Stormwater Monitoring and BMP Development Status Report

April 2008

CTSW-RT-08-167.02.01

Final Report

California Department of Transportation

Division of Environmental Analysis

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15. Abstract

The April 2008 Status Report documents the status of stormwater monitoring and Best Management Practices (BMP) technology development conducted by Caltrans. The report provides a summary of the monitoring and applied studies conducted during the 2006/07 fiscal year and those proposed for the next three years. This report fulfills specific requirements of Sections 3.3 and 7.3.1 of the Department's 2003 Statewide Stormwater Management Plan (SWMP) and Section K.2 of the Department's 1999 statewide NPDES stormwater permit.

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EXECUTIVESUMMARY

This Stormwater Monitoring and Best Management Practice (BMP) Status Report (Status Report) supplements the California Department of Transportation's (Department's or Caltrans') Stormwater Management Annual Report (CTSW-RT-08-182.32.1) and documents the status of stormwater monitoring and BMP technology development conducted by the Department. This Status Report provides a summary of the monitoring and applied studies conducted during fiscal year 2006/07 (FY 2006/07, July 1, 2006 to June 30, 2007) and those proposed for the next three years. This Status Report fulfills specific requirements of Sections 3.3 and 7.3.1 of the Department's Statewide Stormwater Management Plan (SWMP) and Section K.2 of the Department's statewide NPDES stormwater permit.

The Department has an ongoing program to develop and monitor treatment BMPs and source control BMPs, as well as conduct stormwater characterization studies. Treatment technology pilot studies are designed to gather definitive cost and performance data. Successfully piloted technologies may be considered for approval and listing in the SWMP as BMPs to be implemented in highway projects according to SWMP guidelines. Source control studies follow a similar process. The Department's Statewide Characterization Monitoring Study has been completed (see the Discharge Characterization Study Report, November 2003, CTSW-RT-03-065.51.42), but ongoing stormwater characterization studies are created to address specific concerns, such as pathogens, long-term trends, and first flush. This allows the Department to solve both a particular need and to enhance the existing characterization data set.

This Status Report provides brief descriptions of each new, ongoing, or recently completed treatment technology study, source control study, and stormwater characterization study, including a summary of the principal findings, conclusions, and impacts to the program to date. Three-year action plans of expected deliverables and schedules are included for new or ongoing studies.

The status of the BMP development and monitoring studies during FY 2006/07 is summarized in Table ES-1. The BMP development and monitoring studies are generally organized as completed, ongoing, or reporting (under report preparation). Studies in the report preparation phase have completed monitoring, but final documents are not yet available. Most applied studies during the 2006/07 monitoring season were ongoing. Table ES-1 notes the sections where more details for each study are located in this report.

The Treatment BMP Technology Report (CTSW-RT-08-167.02.02) is a companion report that catalogs fact sheets for all identified stormwater treatment technologies.

Table ES-1. Status of the Department's Stormwater Monitoring and BMP Development Studies for 2006/07

Report Section	Study Title	Study Status
2.0	**Stormwater Treatment Technology Studies**	
2.4	Bioretention	Ongoing
2.5	Chemical Treatment	Ongoing
2.6	Detention Basins	Ongoing
2.7	Drain Inlet Inserts	Ongoing
2.8	Gross Solids Removal Devices	Ongoing
2.9	Infiltration	Ongoing
2.10	Filtration	Ongoing
2.11	Vegetated Treatment Systems	Ongoing
2.12	Vector Studies	Ongoing
2.13	Open Graded Asphalt Pavements	Ongoing
2.14	Inclined Plate and Tube Settlers	Ongoing
3.0	**Erosion Control Studies**	
3.3	Roadside Erosion Control and Management Study (formerly VEMS)	Ongoing
3.4	Soil Resource Evaluation Process	Ongoing
3.5	Mycorrhizal Fungi Studies	Reporting
3.6	Arid Region Non-Vegetative Permanent Erosion Control Study	Ongoing
3.7	Ice Slicer	Ongoing
3.8	Temporary Erosion Control	Ongoing
3.9	Evaluation of Erosion Control Test Trials in Lake Tahoe	Ongoing
3.10	Effect of Highway 50 De-Icing Alternatives on Aerosols at Lake Tahoe	Ongoing
4.0	**Stormwater Quality Characterization Studies**	
4.2	Long Term Discharge Characterization Study	Ongoing
4.3	California Toxics Rule (CTR) Characterization Study	Reporting
4.4	First Flush Characterization Study	Ongoing
4.5	Pathogens Characterization Study	Ongoing
4.6	ASBS Monitoring Project	Ongoing
4.7	Source Identification Studies	Ongoing
4.8	San Deguitos Creek Project	Ongoing

Table ES-1. Status of the Department's Stormwater Monitoring and BMP Development Studies for 2006/07

Report Section	Study Title	Study Status
4.9	Water Quality and Toxicity Evaluation of Discharge Generated From Asphalt Pavement Surface Materials	Ongoing
4.10	Performance Evaluation of Permeable Pavement Materials for Water Quality Under Heavy Traffic	Ongoing

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Acronyms

ADV	Automated Data Validation
AITS	Alternative Infiltration Trench Structure
AMF	arbuscular mycorrhizal fungi
APT	accelerated pavement testing
ASBS	areas of special biological significance
BB	baffle box
BMP	best management practice
BSA	bovine serum albumin
CASQA	California Stormwater Quality Association
CCC	California Coastal Commission
CDS	continuous deflection separator
cfs	cubic feet per second
CSF	Compost stormwater filter
CTR	California Toxics Rule
DAT	Data Analysis Software Tool
DB	detention basin
DHS	California Department of Health Services
DII	drain inlet insert
DOC	Dissolved Organic Content
EDD	Electronic data deliverable
EMC	Event Mean Concentration
EOP	edge of pavement
EPA	U.S. Environmental Protection Agency
ERVTS	expanded RVTS
ESSSP	East Span Seismic Safety Project
FY	fiscal year
FY 2006/07	fiscal year 2006/07 (July 1, 2006 through June 30, 2007)
GAC	granular activated carbon
GRVTS	groundcover RVTS
GSRD	gross solid removal device
HOV	High Occupancy Vehicle
HVS	Heavy Vehicle Simulation
ISD	inclined screen device
LID	low impact development
LRD	linear radial device
LTAM	Lake Tahoe Airshed Model
MANOVA	multivariate analysis of variance
MEP	maximum extent practicable
mg/L	milligrams per liter

List of Acronyms

mm	millimeter
NLT	North Lake Tahoe
OGAC	open graded asphalt concrete
OM	Operational Monitoring only
OM&M	Operation, Maintenance and Management
OMMP	operations, maintenance, and monitoring plan
PCR	pathogens characterization study
PM	post mile
QA/QC	quality control/quality assurance
RAC-O	rubberized open graded asphalt concrete
RAC-G	rubberized gap-graded asphalt concrete
RECMS	Roadside Erosion Control Management Studies
ROS	Regression on Order Statistics
RVTS	Roadside Vegetated Treatment Sites
RWQCB	California Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SFOBB	San Francisco – Oakland Bay Bridge
SLT	South Lake Tahoe
SOP	Standard Operating Procedures
SR	state route
SRE	Soil Resource Evaluation
SRE-1	Soil Resource Evaluation-1
SRE-2	Soil Resource Evaluation-2
SSP	Standard Special Provision
SWMP	Statewide Stormwater Management Plan
SWRCB	State Water Resources Control Board
TBD	To be determined
TF	toxicity frequency
TKN	total kjeldahl nitrogen
TMDL	total maximum daily load
TOC	Total Organic Content
TRPA	Tahoe Regional Planning Agency
TSS	Total Suspended Solids
USFS	United States Forest Service
VEMS	Vegetated Establishment and Management Study
VS	Visual Screen
WQV	water quality volume

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1.1 PURPOSE

This Stormwater Monitoring and Best Management Practice (BMP) Development Status Report (Status Report) fulfills the California Department of Transportation's (Department's or Caltans') requirement under Section K.2 of the statewide NPDES permit 99-06-DWQ, (Caltrans, 1999) and Section 7.3.1 of the Stormwater Management Plan (SWMP) (Caltrans, 2003) to prepare and submit annual Stormwater Characterization Monitoring Plans, 3-Year Action Plans, Research Summary Reports, a Monitoring Strategy Report Update, and a Monitoring and Reporting Program Report. Table 1-1 presents the relationship between the reporting requirements and this submittal.

Table 1-1. Reporting Requirements Fulfilled by this Report

Reporting Requirements		FY 05/06
Title and location in permit, 1999	**Title and location in SWMP, May 2003**	**Section of this Report**
Monitoring Strategy Report Update (Section K.2)	NA	Sections 2, 3 and 4
NA	Stormwater Monitoring Plan: 3 Year Action Plan (Table 7-1)	Sections 2, 3 and 4
Monitoring and Reporting Program (Section K.2.a)	Stormwater Monitoring Plan: Characterization Monitoring Plan (Table 7-1)	Section 4 and Appendix A
NA	Stormwater Treatment Technology Research Status Report (Table 7-1)	Section 2
NA	Erosion Control Research Status Report (Table 7-1)	Section 3

The objectives of this Status Report are to summarize the progress of the monitoring and BMP development studies conducted during the past year and outline work proposed over the next three years. This Status Report will be included with the submission of the Department's *Storm Water Management Program Annual Report* (CTSW-RT-08-182-32.1, Annual Report) to the State Water Resources Control Board (SWRCB).

This Status Report provides brief descriptions of each treatment technology study, source control study, stormwater characterization study, and a summary of the principal findings and conclusions to date.

Three-year action plans of expected deliverables and schedules are included for new or ongoing studies. All Department stormwater studies are performed according to specific sampling and analysis plans. The sampling and analysis plans are prepared based on the guidelines provided in the Department's Comprehensive Guidance Manual (CTSW-RT-03-105-51.42). The Department has developed software and manuals that are consistently being used to collect representative samples, scientifically validate monitoring data, and report the data in a consistent manner. The primary application of these manuals for stormwater characterization studies are briefly described in Appendix A.

Appendix B provides summaries of interim, final, and reconnaissance study reports completed during fiscal year (FY) 2006/07 (July 1, 2006 to June 30, 2007). The summaries are presented as fact sheets which include the study objectives, activities, and conclusions/recommendations.

Appendix C provides summaries of monitoring activities conducted during FY 2006/07.

1.2 DEVELOPING DATA FOR PROGRAM EFFECTIVENESS ASSESSMENTS

The results of these studies will help assess program effectiveness of BMP implementation. As assessments become more advanced, the Department will seek to quantify the benefits of BMP implementation. This requires understanding of BMP performance for pollutants of concern. The data collected will be compatible with the program effectiveness model developed by the California Stormwater Quality Association (CASQA). (Municipal Stormwater Program Effectiveness Assessment Guidance, May 2007 [no ID number assigned]).

1.3 REPORT ORGANIZATION

The remaining document is organized into the following sections:

- Section Two provides descriptions of activities and studies conducted during FY 2006/07 as part of the Department's stormwater treatment technology development program.
- Section Three provides descriptions of erosion control studies conducted during FY 2006/07 by the Departmentr.
- Section Four provides descriptions of activities and studies conducted during FY 2006/07 as part of the Department's stormwater characterization program, which includes specialized characterization studies.
- Section Five contains a summary of how research findings to date have been incorporated into Caltrans' stormwater program.
- Section Six contains general references.
- Appendix A presents the Department's Monitoring Protocols and Tools.

- Appendix B provides summaries of Interim and Final Reports completed during FY 2006/07. The summaries are presented as fact sheets which include the study objectives, activities, and conclusions/recommendations.

- Appendix C tabulates recent and ongoing monitoring activities and their locations.

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This section provides a brief summary and status of reconnaissance studies and ongoing pilot studies conducted by the Department during FY 2006/07 (July 1, 2006 to June 30, 2007).

2.1 PREVIOUS STUDIES

Numerous reports have been issued summarizing the various treatment technology studies conducted by Caltrans over the last several years.

Results of treatment technology studies completed prior to July 1, 2007 are summarized in the following reports.

Department Document No.	Document Title
CTSW0RT-00-034	Evaluation of Compost Stormwater Filters (CSFs) Installed Along the San Joaquin Hills Transportation Corridor. January 2001.
CTSW-RT-03-036	Compost Storm Water Filter System Monitoring Report, State Rout 73. June 2003.
CTSW-RT-03.054.36.02	Caltrans Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Studies, 2002-2003 Monitoring Report. June 2003.
CTSW-RT-01-050	Caltrans BMP Retrofit Pilot Program, Final Report. January 2004.
CTSW-RT-06-157.01.2	Final Report Caltrans Tahoe Basin Highway 267 Sand Trap with Filter Fabric 2-Year Pilot Study 2004-2006 Monitoring Report. October 2006.
CTSW-RT-06-128.01.1	Caltrans Statewide Sand Filter Study Final 2006 Storm Water Monitoring Report. January 2007.

The Department's ongoing treatment technology projects and those completed after July 1, 2006 are presented in the following subsections.

2.2 LITERATURE SEARCHES AND RECONNAISSANCE STUDIES

The first step in the Department's BMP selection process is accomplished through literature searches. Findings for treatment technologies are annually summarized in the Treatment BMP Technology Report (CTSW-RT-08-167.02.02), which is a companion document to this Status Report. The second step involves performing reconnaissance studies and pilot studies for promising technologies. Reconnaissance studies are performed when additional information is required to determine whether a pilot study is worthwhile. Reconnaissance studies provide more thorough engineering evaluations than the Treatment BMP Technology Report and often include preliminary cost estimates.

One reconnaissance study was completed during 2006/07 and is described in the following subsection.

2.2.1 Mechanical Cleaning Design Concepts Reconnaissance Study

Objectives

The purpose of this study was to develop new design concepts that utilize alternative cleaning methods for the Department's Gross Solids Removal Devices (GSRDs) Pilot Program. These new GSRD design concepts incorporate mechanical cleaning assistance. The Department's existing approved GSRD designs do not employ mechanical self-cleaning components and therefore can require labor-intensive manual cleaning. The study considered the practicality of mechanical cleaning in GSRDs and the potential implementation as a cost savings alternative.

Findings/Conclusions

Preliminary findings indicate that several GSRDs with mechanical self-cleaning components may be feasible. However, the mechanical design, capital costs, and maintenance of the mechanical components have precluded the identified concepts from further consideration for deployment.

Available Documents

Department Document No.	Document Title
CTSW-RT-07-172-31.2	Mechanical Cleaning Design Concepts Reconnaissance Study. June 2007.

2.3 OVERVIEW OF PILOT STUDY PROGRAMS

The Department's pilot studies described in this section are being conducted under the Tahoe Basin Pilot Program, the District 12 State Route (SR) 73 Pilot Program, the GSRD Program, and other pilot study efforts. These programs are described below. The individual pilot studies that make up each pilot program are organized by BMP type and are discussed in Sections 2.4 through 2.14.

Tahoe Basin Pilot Program

The Tahoe Basin Pilot Program consists of both small-scale and full-scale pilot testing. A small-scale test facility was constructed at the Department's South Lake Tahoe Maintenance Station in the Lake Tahoe Basin. Fiscal year 2006/07 was the sixth season of operation for the test facility. Eight full-scale pilot media filters have been constructed, and are currently being monitored. The performance monitoring program for sand traps is complete and a final report is available (CTSW-RT-03-054.36.02).

District 12 SR73 Pilot Program

In 2001, the Department began a pilot program along the San Joaquin Hills Transportation Corridor (SR73) in Orange County. As part of this program, operation, maintenance, and

monitoring of three Compost Storm Filter Pilots were performed. A final report with the results has been prepared and is available (CTSW-RT-03-036).

Design, construction, and/or monitoring are currently underway for approximately 24 other BMPs along SR73. The program includes 20 modified detention basins, one GSRD, one bioretention basin, and two sand filters.

