplemental Information

Further Detail of the BMP

Raw Material Containment

Paved areas should be sloped in a manner that minimizes pooling of water on the site, particularly with materials that may leach pollutants into stormwater and/or groundwater, such as compost, logs, and wood chips. A minimum slope of 1.5% is recommended.

- Curbing should be placed along the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of stormwater from stockpile areas.
- The storm drainage system should be designed to minimize use of catch basins in the interior of the area as they tend to rapidly fill with manufacturing material.
- The area should be sloped to drain stormwater to the perimeter where it can be collected or to internal drainage alleyways where material is not stockpiled.
- If the raw material, by-product, or product is a liquid, more information for outside storage of liquids can be found under SC31, Outdoor Liquid Container Storage.

Supplemental Information

Examples

The "doghouse" design has been used to store small liquid containers. The roof and flooring design prevent contact with direct rain or runoff. The doghouse has two solid structural walls and two canvas covered walls. The flooring is wire mesh about secondary containment. The unit has been used successively at Lockheed Missile and Space Company in Sunnyvale.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

Waste Handling & Disposal SC-34

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Description

Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, suspended solids, and other pollutants to enter stormwater runoff. The discharge of pollutants to stormwater from waste handling and disposal can be prevented and reduced by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, re-use, and recycling; and preventing runon and runoff.

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Approach

Pollution Prevention

- Reduction in the amount of waste generated can be accomplished using the following source controls such as:
  - Production planning and sequencing
  - Process or equipment modification
  - Raw material substitution or elimination
  - Loss prevention and housekeeping
  - Waste segregation and separation
  - Close loop recycling
- Establish a material tracking system to increase awareness about material usage. This may reduce spills and minimize contamination, thus reducing the amount of waste produced.
- Recycle materials whenever possible.

Suggested Protocols

General

- Cover storage containers with leak proof lids or some other means. If waste is not in containers, cover all waste piles (plastic tarps are acceptable coverage) and prevent stormwater runon and runoff with a berm. The waste containers or piles must be covered except when in use.
- Use drip pans or absorbent materials whenever grease containers are emptied by vacuum trucks or other means. Grease cannot be left on the ground. Collected grease must be properly disposed of as garbage.
- Check storage containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.
- Sweep and clean the storage area regularly. If it is paved, do not hose down the area to a storm drain.
- Dispose of rinse and wash water from cleaning waste containers into a sanitary sewer if allowed by the local sewer authority. Do not discharge wash water to the street or storm drain.
- Transfer waste from damaged containers into safe containers.
- Take special care when loading or unloading wastes to minimize losses. Loading systems can be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide a sufficient number of litter receptacles for the facility.
- Clean out and cover litter receptacles frequently to prevent spillage.

Waste Collection

- Keep waste collection areas clean.
- Inspect solid waste containers for structural damage or leaks regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Place waste containers under cover if possible.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc. may not be

disposed of in solid waste containers (see chemical/ hazardous waste collection section below).

- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal.

Good Housekeeping

- Use all of the product before disposing of the container.
- Keep the waste management area clean at all times by sweeping and cleaning up spills immediately.
- Use dry methods when possible (e.g. sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.
- Stencil storm drains on the facility's property with prohibitive message regarding waste disposal.

Chemical/Hazardous Wastes

- Select designated hazardous waste collection areas on-site.
- Store hazardous materials and wastes in covered containers protected from vandalism, and in compliance with fire and hazardous waste codes.
- Place hazardous waste containers in secondary containment.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.

Runon/Runoff Prevention

- Prevent stormwater runon from entering the waste management area by enclosing the area or building a berm around the area.
- Prevent the waste materials from directly contacting rain.
- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropyleneor hypalon.
- Cover the area with a permanent roof if feasible.
- Cover dumpsters to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster.
- Move the activity indoor after ensuring all safety concerns such as fire hazard and ventilation are addressed.

Inspection

- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.
- Check waste management areas for leaking containers or spills.
- Repair leaking equipment including valves, lines, seals, or pumps promptly.

Training

- Train staff pollution prevention measures and proper disposal methods.
- Train employees and contractors proper spill containment and cleanup. The employee should have the tools and knowledge to immediately begin cleaning up a spill if one should occur.
- Train employees and subcontractors in proper hazardous waste management.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.
- Vehicles transporting waste should have spill prevention equipment that can prevent spills during transport. The spill prevention equipment includes:
  - Vehicles equipped with baffles for liquid waste
  - Trucks with sealed gates and spill guards for solid waste

Other Considerations

- Hazardous waste cannot be re-used or recycled; it must be disposed of by a licensed hazardous waste hauler.

Requirements

Costs

- Capital and operation and maintenance costs will vary substantially depending on the size of the facility and the types of waste handled. Costs should be low if there is an inventory program in place.

Maintenance

- None except for maintaining equipment for material tracking program.

Supplemental Information

Further Detail of the BMP

Land Treatment System

- Minimize the runoff of polluted stormwater from land application of municipal waste on-site by:
  - Choosing a site where slopes are under 6%, the soil is permeable, there is a low water table, it is located away from wetlands or marshes, there is a closed drainage system.
  - Avoiding application of waste to the site when it is raining or when the ground is saturated with water.
  - Growing vegetation on land disposal areas to stabilize soils and reduce the volume of surface water runoff from the site.
  - Maintaining adequate barriers between the land application site and the receiving waters. Planted strips are particularly good.
  - Using erosion control techniques such as mulching and matting, filter fences, straw bales, diversion terracing, and sediment basins.
  - Performing routine maintenance to ensure the erosion control or site stabilization measures are working.

References and Resources

King County Stormwater Pollution Control Manual - http://dnr.metrokc.gov/wlr/dss/spcm.htm

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Pollution from Surface Cleaning Folder, 1996. Bay Area Stormwater Management Agencies Associations (BASMAA). On-line: http://www.basmaa.org

Safer Alternative Products SC-35

Description

Promote the use of less harmful products and products that contain little or no TMDL pollutants. Alternatives exist for most product classes including chemical fertilizers, pesticides, cleaning solutions, janitorial chemicals, automotive and paint products, and consumables (batteries, fluorescent lamps).

Approach

Pattern a new program after the many established programs around the state and country. Integrate this best management practice as much as possible with existing programs at your facility.

Develop a comprehensive program based on:

- The "Precautionary Principle," which is an alternative to the "Risk Assessment" model that says it's acceptable to use a potentially harmful product until physical evidence of its harmful effects are established and deemed too costly from an environmental or public health perspective. For instance, a risk assessment approach might say it's acceptable to use a pesticide until there is direct proof of an environmental impact. The Precautionary Principle approach is used to evaluate whether a given product is safe, whether it is really necessary, and whether alternative products would perform just as well.
- Environmentally Preferable Purchasing Program to minimize the purchase of products containing hazardous ingredients used in the facility's custodial services, fleet maintenance, and facility maintenance in favor of using alternate products that pose less risk to employees and to the environment.
- Integrated Pest Management (IPM) or Less-Toxic Pesticide Program, which uses a pest management approach that minimizes the use of toxic chemicals and gets rid of pests by methods that pose a lower risk to employees, the public, and the environment.
- Energy Efficiency Program including no-cost and low-cost energy conservation and efficiency actions that can reduce both energy consumption and electricity bills, along with long-term energy efficiency investments.

Consider the following mechanisms for developing and implementing a comprehensive program:

- Policies

Objectives

- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

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- Procedures
  - Standard operating procedures (SOPs)
  - Purchasing guidelines and procedures
  - Bid packages (services and supplies)
- Materials
  - Preferred or approved product and supplier lists
  - Product and supplier evaluation criteria
  - Training sessions and manuals
  - Fact sheets for employees

Implement this BMP in conjunction with the Vehicle and Equipment Management fact sheets (SC20 – SC22) and SC41, Building and Grounds Maintenance.

Training

- Employees who handle potentially harmful materials in the use of safer alternatives.
- Purchasing departments should be encouraged to procure less hazardous materials and products that contain little or no harmful substances or TMDL pollutants.

Regulations

This BMP has no regulatory requirements. Existing regulations already encourage facilities to reduce the use of hazardous materials through incentives such as reduced:

- Specialized equipment storage and handling requirements,
- Storm water runoff sampling requirements,
- Training and licensing requirements, and
- Record keeping and reporting requirements.

Equipment

- There are no major equipment requirements to this BMP.

Limitations

- Alternative products may not be available, suitable, or effective in every case.

Requirements

Cost Considerations

- The primary cost is for staff time to: 1) develop new policies and procedures and 2) educate purchasing departments and employees who handle potentially harmful materials about the availability, procurement, and use of safer alternatives.

- Some alternative products may be slightly more expensive than conventional products.

Supplemental Information

Employees and contractors / service providers can both be educated about safer alternatives by using information developed by a number of organizations including the references and resources listed below.

The following discussion provides some general information on safer alternatives. More specific information on particular hazardous materials and the available alternatives may be found in the references and resources listed below.

- Automotive products – Less toxic alternatives are not available for many automotive products, especially engine fluids. But there are alternatives to grease lubricants, car polishes, degreasers, and windshield washer solution. Rerefined motor oil is also available.
- Vehicle/Trailer lubrication – Fifth wheel bearings on trucks require routine lubrication. Adhesive lubricants are available to replace typical chassis grease.
- Cleaners – Vegetables-based or citrus-based soaps are available to replace petroleum-based soaps/detergents.
- Paint products – Water-based paints, wood preservatives, stains, and finishes are available.
- Pesticides – Specific alternative products or methods exist to control most insects, fungi, and weeds.
- Chemical Fertilizers – Compost and soil amendments are natural alternatives.
- Consumables – Manufacturers have either reduced or are in the process of reducing the amount of heavy metals in consumables such as batteries and fluorescent lamps. All fluorescent lamps contain mercury, however low-mercury containing lamps are now available from most hardware and lighting stores. Fluorescent lamps are also more energy efficient than the average incandescent lamp.
- Janitorial chemicals – Even biodegradable soap can harm fish and wildlife before it biodegrades. Biodegradable does not mean non-toxic. Safer products and procedures are available for floor stripping and cleaning, as well as carpet, glass, metal, and restroom cleaning and disinfecting.

Examples

There are a number of business and trade associations, and communities with effective programs. Some of the more prominent are listed below in the references and resources section.

References and Resources

Note: Many of these references provide alternative products for materials that typically are used inside and disposed to the sanitary sewer as well as alternatives to products that usually end up in the storm drain.

General Sustainable Practices and Pollution Prevention Including Pollutant-Specific Information

California Department of Toxic Substances Control (www.dtsc.ca.gov)

California Integrated Waste Management Board (www.ciwmb.ca.gov)

City of Santa Monica (www.santa-monica.org/environment)

City of Palo Alto (www.city.palo-alto.ca.us/cleanbay)

City and County of San Francisco, Department of the Environment (www.ci.sf.ca.us/sfenvironment)

Earth 911 (www.earth911.org/master.asp)

Environmental Finance Center Region IX (www.greenstart.org/efc9)

Flex Your Power (www.flexyourpower.ca.gov)

GreenBiz.com (www.greenbiz.com)

Green Business Program (www.abag.org/bayarea/enviro/gbus/gb.html)

Pacific Industrial and Business Association (www.piba.org)

Sacramento Clean Water Business Partners (www.sacstormwater.org)

USEPA BMP fact sheet – Alternative products (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/poll_2.cfm)

USEPA Region IX Pollution Prevention Program (www.epa.gov/region09/p2)

Western Regional Pollution Prevention Network (www.westp2net.org)

Metals (mercury, copper)

National Electrical Manufacturers Association - Environment, Health and Safety (www.nema.org)

Sustainable Conservation (www.suscon.org)

Auto Recycling Project

Brake Pad Partnership

Pesticides and Chemical Fertilizers

Bio-Integral Resource Center (www.birc.org)

California Department of Pesticide Regulation (www.cdpr.ca.gov)

University of California Statewide IPM Program (www.ipm.ucdavis.edu/default.html)

Dioxins

Bay Area Dioxins Project (http://dioxin.abag.ca.gov/)

Building & Grounds Maintenance SC-41

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, and abnormal pH. Utilizing the following protocols will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Pollution Prevention

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.
- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

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Suggested Protocols

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a waste water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash water runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in he catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement. Ensure that this practice does not kill grass.

Landscaping Activities

- Do not apply any chemicals (insecticide, herbicide, or fertilizer) directly to surface waters, unless the application is approved and permitted by the state.
- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.
- Check irrigation schedules so pesticides will not be washed away and to minimize non-stormwater discharge.

Building Repair, Remodeling, and Construction

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paint brushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.

- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.
- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. In which case you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover with secondary containment during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water; do not put it in the storm drain, pour over landscaped areas.
- Use hand or mechanical weeding where practical.

Fertilizer and Pesticide Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Follow manufacturers' recommendations and label directions. Pesticides must never be applied if precipitation is occuring or predicted. Do not apply insecticides within 100 feet of surface waters such as lakes, ponds, wetlands, and streams.
- Use less toxic pesticides that will do the job, whenever possible. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g. spray drift) of pesticides, including consideration of alternative application techniques.

- Apply pesticides only when wind speeds are low.
- Work fertilizers into the soil rather than dumping or broadcasting them onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering, and repair leaks in the irrigation system as soon as they are observed.

Training

- Educate and train employees on use of pesticides and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, and implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Alternative pest/weed controls may not be available, suitable, or effective in many cases.

Requirements

Costs

- Overall costs should be low in comparison to other BMPs.

Maintenance

- Sweep paved areas regularly to collect loose particles, and wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

Supplemental Information

Further Detail of the BMP

Fire Sprinkler Line Flushing

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping but it is subject to rusting and results in lower quality water. Initially the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time, typically a year, between flushes and may accumulate iron, manganese, lead, copper, nickel and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

King County - ftp://dnr.metrokc.gov/wlr/dss/spcm/Chapter%203.PDF

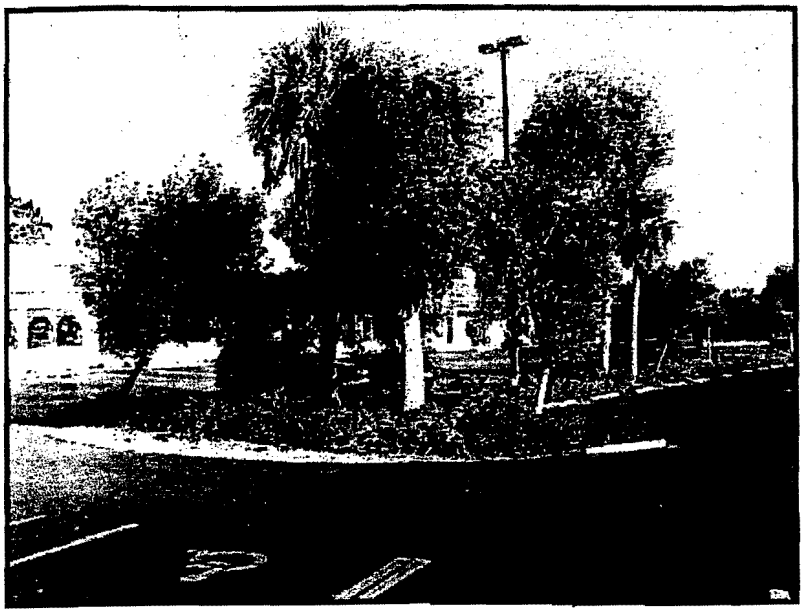
Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASSMA) http://www.basmaa.org/

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA) http://www.basmaa.org/

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP) -
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Parking/Storage Area Maintenance SC-43



Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑
Oxygen Demanding	☑

Description

Parking lots and storage areas can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The following protocols are intended to prevent or reduce the discharge of pollutants from parking/storage areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

Approach

Pollution Prevention

- Encourage alternative designs and maintenance strategies for impervious parking lots. (See New Development and Redevelopment BMP Handbook).
- Keep accurate maintenance logs to evaluate BMP implementation.

Suggested Protocols

General

- Keep the parking and storage areas clean and orderly. Remove debris in a timely fashion.
- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low concentrations.

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SC-43 Parking/Storage Area Maintenance

- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.

Controlling Litter

- Post "No Littering" signs and enforce anti-litter laws.
- Provide an adequate number of litter receptacles.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Provide trash receptacles in parking lots to discourage litter.
- Routinely sweep, shovel and dispose of litter in the trash.

Surface cleaning

- Use dry cleaning methods (e.g. sweeping or vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system.
- Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- Sweep all parking lots at least once before the onset of the wet season.
- If water is used follow the procedures below:
  - Block the storm drain or contain runoff.
  - Wash water should be collected and pumped to the sanitary sewer or discharged to a pervious surface, do not allow wash water to enter storm drains.
  - Dispose of parking lot sweeping debris and dirt at a landfill.
- When cleaning heavy oily deposits:
  - Use absorbent materials on oily spots prior to sweeping or washing.
  - Dispose of used absorbents appropriately.

Surface Repair

- Pre-heat, transfer or load hot bituminous material away from storm drain inlets.
- Apply concrete, asphalt, and seal coat during dry weather to prevent contamination form contacting stormwater runoff.
- Cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc., where applicable. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.

- Use only as much water as necessary for dust control, to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

Inspection

- Have designated personnel conduct inspections of the parking facilities and stormwater conveyance systems associated with them on a regular basis.
- Inspect cleaning equipment/sweepers for leaks on a regular basis.

Training

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.

Spill Response and Prevention

- Refer to SC-11, Spill Prevention, Control & Cleanup.
- Keep your Spill Prevention Control and countermeasure (SPCC) plan up-to-date, nad implement accordingly.
- Have spill cleanup materials readily available and in a known location.
- Cleanup spills immediately and use dry methods if possible.
- Properly dispose of spill cleanup material.

Other Considerations

- Limitations related to sweeping activities at large parking facilities may include high equipment costs, the need for sweeper operator training, and the inability of current sweeper technology to remove oil and grease.

Requirements

Costs

Cleaning/sweeping costs can be quite large, construction and maintenance of stormwater structural controls can be quite expensive as well.

Maintenance

- Sweep parking lot to minimize cleaning with water.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Clean parking facilities on a regular basis to prevent accumulated wastes and pollutants from being discharged into conveyance systems during rainy conditions.

SC-43 Parking/Storage Area Maintenance

Supplemental Information

Further Detail of the BMP

Surface Repair

Apply concrete, asphalt, and seal coat during dry weather to prevent contamination form contacting stormwater runoff. Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and until all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal. Use only as much water as necessary for dust control, to avoid runoff.

References and Resources

http://www.stormwatercenter.net/

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Model Urban Runoff Program: A How-To Guide for Developing Urban Runoff Programs for Small Municipalities. Prepared by City of Monterey, City of Santa Cruz, California Coastal Commission, Monterey Bay National Marine Sanctuary, Association of Monterey Bay Area Governments, Woodward-Clyde, Central Coast Regional Water Quality control Board. July 1998 (Revised February 2002 by the California Coastal Commission).

Orange County Stormwater Program
http://www.ocwatersheds.com/StormWater/swp_introduction.asp

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA) http://www.basma.org

San Diego Stormwater Co-permittees Jurisdictional Urban Runoff Management Program (URMP)
http://www.projectcleanwater.org/pdf/Model%20Program%20Municipal%20Facilities.pdf

Drainage System Maintenance SC-44

Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize

Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff and stormwater that may contain certain pollutants. The protocols in this fact sheet are intended to reduce pollutants reaching receiving waters through proper conveyance system operation and maintenance.

Targeted Constituents

Sediment	✓
Nutrients	
Trash	✓
Metals	
Bacteria	✓
Oil and Grease	
Organics	

Approach

Pollution Prevention

Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

Suggested Protocols

Catch Basins/Inlet Structures

- Staff should regularly inspect facilities to ensure compliance with the following:
  - Immediate repair of any deterioration threatening structural integrity.
  - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
  - Stenciling of catch basins and inlets (see SC34 Waste Handling and Disposal).

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- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.
- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS.

Illicit Connections and Discharges

- Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:
  - Is there evidence of spills such as paints, discoloring, etc?

- Are there any odors associated with the drainage system?
- Record locations of apparent illegal discharges/illicit connections?
- Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- Eliminate the discharge once the origin of flow is established.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Illegal Dumping

- Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties
- Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

Training

- Train crews in proper maintenance activities, including record keeping and disposal.
- Allow only properly trained individuals to handle hazardous materials/wastes.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).

- OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
- Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Spill Response and Prevention

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.
- Refer to fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Other Considerations (Limitations and Regulations)

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.
- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and prohibition against disposal of flushed effluent to sanitary sewer in some areas.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

Requirements

Costs

- An aggressive catch basin cleaning program could require a significant capital and O&M budget.
- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The primary cost is for staff time. Cost depends on how aggressively a program is implemented. Other cost considerations for an illegal dumping program include:
  - Purchase and installation of signs.
  - Rental of vehicle(s) to haul illegally-disposed items and material to landfills.
  - Rental of heavy equipment to remove larger items (e.g., car bodies) from channels.
  - Purchase of landfill space to dispose of illegally-dumped items and material.

- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.

Supplemental Information

Further Detail of the BMP

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing resuspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm sewer flushing.

References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

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King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net

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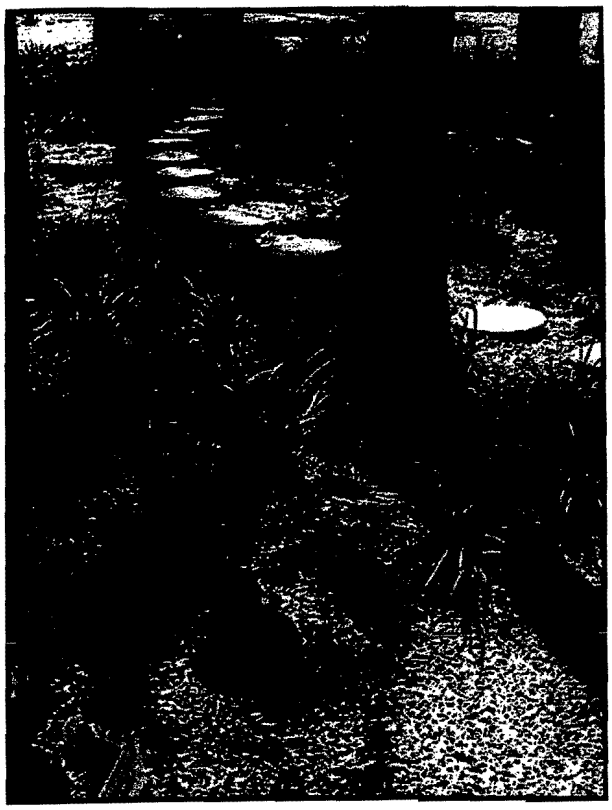
http://www.epa.gov/npdes/menuofbmps/poll_16.htm

Site Design & Landscape Planning SD-10



Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

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SD-10 Site Design & Landscape Planning

Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

SD-10 Site Design & Landscape Planning

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

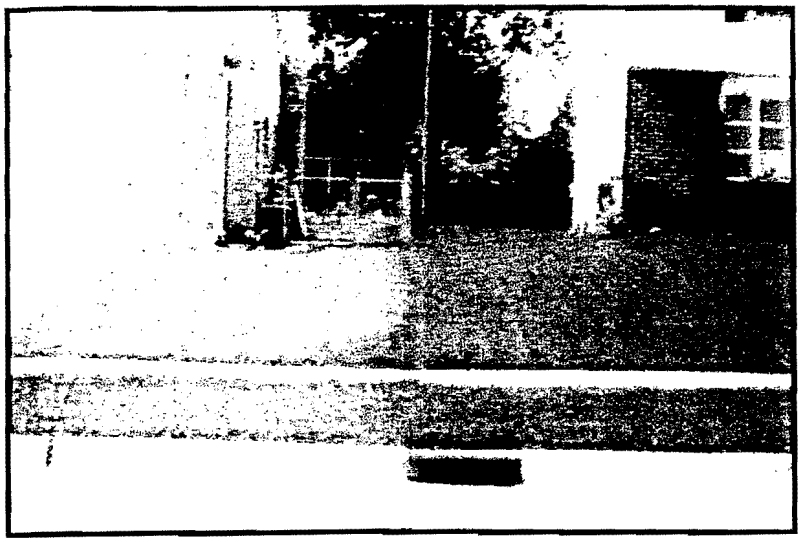
Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Efficient Irrigation SD-12



Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Designing New Installations

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Other Resources

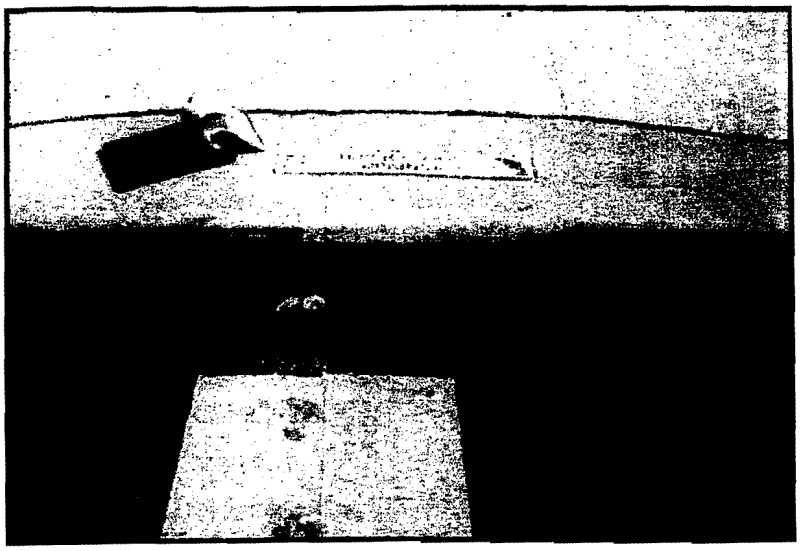
A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Storm Drain Signage SD-13



Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

Designing New Installations

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include "NO DUMPING

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– DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

Additional Information

Maintenance Considerations

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

Placement

- Signage on top of curbs tends to weather and fade.
- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

Supplemental Information

Examples

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

Other Resources

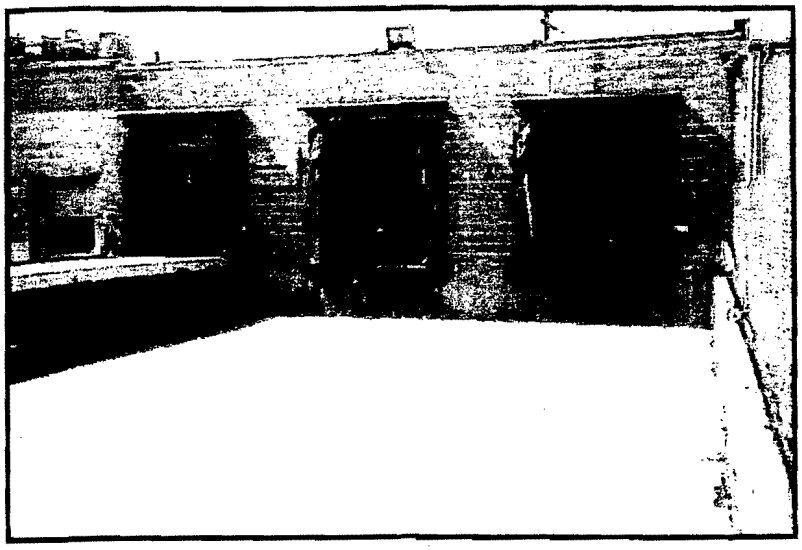
A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Maintenance Bays & Docks SD-31



Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Description

Several measures can be taken to prevent operations at maintenance bays and loading docks from contributing a variety of toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to the stormwater conveyance system.

Approach

In designs for maintenance bays and loading docks, containment is encouraged. Preventative measures include overflow containment structures and dead-end sumps. However, in the case of loading docks from grocery stores and warehouse/distribution centers, engineered infiltration systems may be considered.

Suitable Applications

Appropriate applications include commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for vehicle maintenance and repair are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code requirements.

Designing New Installations

Designs of maintenance bays should consider the following:

- Repair/maintenance bays and vehicle parts with fluids should be indoors; or designed to preclude urban run-on and runoff.
- Repair/maintenance floor areas should be paved with Portland cement concrete (or equivalent smooth impervious surface).

- Repair/maintenance bays should be designed to capture all wash water leaks and spills. Provide impermeable berms, drop inlets, trench catch basins, or overflow containment structures around repair bays to prevent spilled materials and wash-down waters form entering the storm drain system. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.
- Other features may be comparable and equally effective.

The following designs of loading/unloading dock areas should be considered:

- Loading dock areas should be covered, or drainage should be designed to preclude urban run-on and runoff.
- Direct connections into storm drains from depressed loading docks (truck wells) are prohibited.
- Below-grade loading docks from grocery stores and warehouse/distribution centers of fresh food items should drain through water quality inlets, or to an engineered infiltration system, or an equally effective alternative. Pre-treatment may also be required.
- Other features may be comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Trash Storage Areas SD-32

Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

Designing New Installations

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

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- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Maintenance Considerations

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

Other Resources

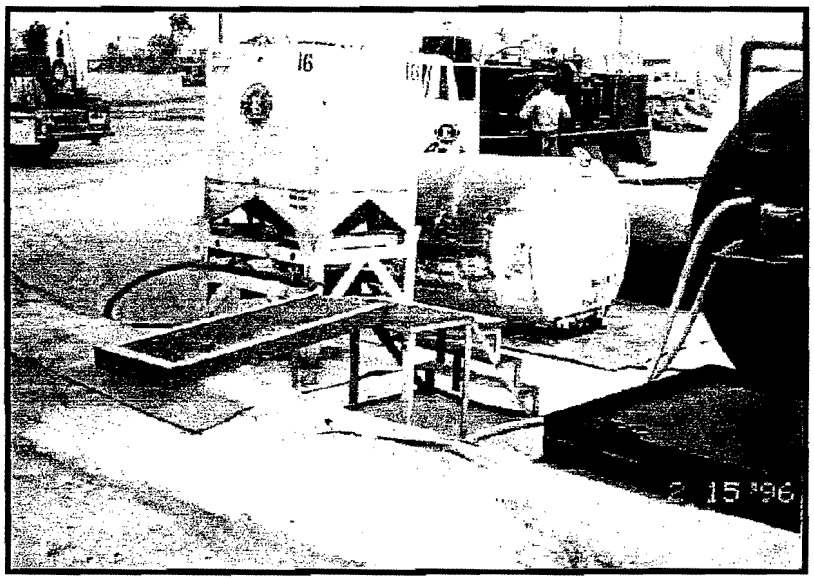
A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Outdoor Material Storage Areas SD-34



Design Objectives

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutant
- Collect and Convey

Description

Proper design of outdoor storage areas for materials reduces opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the stormwater conveyance system. Materials may be in the form of raw products, by-products, finished products, and waste products. The type of pollutants associated with the materials will vary depending on the type of commercial or industrial activity.

Approach

Outdoor storage areas require a drainage approach different from the typical infiltration/detention strategy. In outdoor storage areas, infiltration is discouraged. Containment is encouraged. Preventative measures include enclosures, secondary containment structures and impervious surfaces.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Some materials are more of a concern than others. Toxic and hazardous materials must be prevented from coming in contact with stormwater. Non-toxic or non-hazardous materials do not have to be prevented from stormwater contact. However, these materials may have toxic effects on receiving waters if allowed to be discharged with stormwater in significant quantities. Accumulated material on an impervious surface could result in significant impact on the rivers or streams that receive the runoff.

Material may be stored in a variety of ways, including bulk piles, containers, shelving, stacking, and tanks. Stormwater contamination may be prevented by eliminating the possibility of stormwater contact with the material storage areas either through diversion, cover, or capture of the stormwater. Control measures may also include minimizing the storage area. Design

requirements for material storage areas are governed by Building and Fire Codes, and by current City or County ordinances and zoning requirements. Control measures are site specific, and must meet local agency requirements.

Designing New Installations

Where proposed project plans include outdoor areas for storage of materials that may contribute pollutants to the stormwater conveyance system, the following structural or treatment BMPS should be considered:

- Materials with the potential to contaminate stormwater should be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the stormwater conveyance system, or (2) protected by secondary containment structures such as berms, dikes, or curbs.
- The storage area should be paved and sufficiently impervious to contain leaks and spills.
- The storage area should slope towards a dead-end sump to contain spills and direct runoff from downspouts/roofs should be directed away from storage areas.
- The storage area should have a roof or awning that extends beyond the storage area to minimize collection of stormwater within the secondary containment area. A manufactured storage shed may be used for small containers.

Note that the location(s) of installations of where these preventative measures will be employed must be included on the map or plans identifying BMPs.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Additional Information

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permits.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

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Infiltration Basin TC-11

Maintenance Concerns, Objectives, and Goals

- Vector Control
- Clogged soil or outlet structures
- Vegetation/Landscape Maintenance
- Groundwater contamination
- Accumulation of metals
- Aesthetics

General Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually infiltrates into the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

Targeted Constituents

✓	Sediment	■
✓	Nutrients	■
✓	Trash	■
✓	Metals	■
✓	Bacteria	■
✓	Oil and Grease	■
✓	Organics	■
✓	Oxygen Demanding	■

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Inspection/Maintenance Considerations

Infiltration basins perform better in well-drained permeable soils. Infiltration basins in areas of low permeability can clog within a couple years, and require more frequent inspections and maintenance. The use and regular maintenance of pretreatment BMPs will significantly minimize maintenance requirements for the basin. Spill response procedures and controls should be implemented to prevent spills from reaching the infiltration system.

Scarification or other disturbance should only be performed when there are actual signs of clogging or significant loss of infiltrative capacity, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a light tractor. This BMP may require groundwater monitoring. Basins cannot be put into operation until the upstream tributary area is stabilized.

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TC-11 Infiltration Basin

Clogged infiltration basins with surface standing water can become a breeding area for mosquitoes and midges. Maintenance efforts associated with infiltration basins should include frequent inspections to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.

Inspection Activities	
■ Observe drain time for a storm after completion or modification of the facility to confirm that the desired drain time has been obtained. ■ Newly established vegetation should be inspected several times to determine if any landscape maintenance (reseeding, irrigation, etc.) is necessary.	Post construction
■ Inspect for the following issues: differential accumulation of sediment, signs of wetness or damage to structures, erosion of the basin floor, dead or dying grass on the bottom, condition of riprap, drain time, signs of petroleum hydrocarbon contamination, standing water, trash and debris, sediment accumulation, slope stability, pretreatment device condition	Semi-annual and after extreme events
Maintenance Activities	
■ Factors responsible for clogging should be repaired immediately. ■ Weed once monthly during the first two growing seasons.	Post construction
■ Stabilize eroded banks. ■ Repair undercut and eroded areas at inflow and outflow structures. ■ Maintain access to the basin for regular maintenance activities. ■ Mow as appropriate for vegetative cover species. ■ Monitor health of vegetation and replace as necessary. ■ Control mosquitoes as necessary. ■ Remove litter and debris from infiltration basin area as required.	Standard maintenance (as needed)
■ Mow and remove grass clippings, litter, and debris. ■ Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons. ■ Replant eroded or barren spots to prevent erosion and accumulation of sediment.	Semi-annual
■ Scrape bottom and remove sediment when accumulated sediment reduces original infiltration rate by 25-50%. Restore original cross-section and infiltration rate. Properly dispose of sediment. ■ Seed or sod to restore ground cover. ■ Disc or otherwise aerate bottom. ■ Dethatch basin bottom.	3-5 year maintenance

Additional Information

In most cases, sediment from an infiltration basin does not contain toxins at levels posing a hazardous concern. Studies to date indicate that pond sediments are generally below toxicity limits and can be safely landfilled or disposed onsite. Onsite sediment disposal is always preferable (if local authorities permit) as long as the sediments are deposited away from the shoreline to prevent their reentry into the pond and away from recreation areas, where they could possibly be ingested by young children. Sediments should be tested for toxicants in compliance with current disposal requirements if land uses in the catchment include commercial or industrial zones, or if visual or olfactory indications of pollution are noticed. Sediments containing high levels of pollutants should be disposed of properly.

Light equipment, which will not compact the underlying soil, should be used to remove the top layer of sediment. The remaining soil should be tilled and revegetated as soon as possible.

Sediment removal within the basin should be performed when the sediment is dry enough so that it is cracked and readily separates from the basin floor. This also prevents smearing of the basin floor.

References

King County, Stormwater Pollution Control Manual – Best Management Practices for Businesses. July, 1995 Available at: ftp://dnr.metrokc.gov/wlr/dss/spcm/SPCM.HTM

Metropolitan Council, Urban Small Sites Best Management Practices Manual. Available at: http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development & Redevelopment BMP Factsheets. Available at: http://www.cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_files.cfm

Ventura Countywide Stormwater Quality Management Program, Technical Guidance Manual for Stormwater Quality Control Measures. July, 2002.

Vegetated Swale TC-30

Maintenance Concerns, Objectives, and Goals

- Channelization
- Vegetation/Landscape Maintenance
- Vector Control
- Aesthetics
- Hydraulic and Removal Efficacy

General Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems. Therefore, swales are best suited for residential, industrial, and commercial areas with low flow and smaller populations.

Targeted Constituents

✓	Sediment	▲
✓	Nutrients	●
✓	Trash	●
✓	Metals	▲
✓	Bacteria	●
✓	Oil and Grease	▲
✓	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Inspection/Maintenance Considerations

It is important to consider that a thick vegetative cover is needed for vegetated swales to function properly. Usually, swales require little more than normal landscape maintenance activities such as irrigation and mowing to maintain pollutant removal efficiency. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g., debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained. The application of fertilizers and pesticides should be minimized.

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Inspection Activities	Suggested Frequency
■ Inspect after seeding and after first major storms for any damages.	Post construction
■ Inspect for signs of erosion, damage to vegetation, channelization of flow, debris and litter, and areas of sediment accumulation. Perform inspections at the beginning and end of the wet season. Additional inspections after periods of heavy runoff are desirable.	Semi-annual
■ Inspect level spreader for clogging, grass along side slopes for erosion and formation of rills or gullies, and sand/soil bed for erosion problems.	Annual

Maintenance Activities	Suggested Frequency
■ Mow grass to maintain a height of 3–4 inches, for safety, aesthetic, or other purposes. Litter should always be removed prior to mowing. Clippings should be composted. ■ Irrigate swale during dry season (April through October) or when necessary to maintain the vegetation. ■ Provide weed control, if necessary to control invasive species.	As needed (frequent, seasonally)
■ Remove litter, branches, rocks blockages, and other debris and dispose of properly. ■ Maintain inlet flow spreader (if applicable). ■ Repair any damaged areas within a channel identified during inspections. Erosion rills or gullies should be corrected as needed. Bare areas should be replanted as necessary.	Semi-annual
■ Declog the pea gravel diaphragm, if necessary. ■ Correct erosion problems in the sand/soil bed of dry swales. ■ Plant an alternative grass species if the original grass cover has not been successfully established. Reseed and apply mulch to damaged areas.	Annual (as needed)
■ Remove all accumulated sediment that may obstruct flow through the swale. Sediment accumulating near culverts and in channels should be removed when it builds up to 3 in. at any spot, or covers vegetation, or once it has accumulated to 10% of the original design volume. Replace the grass areas damaged in the process. ■ Rototill or cultivate the surface of the sand/soil bed of dry swales if the swale does not draw down within 48 hours.	As needed (infrequent)

Additional Information

Recent research (Colwell et al., 2000) indicates that grass height and mowing frequency have little impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.

References

Metropolitan Council, Urban Small Sites Best Management Practices Manual. Available at: http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm

U.S. Environmental Protection Agency, Post-Construction Stormwater Management in New Development & Redevelopment BMP Factsheets. Available at: cfpub.epa.gov/npdes/stormwater/menuofbmps/bmp_files.cfm

Ventura Countywide Stormwater Quality Management Program, Technical Guidance Manual for Stormwater Quality Control Measures. July, 2002.