District 7 Gross Solids Removal Device (GSRD) Pilot Program

The District 7 GSRD Pilot Program was initiated by the Department to develop and evaluate the performance of non-proprietary devices that can capture gross solids and that can be either constructed into existing highway drainage systems or implemented in future highway drainage systems. The term "gross solids" includes litter, vegetation, and other particles of relatively large size. Two GSRD designs have received conditional approval from the Los Angelos Regional Water Quality Control Board (RWQCB) for use as a "full capture" litter BMP. District 7 is in the process of designing and installing over 200 of these GSRDs. The Department also continues to develop new GSRD designs that can be implemented.

Other Pilot Study Efforts

Other pilot study efforts include:

- Bioretention: San Francisco-Oakland Bay Bridge Bioretention Basin
- Detention Basins: District 3 Semi-Batch Detention Basins and Particle Based Pollutant Removal BMPs
- Drain Inlet Inserts
- GSRDs: Laboratory Testing of GSRDs, District 11 Continuous Deflection Separators
- Infiltration: Infiltration Basin Model and Alternative Infiltration Trench Structures
- Filtration: District 2 Austin-Type Sand Filters, Low Cost Adsorbent Materials for Dissolved Metals Removal, Linear Filtration BMPs
- Vegetated Treatment Systems: Roadside Vegetated Treatment Sites (RVTS), Ornamental RVTS
- Vector Studies
- Open-Graded Asphalt Pavements

2.4 BIORETENTION

Bioretention refers to a system in which stormwater is captured and infiltrated in a shallow, typically offline, vegetated basin. Stormwater pollutants are removed through physical and biological processes, including adsorption, filtration, plant uptake, microbial activity, decomposition, sedimentation and volatilization. Bioretention facilities typically include a pretreatment biofilter (vegetated swale or strip) to reduce velocities and filter out particulates, a sand trench to augment the infiltration capacity of the planted bed and to evenly distribute

incoming runoff, and a ponding area to collect and store runoff prior to infiltration. Sometimes an underdrain system is provided to capture and transport the infiltrated runoff.

2.4.1 San Francisco/Oakland Bay Bridge — Bioretention

As part of the San Francisco-Oakland Bay Bridge (SFOBB) East Span Seismic Safety Project (ESSSP), the Department is proposing to treat stormwater on the eastern portion of the ESSSP (i.e., Oakland Approach) and the SFOBB Toll Plaza using bioretention filters and other approved BMPs. The other approved BMPs include detention basins, bioswales and biostrips.

Objectives

This pilot is designed to determine:

- Effectiveness of the bioretention filter in removing constituents of concern
- Construction costs
- Operations and maintenance costs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
I-80, San Francisco Bay, D-4	2	Design complete. Construction to be completed by December, 2007. Final report anticipated in 2012.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
Document No. not assigned	Engineering Design of Storm Water Treatment BMPs for Oakland Bay Bridge Approach. Basis of Design Report. June 2004.

3-Year Action Plan

Overview of Approach

Prepare as-builts and sampling and analysis plans (SAPs). Perform influent and effluent water quality monitoring. Prepare interim reports and a final report documenting performance and cost.

Products or Deliverables

- As-builts
- SAPs
- Interim reports
- Final report

Schedule

- 2007/08 – Construction and plant establishment
- 2008/09 – Plant establishment, monitoring, and development of interim report
- 2009/10 – Monitoring and development of interim report

2.4.2 District 12 SR73 Pilot Program — Bioretention

The Department replaced an existing compost storm filter (CSF) and basin along the San Joaquin Hills Transportation Corridor (SR73) with a bioretention filter.

Objectives

These pilots are designed to determine:

- Effectiveness of the bioretention filter in removing constituents of concern
- Construction costs
- Operation and maintenance costs

Current Status

Location (Route, PM, RWQCB, District)	No. of Pilots	Status
SR 73, Santa Ana, D-12	1	Siting, design, construction, and plant establishment are complete. Water quality monitoring began Fall 2006. Final Report anticipated for 2010.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-03-078.51.35	State Route 73 Best Management Practice Pilot Studies Operations, Monitoring and Maintenance Plan. October 2003.

Department Document No.	Document Title
CTSW-RT-03-006.51.39	Basis of Design report, SR-73 Storm Water BMP Replacement Project at CSF System 1149L Bioretention Area. November 2003.
CTSW-RT-07-211.08.D1	State Route 73 Best Management Practices Pilot Study: Operations, Maintenance, and Monitoring Plan. July 2007.

3-Year Action Plan

Overview of Approach

Complete as-builts. Prepare sampling and analysis plans (SAPs). Perform influent and effluent water quality monitoring. Prepare interim reports and a final report documenting performance and cost.

Products or Deliverables

- As-builts
- SAPs
- Interim reports
- Final report

Schedule

- 2007/08 – Continue monitoring and develop interim report
- 2008/09 – Continue monitoring and develop interim report
- 2009/10 – Continue monitoring and develop final report

2.5 CHEMICAL TREATMENT

Chemical addition is intended to improve phosphorus and particulate removal (by precipitation and coagulation followed by settling) or to improve filtration performance as a filter aid.

2.5.1 Tahoe Basin Small-Scale Pilot Studies

Objectives

The objectives of testing chemical treatment systems are to determine:

- Effectiveness of chemical addition for improving pollutant removal
- Appropriate chemical additive doses for stormwater treatment
- Sensitivity of performance to dose for determining technical feasibility of dosing variable flows
- Negative impacts to water quality due to added chemicals

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
South Lake Tahoe Maintenance Station, Lahontan, D-3	Varies	Sixth monitoring season (2006/07) testing complete. Sixth monitoring season report expected in 2008.

Findings/Conclusions

First through fifth monitoring season reports are now complete. A number of chemicals have been assessed through jar test and/or settling rate experiments, including PASS-C® and PAX-XL9® (both polyaluminum chlorides), PAM, and chitosan (a naturally occurring biopolymer). The "mechanized" systems tested included proprietary high-rate Actiflo® clarification and non-proprietary conventional clarification with PASS-C®. These systems require power and operators. Although impractical for roadside application, mechanized systems were tested to show if it is possible to meet the Tahoe Basin effluent limits. First season monitoring (Phase I, 2001/02) showed the effectiveness of PASS-C®-assisted sedimentation. Second season (Phase II, 2002/03) testing with PASS-C® and liquid chitosan suggested that chemical treatment followed by sedimentation alone may be sufficient to meet the surface water discharge limits in some situations. (Refer to the Phase II report [CTSW-RT-03-079.31.37] for specific discharge limits and circumstances). PASS-C addition, however, lowers effluent pH, sometimes to below 6.5. This is considered to be major disadvantage because of potential toxicity. Both the proprietary and non-proprietary mechanized systems, with operator assistance in selecting optimal doses, met all the surface discharge standards in all the second monitoring season experimental runs. However, in most cases, influent nitrogen concentrations were lower than the surface water numeric effluent limits. Third season (Phase III, 2003/04) experiments with PASS-C®, PAX-XL9® and chitosan showed that PASS-C® and PAX-XL9® gave similar turbidity removal, and for both a dose of 100 mg/L appeared to be an effective dose for most storms but an overdose for some. Chitosan was not as effective as the two polyaluminum chlorides for the storms tested during the third season. Settling experiments with PASS-C® and PAX-XL9® indicated that a turbidity of 20 NTU could be achieved in two to six hours when dosed optimally. Optimal dosing, however, is impractical in the field because no automated methods exist for controlling chemical dose based on the quality of the stormwater being treated. Fourth season (Phase IV, 2004/05) testing included further jar testing and settling rate experiments (PASS-C®, PAX-XL9®, two anionic polyacrylamides, JenChem 1720®, Sumachlor 50®). Fourth season jar testing continued to show the potential of the polyaluminum chlorides and, in tests on the importance of slow mixing, indicated that elimination of slow mixing may still provide acceptable treatment. Fifth season (Phase V, 2005/06) activities included identifying and testing new chemicals that had minimal impact on pH, and evaluating treatment at non-optimal dose conditions. Several new chemicals were identified. Two, JC-1670® and HY-1030®, showed potential for treatment as well as minimal pH impact. Non-optimal dose experiments showed that fixed chemical dosing does not provide effective treatment results for all storms.

The variability in influent stormwater quality is the most significant constraint to the use of chemicals in roadside treatment systems. Although chemical addition followed by settling appears promising at times, there is untreatable stormwater for which no effective treatment appears possible and, for treatable stormwater, optimal dosing is required to prevent potential toxicity due to overdosing. In addition to reducing pH, overdosing can reduce treatment effectiveness and increase residual aluminum concentrations.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-026	Chemical Treatment to Improve Settling Reconnaissance Study. June 2001.
CTSW-RT-01-054	Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan. March 2002.
CTSW-RT-03-053.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Monitoring and Operations Plan. June 2003.
CTSW-RT-03-063.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Jar Test Results and Summary Report. June 2003.
CTSW-RT-03-042	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase I Report. August 2003.
CTSW-RT-03-079.31.37	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Report. December 2003.
CTSW-RT-04-069.04.04	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Monitoring and Operations Plan. June 2004.
CTSW-RT-05-069.04.08	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase VI Monitoring and Operations Plan. January 2005.
CTSW-RT-05-069.04.07	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Final Report. May 2005.
CTSW-RT-05-157.04.01	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase V Monitoring and Operations Plan. January 2006.
CTSW-RT-05-157.04.02	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Report. April 2006.
CTSW-PL-07-157.04.02	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase VI Monitoring and Operations Plan. January 2007.
CTSW-RT-06-157.04.01	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase V Report. February 2007.
TBD	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project. Phase VI Report. Due March 2008.

3-Year Action Plan

Overview of Approach

Complete Phase VI Final Report

Products and Deliverables

- Phase VI Final Report

Schedule

- 2007/08 – Complete Phase VI Final Report
- 2008/09 – None (study to be complete 2007/08)
- 2009/10 – None (study to be complete 2007/08)

2.6 DETENTION BASINS

Detention basins (DBs) temporarily store water to allow solids and associated pollutants to settle out. Storage is achieved by limiting the rate of flow out of the basin, typically through the use of small (approximately 1-inch diameter) orifices on an outflow riser. The Department is conducting multiple pilot detention basin studies. The detention basin designs include various outlet control designs developed to improve runoff water quality. Runoff volumes greater than the predetermined design stormwater quality volume (WQV) are either routed around the basin or through the basin via an overflow weir or standpipe.

2.6.1 District 12 SR73 Pilot Program — Bypass Detention Basins

Bypass DBs use a splitter box upstream of the basin to divert water around the basin once a predetermined depth of water in the basin is reached. Existing SR73 equalization basins (DBs that meter flow into CSF units) have been modified to evaluate the effect that decreasing the basin volume has on detention times and pollutant removal abilities of bypass DBs. In this study, basins were sized at approximately 100, 75, 50 and 25 percent of the design storm WQV. Coincident to this study, three other studies will allow comparison of bypass-type operation with overflow-type operation, "semi-batch" operation, and surface drained (skimmer). (See sections 2.6.2 through 2.6.4.)

Objectives

These pilots are designed to determine:

- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) in bypass DBs
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of bypass DBs compares to that of overflow, surface drained, and semi-batch DBs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, San Diego and Santa Ana, D-12	4	Construction complete. Water quality monitoring ongoing. Final report anticipated in 2010.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-01-029	Detention Basin Optimization-Reconnaissance Study Final Report. June 2001.
CTSW-RT-03-078.51.35	State Route 73 Best Management Practice Pilot Studies Operations, Monitoring and Maintenance Plan. October 2003.
CTSW-RT-06-131-01.1	District 12 State Route 73 BMP Pilot Program 2004-2005 Wet Season Volumes I & II (Interim Report and Lab Data). March 2006.
CTSW-RT-06-131-01.2	District 12 State Route 73 BMP Pilot Program Detention Basins 2005-2006 Wet Season Volumes II & III (Interim Report and Lab Data; Volume I summarizes GSRDs). February 2007.
CTSW-RT-07-211.08.D1	State Route 73 Best Management Practices Pilot Study: Operations, Maintenance, and Monitoring Plan. July 2007.

3-Year Action Plan

Overview of Approach

This three-year action plan covers all of the bypass, overflow, surface-drained, and semi-batch basins (see Sections 2.6.2 through 2.6.4). Water quality and operational monitoring will continue for at least two wet seasons. A final report will be developed after enough data has been gathered to make statistically significant determinations regarding performance.

Products and Deliverables

- Operations, maintenance, and monitoring plans (OM&M plans)
- Interim reports
- Final report

Schedule

- 2007/08 – Conduct operational and water quality monitoring and develop interim report.
- 2008/09 – Conduct operational and water quality monitoring and develop interim report.
- 2009/10 – Continue operational and water quality monitoring and develop final report.

2.6.2 District 12 SR73 Pilot Program — Overflow Detention Basins

In overflow DBs, water in excess of the design WQV will flow into the basin and out over a flood control weir or standpipe. Existing SR73 equalization basins have been modified to evaluate the effect of decreasing the basin volume on detention times and pollutant removal abilities of overflow detention basins. Basins will be sized at approximately 100, 75, 50, and 25 percent of the design storm volume.

Objectives

These pilots are designed to determine:

- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) in overflow DBs
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of overflow DBs compares to that of bypass, surface drained, and semi-batch DBs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, Santa Ana, D-12	4	Water quality monitoring ongoing. Final report anticipated in 2010.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-01-029	Detention Basin Optimization-Reconnaissance Study Final Report. June 2001.

Department Document No.	Document Title
CTSW-RT-03-078.51.35	State Route 73 Best Management Practice Pilot Studies Operations, Monitoring and Maintenance Plan. October 2003.
CTSW-RT-06-131-01.1	District 12 State Route 73 BMP Pilot Program 2004-2005 Wet Season Volumes I & II (Interim Report and Lab Data). March 2006.
CTSW-RT-06-131-01.2	District 12 State Route 73 BMP Pilot Program Detention Basins 2005-2006 Wet Season Volumes II & III (Interim Report and Lab Data; Volume I summarizes GSRDs). February 2007.
CTSW-RT-07-211.08.D1	State Route 73 Best Management Practices Pilot Study: Operations, Maintenance, and Monitoring Plan. July 2007.

3-Year Action Plan

See the three-year action plan for bypass detention basins (Section 2.6.1).

2.6.3 District 12 SR73 Pilot Program — Semi-Batch (Hold and Release) Detention Basins

Existing SR73 equalization basins have been modified to evaluate the effects of semi-batch operation and varying pond volume on detention time and pollutant removal efficiency. Semi-batch operation (also called hold-and-release) is achieved by installing a valve on the outlet of an overflow DB. During storms, when the basin begins to fill, the valve closes. This creates a quiescent pool that is expected to improve settling by retarding water movement. After some chosen time (e.g., 24 hours) has elapsed, the valve will open and the basin will drain like a normal DB. Inflow in excess of the pond design volume will overflow a weir. Like the bypass and overflow basins, the semi-batch basins will be sized at approximately 100, 75, 50 and 25 percent of the design storm WQV.

Objectives

These pilots are designed to determine:

- Technical feasibility of various hold-and-release valves
- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) in semi-batch DBs
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of semi-batch DBs compares to that of bypass, overflow, surface drained DBs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, San Diego, D-12	4	Construction is complete. Water quality monitoring started in 2005/06 wet season. Monitoring to continue for at least 2 more wet seasons. Final report anticipated in 2010.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-01-029	Detention Basin Optimization-Reconnaissance Study Final Report. June 2001.
CTSW-RT-03-078.51.35	State Route 73 Best Management Practice Pilot Studies Operations, Monitoring and Maintenance Plan. October 2003.
CTSW-RT-06-131-01.1	District 12 State Route 73 BMP Pilot Program 2004-2005 Wet Season Volumes I & II (Interim Report and Lab Data). March 2006.
CTSW-RT-06-131-01.2	District 12 State Route 73 BMP Pilot Program Detention Basins 2005-2006 Wet Season Volumes II & III (Interim Report and Lab Data; Volume I summarizes GSRDs). February 2007.
CTSW-RT-07-211.08.D1	State Route 73 Best Management Practices Pilot Study: Operations, Maintenance, and Monitoring Plan. July 2007.

3-Year Action Plan

See the three-year action plan for bypass detention basins (Section 2.6.1).

2.6.4 District 12 SR73 Pilot Program — Surface Drained Detention Basins (Floating Skimmer Outlet)

Existing SR73 equalization basins have been or are being modified with floating skimmer outlets to determine if decanting water from the top of a detention basin rather than the bottom improves pollutant removal. The outflow skimmer is composed of a float and an attached pipe with orifices. Inflow in excess of the WQV will overflow a weir.

Objectives

These pilots are designed to determine:

- Technical feasibility of floating skimmers
- Relationships between basin volume, detention time and removal efficiency (or irreducible concentration) while using a floating skimmer
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs
- How the performance of surface drained DBs compares to that of bypass, overflow, and semi-batch DBs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, San Diego, D-12	4	Construction on three of the four basins is complete. Construction of the fourth basin to be completed Fall 2007. Final report is anticipated for 2010.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-01-029	Detention Basin Optimization-Reconnaissance Study Final Report. June 2001.
CTSW-RT-03-078.51.35	State Route 73 Best Management Practice Pilot Studies Operations, Monitoring and Maintenance Plan. October 2003.
CTSW-RT-06-131-01.1	District 12 State Route 73 BMP Pilot Program 2004-2005 Wet Season Volumes I & II (Interim Report and Lab Data). March 2006.
CTSW-RT-06-131-01.2	District 12 State Route 73 BMP Pilot Program Detention Basins 2005-2006 Wet Season Volumes II & III (Interim Report and Lab Data; Volume I summarizes GSRDs). February 2007.
CTSW-RT-07-211.08.D1	State Route 73 Best Management Practices Pilot Study: Operations, Maintenance, and Monitoring Plan. July 2007.

3-Year Action Plan

See the three-year action plan for bypass detention basins (Section 2.6.1).

2.6.5 District 12 SR73 Pilot Program — Alternative Inlet Detention Basins

The objective is to test the use of GSRDs in conjunction with detention basins. Existing SR73 equalization basins were retrofitted with GSRDs to examine the effect on maintenance costs associated with dissipating flow energy and capturing litter as it enters a detention basin. Three detention basins with GSRDs are being tested:

- CSFs 1076R & 1081L: Linear Radial Configuration 1 (LR1)
- CSF 1085L: V-screen Configuration 1 (VS1)
- CSF 1180R: Inclined Screen Configuration 3 (IS3)

Objectives

These pilots are designed to determine:

- Technical feasibility of using a GSRD to dissipate flow energy
- Technical feasibility of using a GSRD to trap litter in a detention basin
- Construction costs in the Department's retrofit environment
- Operation and maintenance costs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, Santa Ana, D-12	1 LR1 (Basin 1076R)	Construction complete. Operational monitoring to be continued for 2006/07. Final report anticipated for 2010.
SR73, Santa Ana, D-12	2 LR1s (Basin 1081L)	Construction complete. Operational monitoring to be continued for 2006/07. Final report anticipated for 2010.
SR-73, Santa Ana, D-12	1 V-screen Configuration 1 (VS1)	GSRD on Basin 1085L: Pilot study complete. Converting pilot project to SWMP-approved detention basin. Final Report currently being developed.
SR-73, Santa Ana, D-12	1 Inclined Screen Configuration 3 (IS3)	GSRD on basin 1180R: Pilot study complete. Pilot project will be turned over to District Maintenance. Final Report anticipated in 2010 for all State Route 73 pilot studies.

Findings/Conclusions

CSF 1085L with VS1 and CSF 1180R with IS3 will not be recommended for approval to meet the trash TMDL requirements.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-005	Inlet/Outlet Alternatives For Extended Detention Basins Technical Memorandum. May 2001.
CTSW-RT-03-078.51.35	State Route 73 Best Management Practice Pilot Studies Operations, Monitoring and Maintenance Plan. October 2003.
CTSW-RT-06-131-01.1	District 12 State Route 73 BMP Pilot Program 2004-2005 Wet Season Volumes I & II (Interim Report and Lab Data). March 2006.
CTSW-RT-06-131-01.2	District 12 State Route 73 BMP Pilot Program Detention Basins 2005-2006 Wet Season Volumes II & III (Interim Report and Lab Data; Volume I summarizes GSRDs). February 2007.
CTSW-RT-07-211.08.D1	State Route 73 Best Management Practices Pilot Study: Operations, Maintenance, and Monitoring Plan. July 2007.

3-Year Action Plan

Overview of Approach

District to operate BMPs. Results to be reported in State Route 73 Pilot Study Final Report (due 2010).

Products and Deliverables

- None

Schedule

- 2007/08 – None (study complete).
- 2008/09 – None (study complete).
- 2009/10 – None (study complete).

2.6.6 Particle-Based Pollutant Removal BMPs

Most BMPs are designed to treat runoff by removing particles and their associated pollutant load, but there is currently little understanding of the types of particles retained by particular BMPs and the conditions that favor particle retention. Accordingly, some of the variability in reported BMP performance statistics may be attributed directly to particle dynamics. This study has been conducted in phases. Phase I of the study developed a methodology to assess small particles and constituents associated with them. Phase II of the study included a preliminary investigation of the performance of a detention basin with respect to particles. Phase III of the study includes laboratory studies to develop a fundamental understanding of particles and pollutants associated with them.

Objectives

The objectives of this study are to assess particle sizes and pollutants associated with them.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
UC-Davis Laboratory	NA	Continue assessing the particle size distribution and pollutants associated with them. Develop model to simulate detention basin design and performance evaluation. Develop Final Reports.

Findings/Conclusions

Phase I of the study was completed in 2004/05 and a final report was developed (CTSW-RT-05-73-22.2). The results of the first year's monitoring for Phase II were also presented in a report (CTSW-RT-06-168-05.1). The Phase II findings are summarized below.

Results indicated that the majority of the particles by count in the influent samples (greater than 90 percent by count in all but one storm) were less than 2 μm in diameter. Particles in the less than 2 μm size range contributed less than three percent of the total particle mass in the influent samples. However, up to 50 percent of the particle mass was composed of particles with a diameter less than 50 μm in diameter. In centrifuged solids, 50 percent of the particle volume was comprised of particles less than 20 μm in diameter. A first flush effect of particles in the influent samples was observed in the monitored storm events with greater numbers of particles occurring at the onset of runoff. At the end of storm events, effluent particle numbers were less than influent particle numbers due to settling and natural aggregation. In field and laboratory settling studies, significant reductions in particles over all size ranges (greater than 0.5 μm diameter) occurred throughout a 72-hour period, indicating that BMP treatment is more effective at a longer detention time, even for the smallest particles.

Metal mass concentrations in centrifuged solids were detected in the following decreasing order: Zn > Pb > Cu > Ni > Cd. In the one storm for which metals were measured for both influent and effluent centrifuged solids, effluent metal concentrations were 52 to 73 percent lower than influent metal concentrations.

Calculated pollutant mass removal efficiencies indicate that significant portions of the particle-bound constituent mass was removed from the detention basin after a 24-hour holding time (e.g., greater than 80 percent of total suspended solids (TSS), total copper and lead). The reduction in particulate mass is likely due to the increase in particle settling.

Results obtained from monitored storm events revealed that particles with diameters greater than 50 μm were completely removed from the detention basin within 24 hours. Extending detention times to 48 and 72 hours caused greater removal of particles, even in the smallest sizes measured (less than 5 μm).

No toxicity was observed from the detention basin effluent during three storm events, even though a number of influent grab samples exhibited moderate toxicity to *P. promelas*. The overall degree of toxicity observed prior to BMP treatment was less than that observed during similar studies performed on highway runoff. A first flush toxicity effect was observed, indicated by a greater level of toxicity in the first several grab samples collected during each storm event compared to samples collected later during the storm. Toxicity was also observed in several grab samples collected a few hours after the first flush toxic effect dissipated. This study identified zinc as the primary toxic constituent of concern in grab samples from three storm events monitored.

From the above preliminary field investigation, it was observed that the existing detention basin was not appropriate for a particle size distribution and particle bound pollutant investigation. Input sediment was not representative of influent typically observed for detention basins because of numerous gopher activities and soil erosion impacts to the detention basin. Consequently, the detention basin needed to be re-designed and re-constructed, but this was found to be impractical for the selected site. For this reason, the Department decided to further assess the particle size distribution and pollutants associated with them under more controlled, laboratory conditions, which is currently being carried out under Phase III.

Available Documents

Department Document No.	Document Title
CTSW-RT-05-73-23.2	Small Particles and Associated Constituents in Highway Runoff: Methodology and Preliminary Results. July 2005.
CTSW-RT-06-168-05.1	Performance Evaluation of a Detention Basin based on Removal of Particles and Associated Pollutants. April 2007.

3-Year Action Plan

Tasks/Approach

Continuing work for Phase III of the project consists of: (1) measurement of fractionated particle density, (2) measurement of the size of fractionated metal constituents using scanning electron microscopy, (3) measurement of the surface charge of fractionated particles, and (4) development of a numerical model to estimate input metal load and to evaluate particle and metal removal from a detention basin.

Specific work includes collecting samples from three highway sites along I-80, from UC-Davis parking lots, and from the floor of three detention basins along SR-73. Numerous settling column tests will also be performed to assess the settling and natural coagulation of particles. The information gained from this phase of the study will be used to develop a dynamic particle-based model within the detention basin and will be used to simulate a more realistic detention basin design and performance evaluation. Future phases of the project will include incorporating additional components to the model, gathering field data, and verifying the model.

Product or Deliverables

- Final report for Phase III
- Other documents for subsequent phases to be determined

Schedule

- 2007/08 – Continue model development and Phase III lab testing.
- 2008/09 – Continue developing the particle-based model and develop final report for Phase III.
- 2009/10 – Plan and implement subsequent phases, including field investigation(s).

2.6.7 District 3 Semi-Batch (Hold and Release) Detention Basins

Caltrans intends to install semi-batch (also referred to as hold and release) outlet controls at newly constructed pilot detention basins along State Route 267 in the Lake Tahoe area to assess potential improvement of stormwater runoff quality. The designs for these basins consider lessons learned from the previous pilot studies. In addition, special climactic conditions and other issues specific to the Tahoe area were considered. These basins experience heavy snowfall and freezing conditions during the winter months. Additionally, Caltrans anticipates that future pilot studies in these basins will include chemical dosing of stormwater with flocculants to increase sediment removal.

Objectives

The objective of the SR 267 Semi-Batch Detention Basin Pilot Study is to develop and test an outlet control design that improves runoff water quality, considers cold weather issues and minimizes operation and maintenance issues.

A secondary objective is to provide a system which is flexible and can be easily programmed to test effects of various storm events. The system consists of intelligent outlet control valves capable of changing the outlet orifice size based on feedback from a programmable logic controller (PLC). The PLC measures water levels from an ultra-sonic probe or pressure transducer.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR267, Lahontan, D-3	4	Operational monitoring is planned for one basin for the 2007/08 wet season. Other basins will be monitored in future years.

Findings/Conclusions

None to report at this time (monitoring to begin 2007/08).

Available Documents

Department Document No.	Document Title
CTSW-RT-06-138-09.1	Chemically-Enhanced Detention Basin Pilot Study. January 2006.
CTSW-RT-06-172-10.1	SR-267 Chemically-Enhanced Detention Basins Pilot Study Final Design Report. June 2006.

3-Year Action Plan

Overview of Approach

Operational monitoring will be performed for at least three wet seasons at one or more sites. A final report will be developed after enough data has been gathered to make statistically significant determinations regarding performance.

Products or Deliverables

- Interim reports
- Final report

Schedule

- 2007/08 – Conduct operational monitoring and develop interim report.
- 2008/09 – Conduct operational and water quality monitoring and develop interim report.
- 2009/10 – Conduct operational and water quality monitoring and develop final report.

2.7 DRAIN INLET INSERTS

Drain inlet inserts (DIIs) may serve, in certain circumstances, as a post-construction BMP for removing such constituents as gross solids, metals, sediment, and oil and grease. DIIs are placed into stormwater drain inlets, and can typically be installed by one or two people. DIIs can be sorted into several categories such as baffle boxes, boxes/baskets, fabric, media filters, and screens.

Objectives

The purpose of this study is to develop a non-proprietary DII design and modify existing DIIs (Drain Pac® and Ultra-Urban®) in order to improve removal efficiencies from previous studies,

particularly for zinc, copper, and sediment. Media tested include compost, peat, and proprietary polymers.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
Sacramento State University Campus	4	Testing began in 2005/06. A technical memo will be developed in 2007/08 to provide recommendations for further testing.

Findings/Conclusions

Preliminary results indicate superior sediment removal by one of the non-proprietary DII designs over similar proprietary devices. Results from previous testing by OWP for the California Integrated Waste Management Board can be viewed at www.owp.csus.edu/research.

Available Documents

None to report at this time (study ongoing).

3-Year Action Plan

Overview of Approach

A technical memorandum will be developed to provide recommendations for further testing in 2007/08. Plans for future testing will consider using metals absorbing media identified from a literature review.

Products or Deliverables

- Technical memorandum.

Schedule

- 2007/08 – Develop technical memorandum and conduct further testing as recommended in tech memo.
- 2008/09 – Conduct further testing as recommended in technical memorandum.
- 2009/10 – Conduct further testing as recommended in technical memorandum.

2.8 GROSS SOLIDS REMOVAL DEVICES (GSRDS)

GSRDs include physical/mechanical methods of removing litter and solids five millimeters (mm) (0.25-inch nominal) and larger from the stormwater runoff using various screening technologies. The objective of the GSRD pilots is to test end-of-pipe treatment devices that can be

incorporated into existing or future highway drainage systems to capture litter and other coarse solids (collectively known as "gross solids").

2.8.1 District 7 GSRD Pilot Program

The District 7 GSRDs were developed to help meet the requirements of the Los Angeles RWQCB's adopted total maximum daily load (TMDL) for litter for the Los Angeles River Watershed and Ballona Creek Watershed. Eleven different types of GSRDs have been or are being tested in the Los Angeles River, Ballona Creek, and San Gabriel watersheds in District 7.

The following text describes each type of GSRD.

Linear Radial Devices (LRD):

- Configuration 1 (LR1) – louvered well casing at two-percent slope (approved)
- Configuration 2 (LR2) – wire mesh screens with nylon mesh bags (study complete – concept abandoned)
- Configuration 3 (LR3) – louvered well casing placed at 35 percent slope (steep slope study – see I-101, PM 17.82 in Current Status table, below)

LR1 uses modular well casings with 5-mm (0.25-inch nominal) louvers to remove litter. Flow enters the casing and passes radially through the louvers, trapping litter and solids inside. The clean water flows into a vault holding the GSRD and is directed to an outlet pipe. Access doors are provided on the well casings for ease of maintenance and cleaning using a vactor truck. LR2 uses modular well casing with 5 mm by 5 mm rigid mesh screen housing. Inside the screen are nylon mesh bags with 5 mm openings that capture gross solids. LR3 is similar to LR1 devices except that the modular well casings are placed on a 35 percent slope.

Inclined Screen Devices (ISD):

- Configuration 1 (IS1) – parabolic wedge wire screen for vacuum truck cleaning (approved)
- Configuration 2 (IS2) – parabolic bars (study complete - concept abandoned)
- Configuration 3 (IS3) – parabolic wedge wire screen for front-end loader cleaning (study complete - design changes being considered)
- Configuration 4 (IS4) – wedge wire screen, direct flow (study complete considering changes)
- Configuration 5 (IS5) – wedge wire screen (study ongoing – see I-210/Orcas, I-210/Filmore, and SR 91/Cerritos studies in Current Status)

In IS1, flow overtops a weir and falls through an inclined parabolic wedge wire screen with 3-mm spacing. Litter stopped by the screen falls or is pushed down the face of the screen into a litter storage area. The litter storage area is sloped and is provided with a drain to prevent standing water. IS2 uses 5-mm spaces. IS3 is the same as IS1, except IS3 has access for cleaning by a front-end loader. IS4 contains a straight screen rather than a curved one; and runoff discharges onto the screen at a single point instead of being uniformly distributed across

the width of the screen by an influent trough. IS5 uses u-shaped wedge wire screens with a concrete head wall. Runoff enters the device, hits the head wall, and flows along a platform where the runoff flows onto the wedge wire screens.