Attachment D SUSMP Calculations

Storm Drain Plans

APPENDIX A VOLUME & FLOW RATE CALCULATIONS

A.1 METHOD FOR CALCULATING STANDARD URBAN STORMWATER MITIGATION PLAN FLOW RATES AND VOLUMES BASED ON 0.75-INCHES OF RAINFALL: WORKSHEET

PROJECT NAME

TORRANCE SHOPPING CENTER

⟹ VEGETATED SWALE TRIBUTARY AREA

NOMENCLATURE

A_I = Impervious Area (acres)
A_P = Pervious Area (acres)
A_U = Contributing Undeveloped Upstream Area (acres)
A_{Total} = Total Area of Development and Contributing Undeveloped Upstream Area (acres)
C_D = Developed Runoff Coefficient
C_U = Undeveloped Runoff Coefficient
I_X = Rainfall Intensity (inches / hour)
Q_{PM} = Peak Mitigation Flow Rate (cfs)
T_C = Time of Concentration (minutes, must be between 5-30 min.)
V_M = Mitigation Volume (ft^3)

EQUATIONS

$A_{Total} = A_I + A_P + A_U$

$A_I = (A_{Total} * \%$ of Development which is Impervious)

$A_P = (A_{Total} * \%$ of Development which is Pervious)

$A_U = (A_{Total} * \%$ of Contributing Undeveloped Upstream Area***)

$C_D = (0.9 * Imp.) + [(1.0 - Imp.) * C_U]$ If $C_D < C_U$, use $C_D = C_U$

$Q_{PM} = C_D * I_X * A_{Total} * (1$ hour / 3,600 seconds) * (1 ft / 12 inches) * (43,560 ft^2 / 1 acre)
$= C_D * I_X * A_{Total} * (1.008333$ ft^3-hour / acre-inches-seconds)

$T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * Length^{0.483} * Slope^{-0.135}$

$V_M = (0.75$ inches) * [(A_I)(0.9) + ($A_P + A_U$)(C_U)] * (1 ft / 12 inches) * (43,560 ft^2 / 1 acre)
$= (2{,}722.5$ ft^3 / acre) * [(A_I)(0.9) + ($A_P + A_U$)(C_U)]

***** Contributing Undeveloped Upstream Area is an area where stormwater runoff from an undeveloped upstream area will flow directly or indirectly to the Post-Construction Best Management Practices (BMPs) proposed for the development. This additional flow must be included in the flow rate and volume calculations to appropriately size the BMPs.**

PROVIDE PROPOSED PROJECT CHARACTERISTICS

A_{Total}	1.79	Acres
Type of Development	COMMERCIAL	
Predominate Soil Type #	010	
% of Project Impervious	90%	
% of Project Pervious	10%	
% of Project Contributing Undeveloped Area	∅	
A_I	1.61	Acres
A_P	0.18	Acres
A_U	–	Acres

DETERMINING THE PEAK MITIGATED FLOW RATE (Q_{PM}):

In order to determine the peak mitigated flow rate (Q_{PM}) from the new development, use the Los Angeles County Department of Public Works *Hydrology Manual*. Use the Modified Rational Method for calculating the peak mitigation Q_{PM} for compliance with the Standard Urban Stormwater Mitigation Plan (SUSMP). Use attached **Table 1** for all maximum intensity (I_X) values used.

By trial and error, determine the time of concentration (T_C), as shown below:

CALCULATION STEPS:

1. Assume an initial T_C value between 5 and 30 minutes.

T_C 15 minutes

2. Using Table 1, look up the assumed T_C value and select the corresponding I_X intensity in inches/hour.

I_X 0.267 inches/hour

3. Determine the value for the Undeveloped Runoff Coefficient, C_U, using the runoff coefficient curve corresponding to the predominant soil type.

C_U 0.1

4. Calculate the Developed Runoff Coefficient, $C_D = (0.9 * \text{Imp.}) + [(1.0 - \text{Imp.}) * C_U]$

C_D 0.82

5. Calculate the value for $C_D * I_X$

$C_D * I_X$ 0.219

6. Calculate the time of concentration, $T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$

Calculated T_C 18.2 minutes

7. Calculate the difference between the initially assumed T_C and the calculated T_C, if the difference is greater than 0.5 minutes. Use the calculated T_C as the assumed initial T_C in the second iteration. If the T_C value is within 0.5 minutes, round the acceptable T_C value to the nearest minute.

TABLE FOR ITERATIONS:

Iteration No.	Initial T_C (min)	I_X (in/hr)	C_U	C_D	$C_D * I_X$ (in/hr)	Calculated T_C (min)	Difference (min)
1	15	.267	0.1	.82	.219	18.2	3.2
2	18.2	.243	0.1	.82	.199	21.1	3.1
3	21.1	.227	0.1	0.82	.186	21.8	0.7
4	21.8	.224	0.1	0.82	.184	21.9	0.1
5							
6							
7							
8							
9							
10							

Acceptable T_C value 22.0 minutes

8. Calculate the Peak Mitigation Flow Rate,
   $Q_{PM} = C_D * I_X * A_{Total} * (1.008333\ ft^3\text{-hour / acre-inches-seconds})$

Q_{PM} 0.33 cfs

TABLE 1

INTENSITY - DURATION DATA FOR 0.75-INCHES OF RAINFALL
FOR ALL RAINFALL ZONES

Duration, T_C (min)	Rainfall Intensity, I_X (in/hr)
5	0.447
6	0.411
7	0.382
8	0.359
9	0.339
10	0.323
11	0.309
12	0.297
13	0.286
14	0.276
15	0.267
16	0.259
17	0.252
18	0.245
19	0.239
20	0.233
21	0.228
22	0.223
23	0.218
24	0.214
25	0.210
26	0.206
27	0.203
28	0.199
29	0.196
30	0.193

DETERMINING THE VOLUME (V_M)

In order to determine the volume (V_M) of stormwater runoff to be mitigated from the new development, use the following equation:

$$V_M = (2{,}722.5\ ft^3 / acre) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$$

$$(2{,}722.5) \times [(1.61)(.9) + (0.18)(.1)]$$

$$V_M = 3{,}994\ ft^3$$

Drainage Subarea : 1.79 Acres to Vegetated Swale

Subarea information

Area, A =	1.79	acres
Project Imperviousness, imp =	0.9	
Intensity, I =	0.224	
Runoff coefficient, C = (0.75 x imp)+0.15	0.83	

Design Flowrate (Q)

Q = C x I x A =	0.33	cfs

Swale Bottom Width

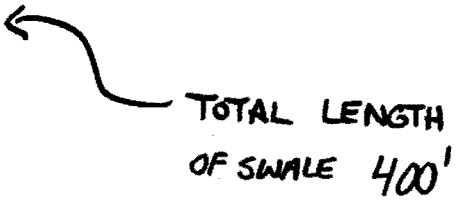
Manning's number, n_{WQ} =	0.2	
Design Flow Depth y =	0.33	ft
Longitudinal Slope, s =	0.01	ft/ft
Estimated swale bottom width, $b = (Q \times n_{WQ})/(1.49 \times y^{1.67} \times s^{0.5})$ =	4.0	ft
*if b<2 ft, set b to 2 ft and recalculate design flow depth		
Design swale bottom width, b =	4	ft
Design Flow Depth $y = ((Q \times n_{WQ})/(1.49 \times b \times s^{0.5}))^{0.6}$ =	0.08	ft

Design Flow Velocity

Side slope length per unit height, Z =	3		(2:1 maximum)
Cross sectional area, $A_{WQ} = by + Zy^2$ =	1.65	sf	
Design flow velocity, $V_{WQ} = Q/A_{WQ}$ =	0.20	ft/s	
Flow velocity is less than 1.0 ft/s (maximum)?	**YES**		

Swale Length

Hydraulic residence time, t_{HR} =	10	min	(10 min minimum)
Swale Length, $L = 60 \times t_{HR} \times V_{WQ}$ =	121	ft	
*if L<100 ft, use L of 100 ft			
Design swale length, L =	120.5	ft	



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VEGETATED SWALE CALCULATIONS (SUSMP)

* BASED ON Q_{PM} = 0.33CFS

SWALE LENGTH TOTAL = 400 L.F.

BOTTOM SWALE WIDTH = 12 FT

SURFACE AREA OF SWALE BOTTOM = 4,800 FT^2

PERCOLATION RATE OF SOIL $\approx$ 2.4 IN/HR

$$\left(\frac{2.4\ IN}{HR}\right)\left(\frac{1\ HR}{60\ MIN}\right)\left(\frac{1\ FT}{12\ IN}\right) = .0033\ FT/MIN$$

$$\left(\frac{.0033\ FT}{MIN}\right)\left(\frac{1\ MIN}{60\ SEC}\right) = 0.0000555\ FT/SEC$$

$$4{,}800\ FT^2 \times .00005555\ FT/SEC$$

= 0.27 CFS INFILTRATION TREATMENT

IN ADDITION TO SURFACE TREATMENT FOR FLOATABLES/SUSPENDED SOLIDS ETC... PER PREVIOUS CALCULATIONS

A.1 METHOD FOR CALCULATING STANDARD URBAN STORMWATER MITIGATION PLAN FLOW RATES AND VOLUMES BASED ON 0.75-INCHES OF RAINFALL: WORKSHEET

PROJECT NAME

Title: Torrance Shopping Center; Dry Well Tributary Area

NOMENCLATURE

A_I	=	Impervious Area (acres)
A_P	=	Pervious Area (acres)
A_U	=	Contributing Undeveloped Upstream Area (acres)
A_{Total}	=	Total Area of Development and Contributing Undeveloped Upstream Area (acres)
C_D	=	Developed Runoff Coefficient
C_U	=	Undeveloped Runoff Coefficient
I_X	=	Rainfall Intensity (inches / hour)
Q_{PM}	=	Peak Mitigation Flow Rate (cfs)
T_C	=	Time of Concentration (minutes, must be between 5-30 min.)
V_M	=	Mitigation Volume (ft^3)

EQUATIONS

$A_{Total} = A_I + A_P + A_U$

$A_I = (A_{Total} * \%$ of Development which is Impervious)

$A_P = (A_{Total} * \%$ of Development which is Pervious)

$A_U = (A_{Total} * \%$ of Contributing Undeveloped Upstream Area***)

$C_D = (0.9 * Imp.) + [(1.0 - Imp.) * C_U]$ If $C_D < C_U$, use $C_D = C_U$

$Q_{PM} = C_D * I_X * A_{Total} * (1 \text{ hour} / 3{,}600 \text{ seconds}) * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$

$= C_D * I_X * A_{Total} * (1.008333 \text{ ft}^3\text{-hour / acre-inches-seconds})$

$T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * Length^{0.483} * Slope^{-0.135}$

$V_M = (0.75 \text{ inches}) * [(A_I)(0.9) + (A_P + A_U)(C_U)] * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$

$= (2{,}722.5 \text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$

***** Contributing Undeveloped Upstream Area is an area where stormwater runoff from an undeveloped upstream area will flow directly or indirectly to the Post-Construction Best Management Practices (BMPs) proposed for the development. This additional flow must be included in the flow rate and volume calculations to appropriately size the BMPs.**

PROVIDE PROPOSED PROJECT CHARACTERISTICS

A_{TOTAL}	3.42	Acres
Type of Development	Commercial	
Predominate Soil Type #	010	
% of Sub-Area Impervious	90%	
% of Sub-Area Pervious	10%	
% of Project Contributing Undeveloped Area	0%	
A_I	3.08	Acres
A_P	0.34	Acres
A_U	0	Acres

DETERMINING THE PEAK MITIGATED FLOW RATE (Q_{PM}):

In order to determine the peak mitigated flow rate (Q_{PM}) from the new development, use the Los Angeles County Department of Public Works Hydrology Manual. Use the Modified Rational Method for calculating the peak mitigation Q_{PM} for compliance with the Standard Urban Stormwater Mitigation Plan (SUSMP). Use attached Table 1 for all maximum intensity (I_X) values used.

By trial and error, determine the time of concentration (T_C), as shown below:

CALCULATION STEPS:

1. Assume an initial T_C value between 5 and 30 minutes.

   T_C 30 minutes

2. Using Table 1, look up the assumed T_C value and select the corresponding I_X intensity in inches/hour.

   I_X 0.193 inches/hour

3. Determine the value for the Undeveloped Runoff Coefficient, C_U, using the runoff coefficient curve corresponding to the predominant soil type.

   C_U 0.10

4. Calculate the Developed Runoff Coefficient, $C_D = (0.9 * Imp.) + [(1.0 - Imp.) * C_U]$

   C_D 0.82

5. Calculate the value for $C_D * I_X$

   $C_D * I_X$ 0.16

6. Calculate the time of concentration, $T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * Length^{0.483} * Slope^{-0.135}$

   Calculated T_C 45.18 minutes

7. Calculate the difference between the initially assumed T_C and the calculated T_C, if the difference is greater than 0.5 minutes. Use the calculated T_C as the assumed initial T_C in the second iteration. If the T_C value is within 0.5 minutes, round the acceptable T_C value to the nearest minute.

TABLE FOR ITERATIONS:

Iteration No.	Initial T_C (min)	I_X (in/hr)	C_U	C_D	$C_D * I_X$ (in/hr)	Calculated T_C (min)	Difference (min)
1	30	0.193	0.10	0.82	0.158	45.18	-15.18
2							
3							
4							
5							
6							
7							
8							
9							
10							

Length: 850 ft.
Slope: 0.4%

Acceptable T_C value 30 minutes

8. Calculate the Peak Mitigation Flow Rate,
   $Q_{PM} = C_D * I_X * A_{Total} * (1.008333\ ft^3\text{-hour / acre-inches-seconds})$

   Q_{PM} 0.54 cfs

TABLE 1

INTENSITY - DURATION DATA FOR 0.75-INCHES OF RAINFALL
FOR ALL RAINFALL ZONES

Duration, T_C (min)	Rainfall Intensity, I_X (in/hr)
5	0.447
6	0.411
7	0.382
8	0.359
9	0.339
10	0.323
11	0.309
12	0.297
13	0.286
14	0.276
15	0.267
16	0.259
17	0.252
18	0.245
19	0.239
20	0.233
21	0.228
22	0.223
23	0.218
24	0.214
25	0.210
26	0.206
27	0.203
28	0.199
29	0.196
30	0.193

A_I	3.08	
A_P	0.34	
A_U	0	
C_U	0.1	
Vm	7541.87	cuft

DRYWELL CAPACITY:

PERCOLATION RATE = 60 INCHES PER HOUR

$60"/12" = 5'$

$5'/3600 \frac{S}{HOUR} = 0.0013888$

$4'\phi$ SHAFT $\times \pi = 12.6$ FT^3/FT DEPTH

$= 0.018$ CFS/FOOT DEPTH

30' DEPTH = 0.54 CFS

USE FACTOR OF SAFETY = 2

= 0.26 CFS

2 DRYWELLS @ 0.26 CFS = 0.54 CFS

OKAY

$Q_{PM} = 0.54$ CFS

GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED RETAIL CENTER EXPANSION
19330 HAWTHORNE BOULEVARD
TORRANCE, CALIFORNIA

PROJECT NO. 112-11035
DECEMBER 19, 2011

PREPARED FOR:

REGENCY CENTERS
915 WILSHIRE BOULEVARD
SUITE 2200
LOS ANGELES, CALIFORNIA 90017

ATTENTION: MR. STEVE SHAUL

PREPARED BY:

KRAZAN & ASSOCIATES, INC.
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GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED RETAIL CENTER EXPANSION
19330 HAWTHORNE BOULEVARD
TORRANCE, CALIFORNIA

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Krazan & ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

December 19, 2011 KA Project No. 112-11035

GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED RETAIL CENTER EXPANSION
19330 HAWTHORNE BOULEVARD
TORRANCE, CALIFORNIA

INTRODUCTION

This report presents the results of our Geotechnical Engineering Investigation for the proposed expansion of a retail center located in Torrance, California. Discussions regarding site conditions are presented herein, together with conclusions and recommendations pertaining to site preparation, grading, utility trench backfill, drainage and landscaping, foundations, concrete floor slabs and exterior concrete flatwork, retaining walls, soil corrosivity, and pavement design.

A Vicinity Map showing the location of the site is presented on Figure 1. A Site Plan showing the approximate boring and bulk sample locations is presented on Figure 2. Descriptions of the field and laboratory investigations, boring log legend and boring logs are presented in Appendix A. Appendix A contains Boring Logs and description of the laboratory-testing phase of this study, along with the laboratory test results. Appendices B and C contain guide specifications for earthwork and flexible pavements, respectively. If conflicts in the text of the report occur with the general specifications in the appendices, the recommendations in the text of the report have precedence.

PURPOSE AND SCOPE OF SERVICES

This geotechnical investigation was conducted to evaluate subsurface soil and groundwater conditions at the project site. Engineering analysis of the field and laboratory data was performed for the purpose of developing and providing geotechnical recommendations for use in the design and construction of the proposed earthwork, foundation and pavement aspects of the project. The recommendations presented do not address the existing structure.

Our scope of services was outlined in our proposal dated November 28, 2011 (KA Proposal No. 112048-11) and included the following:

- Review of the previous Geotechnical Engineering Investigation Report prepared for the subject site.
- A site reconnaissance by a member of our engineering staff to evaluate the surface conditions at the project site.

- Review of selected published geologic maps, reports and literature pertinent to the site and surrounding area.

- Drilling a total of eleven (11) borings at the subject site to depths ranging from approximately 10 to 50 feet below the existing ground surface for evaluation of the subsurface conditions at the project site.

- Performing two (2) percolation tests at the subject site to determine anticipated infiltration rates for on-site storm water retention areas.

- Performing laboratory tests on representative soil samples obtained from the borings to evaluate the physical and index properties of the subsurface soils.

- Evaluation of the data obtained from the investigations and engineering analyses of the data with respect to the geotechnical aspects of structural design, site grading and paving.

- Preparation of this report summarizing the findings, results, conclusions and recommendations of our investigation.

Based on discussions with the project Civil Engineer, the proposed scope of work and boring locations were in accordance with project specifications.

Environmental services, such as chemical analyses of soil and groundwater for possible environmental contaminates, were not in our scope of services.

PROPOSED CONSTRUCTION

Based on our review of the site plan and our discussions with the project representative, we understand that the proposed project will include expansion of the existing retail building located at the subject site. In addition, it is understood that on site retention areas are planned for the subject site.

The proposed building addition is anticipated to be a combination of concrete masonry shear walls and steel columns supporting a roof structure of steel joist girders and steel joists. The floor slab is anticipated to be structurally connected to the perimeter walls with dowels. The maximum gravity loads at the interior column are assumed to be 85 kips. The estimated maximum exterior column gravity load is assumed to be 50 kips. Maximum column uplift force from wind is estimated at 30 kips. New concrete masonry walls are estimated to have gravity loads of 1.5 to 2.0 kips per lineal foot for non-load bearing walls, with 4.0 to 6.0 kips per lineal foot for dead plus live loads at load bearing walls. Estimated maximum uniformly distributed loads for new floor slabs is 125 pounds per square foot (psf), with maximum concentrated load of 5.0 kips.

In the event these structural or grading details are inconsistent with the final design criteria, we should be notified so that we can evaluate the potential impacts of the changes on the recommendations presented in this report and provide an updated report as necessary.

SITE LOCATION AND SITE DESCRIPTION

The overall site is roughly rectangular in shape. The site is located north of Hawthorne Boulevard and has a physical address of 19330 Hawthorne Boulevard, Torrance, California (see Vicinity Map, Figure 1). The site is relatively level with no major changes in grade. Presently, the site is occupied by a retail development. Groundcover at the site consists of asphalt concrete pavements and localized landscaped areas. The site is predominately surrounded by residential and retail/commercial development.

PREVIOUS STUDIES

A Geotechnical Engineering Investigation was performed at the subject site in June 2004. This report was prepared by Arroyo Geotechnical. The results of this investigation were presented in a Geotechnical Engineering Investigation report, project number 12147-4000, dated June 2, 2004.

GEOLOGIC SETTING

The subject site is located within the southwest portion of the Central Basin of the Los Angeles Coastal Plain, within the Peninsular Ranges Geomorphic Province of California. The Los Angeles Coastal Plain is situated between the Santa Monica Mountains to the northwest, the San Gabriel Mountains to the northeast, the Santa Ana Mountains to the southeast, and the Pacific Ocean to the west and south. The Los Angeles Basin is dominated by northwest-trending faults and adjacent anticlinal uplifts. The intervening deep synclinal troughs are filled with poorly consolidated Upper Pleistocene and unconsolidated Holocene sediments. Tectonism of the region is dominated by the interaction of the East Pacific Plate and the North American Plate along a transform boundary.

The near-surface deposits in the vicinity of the subject site are indicated to be comprised of recent alluvium consisting of unconsolidated sands, silt, and clays derived from erosion of local mountain ranges. Deposits encountered on the subject site during exploratory drilling are discussed in detail in this report.

Numerous moderate to large earthquakes have affected the area of the subject site within historic time. Based on the proximity of several dominant active faults and seismogenic structures, as well as the historic seismic record, the area of the subject site is considered subject to relatively high seismicity.

FIELD AND LABORATORY INVESTIGATIONS

As previously discussed, the subsurface soil conditions were explored by drilling eleven (11) borings at the subject site using a truck-mounted drill rig or manually operated augering equipment. The borings drilled at the subject site were drilled to depths ranging from approximately 10 to 50 feet below existing site grade. Percolation testing was performed at two (2) of the boring locations drilled as part of this investigation. The approximate boring and bulk sample locations are shown on the Site Plan, Figure 2. These approximate boring and sample locations were estimated in the field based on pacing and measuring from the limits of existing site features. During drilling operations, penetration tests were performed at regular intervals to evaluate the soil consistency and to obtain information regarding the engineering properties of the subsurface soils. Soil samples were retained for laboratory testing. The

soils encountered were continuously examined and visually classified in accordance with the Unified Soil Classification System. Soil samples collected from the boring locations will be stored for six (6) months from the date of collection. A more detailed description of the field investigation is presented in Appendix A.