Baffle Box (BB):

- Configuration 1 (BB1, study complete – concept abandoned).

BB1 applies a two-chamber concept. The first chamber utilizes an underflow weir and 50-mm screen to trap floatable litter. The second chamber uses a 5-mm screen to capture materials that get past the underflow weir and 50-mm screen. Once the flow enters this device, reduced velocities allow solids to settle. Peak flow velocities are maintained at levels that will not re-suspend solids. Litter entering the device generally floats; however, some will eventually settle. Storage is provided for both floatable and settleable litter.

V-screens (VS):

- Configuration 1 (VS1) – forward sloping screen (FSS, study complete – concept abandoned)
- Configuration 2 (VS2) – reverse sloping screen (RSS, study complete – concept abandoned)

VS1 is an open-ended concrete box with a wedge wire, v-shaped screen. The v-shaped screen is placed directly in front of a discharge pipe with the vertex of the "v" along the centerline of the inlet pipe. The screen diverts litter toward the sides of the concrete box. The screen is also at a positive inclination; that is, the top of the screen is slightly farther away from the incoming flow than the bottom of the screen. The difference between VS1 and VS2 is the positive or negative inclination of the screen. VS2 contains a screen at a negative inclination, that is, the bottom of the screen is slightly farther away from the incoming flow than the top of the screen.

Objectives

The District 7 GSRD pilot study is designed to determine:

- Effectiveness of GSRDs in removing gross solids
- Construction costs
- Operation and maintenance costs

Current Status

Location (Route, RWQCB, District, PM)	No. of Pilots	Status
I-210/Orcas, Los Angeles, D-7	1 Inclined Screen – Conf. 5 (IS5)	Construction complete, undergoing gross solids monitoring.
I-210/Filmore, Los Angeles, D-7	1 Inclined Screen – Conf. 5 (IS5)	Construction complete, undergoing gross solids monitoring.

Location (Route, RWQCB, District, PM)	No. of Pilots	Status
SR 91/Cerritos, Los Angeles, D-7	1 Inclined Screen – Conf. 5 (IS5)	Construction complete, undergoing gross solids monitoring.
I- 405/Leadwall, Los Angeles, D-7	1 Forward Sloping V Screen – Conf. 1 (VS1)	Concept abandoned after first year of monitoring, currently under operational monitoring due to excessive clogging.
I -101/Gaviota, Los Angeles, D-7	1 Steep-slope linear radial device – Conf. 3 (LR3)	Concept abandoned after first year of monitoring, currently under operational monitoring due to excessive clogging.

Findings/Conclusions

LR1, IS1, and IS4 were determined to be effective at removing gross solids from stormwater runoff. LR2, LR3, IS2, BB1, VS1, and VS2 were determined to be either too maintenance intensive or ineffective. As a result, these devices have been removed from further consideration. IS3 proved to be a valid design concept. However, a re-design has been recommended to eliminate the intensive cleaning requirements that were documented throughout the study period. The remaining GSRDs are still being evaluated.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-004	Sampling and Analysis Plan: Litter Solids Removal Device Pilot Study. January 2001.
CTSW-RT-01-005	Preliminary Design Report: Litter Solids Removal Device. January 2001.
CTSW-RT-01-047	Gross Solids Removal Device Pilot Study 2000-2001 Interim Report. August 2001.
CTSW-RT-01-069	Basis of Design Report: Gross Solids Removal Device Pilot Study, Phase II. November 2001.
CTSW-RT-02-071	Phase II & III Gross Solids Removal Devices , Operations and Maintenance Plan Monitoring Season 2002-2003. November 2002.
CTSW-RT-03-077.31.24	Phase IV Gross Solids Removal Devices, Operations, Maintenance, and Monitoring Plan. Monitoring Season 2003-2004. September 2003.
CTSW-RT-03-072.31.22	Phase 1 Gross Solids Removal Devices Pilot Study: 2000-2002. Final Report. October 2003.

Department Document No.	Document Title
CTSW-RT-03-097.31.22	Phase II Gross Solids Removal Devices Pilot Study: 2001-2003. Final Report. November 2003.
CTSW-RT-03-098.31.17	Phase III Gross Solids Removal Devices Basis of Design Report. November 2003.
CTSW-RT-03-099.31.24	Phase III Gross Solids Removal Devices Pilot Study: 2002-2003 Interim Report. November 2003.
CTSW-RT-04-0130.03.1	Phase III and IV Gross Solids Removal Devices Operations, Maintenance and Monitoring Plan, Monitoring Season 2005-2006. July 2004.
CTSW-RT-05-130-03.1	Phase III Gross Solids Removal Devices Pilot Study: 2002-2005. December 2005.
CTSW-RT-05-130-03.2	Phase IV Gross Solids Removal Devices Pilot Study: 2002-2005. December 2005.
CTSW-RT-06-0130.01.0	Phase III, IV, and V Gross Solids Removal Devices Operations, Maintenance and Monitoring Plan: Monitoring Season 2006-2007. September 2006.

3-Year Action Plan

Overview of Approach

Conduct operational monitoring of Phase III and IV GSRDs and operational and gross solids monitoring of Phase V GSRDs. Develop annual operations, maintenance, and monitoring plans (OMMPs), interim report, and final report.

Products and Deliverables

- Annual OMMPs
- Interim report on Phase V GSRDs
- Final report of Phase V GSRDs.

Schedule

- 2007/08 – Continue monitoring and develop interim report for Phase V GSRDs. None for Phase I, II, III and IV GSRDs (studies complete).
- 2008/09 – Continue monitoring and develop OMMP and final report(s) for Phase V GSRDs. None for Phase I, II, III and IV GSRDs (studies complete).
- 2009/10 – None (Phase I, II, III and IV studies complete. Phase V study to be complete by end of 2008/09 season)

2.8.2 District 12 SR73 Pilot Program — GSRDs

In response to Cease and Desist Order No. 2001-198 issued by the San Diego Regional Water Quality Control Board (RWQCB), the Department replaced three compost storm filters (CSFs)

along the San Joaquin Hills Transportation Corridor (SR73) with GSRDs. There is one IS5 GSRD (CSF 630L) currently being monitored. See Section 2.8.1 for a description of IS5s

Objectives

This pilot is designed to determine:

- Effectiveness of GSRDs in removing gross solids
- Construction costs
- Operations and maintenance costs

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, San Diego, D-12	1 Inclined Screen – Conf. 5 (IS5)	GSRD on basin 630L: Construction complete. Undergoing gross solids monitoring. Final Report anticipated for 2010.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-03-030	SR-73 1085L GSRD with Sediment Trap, Operations, Maintenance, and Monitoring Plan Monitoring Season 2002-2003. January 2003.
CTSW-RT-03-078.51.35	State Route 73 Best Management Practice Pilot Studies Operations, Monitoring and Maintenance Plan. October 2003.
CTSW-RT-03-120.31.25	SR-73 Storm Water BMP Replacement Project at CSF System 1085L GSRD Interim Report. December 2003.
CTSW-RT-03-121.31.10	SR-73 Storm Water BMP Replacement Project at CSF System 1085L and 630L Gross Solids Removal Device. Basis of Design Report December 2003.
CTSW-RT-06-131-01.1	District 12 State Route 73 BMP Pilot Program 2004-2005 Wet Season Volumes I & II (Interim Report and Lab Data). March 2006.
CTSW-RT-06-131-01.2	District 12 State Route 73 BMP Pilot Program 2005-2006 GSRDs Wet Season Volumes I & III (Interim Report and Lab Data; Volume II summarizes Detention Basins). February 2007.
CTSW-RT-07-211.08.D1	State Route 73 Best Management Practices Pilot Study: Operations, Maintenance, and Monitoring Plan. July 2007.

3-Year Action Plan

Overview of Approach

Monitoring of the devices for litter loading rates, maintenance requirements, and operational problems will continue for one wet season. An interim report will be developed. Cumulative results will be reported in State Route 73 Pilot Studies Final Report (due 2010).

Products and Deliverables

- Interim report

Schedule

- 2007/08 – Continue monitoring and develop interim report
- 2008/09 – None (study to be complete by end of 2007/08 season)
- 2009/10 – Develop State Route 73 Pilot Studies Final Report

2.8.3 District 11 Continuous Deflection Separators (CDS)

District 11 has installed two CDS units on SR-56. Sand was inserted into one unit to reduce discharges of oil and grease from the highway surface. These CDS units were modified by creating weep holes at the bottom to facilitate drainage.

Objectives

These pilots are designed to determine:

- Effectiveness of CDS in removing pollutants of concern
- Effectiveness of weep holes in draining standing water

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR56/Carmel Creek Road and Carmel County Road, San Diego, D-11	2	A fifth and final year of monitoring (2006/07) was completed. Final Report was also completed.

Findings/Conclusions

Weep holes did not work to prevent standing water, and therefore both units continue to provide an opportunity for vector breeding. CDS units were effective at capturing gross pollutants. GSRDs might be better for projects since they are approved treatment BMPs and are as effective in capturing gross pollutants without creating a standing water problem.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-121.650.05	Annual Repot 2002-2003: State Route 56 CDS & Receiving Water Monitoring. May 2003.
CTSW-RT-04-007.650.05	Monitoring Report 2003-2004: State Route 56 CDS & Receiving Water Monitoring. May 2004.
CTSW-RT-05-650.05.1	Annual Report 2004-2005: State Route 56 CDS & Receiving Water Monitoring. June 2005.
CTSW-RT-06-650.05.1	Annual Report 2005-2006: State Route 56 CDS & Receiving Water Monitoring. June 2006.
CTSW-RT-07-650.15.1	Annual Report 2006-2007: State Route 56 CDS & Receiving Water Monitoring. May 2007.

3-Year Action Plan

Overview of Approach

Monitoring was completed (five-year monitoring) in accordance with the California Coastal Commission Permit.

Although the study is complete, Caltrans is planning to develop an evaluation report recommending approval or rejection of CDS units for their stormwater program.

Products and Deliverables

- None (study completed during 2006/07 season)

Schedule

- 2007/08 – None (study completed during 2006/07 season)
- 2008/09 – None (study completed during 2006/07 season)
- 2009/10 – None (study completed during 2006/07 season)

2.8.4 Laboratory Testing of GSRDs

Laboratory testing is being conducted at the UC-Davis Hydraulics Laboratory to improve performance of proposed GSRDs.

Objectives

These pilots are designed to utilize advanced concepts in flow control to improve the hydraulic performance of the proposed devices under different flow rates and debris-loading conditions. The results of these tests will substantially reduce the costs associated with the deployment of these devices in the field, and help with the creation of standard specifications for Caltrans engineers.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
UC-Davis Hydraulics Lab	3	Major breakthrough achieved in design improvements, including footprint (and resulting volume) reduction. Further tests for different flow-control mechanisms are underway.

Findings/Conclusions

The incorporation of devices to evenly distribute the flow over the inclined screens, to create a strong 'Coanda jet' effect, and to induce an attached jet flow to achieve self-cleansing have produced enormous improvements in the performance of IS4 GSRDs. (See Section 2.8.1 for a description of IS4 GSRDs). Further studies have been conducted on reducing the size of the IS4 GSRD while incorporating the above improvements. These reduced-volume IS4-GSRDs have also shown highly improved self-cleansing capability resulting in more efficient solids capturing.

Available Documents

None to report at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Conduct flow tests with different flow-control mechanisms, for various flow rates, slopes, and solids loadings. Reduce size of IS4-GSRDs to a minimum footprint (and resulting volume), incorporating flow control mechanisms while still meeting the solids loading and flow requirements.

Products and Deliverables

- Final report

Schedule

- 2007/08 – Continue laboratory testing and develop final report
- 2008/09 – Explore possibility for reducing volume of GSRDs.
- 2009/10 – None (study to be completed during 2008/09 season)

2.9 INFILTRATION

Infiltration technologies allow stormwater to be temporarily stored, and subsequently infiltrate into the underlying soil. Runoff volumes greater than the predetermined design WQV are typically routed around infiltration devices.

2.9.1 Infiltration Basin Model – Effects on Soil and Groundwater

This study modifies existing models to predict the accumulation rates, depths, and concentrations of constituents over time. Effects of incidental infiltration through vegetated surfaces, such as biofilters, will also be considered.

Objectives

The purpose of this study is to model the long-term impacts of infiltrating stormwater on soils and groundwater. Specifically, the study will ascertain which constituents may leach to groundwater and exceed standards and which constituents may accumulate in the soil and exceed standards. The objective of this study is to answer the following questions:

- How quickly will the constituents buildup in the soil?
- How often will maintenance be required?
- Will the soil become a hazardous material?
- How deep will the constituents travel?
- Will constituents pollute the groundwater?

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
UC-Davis Laboratory	NA	A Final Report is being developed to incorporate revisions and validate the model.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None to report at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Complete the screening assessment modeling of selected pollutants, including several metals and organics, including herbicides.

Products and Deliverables

- Final report

Schedule

- 2007/08 – Develop final report
- 2008/09 – None (study to be completed during 2007/08 season)
- 2009/10 – None (study to be completed during 2007/08 season)

2.9.2 Alternative Infiltration Trench Structures

Traditional infiltration trenches require a rock matrix backfill. When the trench clogs, extensive and costly maintenance is required to remove the rock matrix, restore infiltration capacity, and replace or reinstall the rock matrix backfill. A backfill material with greater void space could make maintenance easier and reduce the size of the trench and therefore increase the number of locations the BMP can be deployed.

Objectives

The purpose of the Alternative Infiltration Trench Structures (AITS) Pilot Study is to evaluate high void materials that may be used as an alternate to typical backfill in infiltration trenches.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
TBD	4	Suitable sites are being investigated in District 10

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None to report at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Several infiltration trenches with alternative structures will be built and monitored for operation and maintenance issues. No water quality monitoring will be done, because water quality performance is not a research objective based on prior modeling (see Section 2.9.1). Operational monitoring will continue for at least two wet seasons.

Products and Deliverables

- Study design tech memo
- Site selection tech memo
- Interim reports

Schedule

- 2007/08 – Complete site selection and design and construct infiltration trenches.
- 2008/09 – Conduct operational monitoring and develop interim report.
- 2009/10 – Conduct operational monitoring and develop interim report.

2.10 FILTRATION

2.10.1 Tahoe Basin Small-Scale Pilot Studies – Sand Filters

Objectives

The Tahoe small-scale pilot treatment systems operate intermittently to treat discrete batches of stormwater collected after various runoff events. The objectives of these pilot studies include:

- Testing the effectiveness of sedimentation and sand filtration treatment systems in removing colloidal, dissolved and particulate stormwater pollutants
- Developing design parameters for full-scale pilots

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
Meyers Maintenance Station, Lahontan, D-3	2 (Fine Sand)	Sixth monitoring season (2006/07) testing complete. Sixth monitoring season report expected in 2008.

Findings/Conclusions

First, second, third, fourth, and fifth monitoring season reports are now complete. First season (2001/02, Phase I) monitoring included testing filter systems with one of three different sand media: coarse (~ 1 mm), fine (~ 0.5 mm) and concrete (~ 0.2 mm). Arrangements of coarse and fine sand tested included: direct filtration, direct filtration with filter aid, direct filtration with coagulant and filtration following coagulant and sedimentation. One system tested concrete sand in a simulation of a typical Austin sand filter. First season (Phase I) monitoring showed that the sand filter systems tested were ineffective when used without prior chemical addition and sedimentation. Second and third season monitoring (Phase II and Phase III) confirmed that sedimentation without chemicals followed by fine sand filtration was ineffective as a treatment system for meeting the numeric discharge limits in the Tahoe Basin. Fourth, fifth, and sixth season monitoring (Phase IV, Phase V, and Phase VI) of fine sand filters was for control purposes to compare the treatment effectiveness of adsorptive media. Findings from the fourth, fifth, and sixth seasons are presented in reports listed below.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-054	Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan. October 2001.
CTSW-RT-03-053.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Monitoring and Operations Plan. June 2003.
CTSW-RT-03-042	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase I Report. August 2003.
CTSW-RT-03-079.31.37	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Report. December 2003.
CTSW-RT-04-069.04.04	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Monitoring and Operations Plan. June 2004.
CTSW-RT-05-069.04.08	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Monitoring and Operations Plan. January 2005.
CTSW-RT-05-069.04.07	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Final Report. May 2005.
CTSW-RT-05-157.04.01	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase V Monitoring and Operations Plan. January 2006.
CTSW-RT-05-157.04.02	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Report. April 2006.
CTSW-PL-07-157.04.02	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase VI Monitoring and Operations Plan. January 2007.
CTSW-RT-06-157.04.01	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase V Final Report. February 2007.

Department Document No.	Document Title
TBD	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project. Phase VI Report. Due March 2008.

3-Year Action Plan

Overview of Approach

Complete Phase VI Final Report.

Products or Deliverables

- Final report for Phase VI.

Schedule

- 2007/08 – Complete Phase VI Final Report.
- 2007/08 – None (study to be complete 2007/08)
- 2008/09 – None (study to be complete 2007/08)

2.10.2 Low Cost Adsorbent Materials for Dissolved Metals Removal

Objectives

The purpose of this study is to identify promising adsorbent materials for the removal of dissolved metals (zinc, copper and lead) from stormwater. This phase of the study compared the performance of activated carbons prepared from agricultural byproducts to granular activated carbon (GAC) from commercial sources. The investigation employs both batch and column experiments and is intended to more completely characterize the adsorption characteristics under varied water quality conditions. This project is a laboratory-based investigation that uses stormwater from several highway sites in some of the experiments and is intended to guide the design and operation of future pilot studies.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
UC-Davis	1	Ongoing.

Findings/Conclusions

In this study the amount of adsorption is quantified using a solid-water distribution coefficient, K_d, defined as:

$$K_d = \frac{q_e}{C_e}$$

where,

K_d = solid-water distribution coefficient (L solution/kg adsorbent)

q_e = solid phase metal concentration at equilibrium (mg metal/kg adsorbent)

C_e = metal concentration in water at equilibrium (mg metal/L solution)

The distribution coefficient is a measure of the amount of adsorption of a particular metal that occurs on a particular adsorbent when the aqueous concentration is 1 mg/L. Higher values of K_d mean that the adsorbent has a higher capacity under that condition and therefore that less of it needs to be used to reach a given treatment goal.

Over the ~2 year project, six commercial GAC samples and six activated agricultural products (pistachio shells, pecan shells, walnut shells, almond shells, rice husk, and rice straw) were studied. The commercial carbons were selected to include three different manufacturers and two different carbon source materials (coal and coconut shells). All GACs were sieved before testing to achieve a consistent range of particle sizes. None of the nut shell materials is as effective as the rice derived materials. Three of the commercial GACs exhibited consistently better performance. One critical difference between the commercial GACs and the activated agricultural byproducts was that the commercial GACs exhibited the maximum distribution coefficients at pH 7, while the activated agricultural byproducts showed increasing removal with increasing pH. Calcium ions, present at high concentrations in most stormwater, interfered with metal adsorption to differing degrees on these adsorbents. For each adsorbent at each pH value tested (5, 7 or 9) the order of adsorption affinity is Zn<Cu<Pb (with very few exceptions). To a first order approximation the mass of adsorbent required to treat a fixed volume of stormwater is related to 1/Kd, so Zn will control the design of an adsorbent-based treatment BMP to remove these three metals no matter which adsorbent is selected.

Available Documents

Department Document No.	Document Title
To be determined	Low Cost Adsorbent Materials for Dissolved Metals Removal. Phase I Final Report to be completed in early 2008. Phase II Final Report to be completed in later 2008.

3-Year Action Plan

Overview of Approach

Continuing work will (1) more conclusively identify the identity of constituents in stormwater that interfere with dissolved metal adsorption, (2) develop recommendations for deployment of adsorbent materials for dissolved metal removal as the basis for cost estimates and design specifications, and (3) develop recommendations on possible configurations and adsorbent materials for subsequent pilot testing.

Products or Deliverables

- To be determined.

Schedule

- 2007/08 – Continue study as described above – specific activities to be determined.
- 2008/09 – Continue study as described above – specific activities to be determined.
- 2009/10 – Continue study as described above – specific activities to be determined.

2.10.3 District 12 SR73 Pilot Program – Sand Filters

Two different designs exist for Austin-type sand filters: so called "separate" and "combined" sedimentation, also known as "full" and "partial," respectively. A separate sedimentation filter has separate sedimentation and filtration basins. The entire WQV is detained in the sedimentation basin and slowly discharged to the filter. A combined sedimentation filter has a combined sedimentation and filtration basin. In this design, the invert of the basin is the filter bed. Both of these designs are being piloted in District 12 along the San Joaquin Hills Toll Road (SR73). Both of these designs have been previously tested in District 2. Additionally, the five Austin-type sand filters constructed and monitored in Southern California as part of the BMP Retrofit Pilot Program were all full sedimentation devices. In contrast to the Southern California pilot filters, the District 2 and 12 filters have earthen (rather than concrete) sidewalls.

Objectives

These pilots are designed to determine:

- Constituent removal effectiveness for each type of Austin sand filter
- Costs of constructing the full sedimentation Austin sand filter using earthen walls and bottom
- Construction costs and maintenance requirements of the partial sedimentation design
- Any additional maintenance requirements and costs for these sand filters in areas with relatively large annual rainfall and freezing temperatures
- Comparison of cost and performance to the Caltrans BMP Retrofit Pilot Program Austin sand filters

The study consists of two pilot study locations, each with influent and effluent water quality monitoring. Stormwater runoff is collected using automatic samplers. The influent and effluent water quality is compared to see if there is a statistical difference between the two. Chemical analyses of the stormwater runoff will include the Department's standard suite of constituents.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR73, Santa Ana, D-12	2	Construction complete, monitoring started

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None to report at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Continue monitoring and develop interim and final Reports.

Products or Deliverables

- Interim reports
- Final report

Schedule

- 2007/08 – Continue monitoring and develop interim report.
- 2008/09 – Continue monitoring and develop interim report.
- 2009/10 – Continue monitoring and develop final report.

2.10.4 Linear Filtration Trenches

Many conventional treatment BMPs are difficult to implement along Caltrans highways due to narrow space constraints and right-of-way limitations, or poor soil conditions that prevent implementation of linear infiltration BMPs. To address these considerations, seven types of linear filtration devices have been identified for further evaluation. Preliminary research indicates that these devices can fit in narrow space constraints.

Objectives

The overall objective of this pilot study is to investigate the effectiveness and feasibility of using linear filtration systems to treat both piped and sheet flow runoff from Caltrans highways. The seven new technologies are: (1) bioretention trench, (2) linear filtration trench, (3) linear sand filter, (4) ecology embankment, (5) low head ecology embankment, (6) full-draining Delaware filter, and (7) vegetated rock filter.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
I-5, Central Valley, D-3	7	Under design.
I-210, Los Angeles, D-7	7	Under design.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None available at this time (study ongoing).

3-Year Action Plan

Overview of Approach

The pilot study encompasses conceptual design, siting, final design, installation, and monitoring of seven linear filtration devices at two sites.

Products or Deliverables

- Plans, specifications, & estimates
- Design & construction reports
- SAPs
- Interim and final monitoring reports

Schedule

- 2007/08 – Complete designs and construction.
- 2008/09 – Commence monitoring and develop interim report.
- 2009/10 – Continue monitoring. Develop interim report.

2.10.5 Tahoe Basin Small-Scale Pilot Studies - Alternative Media Filters

Alternative media filters use filtration media other than sand and have the potential to remove dissolved constituents such as metals, nutrients, and trace organics that are not removed particularly well by sand. Alternative media may be arranged in either bed or canister configurations.

Objectives

The Tahoe small-scale pilot treatment systems operate intermittently to treat discrete batches of stormwater collected after various runoff events. Objectives of these pilot studies include:

- Testing the effectiveness of sedimentation and media filtration treatment systems in removing colloidal, dissolved and particulate stormwater pollutants
- Developing design parameters for full-scale pilots

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
South Lake Tahoe Maintenance Station	Varies	Sixth monitoring season (06/07) testing complete. Sixth monitoring season report will be developed in 2008.

Findings/Conclusions

First, second, third, fourth, and fifth monitoring season reports are now complete. First season monitoring (Phase I) showed that the filtration systems tested, with the possible exception of activated alumina filtration, were ineffective when used without prior chemical addition and sedimentation. Second season monitoring (Phase II) showed that filtration through activated alumina and expanded shale, following 24-hour sedimentation without chemical addition, almost always met the required surface water discharge limits. However, both media, expanded shale in particular, increased effluent pH and dissolved aluminum concentrations. Sedimentation without chemicals followed by fine sand filtration was found to be ineffective as a treatment system for the Tahoe Basin. Third monitoring season (Phase III) breakthrough testing to determine expected life of activated alumina, expanded shale, and other media showed that activated alumina had the longest treatment life as well as the best treatment performance. Fourth season testing (Phase IV) included performance and breakthrough testing of new adsorptive media (iron-modified activated alumina, granular ferric hydroxide and a proprietary iron oxide) as well as further testing of activated alumina of various grain sizes. Fourth season monitoring indicated that iron-modified activated alumina had treatment performance comparable to activated alumina but reduced effluent pH and was more prone to hydraulic failure. Fifth season monitoring (Phase V) included testing of activated alumina/iron-modified activated alumina dual media filters for preventing increases in effluent pH and aluminum. It also included lab-scale testing/development of small footprint filters intended for locations where Caltrans right-of-way is very limited. Results indicated that the activated alumina/iron modified activated alumina dual media filter concept was successful in mitigating the elevated aluminum commonly present in activated alumina filter effluents. Pretreatment through geotextile fabric was effective in improving the hydraulic performance of small footprint filters. Results indicated that further testing of geotextile fabric plus activated alumina systems is needed. Sixth season monitoring (Phase VI) included continuing testing of the dual media concept and activated alumina washing methods for preventing increases in effluent pH and aluminum. Small footprint testing also

included assessment of hydraulic treatment performance at higher loading rates than previously studied.

Available Documents

Department Document No.	Document Title
CTSW-RT-01-054	Lake Tahoe Storm Water Treatment Pilot Project Monitoring and Operations Plan. March 2002.
CTSW-RT-03-053.33.41	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Monitoring and Operations Plan. June 2003.
CTSW-RT-03-042	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase I Report. August 2003.
CTSW-RT-03-079.31.37	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase II Report. December 2003.
CTSW-RT-04-069.04.04	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Monitoring and Operations Plan. June 2004.
CTSW-RT-05-069.04.08	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Monitoring and Operations Plan. January 2005.
CTSW-RT-05-069.04.07	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase III Final Report. May 2005.
CTSW-RT-05-157.04.01	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase V Monitoring and Operations Plan. January 2006.
CTSW-RT-05-157.04.01	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase V Monitoring and Operations Plan. January 2006.
CTSW-RT-05-157.04.02	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project, Phase IV Report. April 2006.
CTSW-PL-07-157.04.02	Caltrans Lake Tahoe Storm Water Small Scale Pilot Treatment Project, Phase VI Monitoring and Operations Plan. January 2007.
CTSW-RT-06-157.04.01	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project. Phase V Report. February 2007.
TBD	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project. Phase VI Report. Due March 2008.

3-Year Action Plan

Overview of Approach

The study will continue using media that has shown to be the most promising based on past results and new media identified through literature reviews. Four-inch columns will be used to test removal efficiencies and treatment life for different media.

Products or Deliverables

- Reconnaissance study or other literature review reports
- Annual monitoring and operations plans
- Final report

Schedule

- As needed - Reconnaissance study or other literature review reports
- 2007/08 - Monitoring and development of Phase VII Final Report
- 2008/09 - None (study to be completed 2007/08)
- 2009/10 - None (study to be completed 2007/08)

2.10.6 Tahoe Basin Full-Scale Pilot Studies: Alternative Media Filters

Alternative media filters use filtration media other than sand and have the potential to remove dissolved constituents such as metals, nutrients, and trace organics that are not removed particularly well by sand. Alternative media may be arranged in either open bed or small footprint configurations.

Objectives

Both the open bed and small footprint pilots were designed to determine:

- The effectiveness of various filter media in removing turbidity and nutrients
- The hydraulic performance of the media filter BMPs in the alpine climate
- The maintenance requirements
- The construction and maintenance cost

Six full-scale open bed pilot BMPs have been constructed using activated alumina, iron-modified activated alumina, and limestone as the filter media. Activated alumina and iron-modified activated alumina showed some promise for removing turbidity and phosphorous from stormwater when tested in the small-scale pilot facility. Limestone gave slightly better nutrient removal than fine sand in small-scale tests. All six filters are designed as partial sedimentation type Austin-style sand filters, but have 12 or 24 inches of media overlain by six inches of sand rather than the typical 18-inch layer of sand. The table below lists the full-scale open bed media filters currently being monitored in Tahoe:

Media Filter	Location	Construction Date
Activated alumina (12-inch depth)	Hwy 50	2003
Activated alumina (12-inch depth, reduced area)	Hwy 50	2003
Limestone (24-inch depth)	SR267	2005

Media Filter	Location	Construction Date
Activated alumina (24-inch depth)	SR267	2005
Iron-modified activated alumina (24-inch depth)	SR267	2005
Iron-modified activated alumina (12-inch depth, reduced area)	SR267	2005

In addition to the open bed media filters, two small footprint media filters have been constructed. These filters were installed as retrofits to the vaults previously used in the sand trap with filter fabric study (TR-2000s). The small footprint filters consist of two chambers. The first chamber is a setting chamber that captures traction sand. Water from this chamber flows into the upper portion of the second chamber through a series of pipes. The pipes are capped with filter fabric bags that remove sediment before it flows into the activated alumina media filter in the lower portion of the second chamber. The table below lists the small footprint media filters currently being monitored in Tahoe:

Media Filter	Location	Construction Date
Activated Alumina	SR267	2007
Activated Alumina (reduced area)	SR267	2007

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
HWY 50, Lahontan, D-3	2	Construction complete, monitoring is ongoing.
SR267, Lahontan, D-3	6	Construction complete, monitoring is ongoing.

Findings/Conclusions

Three years of monitoring of the Hwy 50 activated alumina filters showed that activated alumina filters are promising for turbidity and phosphorous removal. Operational monitoring indicated that maintenance to restore hydraulic conductivity is likely to be more frequent than that required to restore media effectiveness. There was no evidence that media effectiveness had decreased at the end of the four years of monitoring.

Available Documents

Department Document No.	Document Title
CTSW-RT-03-061.31.37	Caltrans Tahoe Basin Highway 50 Full-Scale BMP Pilot Study Monitoring Season 2003-2004. Sampling and Analysis Plan. June 2003.

Department Document No.	Document Title
CTSW-RL-05-129.02.1	Caltrans Tahoe Basin Full-Scale Activated Alumina BMP Pilot Study, Monitoring Season 2004-2005. Monitoring and Operations Plan. March 2005.
CTSW-RT-05.129.02.1	Highway 50 Activated Alumina Media Filter Pilot Study. 2003-2004 Interim Report. August 2005.
CTSW-RT-05-157.02.1	Highway 50 Activated Alumina Media Filter Pilot Study, Monitoring Season 2005-2006. Monitoring and Operations Plan. October 2005.
CTSW-RT-05-157.03.1	Highway 267 Media Filter Pilot Study, Monitoring Season 2005-2006. Monitoring and Operations Plan. November 2005.
CTSW-RT-06-157.03.1	Caltrans Tahoe Basin SR 267 Media Filter Pilot Study. Interim Report, Monitoring Season 2005-2006. October 2006.
CTSW-RL-05-129.02.2	Highway 50 Activated Alumina Media Filter Pilot Study. 2004-2005 Interim Report. September 2006.
CTSW-PL-07-157.22.1	Highway 267 Media Filter Pilot Study, Monitoring Season 2006-2007. Monitoring and Operations Plan. March 2007.
CTSW-PL-07-157.23.1	Highway 50 Activated Alumina Media Filter Pilot Study, Monitoring Season 2006-2007. Monitoring and Operations Plan. March 2007.
CTSW-RT-06-157.02.1	Caltrans Tahoe Basin Highway 50 Activated Alumina Media Filter Pilot Study. 2003-2006 Pilot Study. May 2007.