Laboratory tests were performed on selected soil samples to evaluate their physical characteristics and engineering properties. The laboratory-testing program was formulated with emphasis on the evaluation of natural in-situ moisture and density, gradation, shear strength, consolidation potential, R-value, maximum dry density, resistivity, pH value, sulfate and chloride contents of the materials encountered. Details of the laboratory-testing program are discussed in Appendix A. The results of the laboratory tests are presented on the boring logs or on the test reports, which are also included in Appendix A. This information, along with the field observations, was used to prepare the final boring logs in Appendix A.

SOIL PROFILE AND SUBSURFACE CONDITIONS

Nine (9) of the eleven (11) borings drilled as part of this investigation were drilled through the existing asphalt concrete pavement. The pavement section encountered at the boring locations consisted of 3 to 4 inches of asphalt concrete underlain by up to 5 inches of discernable base material. Based on the conditions encountered at the boring locations, the subsurface conditions encountered appear typical of those found in the geologic region of the site. In general, the subsurface soils generally consisted of medium dense to dense sands with fine to medium gravel to depths of up to six (6) feet below the existing site grades. The underlying soil consisted of medium dense to dense poorly graded sand to the maximum depth explored, 50 feet below site grade. Fill materials may be present at the site between our borings. Verification of the extent of fill, if encountered, should be determined during site grading.

Field and laboratory tests suggest that the near surface soils are moderately strong and slightly compressible. Penetration resistance, measured by the number of blows required to drive a Modified California sampler or a Standard Penetration Test (SPT) sampler, ranged from 14 to over 46 blows per foot. Representative soil samples had angles of internal friction of 30 to 32 degrees with cohesions of 100 to 200 psf. One representative soil sample was found to be non-expansive. One representative soil sample was found to have a maximum dry density of 112.6 pcf.

The above is a general description of soil conditions encountered at the site in the borings drilled for this investigation. No unusual conditions were encountered in the boring locations that would impact the proposed foundations or paving recommendations. For a more detailed description of the soil conditions encountered, please refer to the boring logs in Appendix A.

COMPRESSIVE STRENGTH TESTING

Two (2) core samples were collected from the subject site. The core samples were collected from the existing Portland cement slab-on-grade. The cores were tested to determine the compressive strength of the samples. The results of the compressive strength testing are presented in Table I below:

Table I – Compressive Strength Results

Core ID	Core Location	Core Thickness	Compressive Strength
B-3	Rear Building Area	4.8 in.	5210 psi.
B-4	Rear Building Area	4.5 in.	5400 psi

GROUNDWATER

Test boring locations were checked for the presence of groundwater during the drilling process as well as approximately twenty-four hours after completion of the drilling operations. Free groundwater was not encountered in any of the borings drilled as part of this investigation. Based on our findings, groundwater is anticipated to exist at depths in excess of 50 feet below existing site grades.

It should be recognized that water table elevation might fluctuate with time. The depth to groundwater can be expected to fluctuate both seasonally and from year to year. Fluctuations in the groundwater level may occur due to variations in precipitation, irrigation practices at the site and in the surrounding areas, climatic conditions, flow in adjacent or nearby canals, pumping from wells and possibly as the result of other factors that were not evident at the time of our investigation. Therefore, water level observations at the time of our field investigation may vary from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report. Long-term monitoring in observation wells, sealed from the influence of surface water, is often required to more accurately define the potential range of groundwater conditions on a site.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of our field and laboratory investigation, along with previous geotechnical experience in the project area, the following is a summary of our evaluations, conclusions, and recommendations.

ADMINISTRATIVE SUMMARY

Based on the data collected during this investigation, and from a geologic and geotechnical engineering standpoint, it is our opinion that the proposed improvements may be made as anticipated provided that the recommendations presented in this report are considered in the design and construction of the project.

In brief, the subject site and soil conditions appear to be conducive to the proposed development. The near surface loose soils within the project site are moderately compressible under saturated conditions. Accordingly, mitigation measures are recommended to reduce potential excessive soil settlement.

Recommendations pertaining to the removal and recompaction of these loose, moisture-sensitive soils are presented herein. After completion of the recommended site preparation, the site should be suitable for shallow footing support.

Fill materials may be present at the site between our boring locations. In general, any fill soils encountered should be assumed uncompacted and unsuitable for support of foundations and pavements. Any fill soils, if encountered during grading should also be overexcavated and recompacted.

Expansion Index (EI) testing was performed on a representative soil sample obtained from the site. The test results indicate that the near-surface soils have expansion potentials of very low (EI less than 20). To decrease the potential soil movement, it is recommended that the upper 24 inches of soil within the building slab and all exterior flatwork areas consist of "non-expansive" soils (with EI=20).

To reduce post-construction soil movement and provide uniform support for the proposed buildings, overexcavation and recompaction within the proposed building footprint areas should be performed to a minimum depth of 3 feet below existing grades or 2 feet below bottom of the proposed footings, whichever is deeper. The actual depth of the overexcavation and recompaction should be determined by the Geotechnical Engineering representative during construction. The overexcavation and recompaction should also extend laterally 5 feet beyond edges of the proposed footings. Any undocumented fill encountered during grading should be removed and replaced with Engineered Fill.

Within the proposed exterior flatwork and pavement areas, the overexcavation and recompaction should be performed to a depth of at least 2 feet below existing grade or finish subgrade, whichever is deeper. This compaction effort should stabilize the surface soils and locate any unsuitable or pliant areas not found during our field investigation.

Sandy soil conditions were encountered at the site. These cohesionless soils have a tendency to cave in trench wall excavations. Shoring or sloping back trench sidewalls may be required within these loose cohesionless soils.

The shrinkage on recompacted soil and fill placement is estimated at 10 to 20 percent. Subsidence within building areas, below the recompaction bottom, is anticipated to be less than 0.01 feet, due to the recommended overexcavation. Subsidence within parking areas, below the 24-inch recompaction depth, is estimated at 0.1 feet.

Based on our findings, it is our opinion that the potential for liquefaction at the site is low. Therefore, no mitigation measures would be warranted.

A total of two (2) percolations tests were performed at the subject site. The approximate locations of these tests are indicated on Figure 2. Results of these tests are presented in Appendix A of this report. The data, which is presented in tabular format, indicates varied infiltration rates. The soil absorption or percolation rates are based on tests conducted with clear water. The infiltration rates may vary with time as a result of soil clogging from water impurities. A factor of safety should be incorporated into the design and evaluation of the infiltration areas to compensate for these factors. This factor of safety

should be based on the application of the proposed infiltration areas. The infiltration rate at the end of the test for each test location indicated percolation rates ranging from approximately 2.4 inches per hour to 2.5 inches per hour.

GROUNDWATER INFLUENCE ON STRUCTURES/CONSTRUCTION

Based on our findings and historical records, it is not anticipated that groundwater will rise within the zone of structural influence or affect the construction of foundations and pavements for the project. However, if earthwork is performed during or soon after periods of precipitation, the subgrade soils may become saturated, "pump," or not respond to densification techniques. Typical remedial measures include: discing and aerating the soil during dry weather; mixing the soil with dryer materials; removing and replacing the soil with an approved fill material; or mixing the soil with an approved lime or cement product.

SEISMIC CONSIDERATIONS

Ground Shaking

Although ground rupture is not considered to be a major concern at the subject site, the site will likely be subject to at least one moderate to severe earthquake and associated seismic shaking during its lifetime, as well as periodic slight to moderate earthquakes. Some degree of structural damage due to stronger seismic shaking should be expected at the site, but the risk can be reduced through adherence to seismic design codes.

Soil Liquefaction

Soil liquefaction is a state of soil particle suspension caused by a complete loss of strength when the effective stress drops to zero. Liquefaction normally occurs under saturated conditions in soils such as sand in which the strength is purely frictional. However, liquefaction has occurred in soils other than clean sand. Liquefaction usually occurs under vibratory conditions such as those induced by seismic events. To evaluate the liquefaction potential of the site, the following items were evaluated:

1) Soil type
2) Groundwater depth
3) Relative density
4) Initial confining pressure
5) Intensity and duration of ground shaking

Based on our findings, it is our opinion that the potential for seismic-induced soil liquefaction within the project site is low due to absence of shallower groundwater. Therefore, measures to mitigate liquefaction potential are not considered necessary. In accordance with the State of California, Seismic Hazard Zones Map, Torrance, Released: 1998, the site is not located within a potential liquefaction zone and the groundwater is estimated at a depth of 50 feet below ground surface.

Seismic Induced Settlement

One of the most common phenomena during seismic shaking accompanying any earthquake is the induced settlement of loose unconsolidated soils. Based on site subsurface conditions and the moderate to high seismicity of the region, any loose fill materials at the site could be vulnerable to this potential hazard. However, this hazard can be mitigated by following the design and construction recommendations of our Geotechnical Engineering Investigation (over-excavation and rework of the loose soils and/or fill). Based on the moderate penetration resistance measured, the native deposits underlying the surface materials do not appear to be subject to significant seismic settlement.

Seismic Parameters – 2010 Building Code

Seismic Parameters for the subject site have been determined based on the California Building Code (2010 CBC). The site class per Table 1613.5.2, of the 2010 CBC is based upon the site soil conditions. It is our opinion that Site Class D is most consistent with the subject site soil conditions.

For seismic design of the structures based on the seismic provisions of the 2010 CBC, we recommend the following parameters:

Seismic Item	Value	CBC Reference
Site Class	D	Table 1613.5.2
Site Coefficient F_a	1.00	Table 1613.5.3 (1)
S_s	1.702	Figure 1613.5 (3)
S_{MS}	1.702	Section 1613.5.3
S_{DS}	1.135	Section 1613.5.4
Site Coefficient F_v	1.50	Table 1613.5.3 (2)
S_1	0.70	Figure 1613.5 (4)
S_{M1}	1.050	Section 1613.5.3
S_{D1}	0.70	Section 1613.5.4

WEAK AND DISTURBED SOILS

Of primary importance in the development of this site is the removal/recompaction of potentially compressible soils from the areas of the proposed structures. This is discussed in detail in the Earthwork section of this report.

COLLAPSIBLE SOILS

The upper onsite native soils are moisture-sensitive and are moderately compressible under saturated conditions. As recommended in the site preparation section of this report, the collapsible soils should be removed and recompacted to a minimum of 95 percent of the maximum dry density based on the ASTM D1557 Test Method.

EARTHWORK

Site Preparation – Clearing and Stripping

General site clearing should include removal of vegetation and existing utilities, structures; trees and associated root systems; rubble; rubbish; and any loose and/or saturated materials. Site stripping should extend to a minimum depth of 2 to 4 inches, or until all organics in excess of 3 percent by volume are removed. Deeper stripping may be required in localized areas. These materials will not be suitable for reuse as Engineered Fill. However, stripped topsoil may be stockpiled and reused in landscape or non-structural areas.

Any excavations that result from clearing operations should be backfilled with engineered fill. A representative of the Geotechnical Engineer of Record should be present during site clearing operations in order to locate areas where depressions or disturbed soils are present and to observe and test the backfill as it is placed. If site clearing and backfilling operations occur without appropriate observation and testing by the Geotechnical Engineer of Record, there may be the need to over-excavate the building area to identify uncontrolled fills prior to mass grading of the building pad.

As with site clearing operations, any buried structures encountered during construction should be properly removed and backfilled. The resulting excavations should be backfilled with engineered fill.

Overexcavation and Recompaction

To reduce post-construction soil movement and provide uniform support for the proposed structures, including buildings, retaining walls, etc., overexcavation and recompaction within the proposed footprint areas, including adjacent flatwork and appurtenances, should be performed to a minimum depth of 3 feet below existing grades or 2 feet below bottom of the proposed footings, whichever is deeper. The overexcavation and recompaction should also extend laterally 5 feet beyond edges of the proposed footings and adjacent flatwork or appurtenances. Any undocumented fill encountered during grading should be removed and replaced with Engineered Fill.

Within any proposed exterior flatwork and pavement areas, the overexcavation and recompaction should be performed to a depth of at least 2 feet below existing grade or below finish subgrade, whichever is deeper. This compaction effort should stabilize the surface soils and locate any unsuitable or pliant areas not found during our field investigation.

Fill Placement

Following the recommended overexcavation and prior to placement of fill soils, the upper 8 inches of exposed native subgrade soils should be scarified, moisture-conditioned to near optimum moisture content, and recompacted to a minimum of 95 percent of the maximum dry density based on ASTM D1557 Test Method. Fill material should be compacted to a minimum of 95 percent of the maximum dry density based on the ASTM D1557 Test Method.

It is recommended that the upper 24 inches of soil within the building slab and exterior flatwork areas consist of "non-expansive" fill consisting of silty sand or sandy silt with an Expansion Index equal to or less than 20 (EI=20). The non-expansive native soil and/or the upper 24 inches of Imported or Select Fill soils should meet the specifications as described under the subheading "Engineered Fill". The limits of non-expansive soils should extend a minimum of 5 feet beyond the perimeter of the building and exterior flatwork area. The non-expansive soil should be compacted to at least 95 percent relative compaction based on ASTM D1557 Test Method. The exposed native soils in the excavation should not be allowed to dry out and should be kept continuously moist prior to backfilling.

Due to the potential for variation in soil types, the overexcavated soils to be used as "non-expansive" fill should be tested for expansion index prior to placement. Onsite soils with an expansion index (EI) greater than 20 should not be placed in the upper 24 inches of slab and exterior flatwork areas. Fill materials should be free of organic material, debris and cobbles over 4 inches, and should be compacted to a minimum of 95 percent of the maximum density based on ASTM D1557 Test Method.

The upper soils, during wet winter months, may become very moist due to the absorptive characteristics of the soil. Earthwork operations performed during winter months may encounter very moist unstable soils, which may require removal to grade a stable building foundation. Project site winterization consisting of placement of aggregate base and protecting exposed soils during the construction phase should be performed.

ENGINEERED FILL

The organic-free, on-site, native soils are predominately sand and gravelly sand. Most of these soils will be suitable for reuse as non-expansive Engineered Fill, provided they are cleansed of excessive organics and debris. The soils with an EI greater than 20 should not be used within the upper 2 feet of the building pad and exterior flatwork areas.

The preferred materials specified for Engineered Fill are suitable for most applications with the exception of exposure to erosion. Project site winterization and protection of exposed soils during the construction phase should be the sole responsibility of the contractor, since he has complete control of the project site at that time.

Imported Fill material should be predominately non-expansive granular material. This material should be approved by the Geotechnical Engineer prior to use and should typically possess the following characteristics:

NON-EXPANSIVE FILL PROPERTIES	
Percent Passing No. 200 Sieve	20 to 50
Plasticity Index (PI)	12 maximum
Liquid Limit	35 maximum
UBC Standard 29-2 Expansion Index	20 maximum

Imported Fill should be free from rocks and clods greater than 4 inches in diameter. All Imported Fill material should be submitted to the Soils Engineer for approval at least 48 hours prior to delivery at the site. It is anticipated that material compliant with the recommendations presented herein are locally available.

Fill soils should be placed in lifts approximately 6 to 8 inch thick, moisture-conditioned to near optimum moisture content, and compacted to achieve at least 95 percent of maximum density as determined by ASTM D1557 Test Method. Additional lifts should not be placed if the previous lift did not meet the required dry density or if soil conditions are not stable.

SLOPES

The proposed improvements are not anticipated to included construction of or modification of any slopes. As such, slope stability analysis was not performed as part of this investigation.

TEMPORARY EXCAVATION STABILITY

All excavations should comply with the current requirements of Occupational Safety and Health Administration (OSHA). All cuts greater than 3 feet in depth should be sloped or shored. Temporary excavations should be sloped at 1:1 (horizontal to vertical) or flatter, up to a maximum depth of 7 feet, and at 2:1 (horizontal to vertical) to a maximum depth of 15 feet. Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within five feet of the top (edge) of the excavation. Where sloped excavations are not feasible due to site constraints, the excavations may require shoring. The design of the shoring system is normally the responsibility of the contractor or shoring designer, and therefore, is outside the scope of this report. The design of the temporary shoring should take into account lateral pressures exerted by the adjacent soil, and, where anticipated, surcharge loads due to adjacent buildings and any construction equipment or traffic expected to operate alongside the excavation.

The excavation/shoring recommendations provided herein are based on soil characteristics derived from our test borings within the area. Variations in soil conditions will likely be encountered during the excavations.

UTILITY TRENCH LOCATION, CONSTRUCTION AND BACKFILL

To maintain the desired support for new foundations, new utility trenches should be located such that the base of the trench excavation is located above an imaginary plane having an inclination of 1.0 horizontal to 1.0 vertical, extending downward from the bottom edge of the adjacent footing. Utility trenches should be excavated according to accepted engineering practices following OSHA standards by a contractor experienced in such work. The responsibility for the safety of open trenches should be borne by the contractor. Traffic and vibration adjacent to trench walls should be kept to a minimum; cyclic wetting and drying of excavation side slopes should be avoided. Depending upon the location and depth of some utility trenches, groundwater flow into open excavations could be experienced, especially during or shortly following periods of precipitation.

For purposes of this section of the report, backfill is defined as material placed in a trench starting one foot above the pipe; bedding and shading (also referred to as initial backfill) is all material placed in a trench below the backfill. With the exception of specific requirements of the local utility companies or building department, pipe bedding and shading should consist of clean medium-grained sand. The sand should be placed in a damp state and should be compacted by mechanical means prior to the placement of backfill soils. Above the pipe zone, underground utility trenches may be backfilled with either free-draining sand, on-site soil or imported soil. The trench backfill should be compacted to at least 95 percent relative compaction.

COMPACTED MATERIAL ACCEPTANCE

Compaction specifications are not the only criteria for acceptance of the site grading or other such activities. However, the compaction test is the most universally recognized test method for assessing the performance of the Grading Contractor. The numerical test results from the compaction test cannot be solely used to predict the engineering performance of the compacted material. Therefore, the acceptance of compacted materials will also be dependent on the moisture content and the stability of that material. The Geotechnical Engineer has the option of rejecting any compacted material regardless of the degree of compaction if that material is considered to be too dry or excessively wet, unstable or if future instability is suspected. A specific example of rejection of fill material passing the required percent compaction is a fill which has been compacted with in-situ moisture content significantly less than optimum moisture. Where expansive soils are present, heaving of the soils may occur with the introduction of water. Where the material is a lean clay or silt, this type of dry fill (brittle fill) is susceptible to future settlement if it becomes saturated or flooded.

SURFACE DRAINAGE AND LANDSCAPING

The ground surface should slope away from building and pavement areas toward appropriate drop inlets or other surface drainage devices. We recommend that adjacent paved exterior grades be sloped a minimum of 2 percent for a minimum distance of 10 feet away from structures. Ideally, asphalt concrete pavement areas should be sloped at a minimum of 2 percent, with Portland cement concrete sloped at a minimum of one percent toward drainage structures. These grades should be maintained for the life of the project. Roof drains should be designed to avoid discharging into landscape areas adjacent to the

building. Downspouts should be directed to discharge directly onto paved surfaces to allow for surface drainage into the storm systems or should be connected directly to the on-site storm drain.

FOUNDATION

The proposed structures may be supported on a shallow foundation system bearing on Engineered Fill. Spread and continuous footings can be designed for the following maximum allowable soil bearing pressures:

Load	Allowable Loading
Dead Load Only	2,000 psf
Dead-Plus-Live Load	2,500 psf
Total Load, including wind or seismic loads	3,300 psf

The footings should have a minimum depth of 18 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is deeper. Minimum footing widths should be 15 inches for continuous footings and 24 inches for isolated footings. The footing excavations should not be allowed to dry out any time prior to pouring concrete.

Settlement

Provided the site is prepared as recommended and that the foundations are designed and constructed in accordance with our recommendations, the total settlement due to foundation loads is not expected to exceed ¾-inch. The differential settlements are anticipated to be less than ¾-inch between adjacent columns and perimeter walls to adjacent columns, and less than ½-inch in 40 feet along perimeter walls. Most of the settlement is expected to occur during construction as the loads are applied. However, additional post-construction settlement may occur if the foundation soils are flooded or saturated.

Lateral Load Resistance

Resistance to lateral footing displacement can be computed using an allowable friction factor of 0.40 acting between the base of foundations and the supporting subgrade. Where a vapor barrier material is used below concrete slabs-on-grade, a coefficient of friction should be provided by the vapor barrier manufacturer. Lateral resistance for footings can alternatively be developed using an allowable equivalent fluid passive pressure of 350 pounds per cubic foot acting against the appropriate vertical footing faces. Where equivalent fluid pressure against the sides of the footings or embedded slab edge are to be used, the footing or slab edge must be cast directly against undisturbed soils or the soils surrounding the structure must be recompacted to the requirements for engineered fill presented above. The frictional and passive resistance of the soil may be combined without reduction in determining the total lateral resistance. A one-third increase in the value above may be used for short duration, wind, or seismic loads.

CONCRETE FLOOR SLABS

Slabs subject to structural loading may be designed utilizing a modulus of subgrade reaction (K) of 150 pounds per square inch per inch (psi/in). The K value was approximated based on inter-relationship of soil classification and bearing values (Portland Cement Association, Rocky Mountain Northwest).

For concrete slabs, a minimum 4-inch layer of aggregate material conforming to Caltrans standard specification section 26-102.A, Aggregate base, should be used. This material should be placed on the completed subgrade. A material such as clean sand is not acceptable as an alternative for the aggregate base.

Where moisture barriers are desired, it is recommended that new slabs be underlain by two to four inches (2-4") of clean sand with a minimum 15 mil polyolefin membrane vapor barrier (i.e. Stego Wrap or equivalent) placed with two inches (2") of clean sand on top of the vapor barrier.

Moisture within the structure may be derived from water vapors, which were transformed from the moisture within the soils. This moisture vapor can travel through the vapor membrane and penetrate the slab-on-grade. This moisture vapor penetration can affect floor coverings and produce mold and mildew in the structure. To minimize moisture vapor intrusion, it is recommended that a vapor retarder be installed in accordance with ASTM guidelines. It is recommended that the utility trenches within the structure be compacted, as specified in our report, to minimize the transmission of moisture through the utility trench backfill. Special attention to the immediate drainage and irrigation around the building is recommended. Positive drainage should be established away from the structure and should be maintained throughout the life of the structure. In addition, ventilation of the structure (i.e. ventilation fans) is recommended to reduce the accumulation of interior moisture.

EXTERIOR FLATWORK

Exterior slabs should be cast free of the adjacent building foundation in order to act independently of the walls and foundation system in all areas except doorways leading into the building. This may be accomplished by using a strip of a ½-inch thick asphalt impregnated felt divider material between the slab edges and the adjacent structure. Where floating slabs-on-grade are not desired due to the need for vertical control such as at doorways, dowel bars may be considered. There is a potential drawback to the use of dowel bars for slabs; there is a potential that a crack may develop parallel to the edge of the slab about two to four feet back of the edge. Exterior finish grades should have a minimum slope gradient of 1 to 1½ percent away from the buildings to preclude ponding of water adjacent to the structures.

Frequent construction or control joints should be provided in all concrete slabs where cracking is objectionable. Joint spacing should not exceed 30 times the slab thickness. Control joints, whether scored or saw-cut should be no less than one-fourth of the slab thickness. Continuous reinforcing or dowels at the construction and control joints will also aid in reducing uneven slab uplift.

Exterior flatwork will be subjected to edge effects due to the fluctuation in the moisture content of the subgrade soils along the outer edges of the slab. Deepened edge sections (also referred to as down turned curbs) and controlled irrigation of landscaped areas adjacent to the flatwork will aid in reducing the potential for the shrinkage and swelling of the underling soils. By deepening the edge section of concrete flatwork a minimum of 12 inches below the subgrade soils, there is less potential for soil moisture change below at least the perimeter of the slabs. By maintaining the soil moisture content, the resulting soil displacement or shrink/swell cycles will also be reduced.

RETAINING WALLS

For retaining walls with level ground surface behind the walls, we recommend that retaining walls capable of deflecting a minimum of 0.1 percent of its height at the top be designed using an equivalent fluid active pressure of 36 pounds per square foot per foot of depth. Walls that are incapable of this deflection or walls that are fully constrained against deflection may be designed for an equivalent fluid at-rest pressure of 56 pounds per square foot per foot per depth. This is anticipated to apply to the loading dock walls. A passive lateral pressure of 350 pounds per square foot may be used to calculate sliding resistance. If walls are to be constructed above descending slopes, our office should be contacted to discuss further reduction in allowable passive pressures for resistance of lateral forces, and for overall retaining wall foundation design.

The surcharge effect from loads adjacent to the walls should be included in the wall design. The surcharge load for walls capable of deflecting (cantilever walls), we recommend applying a uniform surcharge pressure equal to one-third of the applied load over the full height of the wall. Where walls are restrained the surcharge load should be based on one-half of the applied load above the wall, also distributed over the full height of the wall. For other surcharges, such as from adjacent foundations, point loads or line loads, Krazan & Associates should be consulted.

Remedial grading should be performed in proposed retaining wall areas in accordance with the recommendations presented in the Overexcavation and Recompaction section of this report. Retaining walls should be supported on a minimum of 2 feet of Engineered Fill. Expansive soils should not be used for backfill against walls. The zone of non-expansive backfill material should extend from the bottom of each retaining wall laterally back a distance equal to the height of the wall, to a maximum of five (5) feet.

The active and at-rest earth pressures do not include hydrostatic pressures. To reduce the build-up of hydrostatic pressures, drainage should be provided behind the retaining walls. Wall drain should consist of a minimum 12-inch wide zone of drainage material, such as ¾-inch or ½-inch drain rock wrapped in a non-woven polypropylene geotextile filter fabric such as Mirafi 140N or equivalent. Alternatively, drainage may be provided by the placement of a commercially produced composite drainage blanket, such as Miradrain, extending continuously up from the base of the wall. The drainage material should extend from the base of the wall to finished subgrade in paved areas and to within about 12 inches below the top of the wall in landscape areas. In landscape areas the top 12 inches should be backfilled with compacted native soil. A 4-inch minimum diameter, perforated, Schedule 40 PVC drain pipe should be placed with holes facing down in the lower portion of the wall drainage material, surrounded with drain rock wrapped in filter fabric. A solid drainpipe leading to a suitable discharge point should provide drainage outlet. As an alternative, weep holes may be used to provide drainage. If weep holes are used,

the weep holes should be 3 inches in diameter and spaced about 8 feet on centers. The backside of the weep holes should be covered with a corrosion-resistant mesh to prevent loss of backfill and/or drainage material.

PAVEMENT DESIGN

Based on the established standard practice of designing flexible pavements in accordance with State of California Department of Transportation (Caltrans) for projects within California, we have developed pavement sections in accordance with the procedure presented in Caltrans Standard Test Method 301. This pavement design procedure is based on the volume of traffic (Traffic Index) and the soil resistance "R" value (R-value). Pavement design was performed using Caltrans design software CalFP V1.1. The AASHTO procedure was used to evaluate rigid pavement section requirements.

It is our understanding that project specifications require that concrete and asphaltic concrete pavement be designed for Standard Duty and Heavy Duty traffic loading based on equivalent 18 kip axle loads of 109,500 (ESAL) and 335,800 (ESAL) respectively, and a design life of 20 years.

Asphalt Concrete (Flexible) Pavements

One (1) near-surface soil sample was obtained from the soil borings at the project site for laboratory R-Value testing. The samples were tested in accordance with California Test 301. Results of the tests are as follows:

R-VALUE TEST RESULTS			
Sample Number	**Sample Depth (ft)**	**Description**	**R-Value at Equilibrium**
RV #1	0-2	Sand with fine Gravel	56

Caltrans provides a conversion equation to convert ESAL to TI. The equation, which is based on a mix of traffic, is: $TI = 9 \cdot (ESAL/10^6)^{0.119}$. *Based on this equation, the Traffic Indexes that correspond to the Standard Duty and Heavy Duty traffic loadings are 7.0 and 8.0 respectively.* The Civil Engineer should confirm the truck count prior to assigning the Traffic Index and selecting the pavement sections for incorporation into the project plans.

Based on a review of the boring logs and the R-value data presented above, the near surface soil of the site consists of mostly sand with gravel. As such, an R-value of 55 was used to determine the recommended minimum flexible pavement sections. If site grading exposes soil other than that assumed, we should perform additional tests to confirm or revise the recommended pavement sections for actual field conditions. Various alternative pavement sections based on the Caltrans Flexible Pavement Design Method are presented below:

ASPHALT CONCRETE (FLEXIBLE) PAVEMENTS (R-value = 55 or greater)			
Traffic Index (inches)	**Asphalt Concrete (inches)**	**Class 2 Aggregate Base (inches)**	**Compacted Subgrade (inches)**
4.0	3.0	4.0	12.0
5.0	3.0	5.0	12.0
6.0	3.5	6.0	12.0
7.0	4.0	7.0	12.0
8.0	4.5	7.5	12.0
9.0	5.0	9.0	12.0

We recommend that the subgrade soil be prepared as discussed in this report. The compacted subgrade should be non-yielding when proof-rolled with a loaded ten-wheel truck, such as a water truck or dump truck, prior to pavement construction. Subgrade preparation should extend a minimum of 2 feet laterally beyond the edge of pavement or back of curbs.

Pavement areas should be sloped and drainage gradients maintained to carry all surface water off the site. A cross slope of 2 percent is recommended in asphalt concrete pavement areas to provide good surface drainage and to reduce the potential for water to penetrate into the pavement structure.

Unless otherwise required by local jurisdictions, paving materials should comply with the materials specifications presented in the Caltrans Standard Specifications Section. Class 2 aggregate should comply with the materials requirements for Class 2 base found in Section 26. It is anticipated that the recommended paving materials are readily available in the project area.

The mineral aggregate shall be Type B, ½-inch or ¾-inch maximum, medium grading, for the wearing course and ¾-inch maximum, medium grading for the base course, and shall conform to the requirements set forth in Section 39 of the Standard Specifications. The asphalt concrete materials should comply with and be placed in accordance with the specifications presented in Section 39 of the Caltrans Standard Specifications, latest edition. Asphalt concrete should be compacted to a minimum of 95 percent of the maximum laboratory compacted (kneading compactor) unit weight.

ASTM Test procedures should be used to assess the percent relative compaction of soils, aggregate base and asphalt concrete. Aggregate base and subbase, and the upper 24 inches of subgrade should be compacted to at least 95 percent based on the Modified Proctor maximum compacted unit weight obtained in accordance with ASTM test method D1557. Compacted aggregate base should also be stable and unyielding when proof-rolled with a loaded ten-wheel water truck or dump truck.

Portland Cement Concrete (Rigid) Pavement

A four-inch layer of compacted Class 2 aggregate base should be placed over the prepared subgrade prior to placement of the concrete. With the addition of the aggregate base material, we recommend that a combined modulus of subgrade/base reaction value of 150 pounds per cubic inch be used in design where the rigid pavement is to be designed by a Structural Engineer.

Rigid pavement design procedures have been developed by various agencies, including AASHTO and the Portland Cement Association (PCA). We have evaluated the required pavement sections based on the procedure presented in "AASHTO Guide for Design of Pavement Structures 1993" traffic volumes.

RIGID PAVEMENT			
Traffic/Pavement Designation	**Portland Cement Concrete (inches)**	**Class 2 Aggregate Base (inches)**	**Compacted Subgrade (inches)**
Standard Duty	5.0	6.0	12.0
Heavy Duty	6.0	6.0	12.0

Please note that the concrete modulus of rupture is based on *flexural strength*, not compressive strength, and should be specified accordingly. A *flexural strength* of 550 psi should be specified accordingly. Our experience is that the compressive strength will have to be on the order of 3,800 to 4,500 psi may be required to achieve the required flexural strength. Prior to the construction of any rigid pavement, we recommend that concrete mix histories with flexural strength data be obtained from the proposed supplier. In the absence of flexural strength history, we recommend that laboratory trail batching and testing be performed to allow for confirmation that the proposed concrete mix is capable of producing the required flexural strength.

The concrete pavements should be designed with both longitudinal and transverse joints. The saw-cut or formed joints should extend to a minimum depth on one-fourth of the pavement thickness plus ¼ inch. Joint spacing should not exceed 15 feet. Steel reinforcement of all rigid pavements is recommended to keep the joints tight and to control temperature cracking.

Keyed joints are recommended at all construction joints to transfer loads across the joints. Joints should be reinforced with a minimum of ½ inch diameter by 48-inch long deformed reinforcing steel placed at mid-slab depth on 18-inch center-to-center spacing to keep the joints tight for load transfer. The joints should be filled with a flexible sealer. The sealer should be fuel-resistant where placed at the fuel center facility. Expansion joints should be constructed only where the pavements abut structures or fixed objects.

Smooth bar dowels, with a diameter of d/8, where d equals the thickness of the concrete, at least 14 inches in length, placed at a spacing of 12 inches on centers, may also be considered for construction joints to transfer loads across the joints. The dowels should be centered across the joints with one side of the dowel lubricated to reduce the bond strength between the dowel and the concrete and fitted with a plastic cap to allow for bar expansion.

SOIL CORROSIVITY

Excessive sulfate or chloride in either the soil or native water may result in an adverse reaction between the cement in concrete and the soil. California Building Code has developed criteria for evaluation of sulfate and chloride levels and how they relate to cement reactivity with soil and/or water. The soil samples from the subject site were tested to have negligible sulfate and low chloride concentrations. Therefore, no special design requirements are necessary to compensate for sulfate or chloride reactivity with the cement. A qualified corrosion engineer should be consulted regarding the corrosion effects of the onsite soils on underground metal utilities.

TOPSOIL ANALYSIS

A representative sample of the near surface soil was submitted to a subcontracted laboratory for topsoil analysis. The results of the topsoil analysis testing are presented as an attachment to this letter.

PERCOLATION TESTING

A total of two (2) percolation tests were preformed at the subject site. The approximate locations of these tests are indicated on Figure 2. Results of these tests are presented in Appendix A of this report. The data, which is presented in tabular format, indicates varied infiltration rates. The soil absorption or percolation rates are based on tests conducted with clear water. The infiltration rates may vary with time as a result of soil clogging from water impurities. A factor of safety should be incorporated into the design and evaluation of the infiltration areas to compensate for these factors. This factor of safety should be based on the application of the proposed infiltration areas. The infiltration rate at the end of the test for each test location indicated percolation rates ranging from approximately 2.4 inches per hour to 2.5 inches per hour.

The shallow soil conditions present at the subject site were evaluated by drilling shallow borings in the vicinity of the infiltration tests. The borings drilled at the site indicated fine to medium sand to the maximum depth explored.

Testing and Inspection

The Soils Engineer or his authorized agent should be present at the site during the earthwork activities to confirm that actual subsurface conditions are consistent with the exploratory fieldwork. This activity is an integral part of the geotechnical engineering services, as acceptance of earthwork construction is dependent upon compaction testing and stability of the material. This representative can also verify that the intent of these recommendations is incorporated into the project design and construction. Krazan & Associates, Inc. will not be responsible for grades or staking, since this is the responsibility of the Prime Contractor.

If the Owner opts to utilize a different Soil Engineer of Record for earthwork observation and testing services on this project, Krazan & Associates, Inc. cannot be held responsible for the work performed by the contractors and the testing and inspection laboratory, their potential misinterpretation of our recommendations, or failure to follow the intent of our recommendations during earthwork and

foundation construction on the project. Therefore, the retained geotechnical consultant must assume full responsibility for all the geotechnical aspects of the project, and agree in writing to accept that responsibility in accordance with Section 1704.7 of the 2010 California Building Code.

LIMITATIONS

Soils Engineering is one of the newest divisions of Civil Engineering. This branch of Civil Engineering is constantly improving as new technologies and understanding of earth sciences advance. Although your site was analyzed using the most appropriate and most current techniques and methods, undoubtedly there will be substantial future improvements in this branch of engineering. In addition to advancements in the field of Soils Engineering, physical changes in the site, either due to excavation or fill placement, new agency regulations, or possible changes in the proposed structure after the soils report is completed may require the soils report to be professionally reviewed. In light of this, the Owner should be aware that there is a practical limit to the usefulness of this report without critical review. Although the time limit for this review is strictly arbitrary, it is suggested that 2 years be considered a reasonable time for the usefulness of this report.

Foundation and earthwork construction is characterized by the presence of a calculated risk that soil and groundwater conditions have been fully revealed by the original foundation investigation. This risk is derived from the practical necessity of basing interpretations and design conclusions on limited sampling of the earth. The recommendations made in this report are based on the assumption that soil conditions do not vary significantly from those disclosed during our field investigation. If any variations or undesirable conditions are encountered during construction, the Soils Engineer should be notified so that supplemental recommendations may be made.

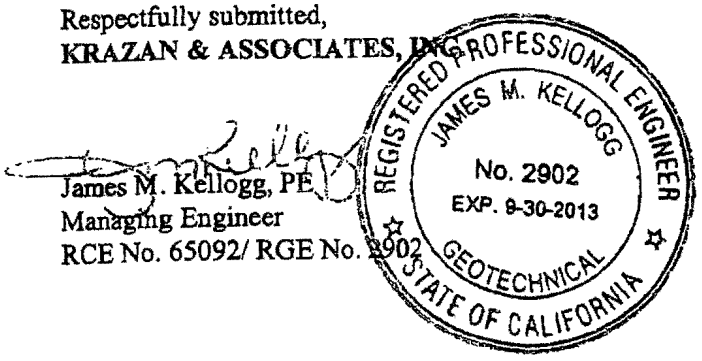
The conclusions of this report are based on the information provided regarding the proposed construction. If the proposed construction is relocated or redesigned, the conclusions in this report may not be valid. The Soils Engineer should be notified of any changes so the recommendations may be reviewed and re-evaluated.

This report is a Geotechnical Engineering Investigation Update with the purpose of evaluating the soil conditions in terms of foundation design. The scope of our services did not include any Environmental Site Assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater, or atmosphere; or the presence of wetlands. Any statements, or absence of statements, in this report or on any boring log regarding odors, unusual or suspicious items, or conditions observed, are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous and/or toxic assessment. This Geotechnical Engineering Investigation report has been prepared for the exclusive use of Regency Centers, and their respective successors.

The geotechnical engineering information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical engineering developments. We emphasize that this report is valid for the project outlined above and should not be used for any other sites.

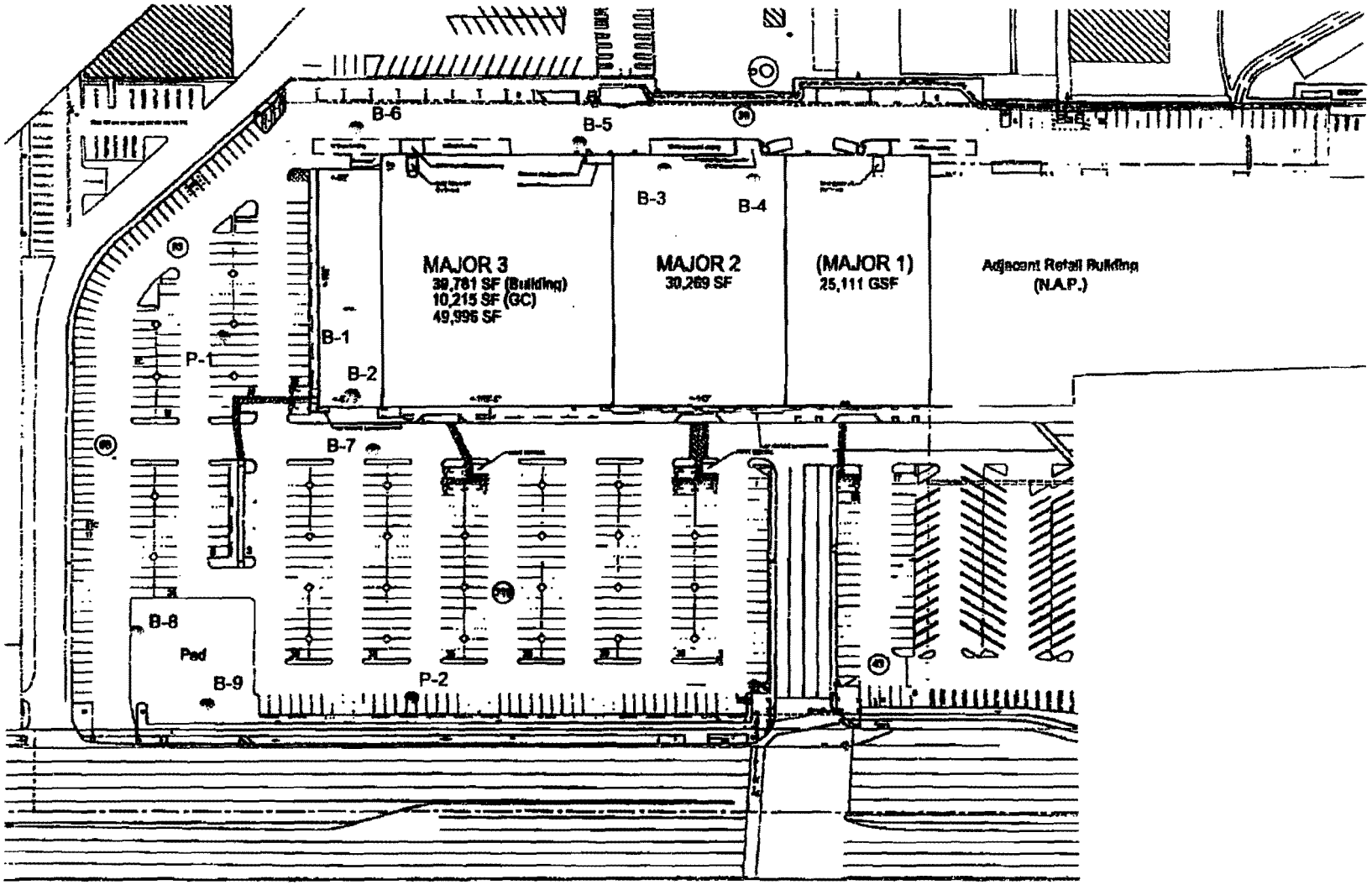
If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (951) 273-1011.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.