3-Year Action Plan

Overview of Approach

Monitoring will continue at the two Highway 50 pilots to determine media life and life-cycle costs. At least two more years of water quality and operational monitoring is anticipated at the SR267 pilot sites.

Products and Deliverables

- Monitoring and operations plans
- Interim reports
- Final report

Schedule

Highway 50 Pilots:

- Monitoring until media is no longer effective and development of Addendum(s) to final report. (Timeline will depend on life of existing media).

SR267 Pilots:

- 2007/08 – Monitoring and development of interim report
- 2008/09 – Monitoring and development of interim report
- 2009/10 – Monitoring and development of final report

2.11 VEGETATED TREATMENT SYSTEMS

Vegetated treatment systems are also known as biofilters. Treatment occurs by allowing contact between stormwater and vegetation. Pollutant removal occurs by contact filtration and infiltration.

2.11.1 Roadside Vegetated Treatment Sites (RVTS) Study

The RVTS Study is a water quality monitoring project undertaken to evaluate the efficiency of existing vegetated side slopes adjacent to freeways for the removal of stormwater contaminants. Multiple locations throughout California were monitored during the 2001/02, 2002/03, 2005/06, and 2006/07 wet seasons.

Objectives

The objectives of the RVTS study are to:

- Determine if standard roadway design requirements for vegetated strips have stormwater treatment capabilities equivalent to biofiltration strips specifically engineered for stormwater treatment performance
- To identify what specific site characteristics for vegetated-slopes provide what level of stormwater treatment
- To improve guidelines for standard design practices for vegetated-slopes to promote stormwater treatment
- To improve understanding of water quality of discharges from Caltrans right of way.

Current Status

Location (Route, RWQCB, District, Post Mile)	No. of Pilots	Status
I-5/Sacramento Central Valley, D-3	4	Monitoring to continue for 2007/08 season.
I-5/Cottonwood, Central Valley, D-2	1	Monitoring complete. No further monitoring scheduled.
SR299/Redding, Central Valley, D-2	3	Monitoring to continue for 2007/08 season.
Hwy 101/San Rafael, San Francisco Bay, D-4	1	Monitoring complete. No further monitoring scheduled.
SR91/Yorba Linda, Santa Ana, D-12	4	Monitoring to continue for 2007/08 season.

Location (Route, RWQCB, District, Post Mile)	No. of Pilots	Status
I-405/Irvine, Santa Ana, D-12	3	Site decommissioned due to plans for road repairs. Site replaced with one of two new sites constructed in District 8 (see last two rows of table).
SR60/Moreno Valley I, Santa Ana, D-8	4	Site decommissioned due to plans for road repairs. Site replaced with one of two new sites constructed in District 8 (see last two rows of table).
I-5/San Onofre, San Diego, D-11	3	Monitoring to continue for 2007/08 season.
I-15/Murrieta, San Diego, D-8	4	Design and construct 5 monitoring stations completed during 2006/07 season. Begin monitoring in 2007/08 season.
I-215/Moreno Valley II, Santa Ana, D-8	4	Design and construct 5 monitoring stations completed during 2006/07 season. Begin monitoring in 2007/08 season.

Findings/Conclusions

Based on the results to date, it was found that a minimum vegetative cover of about 65 percent is required for concentrations reduction to occur, and a rapid decline in performance occurs below about 80 percent coverage. Concentration reductions consistently occur for TSS and total metals and occasionally for dissolved metals. Concentration reductions occasionally occur for ammonia, total kjeldahl nitrogen, and nitrate, with one increase observed for nitrate. Concentration increases occasionally occur for dissolved solids, conductivity, hardness, and organic carbon.

At sites with greater than 80 percent vegetative cover (as established by the vegetation assessment conducted during the first two years of the study), data for constituents whose concentrations decreased indicated the following shortest-effective widths where irreducible minimum concentrations occurred:

- 4.2 meters for slopes equal to 10 percent (Redding)
- 4.6 meters for slopes between 5 and 33 percent (Sacramento)
- 8.3 meters for a slope of 50 percent (San Rafael)

At sites with less than 80 percent coverage, the following shortest-effective widths resulted in irreducible minimum concentrations:

- 9.3 meters for a slope of 52 percent (Cottonwood)
- 1.3 meters for slopes between 8 and 16 percent (San Onofre)
- 13 meters for slopes of 11 percent (Irvine)
- 7.6 meters for slopes of 14 percent (Yorba Linda)

Available Documents

Department Document No.	Document Title
CTSW-RT-03-028	Roadside Vegetated Treatment Sites (RVTS) Study. Final Report. November 2003.
CTSW-RT-06-127.01.2	Roadside Vegetated Treatment Sites (RVTS) Study Final Summary Report 2006 Report. November 2006.
CTSW-RT-07-208-02	2007 Summary Report: Roadside Vegetated Treatment Sites (RVTS) Study. Due January 2008.

3-Year Action Plan

Overview of Approach

Monitor six RVTS (Sacramento, Redding, Yorba Linda, San Onofre, Murietta, and Moreno Valley II). Conduct analysis of all RVTS data to date for incorporation into BMP selection guidelines. Develop Interim Summary report incorporating all monitoring data collected to date and data assessments. Conduct power analysis to estimate number of future monitoring years required at each location to provide a dataset that would demonstrate statistical significance (if it exists) of the observed reductions in concentrations. Recently constructed sites (Murietta and Moreno Valley II) with low vegetation (less than 80%) will be monitored for approximately three more years.

Products and deliverables

- SAPs
- Interim reports
- Power Analysis Technical Memorandum

Schedule

- 2007/08 – Continue monitoring and develop interim report. Complete analysis of all RVTS data to date for incorporation into design guidelines. Complete power analysis.
- 2008/09 – Monitor and develop interim report for RVTS. Complete another power analysis.
- 2009/10 – Monitor and develop interim reports.

2.11.2 Ornamental Roadside Vegetated Treatment Sites (Ornamental RVTS) Study

The RVTS Study described above focused on the treatment performance (on highway runoff) of side slopes vegetated primarily with grasses. The Ornamental RVTS Study focuses on the treatment performance of sites vegetated with ornamental (non-grass) ground covers and low-lying shrubs. The Ornamental RVTS Study includes Expanded RVTS (ERVTS) where

ornamental vegetation will be planted adjacent to the original RVTS to provide a side-by-side comparison of grass-vegetated side slopes to ornamental-vegetated side slopes. The Ornamental RVTS Study also includes test sites with existing ornamental ground cover. These latter sites are referred to as Groundcover RVTS (GRVTS). The ERVTS consist of test strips. The GRVTS consist of test strips and swales.

Objectives

The objective of the Ornamental RVTS Study is to assess the treatment performance (pollutant reduction) of roadside slopes vegetated with ornamental cover.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR680/Milpitas, San Francisco Bay, D-4	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR280/San Francisco, San Francisco Bay, D-4	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
TBD, San Francisco Bay, D-4	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR299/Santa Rosa, San Francisco Bay, D-4	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR101/San Louis Obispo, Central Coast, D-5	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR101/Arroyo Grande, Central Coast, D-5	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR101/Camarillo I, Los Angeles, D-7	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR101/Camarillo II, Los Angeles, D-7	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR101/Newbury Park, Los Angeles, D-7	1 GRVTS swale	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
I-5/San Diego, San Diego, D-11	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR52 or SR78/San Diego II or San Marco, San Diego, D-11	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
I-5/Carlsbad, San Diego, D-11	1 GRVTS swale	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
I-405/Midway City, San Diego, D-12	2 GRVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
I-5/Sacramento, Central Valley, D-3	4 ERVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.

Location (Route, RWQCB, District)	No. of Pilots	Status
SR299/Redding, Central Valley, D-2	4 ERVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.
SR91/Yorba Linda, Santa Ana, D-12	4 ERVTS strips	Design and construction to be completed 2007/08. Monitoring to begin 2008/09.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-06-172.11.1	Final Technical Memorandum Summary of Literature Review for the Scoping and Siting of Groundcovers and Low-Growing Shrubs in Biostrips and Bioswales for Storm Water Treatment. July 2006.
CTSW-RT-06-172.11.1	Final Technical Memorandum Summary of Vegetation Selection for the Scoping and Siting of Groundcovers and Low-Growing Shrubs in Biostrips and Bioswales for Storm Water Treatment. August 2006.
CTSW-TM-07-172.11.3	Groundcovers and Low-Growing Shrub Vegetation Types in Biostrips and Bioswales for Storm Water Treatment Pilot Study Study Design Technical Memorandum. April 2007.
CTSW-TM-07-172.11.4	Scoping and Siting of Groundcovers and Low-Growing Shrub Vegetation Types in Biostrips and Bioswales for Storm Water Treatment Pilot Study Site Selection Technical Memorandum. June 2007

3-Year Action Plan

Overview of Approach

Complete design for installing collection systems and monitoring equipment for all test locations. Install monitoring equipment. Monitor for approximately three years. Develop design documents, as-builts, SAPs, and interim reports.

Products and deliverables

- Design Documents
- As-builts
- SAPs
- Interim reports

Schedule

- 2007/08 – Complete design and construction.
- 2008/09 – Begin monitoring and develop interim report.
- 2009/10 – Continue monitoring and develop interim report.

2.11.3 District 7 Bioswale Retrofit

Bioswales, or biofiltration swales, are vegetated areas similar to conveyance channels, which accept concentrated flow of stormwater runoff. Removal mechanisms include filtration and infiltration as stormwater flows through the vegetation.

Objectives

The purpose of this study is to develop a better understanding of how the pollutant removal capabilities of bioswales vary with the length of the bioswales.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
I-5/I-605, Los Angeles, D-7	1	Testing will begin in 2007/08 and will continue for one year pending re-evaluation in summer 2008.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None to report at this time (study ongoing).

3-Year Action Plan

Overview of Approach

A tech memo will be developed to provide recommendations for further testing in 2008/09.

Products or Deliverables

- Tech memo
- Interim report

Schedule

- 2007/08 – Begin monitoring, develop interim report, and develop tech memo for further recommendations.
- 2008/09 – Further Testing as recommended in tech memo.
- 2009/10 – Further Testing as recommended in tech memo.

2.12 VECTOR STUDIES

Many stormwater treatment technology BMPs are tested to determine performance. Others are modified and tested to see if performance is improved. In its goal to improve BMPs, the Department wants to ensure that proposed improvements do not provide areas of standing water which promote mosquito breeding, and thus impact public health. BMP Pilot Programs have a concurrent vector component, in which California Department of Health Services (DHS) and the local vector control agency monitor the BMPs to document mosquito breeding. In addition, in an effort to understand the relationship between mosquitoes and stormwater BMPs, several research studies were implemented, as discussed below.

Objectives

SR-73 Vector Production Study: Document where habitats for mosquito breeding occur for the various pilot systems in the ongoing SR-73 BMP Pilot Testing Program and provide suggestions to mitigate these areas. Transform findings into suggested guidelines for Caltrans.

North Lake Tahoe (NLT) Vector Production Study of Existing Storm Drain Structures and BMPs: Establish relationship between environmental factors (sun exposure, elevation, air temperature, water temperature, etc.) and mosquito production at drain inlets, drain inlets with a sump or sand trap, and double-barrel traction sand traps. These findings will translate into guidelines for future placement of stormwater structures.

South Lake Tahoe (SLT) Vector Production Study: Compare mosquito production at local BMPs to natural surrounding areas.

Statewide Larval Development Study: Determine times for larval development in the Tahoe region, which is typically cooler than other parts of the state. Some flexibility may be allowed in designing BMPs with a longer drain time in the Tahoe region. This study consists of laboratory tests representing areas in South Lake Tahoe, Sacramento, and Los Angeles.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
SR 73, Santa Ana & San Diego, D-12	23	Monitoring will continue through the 2007/08 season.

Location (Route, RWQCB, District)	No. of Pilots	Status
Hwy 89/NLT, Lahontan, D-3	22	Monitoring was completed in 2006/07 as part of the Statewide Larval Development Study. A Final Report will be completed in 2007/08.
Hwy 28, Lahontan, D-3	8	Monitoring was completed in 2006/07 as part of the Statewide Larval Development Study. A Final Report will be completed in 2007/08.
Hwy 50/SLT, Lahontan, D-3	5	Study complete
Various locations Statewide	NA	Monitoring will continue through the 2007/08 season.

Findings/Conclusions

The maximum allowable response time for addressing larval development from standing water has increased from 72 to 96 hours for much of California.

Available Documents

Department Document No.	Document Title
CTSW-TM-06-123.02.1	Mosquito Production in Stormwater Treatment Devices in South Lake Tahoe, California. March 2006.

3-Year Action Plan

Overview of Approach

Continue monitoring and develop interim and/or final reports for the NLT, SR 73, and larval development studies. The SLT study was completed during the 2005/06 season.

Products and Deliverables

- Larval Development Tech Memo
- NLT Vector Production Final Report
- SR 73 1st Year Interim Report
- SR 73 2nd Year Interim Report
- SR 73 3rd Year Interim Report
- SR 73 Final Report

Schedule

- 2007/08 – Complete the final report for the NLT sites. Continue monitoring and develop interim and final reports for SR 73. Continue larval development

study and complete tech memo by July 2007. None for SLT (study was completed during the 2005/06 season).

- 2008/09 – None for NLT (study to be completed by Fall of 2007). Continue monitoring and develop interim and final reports for SR73 through end of 2007. Continue larval development study through Fall 2007. None for SLT (study was completed during the 2005/06 season).
- 2009/10 – None (all studies to be completed by Fall 2007; no further studies are planned).

2.13 OPEN GRADED ASPHALT PAVEMENTS

Objectives

Open graded asphalt concrete (OGAC), rubberized open graded asphalt concrete (RAC-O), and rubberized gap-graded asphalt concrete (RAC-G) are currently installed by the Department in many applications. These asphalt pavements are also referred to as open graded friction courses, porous friction courses, and porous overlays. Porous overlays improve driver safety by reducing glare on wet nights and eliminating tire spray and hydroplaning. Porous overlays also reduce pavement noise. Preliminary findings in a recent study by the University of Austin Texas suggest that highways with a porous friction course overlay may provide some pollutant removal, e.g., TSS, from stormwater runoff.

The purpose of this study is to investigate the pollutant removal capability, if any, of RAC-O, RAC-G, and/or OGAC from stormwater runoff.

The study consists of eleven pilot study locations throughout California. Each pilot study location will consist of two sites: one test site and one control site. The test site is a freeway section with a relatively new pavement overlay, up to three years old. The control site is located nearby and is a freeway section without the new pavement overlay, but with conventional, dense-graded asphalt concrete. Stormwater runoff is collected, using automatic samplers, at the edge of pavement for the control and test sites. The water quality is compared to see if there is a statistical difference between the water quality at the test site and the control site. Chemical analyses of the stormwater runoff will include the Department's standard suite of constituents.

Current Status

Location (Route, RWQCB, District)	No. of Pilots	Status
Hwy 101, Central Coast, D-5	1	Site to be constructed 2007/08. Monitoring to begin 2008.
Hwy 128, North Coast, D-1	1	Site to be constructed 2007/08. Monitoring to begin 2008.
Hwy 101, North Coast, D-1	1	Site to be constructed 2007/08. Monitoring to begin 2008.

Location (Route, RWQCB, District)	No. of Pilots	Status
Hwy 41, Central Coast, D-5	1	Site to be constructed 2007/08. Monitoring to begin 2008.
I-5, Central Valley, D-2	1	Site to be constructed 2007/08. Monitoring to begin 2008.
I-5, Central Valley, D-2	1	Site to be constructed 2007/08. Monitoring to begin 2008.
Hwy 70, Central Valley, D-3	1	Site to be constructed 2007/08. Monitoring to begin 2008.
I-80, Central Valley, D-3 & 4	1	Site to be constructed 2007/08. Monitoring to begin 2008.
I-5, Central Coast, D-10	1	Site to be constructed 2007/08. Monitoring to begin 2008.
Hwy 140, Central Coast, D-10	1	Site to be constructed 2007/08. Monitoring to begin 2008.
Hwy 99, Central Valley, D-6	1	Site to be constructed 2007/08. Monitoring to begin 2008.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None to report at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Conduct monitoring and develop interim and final Reports.