James M. Kellogg, PE
Managing Engineer
RCE No. 65092/ RGE No. 2902

Figures



GEOTECHNICAL ENGINEERING INVESTIGATION
19330 HAWTHORNE BOULEVARD
TORRANCE, CALIFORNIA

SITE PLAN

Scale:	Date:
NTS	Dec. 19, 2011
Drawn by: JK	Approved by: JK
Project No. 112-11035	Figure No. 1

Krazan
SITE DEVELOPMENT ENGINEERS
Offices Serving the Western United States

GEOTECHNICAL ENGINEERING INVESTIGATION
19330 HAWTHORNE BOULEVARD
TORRANCE, CALIFORNIA

VICINITY MAP

Scale:	Date:
NTS	Dec. 19, 2011
Drawn by:	Approved by:
JK	JK
Project No.	Figure No.
112-11035	2

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SITE DEVELOPMENT ENGINEERS
Offices Serving the Western United States

Appendix A

APPENDIX A

FIELD AND LABORATORY INVESTIGATIONS

Field Investigation

Our field investigation consisted of a surface reconnaissance and a subsurface exploration program consisted of drilling, logging and sampling a total of eleven (11) borings. The depths of exploration ranged from about 10 feet to 50 feet below the existing site surface.

A member of our staff visually classified the soils in the field as the drilling progressed and recorded a continuous log of each boring. Visual classification of the soils encountered in our exploratory borings was made in general accordance with the Unified Soil Classification System (ASTM D2487). A key for the classification of the soil and the boring logs are presented in this Appendix.

During drilling operations, penetration tests were performed at regular intervals to evaluate the soil consistency and to obtain information regarding the engineering properties of the subsoils. Samples were obtained from the borings by driving either a 2.5-inch inside diameter Modified California tube sampler fitted with brass sleeves or a 2-inch outside diameter, 1-3/8-inch inside diameter Standard Penetration ("split-spoon") test (SPT) sampler without sleeves. Soil samples were retained for possible laboratory testing. The samplers were driven up to a depth of 18 inches into the underlying soil using a 140-pound hammer falling 30 inches. The downhole ("safety") hammer was raised by a winch between blows. The number of blows required to drive the sampler was recorded for each 6-inch penetration interval and the number of blows required to drive the sampler the last 12 inches are shown as blows per foot on the boring logs.

The approximate locations of our borings and bulk samples are shown on the Site Plan, Figure 2. These approximate locations were estimated in the field based on pacing and measuring from the limits of existing site features.

Laboratory Investigation

The laboratory investigation was programmed to determine the physical and mechanical properties of the soil underlying the site. The laboratory-testing program was formulated with emphasis on the evaluation of in-situ moisture, density, gradation, shear strength, consolidation potential, and R-value of the materials encountered. In addition, chemical tests were performed to evaluate the soil/cement reactivity and corrosivity. Test results were used in our engineering analysis with respect to site and building pad preparation through mass grading activities, foundation and retaining wall design recommendations, pavement section design, evaluation of the materials as possible fill materials and for possible exclusion of some soils from use at the structures as fill or backfill.

Select laboratory test results are presented on the boring logs, with graphic or tabulated results of selected tests included in this Appendix. The laboratory test data, along with the field observations, was used to prepare the final boring logs presented in the Appendix.

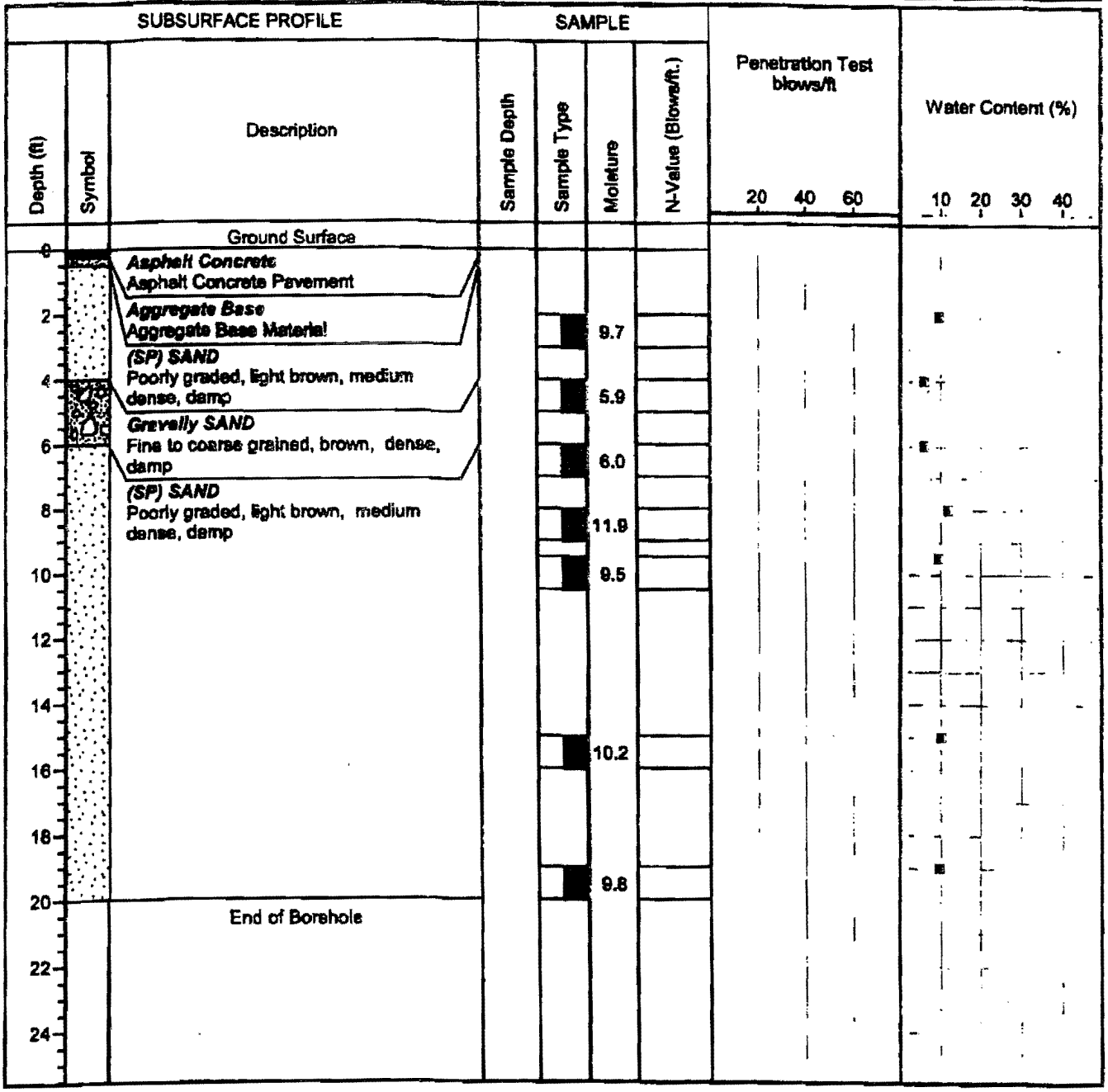
Log of Drill Hole B-1

Project No: 11211035

Figure No: A-1

Logged by: DK

Groundwater Not Encountered



Drill Method: HA

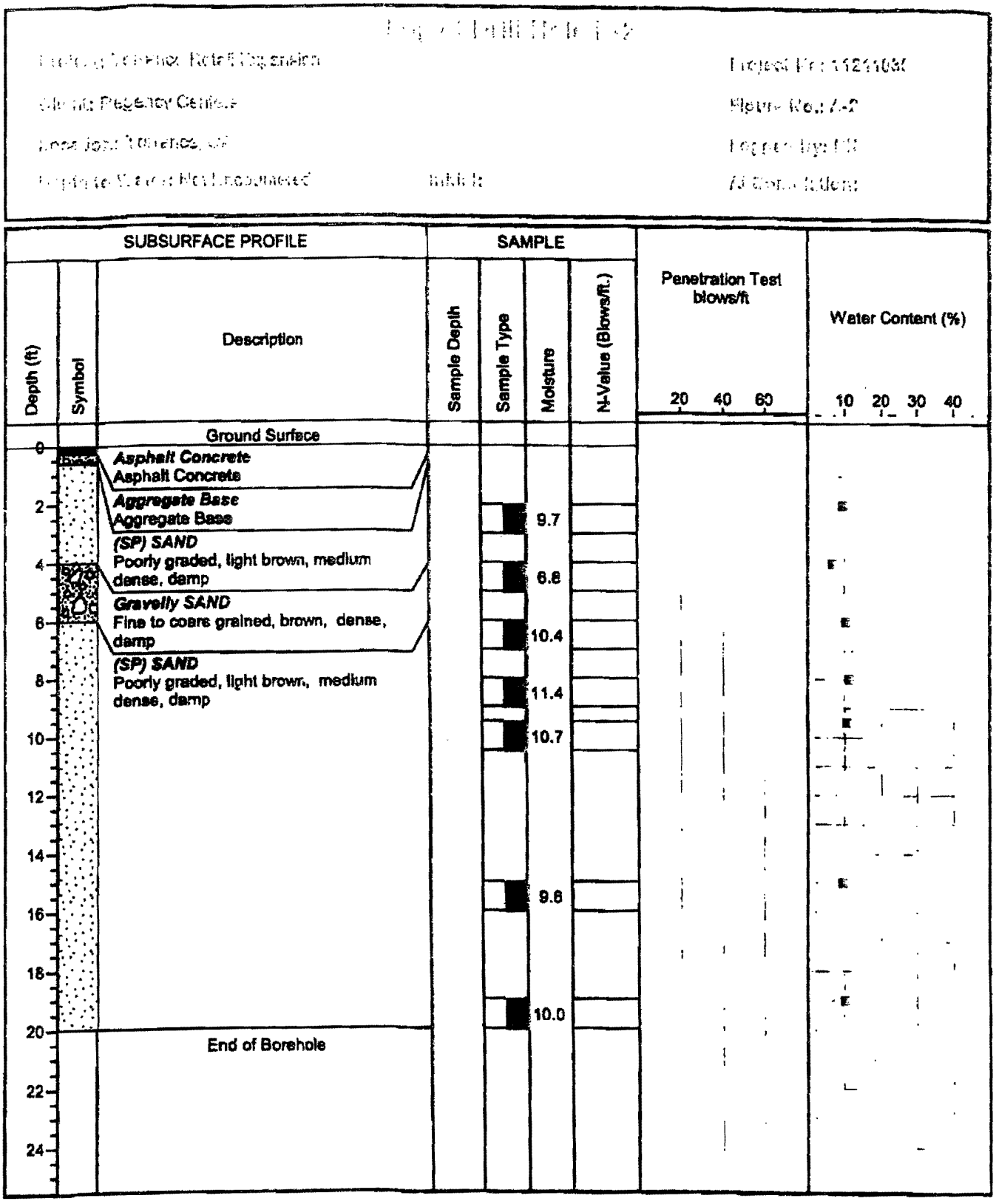
Driller: Baja

Krazan and Associates

Drill Date: 11/30/11

Sample Method: SS

Sheet: 1 of 1



Drill Method: HA

Driller: Baja

Krazan and Associates

Drill Date: 11/30/11

Sample Method: ST

Sheet: 1 of 1

Logged Drill Hole B-3

Project: Torrance Retail Expansion
Project No: 11211035
Client: Regency Centers
Figure No: A-3
Location: Torrance, CA
Logged By: RK
Depth to Water: Not Encountered
Initial:
At Completion:

SUBSURFACE PROFILE			SAMPLE				Penetration Test blows/ft	Water Content (%)
Depth (ft)	Symbol	Description	Sample Depth	Sample Type	Moisture	N-Value (Blows/ft.)	20 40 60	10 20 30 40
0		Ground Surface						
0		***(SP) SAND*** Poorly graded, light brown, medium dense, damp						
2					4.6	26		
4		***Gravelly SAND*** Fine to coarse grained, brown, dense, damp			5.5	38		
6		***(SP) SAND*** Poorly graded, light brown, medium dense to dense, damp			9.1	29		
8					8.4	25		
10					9.9	30		
12								
14								
16					9.0	36		
18								
20		End of Borehole			6.6	32		
22								
24								

Drill Method: HSA
Driller: Baja

Krazan and Associates

Drill Date: 11/30/11
Sample Method: SS
Sheet: 1 of 1

Log of Drill Hole B-4

Project: Torrance Retail Expansion — Project No: 11211035

Client: Regency Centers — Figure No.: A-4

Location: Torrance, CA — Logged By: PK

Depth to Water: Not Encountered — Added:

Date of Completion:

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Depth	Sample Type	Moisture	N-Value (Blows/ft.)	Penetration Test blows/ft (20 40 60)	Water Content (%) (10 20 30 40)
0		Ground Surface						
0		***(SP) SAND*** Poorly graded, orange/brown, medium dense, damp						
2					4.5	28		
4		***Gravelly SAND*** Fine to coarse grained, brown, dense, damp			5.9	32		
6		***(SP) SAND*** Poorly graded, light brown, medium dense to dense, damp			4.9	36		
8					5.6	29		
10					5.2	35		
12								
14								
16					8.4	30		
18								
20		End of Borehole			8.5	34		
22								
24								

Drill Method: HSA

Driller: Baja

Krazan and Associates

Drill Date: 11/30/11

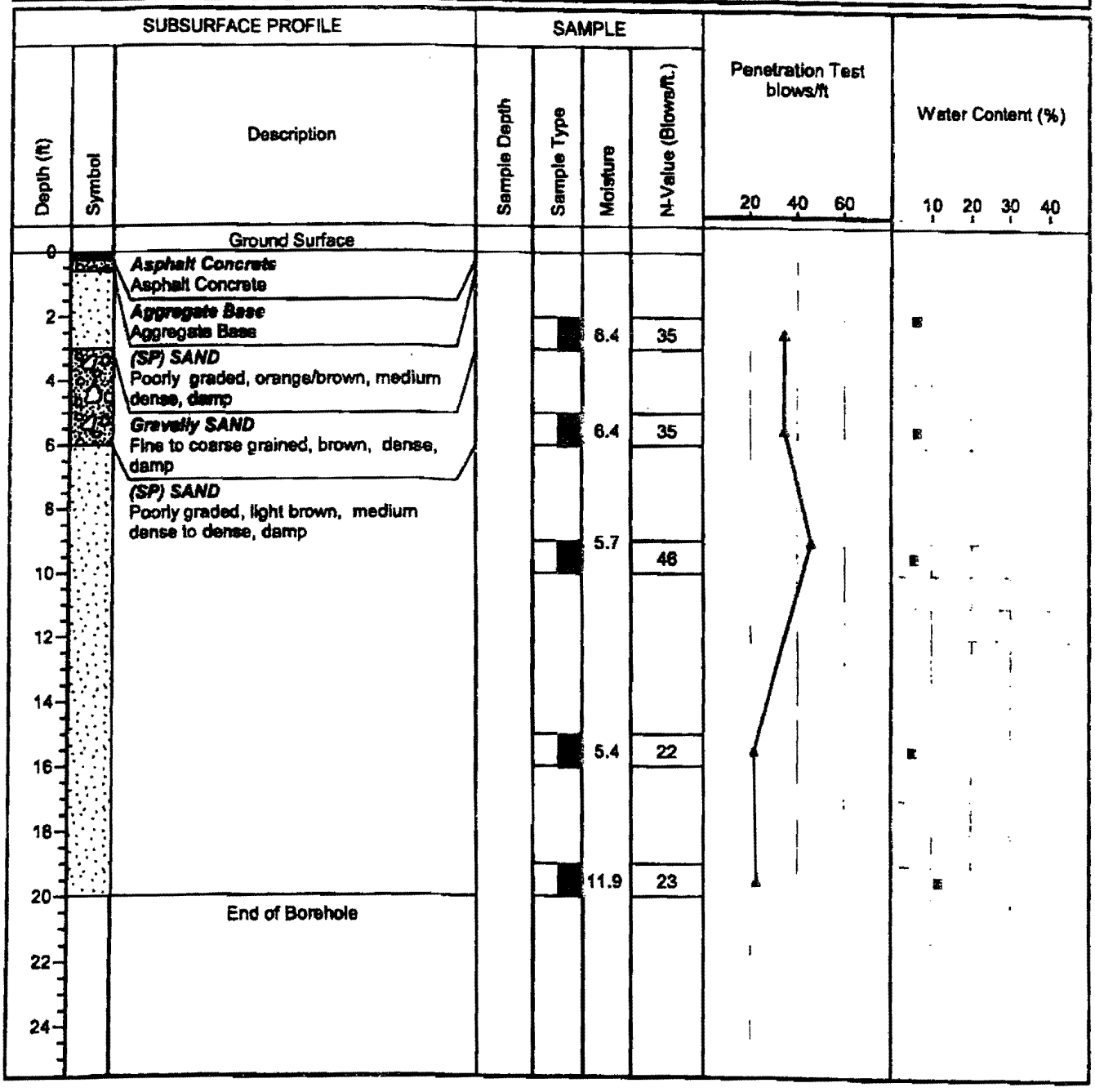
Sample Method: SPT

Sheet: 1 of 1

Log of Drill Hole B-6

Project: Torrance Retail Expansion
Client: Regency Centers
Location: Torrance, CA
Depth to Water: Not Encountered

Project No: 11211035
Figure No: A-5
Logged by: PK
At Completion:



Drill Method: HSA
Driller: Baja

Krazan and Associates

Drill Date: 11/30/11
Sample Method: SPT
Sheet: 1 of 1

Log of Drill Hole B-6

Project: Torrance Retail Expansion — Project No: 11211031

Client: Regency Centers — Figure No.: A-6

Location: Torrance, CA — Logged By: PK

Depth to Water: Not Encountered — Initial: — At Completion:

Depth (ft)	Symbol	Description	Sample Depth	Sample Type	Moisture	N-Value (Blows/ft.)
0		Ground Surface				
0		***Asphalt Concrete*** Asphalt Concrete				
2		***Aggregate Base*** Aggregate Base			7.3	26
4		***(SP) SAND w/gravel*** Fine to coarse grained, brown, dense, damp			8.0	30
6		***(SP) SAND*** Poorly graded, light brown, medium dense, damp			5.2	15
8						
10						
12						
14						
16					5.5	20
18						
20					11.2	22
22						
24						
26						
28						
30						

Penetration Test blows/ft: 20 40 60

Water Content (%): 10 20 30 40

Drill Method: HSA

Driller: Baje

Krazan and Associates

Drill Date: 11/30/11

Sample Method: SPT

Log of Drill Hole B-6

Project: Torrance Retail Expansion
Client: Regency Centers
Location: Torrance, CA
Depth to Water: Not Encountered
Hole Dia.:

Project No: 11211035
Figure No: A-6
Logged By: PK
At Completion:

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Depth	Sample Type	Moisture	N-Value (Blows/ft.)	Penetration Test blows/ft (20 40 60)	Water Content (%) (10 20 30 40)
32								
34								
36								
38								
40								
42								
44								
46								
48								
50		End of Borehole						
52								
54								
56								
58								
60								

Drill Method: HSA
Driller: Baja

Krazan and Associates

Drill Date: 11/30/11
Sample Method: SPT
Sheet: 2 of 2

Log of Drill Hole B-7

Project: Torrance Retail Expansion
Project No: 11211035
Job No: Regency Centers
Figure No.: A-7
Location: Torrance, CA.
Logged By: PK
Depth to Water: Not Encountered
Initial:
At Completion:

Depth (ft)	Symbol	Description	Sample Depth	Sample Type	Moisture	N-Value (Blows/ft.)
0		Ground Surface				
		Asphalt Asphalt Pavement				
2		***Aggregate Base*** Aggregate Base			6.3	22
4		***(SP) SAND w/ Gravel*** Fine to coarse grained, brown, dense, damp			5.9	30
6		***(SP) SAND*** Poorly graded, light brown, medium dense, damp				
8					11.2	25
10						
12						
14						
16					11.7	40
18						
20		End of Borehole			5.8	28
22						
24						

Penetration Test blows/ft: 20 40 60

Water Content (%): 10 20 30 40

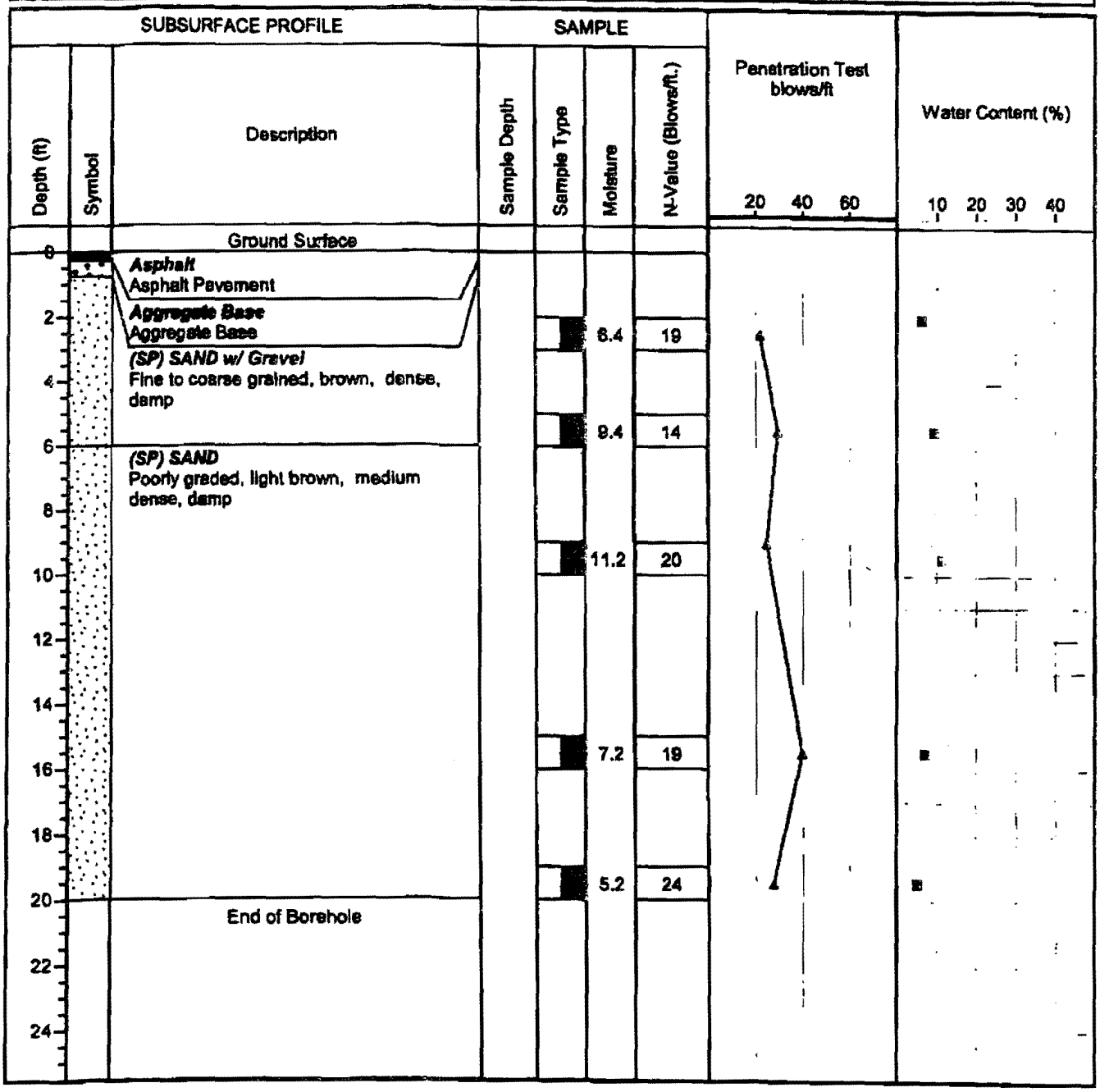
Drill Method: HSA
Driller: Baja

Krazan and Associates

Drill Date: 11/30/11
Sample Method: SPT
Sheet: 1 of 1

Log of Drill Hole B-5

Project: Torrance Retail Expansion
Project No: 11211036
Client: Regency Centers
Figure No: A-5
Location: Torrance, CA
Logged By: PK
Depth to Water: Not Encountered
Initial:
At Completion:



Drill Method: HSA
Driller: Baja

Krazan and Associates

Drill Date: 11/30/11
Sample Method: SPT
Sheet: 1 of 1

Log of Drill Hole B-6

Project: Torrance Retail Expansion
Project No: 11211035
Client: Regency Centers
Figure No: A-6
Location: Torrance, CA
Logged by: PK
Depth to Water: Not Encountered
Date:
% Completion:

Depth (ft)	Symbol	Description	Sample Depth	Sample Type	Moisture	N-Value (Blows/ft.)
0		Ground Surface				
0		***Asphalt*** Asphalt Pavement				
2		***Aggregate Base*** Aggregate Base			4.6	18
4		***(SP) SAND w/ Gravel*** Fine to coarse grained, brown, dense, damp			5.9	35
6		***(SP) SAND*** Poorly graded, light brown, medium dense, damp			4.6	15
10						
12						
14					8.6	21
16						
18					11.7	26
20		End of Borehole				
22						
24						

Penetration Test blows/ft: 20 40 60

Water Content (%): 10 20 30 40

Drill Method: HSA
Driller: Baja

Krazan and Associates

Drill Date: 11/30/11
Sample Method: SPT
Sheet: 1 of 1

Log of Drill Hole B-1

Project: Torrance Retail

Client: Regency Centers

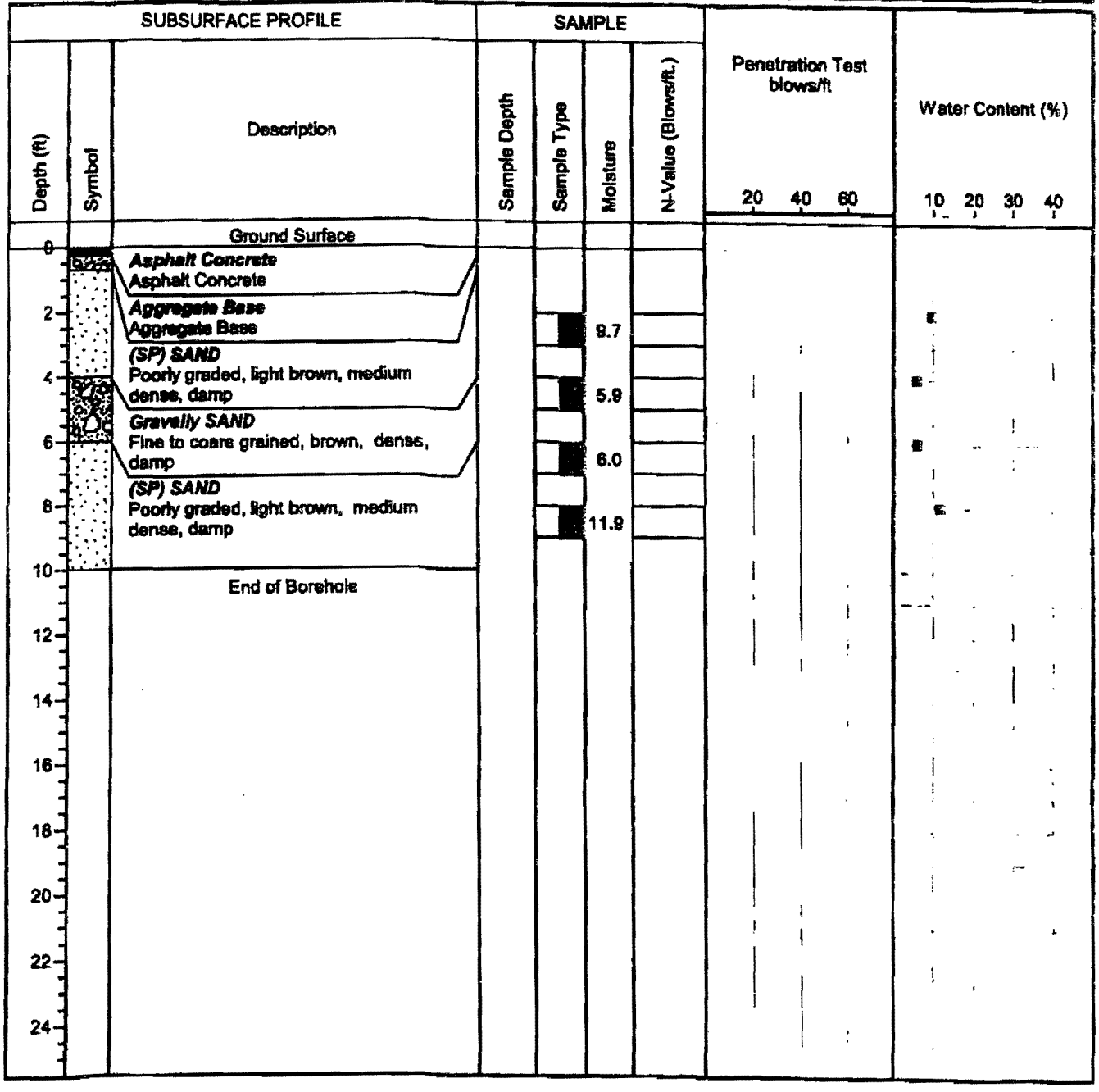
Location: Torrance, CA

Depth to Water: Not Encountered

Project No: 11211035

Figure No.: A-10

Logged By: PK



Drill Method: HA

Driller: Baja

Krazan and Associates

Drill Date: 11/30/11

Sample Method: SS

Sheet: 1 of 1

Log of Drill Hole L-2

Project: Torrance Retail | Project No: 11211035

Client: Regency Centers | Figure No.: A-11

Location: Torrance, CA | Logged By: PK

Depth to Water: Not Encountered | Initial: | AS Sampled:

SUBSURFACE PROFILE			SAMPLE					
Depth (ft)	Symbol	Description	Sample Depth	Sample Type	Moisture	N-Value (Blows/ft.)	Penetration Test blows/ft (20 40 60)	Water Content (%) (10 20 30 40)
0		Ground Surface						
0		***Asphalt Concrete*** Asphalt Concrete						
2		***Aggregate Base*** Aggregate Base			9.7			
4		***(SW) SAND*** Poorly graded, light brown, medium dense, damp			5.8			
6		***Gravelly SAND*** Fine to coare grained, brown, dense, damp			6.0			
8		***(SW) SAND*** Poorly graded, light brown, medium dense, damp			11.9			
10		End of Borehole						
12								
14								
16								
18								
20								
22								
24								

Drill Method: HA

Driller: Baja

Krazan and Associates

Drill Date: 11/30/11

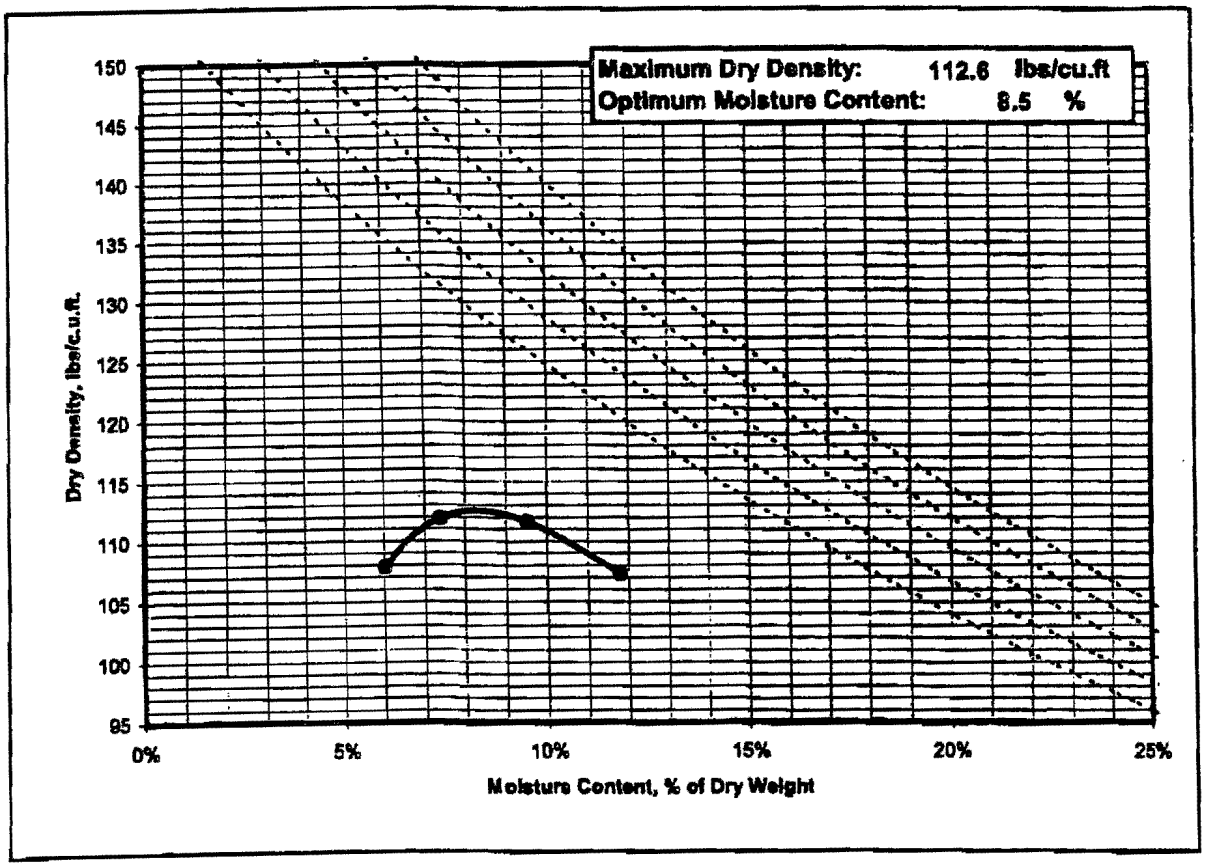
Sample Method: SS

Sheet: 1 of 1

Laboratory Compaction Curve
ASTM - D1557, D698

Project Number	: 11211035
Project Name	: Torrance Retail Center
Date	: 11/30/11
Sample location	: B-5
Sample/Curve Number	: "A"
Soil Classification	: SP
Test Method	: D1557

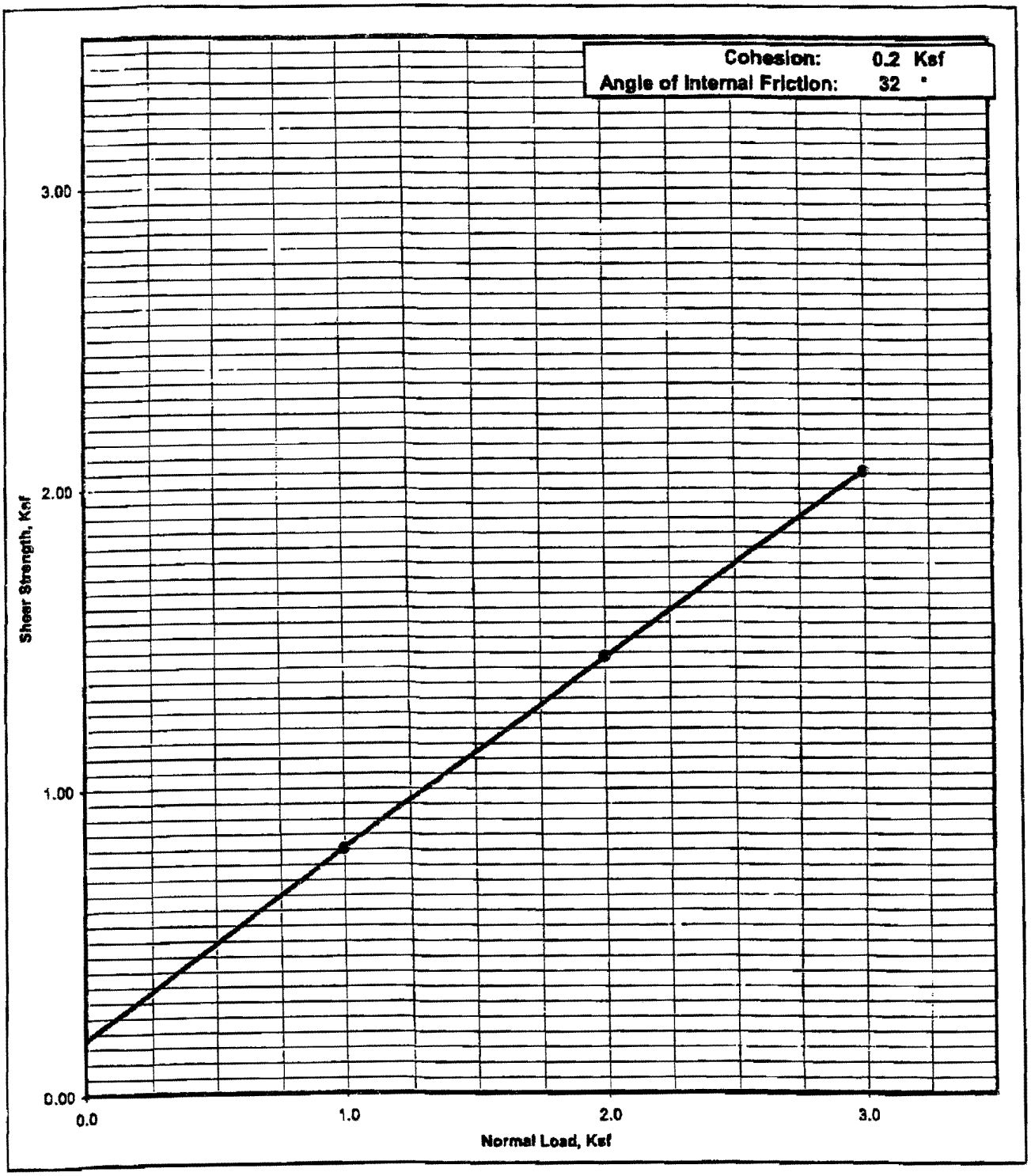
	1	2	3	4
Weight of Moist Specimen & Mold, gm	6153.0	6325.0	6386.0	6320.0
Weight of Compaction Mold, gm	2781.5	2781.5	2781.5	2781.5
Weight of Moist Specimen, gm	3371.5	3543.5	3604.5	3538.5
Volume of mold, cu. ft.	0.0650	0.0650	0.0650	0.0650
Wet Density, lbs/cu.ft.	114.4	120.2	122.3	120.0
Weight of Wet (Moisture) Sample, gm	200.0	200.0	200.0	200.0
Weight of Dry (Moisture) Sample, gm	188.6	186.2	182.6	178.9
Moisture Content, %	6.0%	7.4%	9.5%	11.8%
Dry Density, lbs/cu.ft.	107.8	111.9	111.6	107.4