Products or Deliverables

- Interim reports
- Final report

Schedule

- 2007/08 – Conduct monitoring and develop interim report.
- 2008/09 – Conduct monitoring and develop interim report.
- 2009/10 – Conduct monitoring and develop final report.

2.14 INCLINED PLATE AND TUBE SETTLERS

Objectives

The focus of this study was to perform a literature and product review and prepare a draft report describing the design, construction, operation, and maintenance features of inclined plate and tube settler devices. Based on the literature and product review, alternatives shall be generated for preliminary designs of new devices, or modification and adaptation of available devices to suit Caltrans operations and maintenance requirements (cleaning automation, self-cleaning, low maintenance, vector abatement, etc.).

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
UC-Davis Laboratory	NA	Prepared draft Final Report and submitted to the Department on August 2007.

Findings/Conclusions

Inclined plates were identified as being more suitable than inclined tubes for stormwater runoff treatment due to the higher maintenance requirements of inclined tubes. No inclined plate, however, is commercially used to treat stormwater runoff. A major problem associated with design and performance of the inclined plate was found to be a plenum issue. As demonstrated by a recent 3-D Computational Fluid Dynamic simulation, the water is not distributed equally within each plate and hence the water velocity in certain plates are much higher than the others. Because of this phenomenon, much smaller particles will not have enough time to settle and therefore will be discharged from the sedimentation tank. To address this problem, several design modifications have been recommended which can be evaluated under the next phase of the study.

Available Documents

Department Document No.	Document Title
CTSW-RT-07-168-22.1	Review and Potential Application of Inclined (Plate and Tube) Settlers for Stormwater Runoff Treatment. April 2007.

3-Year Action Plan

Overview of Approach

To resolve the plenum issue, it has been proposed to conduct further research under three phases. The first phase (Phase I) will be based on theoretical simulations using flow 3-D software. These simulations will be performed under different design configuration. Phase I will optimize

design to produce equal water distribution and velocity within each plate will be selected. The information gained from Phase I will be used to design and fabricate a pilot-scale inclined plate settling tank for experimental evaluation (Phase II). When the results of the Phase II pilot investigation are found to be satisfactory, the application of the inclined plate for actual stormwater runoff treatment can be assessed in the field (Phase III).

Product or Deliverables

- Final report

Schedule

- 2007/08 – Perform theoretical simulations.
- 2008/09 – Design, fabricate, and test inclined plates under different configurations.
- 2009/10 – Prepare final report.

2.15 3-YEAR ACTION PLAN SUMMARY

The 3-year plan for the new and continuing pilots studies are summarized in Table 2.1 below.

Table 2-1. Summary of 3-Year Schedule for Stormwater Treatment Technology Pilot Studies

Technology	Pilot Program	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
				2007/08	2008/09	2009/10
Bioretention	San Francisco – Oakland Bay Bridge Bioretention	I-80, San Francisco Bay, D-4	2	Construct	OM&M	OM&M & Reporting
Bioretention	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	1	OM&M	OM&M	OM&M & Reporting
Chemical Treatment	District 3 Tahoe Small Scale Pilot Studies	South Lake Tahoe Maintenance Station, Lahontan, D-3	Varies	Reporting	None (Study Complete)	None (Study Complete)
Detention Basins: Bypass	District 12 SR73 Pilot Program	SR73, San Diego/Santa Ana, D-12	4	OM&M	OM&M	OM&M & Reporting
Detention Basins: Overflow	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	4	OM&M	OM&M	OM&M & Reporting
Detention Basins: Semi-Batch (Hold & Release)	District 12 SR73 Pilot Program	SR73, San Diego, D-12	4	OM&M	OM&M	OM&M & Reporting
Detention Basins: Surface Drained (Floating Skimmer Outlet)	District 12 SR73 Pilot Program	SR73, San Diego, D-12	4	OM&M	OM&M	OM&M & Reporting
Detention Basins: Alternative Inlet (Linear Radial Configuration 1, Basin 1076R)	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	1	None (Study Complete)	None (Study Complete)	None (Study Complete)
Detention Basins: Alternative Inlet (Linear Radial Configuration 1, Basin 1081L)	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	2	None (Study Complete)	None (Study Complete)	None (Study Complete)
Detention Basins: Alternative Inlet (V-screen Configuration 1)	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	1	None (Study Complete)	None (Study Complete)	None (Study Complete)

Technology	Pilot Program	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
				2007/08	2008/09	2009/10
Detention Basins: Alternative Inlet (Inclined Screen Configuration 3)	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	1	None (Study Complete)	None (Study Complete)	None (Study Complete)
Detention Basins: Particle-Based Pollutant Removal BMPs	UC-Davis Studies	UC-Davis Laboratory	NA	Lab Testing	Lab Testing & Reporting	Plan & Implement Subsequent Phases
Detention Basins: Semi-Batch (Hold & Release)	District 3 – Semi-Batch Detention Basins	SR267, Lahontan, D-3	4	OM	OM	OM & Reporting
Drain Inlet Inserts	Drain Inlet Inserts	Sacramento State University Campus	4	Reporting	Implement Subsequent Phases	Implement Subsequent Phases
GSRDs: IS5 (Inclined Screen Configuration 5)	District 7 GSRD Pilot Program	I-210/Orcas, Los Angeles, D-7	1	OM&M	OM&M & Reporting	None (Study Complete)
GSRDs: IS5 (Inclined Screen Configuration 5)	District 7 GSRD Pilot Program	I-210/Filmore, Los Angeles, D-7	1	OM&M	OM&M & Reporting	None (Study Complete)
GSRDs: IS5 (Inclined Screen Configuration 5)	District 7 GSRD Pilot Program	SR91/Cerritos, Los Angeles, D-7	1	OM&M	OM&M & Reporting	None (Study Complete)
GSRDs: VS1 (Forward Sloping V Screen Configuration 1)	District 7 GSRD Pilot Program	I-405/Leadwall, Los Angeles, D-7	1	OM	OM & Reporting	None (Study Complete)
GSRDs: LR3 (Steep-Slope Linear Radial Device Configuration 3)	District 7 GSRD Pilot Program	I -101/Gaviota, Los Angeles, D-7	1	OM	OM & Reporting	None (Study Complete)
GSRDs: IS5 (Inclined Screen Configuration 5)	District 12 SR73 Pilot Program	SR73, San Diego, D-12	1	OM&M	None (Study Complete)	Reporting

Technology	Pilot Program	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
				2007/08	2008/09	2009/10
GSRDs: Continuous Deflection Separators	District 11 Continuous Deflection Separators	SR56/Carmel Creek Road and Carmel County Road, San Diego, D-11	2	None (Study Complete)	None (Study Complete)	None (Study Complete)
GSRDs: Laboratory Testing	UC-Davis Studies	UC-Davis Hydraulics Lab	3	Testing & Reporting	TBD	None (Study Complete)
Infiltration: Infiltration Basin Model – Effects on Soil & Groundwater	UC-Davis Studies	UC-Davis Laboratory	NA	Reporting	None (Study Complete)	None (Study Complete)
Infiltration: Alternative Infiltration Trench Structures	Alternative Infiltration Trench Structures	TBD	4	Site Selection, Design & Construct	OM&M	OM&M
Filtration: Sand Filters (Fine Sand)	Tahoe Basin Small-Scale Pilot Studies	Meyers Maintenance Station, Lahontan, D-3	2	Reporting	None (Study Complete)	None (Study Complete)
Filtration: Low Cost Adsorbent Materials	UC-Davis Studies	UC-Davis	1	TBD	TBD	TBD
Filtration: Sand Filters	District 12 SR73 Pilot Program	SR73, Santa Ana, D-12	2	OM&M	OM&M	OM&M & Reporting
Filtration: Linear Filtration Trenches	Linear Filtration Trenches	I-5, Central Valley, D-3	7	Design & Construct	OM&M	OM&M
Filtration: Linear Filtration Trenches	Linear Filtration Trenches	I-210, Los Angeles, D-7	7	Design & Construct	OM&M	OM&M
Filtration: Alternative Media Filters	Tahoe Basin Small-Scale Pilot Studies	South Lake Tahoe Maintenance Station	Varies	OM&M & Reporting	None (Study Complete)	None (Study Complete)
Filtration: Alternative Media Filters	Tahoe Basin Full-Scale Pilot Studies	Hwy 50, Lahontan, D-3	2	OM&M	TBD	TBD
Filtration: Alternative Media Filters	Tahoe Basin Full-Scale Pilot Studies	SR267, Lahontan, D-3	6	OM&M	OM&M	OM&M & Reporting

Technology	Pilot Program	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
				2007/08	2008/09	2009/10
Vegetated Treatment Systems: RVTS	RVTS Study	I-5/Sacramento, Central Valley, D-3	4	OM&M	TBD	TBD
Vegetated Treatment Systems: RVTS	RVTS Study	I-5/Cottonwood, Central Valley, D-2	1	None (Study Complete)	None (Study Complete)	None (Study Complete)
Vegetated Treatment Systems: RVTS	RVTS Study	SR299/Redding, Central Valley, D-2	3	OM&M	TBD	TBD
Vegetated Treatment Systems: RVTS	RVTS Study	SR101/San Rafael, San Francisco Bay, D-4	1	None (Study Complete)	None (Study Complete)	None (Study Complete)
Vegetated Treatment Systems: RVTS	RVTS Study	SR91/Yorba Linda, Santa Ana, D-12	4	OM&M	TBD	TBD
Vegetated Treatment Systems: RVTS	RVTS Study	I-405/Irvine, Santa Ana, D-12	3	None (Study Complete)	None (Study Complete)	None (Study Complete)
Vegetated Treatment Systems: RVTS	RVTS Study	SR60/Moreno Valley I, Santa Ana, D-8	4	None (Study Complete)	None (Study Complete)	None (Study Complete)
Vegetated Treatment Systems: RVTS	RVTS Study	I-5/San Onofre, San Diego, D-11	3	OM&M	TBD	TBD
Vegetated Treatment Systems: RVTS	RVTS Study	I-15/Murietta, San Diego, D-11	4	OM&M	OM&M	OM&M & Reporting
Vegetated Treatment Systems: RVTS	RVTS Study	I-215/Moreno Valley II, Santa Ana, D-8	4	OM&M	OM&M	OM&M & Reporting
Vegetated Treatment Systems: ERVTS	Ornamental RVTS Study	I-5/Sacramento, Central Valley, D-3	4	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: ERVTS	Ornamental RVTS Study	SR299/Redding, Central Valley, D-2	4	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: ERVTS	Ornamental RVTS Study	SR91/Yorba Linda, Santa Ana, D-12	4	Design & Construct	OM&M	OM&M

Technology	Pilot Program	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
				2007/08	2008/09	2009/10
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	SR680/Milpitas, San Francisco Bay, D-4	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	SR280/San Francisco, San Francisco Bay, D-4	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	TBD, San Francisco Bay, D-4	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	SR299/Santa Rosa, San Francisco Bay, D-4	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	SR101/San Louis Obispo, Central Coast, D-5	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	SR101/Arroyo Grande, Central Coast, D-5	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	SR 101/Camarillo I, Los Angeles, D-7	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	SR 101/Camarillo II, Los Angeles, D-7	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Swale	Ornamental RVTS Study	SR 101/Newbury Park, Los Angeles, D-7	1	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	I-5/San Diego, San Diego, D-11	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Strip	Ornamental RVTS Study	TBD, San Diego, D-11	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Swale	Ornamental RVTS Study	I-5/Carlsbad, San Diego, D-11	1	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: GRVTS Swale	Ornamental RVTS Study	I-405/Midway City, San Diego, D-12	2	Design & Construct	OM&M	OM&M
Vegetated Treatment Systems: Bioswale	District 7 Bioswale Retrofit	I-5/I-605, Los Angeles, D-7	1	OM&M	TBD	TBD
Vector Studies	Vector Studies	SR73, Santa Ana & San Diego, D-12	23	OM&M	OM&M & Reporting	None (Study Complete)

Technology	Pilot Program	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
				2007/08	2008/09	2009/10
Vector Studies	Vector Studies	Hwy 89/NLT, Lahontan, D-3	22	Reporting	None (Study Complete)	None (Study Complete)
Vector Studies	Vector Studies	Hwy 28/NLT, Lahontan, D-3	8	Reporting	None (Study Complete)	None (Study Complete)
Vector Studies	Vector Studies	Hwy 50/SLT, Lahontan, D-3	5	None (Study Complete)	None (Study Complete)	None (Study Complete)
Vector Studies	Vector Studies	Various locations Statewide	NA	OM&M	None (Study Complete)	None (Study Complete)
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	Hwy 101, Central Coast, D-5	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	Hwy 128, North Coast D-1	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	Hwy 101, North Coast D-1	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	Hwy 41, Central Coast, D-5	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	I-5, Central Valley, D-2	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	I-5, Central Valley, D-2	1	Design, Construct & OM&M	OM&M	OM&M & Reporting

Technology	Pilot Program	Location (Route or Facility, RWQCB, District)	No. of Pilots	Scheduled Activities		
				2007/08	2008/09	2009/10
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	Hwy 70, Central Valley, D-3	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	I-80, Central Valley, D-3 & D-4	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	I-5, Central Coast, D-10	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	Hwy 140, Central Coast, D-10	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Open Graded Asphalt Pavement	Open Graded Asphalt Pavement	Hwy 99, Central Valley, D-6	1	Design, Construct & OM&M	OM&M	OM&M & Reporting
Inclined Plate and Tube Settlers	Inclined Plate and Tube Settlers	UC-Davis Laboratory	NA	Testing	Testing	Reporting

GSRD: Gross Solids Removal Device; SR: State Route; TBD: To be determined; OM&M: Operation, Maintenance and Monitoring (include water quality monitoring); OM: Operational monitoring only (plant establishment, flow rates, clogging etc.; does not include water quality monitoring); RVTS: Roadside Vegetated Treatment Site; GRVTS: Groundcover Roadside Vegetated Treatment Site; ERVTS: Expanded Roadside Vegetated Treatment Site

This section provides a brief summary and status of source control reconnaissance studies and ongoing pilot studies conducted by the Department during FY 2006/07.

3.1 PREVIOUS STUDIES

Results from reports completed during FY 2006/07 are summarized throughout Section 3. Results of source control studies completed prior to July 1, 2007 are summarized in the following reports:

Department Document No.	Document Title
CTSW-RT-00-012	District 7 Erosion Control Pilot Study. June 2000.
CTSW-RT-01-066	Temporary Non-Vegetative Soil Stabilization Evaluation Study for 2000-01 Season. October 2001.
CTSW-RT-01-067	Statewide Erosion Control Review. February 2002.
CTSW-RT-02-035	Caltrans Hydraulic Application Study. June 2002.
CTSW-RT-03-049	Erosion Control New Technology Report. June 2003.
CTSW-RT-04-070.01.1	The Use of Mycorrhizal Fungi in Erosion Control Applications Final Report. June 2004. http://www.dot.ca.gov/hq/LandArch/research_new/docs/final_report_65A070.pdf

3.2 LITERATURE SEARCHES AND RECONNAISSANCE STUDIES

Initial BMP selection is based on information gathered from various sources, including literature searches. The Department assesses new practices and products with the following possible outcomes: where sufficient information exists, designate a specific practice or product; for promising technologies, commission pilot studies to determine the effectiveness and applicability to conditions at the Department's facilities; or reject practices and products that do not achieve desired results or do not meet the Department's criteria.

A large part of the Department's source control efforts focus on erosion control. Erosion control effectiveness is the ability of the BMP to reduce soil erosion relative to the amount of erosion measured from the bare soil. Full details on the process of selection and evaluation of erosion control BMPs are given in the Department's Erosion Control New Technology Report, June 2003 (CTSW-RT-03-049).

No reconnaissance studies on erosion control were completed in FY 2006/07.