Krazan Testing Laboratory

Shear Strength Diagram (Direct Shear)
ASTM D - 3080 / AASHTO T - 236

Project Number	Boring No. & Depth	Soil Type	Date
11211035	B-6_2.0	SP	12/20/2011

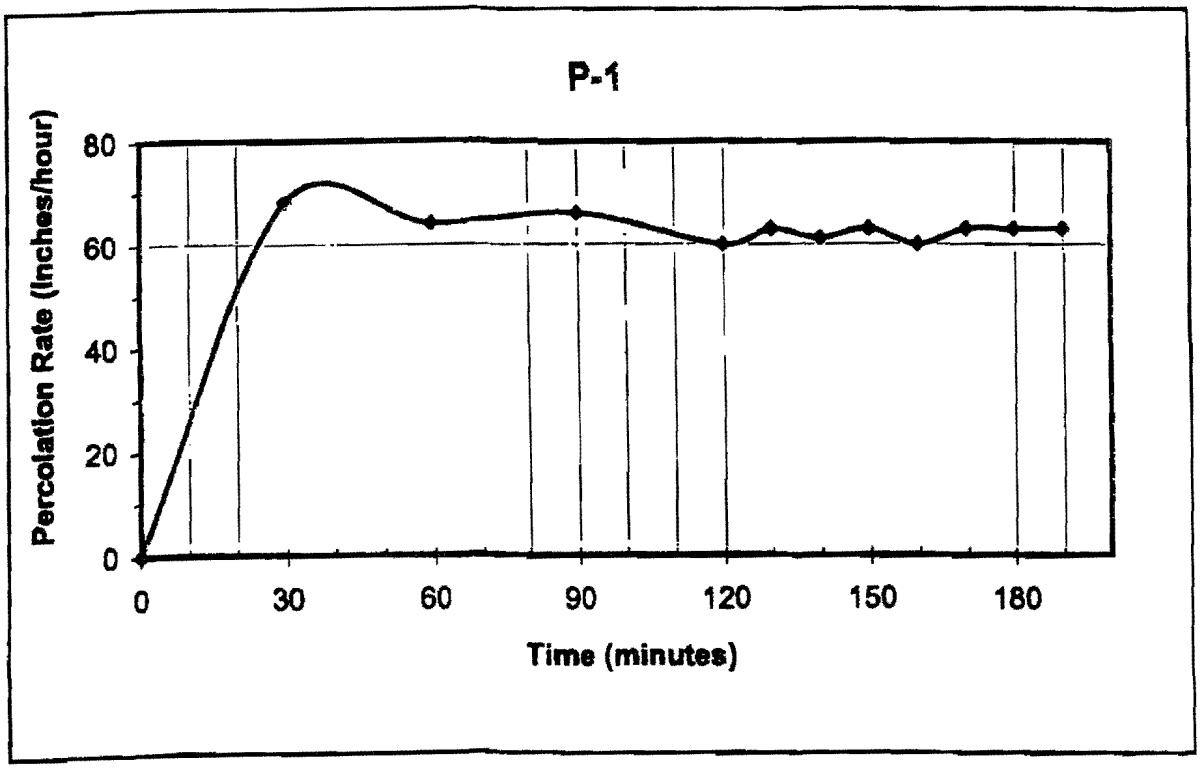


Krazan Testing Laboratory

RESULTS OF PERCOLATION TESTS

Project #	112-11035			**Date**	11/30/2011
Project Name	Proposed Retail Center Expansion				
Project Address	Torrance, California				
Test No:	P-1	**Total Depth**	10.0'	**Test Size**	8"
Depth To Water	>20'	**Soil Classification**	SM		

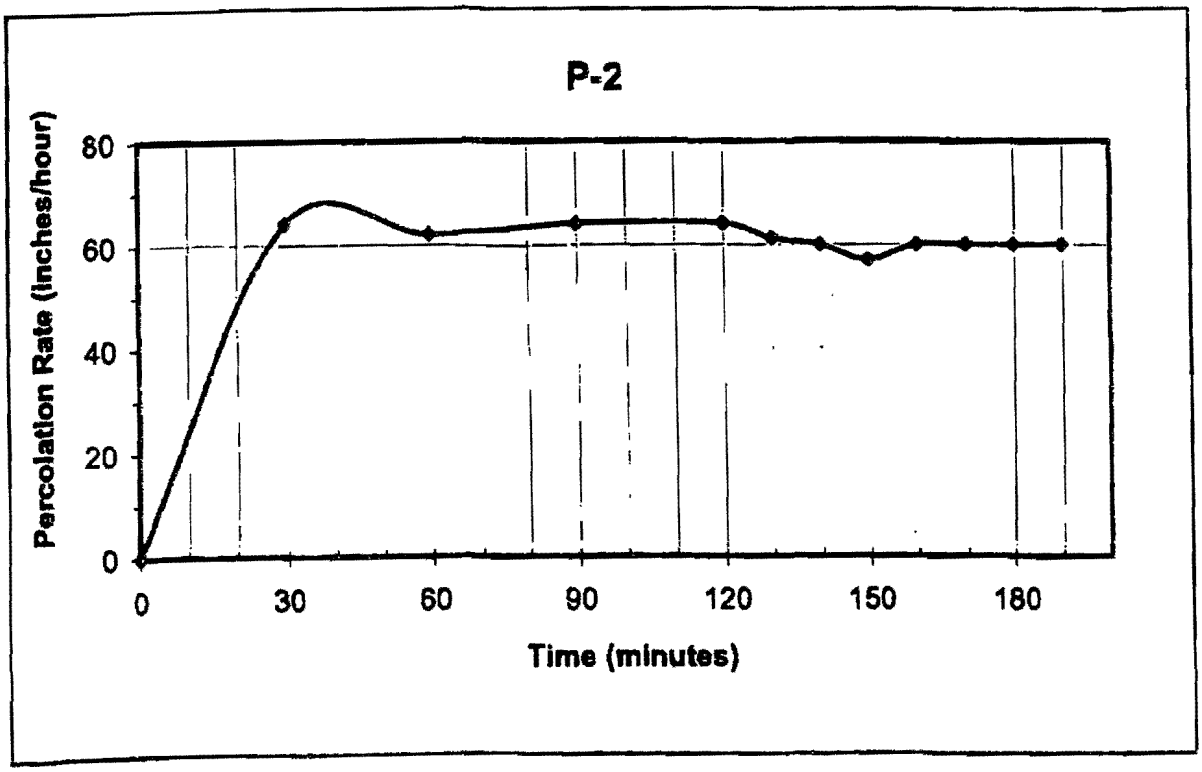
Reading	Elasped Time(min.)	Incremental Time (min.)	Depth To Water(ft.)	Incremental Fall of Water(in.)	Incremental Percolation Rate (in/hr)
Start	0	0.00	4.00	--	
2	30.00	30.00	6.83	34.000	68.00
3	60.00	30.00	6.86	32.000	64.00
4	90.00	30.00	6.75	33.000	66.00
5	120.00	30.00	6.50	30.000	60.00
6	130.00	10.00	4.88	10.500	63.00
7	140.00	10.00	4.85	10.200	61.20
8	150.00	10.00	5.73	10.500	63.00
9	160.00	10.00	4.83	10.000	60.00
10	170.00	10.00	5.70	10.500	63.00
11	180.00	10.00	4.88	10.500	63.00
12	190.00	10.00	5.75	10.500	63.00
	Percolation Rate in Inches per Hour				60.00
	Infiltration Rate in Inches per Hour				2.52



RESULTS OF PERCOLATION TESTS

Project #	112-11035			Date	11/30/2011
Project Name	Proposed Retail Center Expansion				
Project Address	Torrance, California				
Test No:	P-2	Total Depth	10.0'	Test Size	8"
Depth To Water	>20'	Soil Classification	SM		

Reading	Elasped Time(min.)	Incremental Time (min.)	Depth To Water(ft.)	Incremental Fall of Water(in.)	Incremental Percolation Rate (in/hr)
Start	0	0.00	4.00	--	
2	30.00	30.00	6.70	32.000	64.00
3	60.00	30.00	6.80	31.000	62.00
4	90.00	30.00	6.70	32.000	64.00
5	120.00	30.00	6.70	32.000	64.00
6	130.00	10.00	4.85	10.200	61.20
7	140.00	10.00	4.83	10.000	60.00
8	150.00	10.00	4.80	9.500	57.00
9	160.00	10.00	5.63	10.000	60.00
10	170.00	10.00	4.83	10.000	60.00
11	180.00	10.00	5.66	10.000	60.00
12	190.00	10.00	6.50	10.000	60.00
	Percolation Rate in Inches per Hour				57.00
	Infiltration Rate in Inches per Hour				2.40



BELLAVALLE Laboratories, Inc.
Chemists and Consultants

Report of Soil Analysis

1910 W. McKinley, Suite 110, Fresno, CA 93728
FAX (559) 268-8174 - (800) 228-9898 - (559) 233-6129

Krazan & Associates-Corona
1100 Olympic Dr. Ste #103
Corona CA 92881
18454
50

Identification

Lab No. 166656
Sampled 12/12/11
Submitted 12/14/11
Submitted by J Kellogg
Reported 12/20/11
Job/Ranch/Site
Copy To
FAX
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No.	Description	mg/kg SO_4-S	mg/kg Cl	pHs
Methods:		Cal-Trans 417	Cal-Trans 422	Soil 1.10
1	B-4 0-3'	59.2	18	7.6

Analysis by Cal Trans Method

BELL ANALYTICAL Laboratory, Inc. Chemists and Consultants

Report of Soil Analysis

1910 W. McKinley, Suite 110, Fresno, CA 93728
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1100 Olympic Dr. Ste #103
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50

Lab No. 166655
Sampled 12/12/2011
Submitted 12/14/2011
Submitted by J Kellogg
Reported 12/20/2011
Job/Ranch/Site
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Identification

No.	Description	Methods	% SP 61.00	pHs 61.10	EC dS/m 61.20	meq/l Ca 61.60	meq/l Mg 61.60	meq/l Na 61.60	meq/l Cl 61.40	% ESP Calc.	T/ac-ft GR Hndbk 60-224	lbs/ac-ft Lime Req 62.50	+\- Lime Hndbk 60-23a	mg/l B 61.50	mg/kg NO_3-N 63.10	mg/kg PO_4-P 64.10	mg/kg K (AA) 65.10	mg/kg K H_2SO_4 6B8A	mg/kg Zn 66.10
1	B-4 0-3'		34	7.6	1.88	5.8	2.1	5.9		3.0			-	0.1	41	20	42		4.8

Appendix B

APPENDIX B

EARTHWORK SPECIFICATIONS

GENERAL

When the text of the report conflicts with the general specifications in this appendix, the recommendations in the report have precedence.

SCOPE OF WORK: These specifications and applicable plans pertain to and include all earthwork associated with the site rough grading, including, but not limited to, the furnishing of all labor, tools and equipment necessary for site clearing and grubbing, stripping, preparation of foundation materials for receiving fill, excavation, processing, placement and compaction of fill and backfill materials to the lines and grades shown on the project grading plans and disposal of excess materials.

PERFORMANCE: The Contractor shall be responsible for the satisfactory completion of all earthworks in accordance with the project plans and specifications. This work shall be inspected and tested by a representative of the project Geotechnical Engineer of Record. Attainment of design grades, when achieved, shall be certified by the project Civil Engineer. Both the Geotechnical Engineer and the Civil Engineer are the Owner's representatives. If the Contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, he shall make the necessary adjustments until all work is deemed satisfactory as determined by both the Geotechnical Engineer and the Civil Engineer. No deviation from these specifications shall be made except upon written approval of the Geotechnical Engineer, Civil Engineer, or project Architect.

No earthwork shall be performed without the physical presence or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least 2 working days prior to the commencement of any aspect of the site earthwork.

The Contractor agrees that he shall assume sole and complete responsibility for job site conditions during the course of construction of this project, including safety of all persons and property; that this requirement shall apply continuously and not be limited to normal working hours; and that the Contractor shall defend, indemnify and hold the Owner and the Engineers harmless from any and all liability, real or alleged, in connection with the performance of work on this project, except for liability arising from the sole negligence of the Owner or the Engineers.

TECHNICAL REQUIREMENTS: All compacted materials shall be densified to the minimum relative compaction of 95 percent. Soil moisture content requirements presented in the Geotechnical Engineer's report shall also be complied with. The maximum laboratory compacted dry unit weight of each soil placed as fill shall be determined in accordance with ASTM test method D1557-00 (Modified Proctor). The optimum moisture content shall also be determined in accordance with this test method. The terms "relative compaction" and "compaction" are defined as the in-place dry density of the compacted soil divided by the laboratory compacted maximum dry density as determined by ASTM Test Method D1557-00, expressed as a percentage as specified in

the technical portion of the Geotechnical Engineer's report. The location and frequency of field density tests shall be as determined by the Geotechnical Engineer. The results of these tests and compliance with these specifications shall be the basis upon which the Geotechnical Engineer will judge satisfactory completion of work.

SOILS AND FOUNDATION CONDITIONS: The Contractor is presumed to have visited the site and to have familiarized himself with existing site conditions and the contents of the data presented in the Geotechnical Engineering Investigation report.

The Contractor shall make his own interpretation of the data contained in the Geotechnical Engineering Investigation report and the Contractor shall not be relieved of liability under the Contract for any loss sustained as a result of any variance between conditions indicated by or deduced from said report and the actual conditions encountered during the progress of the work.

DUST CONTROL: The work includes dust control as required for the alleviation or prevention of any dust nuisance on or about the site or the borrow area, or off-site if caused by the Contractor's operation either during the performance of the earthwork or resulting from the conditions in which the Contractor leaves the site. The Contractor shall assume all liability, including court costs of codefendants, for all claims related to dust or wind-blown materials attributable to his work.

SITE PREPARATION

Site preparation shall consist of site clearing and grubbing, over-excavation of the building pad areas, preparation of foundation materials for receiving fill, construction of engineered fill including the placement of non-expansive fill where recommended by the Geotechnical Engineer.

CLEARING AND GRUBBING: The Contractor shall accept the site in this present condition and shall demolish and/or remove from the area of designated project earthwork all structures, both surface and subsurface, trees, brush, roots, debris, organic matter and all other matter determined by the Geotechnical Engineer to be deleterious. Site stripping to remove organic materials and organic-laden soils in landscaped areas shall extend to a minimum depth of 2 inches or until all organic-laden soil with organic matter in excess of 3 percent of the soils by volume are removed. Such materials shall become the property of the Contractor and shall be removed from the site.

Tree root systems in proposed building areas should be removed to a minimum depth of 3 feet and to such an extent that would permit removal of all roots greater than 1 inch in diameter. Tree roots removed in parking areas may be limited to the upper 1½ feet of the ground surface. Backfill of tree root excavation should not be permitted until all exposed surfaces have been inspected and the Geotechnical Engineer is present for the proper control of backfill placement and compaction. Burning in areas that are to receive fill materials shall not be permitted.

Excavations required to achieve design grades, depressions, soft or pliant areas, or areas disturbed by demolition activities extending below planned finished subgrade levels should be excavated down to firm, undisturbed soil and backfilled with engineered fill. The resulting excavations should be backfilled with engineered fill.

EXCAVATION: Following clearing and grubbing operations, the proposed building pad area shall be over-excavated to a depth of at least three feet below existing grades or two feet below the planned foundation bottom levels, whichever is deeper, and the remaining areas of the building and adjoining exterior concrete flatwork or pavements at the building perimeter shall be over-excavated to a depth of at least two feet below existing grade. The areas of over-excavation and recompaction beneath footings and slabs shall extend out laterally a minimum of ten feet beyond the perimeter of these elements.

All excavation shall be accomplished to the tolerance normally defined by the Civil Engineer as shown on the project grading plans. All over-excavation below the grades specified shall be backfilled at the Contractor's expense and shall be compacted in accordance with the applicable **TECHNICAL REQUIREMENTS.**

SUBGRADE PREPARATION: Surfaces to receive engineered fill or to support structures directly, shall be scarified to a depth of 8 inches, moisture conditioned as necessary and compacted in accordance with the **TECHNICAL REQUIREMENTS**, above.

Loose soil areas and/or areas of disturbed soil shall be should be excavated down to firm, undisturbed soil, moisture-conditioned as necessary and backfilled with engineered fill. All ruts, hummocks, or other uneven surface features shall be removed by surface grading prior to placement of any fill materials. All areas that are to receive fill materials shall be approved by the Geotechnical Engineer prior to the placement of any of the fill material.

FILL AND BACKFILL MATERIAL: No material shall be moved or compacted without the presence of the Geotechnical Engineer. Material from the required site excavation may be utilized for construction of site fills, with the limitations of their use presented in the Geotechnical Engineer's report, provided the Geotechnical Engineer gives prior approval. All materials utilized for constructing site fills shall be free from vegetation or other deleterious matter as determined by the Geotechnical Engineer, and shall comply with the requirements for non-expansive fill, aggregate base or aggregate subbase as applicable for its proposed used on the site as presented in the Geotechnical Engineer's report.

PLACEMENT, SPREADING AND COMPACTION: The placement and spreading of approved fill materials and the processing and compaction of approved fill and native materials shall be the responsibility of the Contractor. Fill materials should be placed and compacted in horizontal lifts, each not exceeding 8 inches in uncompacted thickness. Due to equipment limitations, thinner lifts may be necessary to achieve the recommended level of compaction. Compaction of fill materials by flooding, ponding, or jetting shall not be permitted unless specifically approved by local code, as well as the Geotechnical Engineer. Additional lifts should not be placed if the previous lift did not meet the required dry density (relative compaction) or if soil conditions are not stable. The compacted subgrade in pavement areas should be non-yielding when proof-rolled with a loaded ten-wheel truck, such as a water truck or dump truck, prior to pavement construction.

Both cut and fill shall be surface-compacted to the satisfaction of the Geotechnical Engineer prior to final acceptance.

SEASONAL LIMITS: No fill material shall be placed, spread, or rolled while it is frozen or thawing, or during unfavorable wet weather conditions. When the work is interrupted by heavy rains, fill operations shall not be resumed until the Geotechnical Engineer indicates that the moisture content and density of previously placed fill is as specified.

General Paving Specifications

Appendix C

APPENDIX C

PAVEMENT SPECIFICATIONS

1. **DEFINITIONS** - The term "pavement" shall include asphalt concrete surfacing, untreated aggregate base, and aggregate subbase. The term "subgrade" is that portion of the area on which surfacing, base, or subbase is to be placed.

The term "Standard Specifications": hereinafter referred to is the January 1999 Standard Specifications of the State of California, Department of Transportation, and the "Materials Manual" is the Materials Manual of Testing and Control Procedures, State of California, Department of Public Works, Division of Highways. The term "relative compaction" refers to the field density expressed as a percentage of the maximum laboratory density as defined in the ASTM D1557-00.

2. **SCOPE OF WORK** - This portion of the work shall include all labor, materials, tools, and equipment necessary for, and reasonably incidental to the completion of the pavement shown on the plans and as herein specified, except work specifically notes as "Work Not Included."

3. **PREPARATION OF THE SUBGRADE** - The Contractor shall prepare the surface of the various subgrades receiving subsequent pavement courses to the lines, grades, and dimensions given on the plans. The upper 24 inches of the soil subgrade beneath the pavement section shall be compacted to a minimum relative compaction of 95 percent. The finished subgrades shall be tested and approved by the Geotechnical Engineer prior to the placement of additional pavement courses.

4. **UNTREATED AGGREGATE BASE** - The aggregate base material shall be spread and compacted on the prepared subgrade in conformity with the lines, grades, and dimensions shown on the plans. The aggregate base material shall conform to the requirements of Section 26 of the Standard Specifications for Class 2 material, ¾-inches maximum size. The aggregate base material shall be compacted to a minimum relative compaction of 95 percent. The aggregate base material shall be spread and compacted in accordance with Section 26 of the Standard Specifications. The aggregate base material shall be spread in layers not exceeding 6 inches and each layer of aggregate material course shall be tested and approved by the Geotechnical Engineer prior to the placement of successive layers.

5. **AGGREGATE SUBBASE** - The aggregate subbase shall be spread and compacted on the prepared subgrade in conformity with the lines, grades, and dimensions shown on the plans. The aggregate subbase material shall conform to the requirements of Section 25 of the Standard Specifications for Class 2 material. The aggregate subbase material shall be compacted to a minimum relative compaction of 95 percent, and it shall be spread and compacted in accordance with Section 25 of the Standard Specifications. Each layer of aggregate subbase shall be tested and approved by the Geotechnical Engineer prior to the placement of successive layers.

6. **ASPHALT CONCRETE SURFACING** - Asphalt concrete surfacing shall consist of a mixture of mineral aggregate and paving grade asphalt, mixed at a central mixing plant and spread and compacted on a prepared base in conformity with the lines, grades, and dimensions shown on the plans. The mineral aggregate shall be Type B, ½-inch or ¾-inch maximum, medium grading, for the wearing course and ¾-inch maximum, medium grading for the base course, and shall conform to the requirements set forth in Section 39 of the Standard Specifications. The drying, proportioning, and mixing of the materials shall conform to Section 39.

The prime coat, spreading and compacting equipment, and spreading and compacting the mixture shall conform to the applicable chapters of Section 39, with the exception that no surface course shall be placed when the atmospheric temperature is below 50 degrees F. The surfacing shall be rolled with a combination steel-wheel and pneumatic rollers, as described in Section 39-6. The surface course shall be placed with an approved self-propelled mechanical spreading and finishing machine.

7. **FOG SEAL COAT** - The fog seal (mixing type asphalt emulsion) shall conform to and be applied in accordance with the requirements of Section 37.