3.3 ROADSIDE EROSION CONTROL AND MANAGEMENT STUDY (RECM, FORMERLY VEGETATION ESTABLISHMNET AND MANAGEMENT STUDY [VEMS])

Objectives

The purpose of this study is to develop guidance for effective establishment and maintenance of erosion control vegetation for short-term first growth and for long-term establishment. The vegetation examined in this study will include both native and non-native species and groundcovers. The Department will use the results of this study in an effort to decrease erosion and thereby improve water quality. There is a need to address both vegetation establishment and regular maintenance needs, including time of year for planting, plant selection, soil stabilization, and vegetation needs throughout the lifecycle. Performance criteria include stabilization within 30 days and mature, stable vegetation in one to three years.

This study will identify vegetation, which is both fast establishing and demonstrates long-term effectiveness in preventing erosion using established overland flow and rainfall simulators to simulate storm patterns in various Department districts. This study also incorporates the development of a GIS-based guide, TransPlant, which will assist in the selection of vegetative seed species for use in specific areas and climates to increase successful revegetation efforts on highway slopes. A guide has been established for District 5, representing the California Central Coast. Future plans include generating guides for remaining districts to assist in the selection of vegetation for roadside stabilization.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
Cal Poly Campus	1	Testing ongoing.

Findings/Conclusions

Detailed results have been reported for eight primary experiments and three secondary experiments. Based on statistical analyses of water quality and vegetation response variables, the following patterns are evident. Reapplied topsoil typically contains quantities and densities of seed sufficient to produce over 70 percent vegetation cover within the first growing season. However, soils obtained from coastal and interior valley locations typically contain high quantities of alien annual grasses and forbs. Topical fine-textured biosolids and plant materials alone or mixed with the type of fine-textured wood fiber typically applied as a hydromulch performed better overall for erosion control and seedling germination. A 2-inch layer of compost significantly reduced germination and cover produced by naturalized alien species, and significantly increased germination of native seeded species. Considering combined effects on runoff, sediment concentration, and vegetation production, jute-over-compost seems to be the

best erosion control treatment over all soil types tested. The most-important factor in hydroseeding is whether seed of burial-intolerant species is positioned properly on top of whatever compost or fiber is applied beneath. Flats at the top and toe of a slope, with jute netting and seed over compost, resulted in nearly no sediment loss at all (0.2g) after simulation of a 50-year storm event. Flats effectively preclude seed germination in the soil below, and effectively resist weed invasion from seed rain onto vegetation covering flats. Commercial fertilizers generally produced more plant cover (compared to control plots that were seeded and not fertilized), but more of the cover produced was naturalized alien annual grass, not native species in the seed mix, which tended to increase erosion. Analysis of leaf-succulents or shrubs like those typically used by the Department for ornamental ground cover was placed under rainfall simulators to represent landscaped roadsides. All ornamental ground cover tested at either 20 percent cover with 80 percent jute netting upslope, or 100 percent groundcover reduced sediment yield by 90 percent or more compared to bare soil. There was no significant difference in erosion between plant cultivars tested. At this coverage, the species type was not significant, only the percent cover. Ornamentals were greater in coverage than native grasses as explained above. Cultivars with prostrate branches and many leaves at the surface provide greater filtration than plants with arching branches that leave soil areas uncovered and vulnerable to overland flow.

Available Documents

Department Document No.	Document Title
CTSW-RT-02-052	Rainfall Simulation: Evaluating Hydroseeding and Plug Planting Technologies for Erosion Control and Improved Water Quality. September 2002.
CTSW-RT-04-069.06.1	Performance of Erosion Control Treatments on Reapplied Topsoil. May 2005.
CTSW-RT-05-069.06.2	Native Shrub Germination Relative to Compost Type, Application Method, and Layer Depth. July 2005.
CTSW-RT-06-167.01.1	RECMS Annual Report June 2005 through May 2006. May 2006.
CTSW-RT-06-167.01.2	Legume Seed Inoculation for Highway Planting in California. July 2006.
CTSW-RT-07-167-01-4	Runoff Water Quality Relative to Groundcover Treatments Under Simulated Rainfall. July 2007.

3-Year Action Plan

Overview of Approach

Using the TransPlant Model parameters, rainfall simulations will be run to develop baseline conditions. The TransPlant Model is being developed and expanded for incorporation to all Department districts. Baseline findings will be applied to develop a testing strategy for

vegetation establishment in other Department districts. A "lab" component will be developed to quantify runoff and sediment from overland flow onto various groundcovers, grasses, or bare soil. A final report will be developed to summarize and evaluate data collected at each site.

Product or Deliverables

- District guidelines
- Final report

Schedule

- 2007/08 – Develop district-level guidelines for the Department's other districts as appropriate. Conduct monitoring and document activities and results in post-storm technical memoranda.
- 2008/09 – Evaluate groundcovers typically used by Caltrans in both rainfall simulators and overland flow versus bare ground. Prepare final report.
- 2009/10 – None (study to be completed during 2007/08 season).

3.4 SOIL RESOURCE EVALUATION PROCESS (SRE)

3.4.1 Soil Resource Evaluation Process- 1 (SRE-1)

Objectives

The rationale for the first phase of this intensive, soil-focused program was that while plants provide excellent erosion control, they often cannot grow or survive on the harsh sites that are created after roadway construction. The sites remain sparsely vegetated for decades and many are chronically erosive. Regeneration of soil resources helps infiltrate rainfall during storm events, and it facilitates plant growth that provides erosion protection for the soil surface. Decreased overland flow and a reduction in sediment yield are overall goals of soil regeneration on harsh, drastically disturbed sites. Another goal includes establishment of a sustainable revegetation cover.

This study created a site evaluation tool that presents revegetation recommendations for large projects. The tool assists landscape architects, civil engineers, and material engineers in assessing soil characteristics that affect revegetation. The tool guides the user through a seven-step process to evaluate a project site. The tool generates revegetation recommendations based on the information from other erosion control studies. The user inputs site characteristics that may affect revegetation success. Based on the input, the tool offers several options that may correct deficiencies for plant establishment. The tool has statewide applicability for projects large enough and harsh enough to benefit from a more thorough and systematic evaluation.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
HWY 101/ Willits, North Coast, D-1	1	Complete.
SR 299-Buckhorn summit, Central Valley, D-2	1	Complete.
I-80/near Blue Canyon, Central Valley, D-3	1	Complete.

Findings/Conclusions

A system of soil/substrate evaluation for harsh, barren field sites was developed. Vigorous revegetation was established on barren, erosive field sites on decomposed granite, coast range sandstone or clay, serpentine and lahar (welded volcanic flows). From this study, the main limits to plant growth were identified to be lack of plant-available water and long-term nitrogen. Primary findings were that incorporation of yard-waste compost increased infiltration, increased plant available water, increased plant available nitrogen and decreased runoff volume. Findings from this project were organized into a computer-based expert system that provides soil and revegetation information for easy access by Caltrans personnel responsible for preparing erosion control specifications and construction design.

This SRE system is compiled into a computer-based expert system that is available on-line at:

http://www.dot.ca.gov/hq/LandArch/research/es_site_0522/index.html.

Available Documents

Department Document No.	Document Title
Not Applicable (see website listed above)	Soil Resource Evaluation. January 2007.

3-Year Action Plan

Overview of Approach

A one page flow chart linked to an interactive CD will be developed, and more data will be added. Related training for the end users will be developed and provided, and a final report will be prepared.

Product or Deliverables

- Flow chart

- Final report

Schedule

- 2007/08 – Complete flow chart, provide training, and develop final report.
- 2008/09 – None (project to be completed during 2007/08 season).
- 2009/10 – None (project to be completed during 2007/08 season).

3.4.2 Soil Resource Evaluation Process- 2 (SRE-2)

Objectives

This research extends the SRE-1 process to additional Caltrans sites that pose difficult erosion or re-vegetation problems. Studies will evaluate the effectiveness of SRE-1 by developing constructible practices for two full-scale re-vegetation pilot projects on harsh, barren, erosive sites in California. The objective of this research is to assist the Department in achieving the target re-vegetation criterion by integrating soil amendments and treatments with appropriate re-vegetation application methods.

This research will demonstrate and evaluate use of the SRE system on two eroding field sites, identify growth limiting conditions, determine appropriate treatments, develop constructible methods or recommendations for specifications, and evaluate effectiveness through plant response monitoring. Chemical and physical characteristics of soil organic matter on disturbed-but-re-vegetated reference substrates will be studied to establish target values for amendment of soil organics on degraded substrates. Moisture characteristics (infiltration, water content and release) of degraded substrates will be assessed with and without amendments or stabilized soil organic matter or soil aggregates.

Study results will guide specification of amendments and construction methods for improved re-vegetation. Data from all sites, along with other relevant references, shall be summarized as additional examples and entered into the SRE system to be used with planning and design of future erosion control projects.

The final product shall identify target rates for the selected sites that can be used by Caltrans to set standard levels for nitrogen and organic matter specifications for compost or soil amendments. Data on infiltration rates as influenced by organic matter or aggregate treatments will be used to provide recommendations for how to improve use and specification of soil amendments (rate and type of soil amendment), plant materials and construction methods in order to increase soil infiltration. Recommendations will be made for changes in the Caltrans Erosion Control (Type D) Standard Special Provision (SSP) 20-040 in the 2006 Caltrans Standard Special Provisions.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
SR 395/ Conway, Lahontan, D-9	1	Site selection ongoing.
SR 20/ Lake County, Central Valley, D-1	1	Site selection ongoing.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None available at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Field construction will be completed and monitoring and analysis will begin during the 2007/08 wet season. A final report will be prepared.

Product or Deliverables

- Final report

Schedule

- 2007/08 – Complete construction, and conduct monitoring and analysis.
- 2008/09 – Prepare final report.
- 2009/10 – None (project to be completed during 2008/09 season).

3.5 MYCORRHIZAL FUNGI STUDIES

3.5.1 Use of Native Plants and Mycorrhizal Fungi for Slope Stabilization

Objectives

This research extends a previous study (see Use of Mycorrhizal Fungi in Erosion Control Applications, June 2004 listed in Section 3.1 of this status report), with field experiments that will determine best practices for mycorrhizal fungi inocula application and viability under standard topsoil stockpiling conditions. The previous study demonstrated the strong potential of achieving improved ecosystem function by targeting key soil microbes. Sustainable long-term gains in soil stability and vegetative cover could be achieved through appropriate inoculations. Testing this hypothesis requires experimental work under site conditions representative of those likely to be encountered by the Department.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
Indiana University/Devils Slide Greenhouse Experiment, San Francisco Bay, D-4	1	Data analysis ongoing.
SR 1/ Devils Slide Field Experiment, San Francisco Bay, D-4	1	Data analysis ongoing.
SR 154/Los Olivos Cut and Fill Field Experiment, Central Coast, D-5	1	Installation and maintenance ongoing.

Findings/Conclusions

In a two-year field study using permanent reference plots and salvaged topsoil from a native coastal sage/scrub habitat in San Mateo County California, aggregate stability declined and bulk density decreased under test conditions. Live and sterile forms of a commercially available soil inoculant containing arbuscular mycorrhizal fungi (AMF) and a soil erosion seed mix were set as levels within a two-way restoration experiment consisting of 20 stockpiles (each 6 m^3) of sandy loam topsoil. Results suggest topsoil can be managed successfully to influence its physical condition during storage, and that the growth dynamics of the restored community can depend on how the topsoil is managed during storage.

Using three soil loss estimates, the addition of live mycorrhizal fungi generally reduce the amount of soil loss from the test plots. The native site-specific inoculum yielded the least sediment throughout the season as determined by percent cover of sediment washed into each

flared end section. The multivariate analysis of variance (MANOVA) on these repeated measures also reveals a significant effect of application method, with the hydromulched application yielding much less soil early in the season. Total sediment mass also exhibited beneficial effects of live mycorrhizal fungi, but these effects were not as strong as the effects observed using percent cover of sediment, and differences between the commercial product and the native culture were not significant. The hydromulched application yielded significantly less sediment than the dry application, strongly suggesting that superior erosion control benefits can be achieved via this method of application. Plant productivity and water yield differences were not significant among replicates This suggests that the variability is being driven by the treatments.

Available Documents

None available at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Data will be assessed for mycorrhizal inoculation and application methods. Fungi viability under standard topsoil stock piling conditions is also being studied. A final report will be developed.

Product or Deliverables

- Final report

Schedule

- 2007/08 – Analyze data and prepare final report.
- 2008/09 – None (project to be completed by end of 2007/08 season).
- 2009/10 – None (project to be completed by end of 2007/08 season).

3.6 ARID REGION NON-VEGETATIVE PERMANENT EROSION CONTROL STUDY

Objectives

The objective of this study is to evaluate the performance of non-vegetative permanent soil stabilizers for reducing soil erosion, and the potential impact of these products on stormwater quality. The Department has identified the need to assess the potential impact of permanent erosion control measures upon stormwater quality. Although numerous products exist for use, the technologies have not necessarily been analyzed by the manufacturer for constituent release (including sediment) into stormwater. The studies are designed to identify and quantify (if possible) the effect of permanent erosion control materials on stormwater.

The following products were selected for this study:

- Soil Master WRTM-Acrylic polymer soil stabilizer
- PolyPavement- Polymer soil stabilizer
- Rock Blanket - Smooth Rock of screen size 8-14" and Class II portland cement
- Soil Tac- Polymer soil stabilizer
- Soil Cement - A mixture of native soil, Class I and II portland cement and water

A previous study included development of a study plan for non-vegetative erosion control in arid regions (CTSW-RT-02-038), and included a literature review, detailed experimental design, and siting. This Arid Region Non-Vegetative Permanent Erosion Control Study included review of the previous study plan and design, for incorporation and improvement.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
I-15/SR 58 – Barstow, Lahontan, D-8	1	Design, 100% complete. Construction to begin February 2008.
SR 58/Hinckley, Lahontan, D-8	1	Design, 100% complete. Construction to begin February 2008.
I-8/Dunaway Rd., Colorado River, D-11	1	Design, 100% complete. Construction to begin February 2008.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-02-038	Caltrans Arid Region Non-Vegetative Erosion Control Study Plan and Experimental Design Review Memo. July 2002.

3-Year Action Plan

Overview of Approach

Activities associated with this task include construction of test plots within each study site, application of a selected erosion control product to each test plot, and installation of sampling equipment to monitoring stormwater runoff from each plot. The monitoring effort will evaluate the potential impact (if any) tested products have on stormwater quality.

Product or Deliverables

- Final report

Schedule

- 2007/08 – Construct stations and conduct monitoring.
- 2008/09 – Conduct monitoring.
- 2009/10 – Develop final report.

3.7 ICE SLICER

Objectives

The purpose of this study is to characterize the quality of stormwater runoff from Department roadways where the deicer, IceSlicer®, has been applied. Reported advantages to using Iceslicer® include: reduced environmental impact and increased cost savings because of reduction in amount of solids applied to the roadways, reduction in airborne particulates, and easier application to roadways.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
SR 28, Lahontan, D-3	1	Monitoring complete
Hwy 50, Lahontan, D-3	1	Monitoring complete
I-80, Central Valley, Lahontan, D-3	1	Site selection underway.

Findings/Conclusions

There is low confidence in the data collected to date due to questionable recording keeping, as well as observed differences in site characteristics (climate, elevation, traffic rate, etc.) between the test site and the control site. The Department is therefore planning to select new sites for the study, where the test and control sites are adjacent to each other to minimize potential differences from varying site characteristics. The Department is also coordinating with District 3 to improve the record keeping and application practices.

Available Documents

Department Document No.	Document Title
CTSW-RT-06-157.14.1	Caltrans Iceslicer® Alternative Deicing Agent Project 2004-2005 Interim Report. October 2006.

3-Year Action Plan

Overview of Approach

Select and construct new test and control sites on I-80. Conduct monitoring for at least two wet seasons. Develop interim and final reports.

Product or Deliverables

- Site Selection Technical Memorandum
- Interim report
- Final report

Schedule

- 2007/08 – Select sites, install monitoring equipment, begin monitoring, and develop interim report.
- 2008/09 – Continue monitoring. Develop final report.
- 2009/10 – None (study to be complete during 2008/09).

3.8 TEMPORARY EROSION CONTROL STUDY

Objectives

The Department successfully employs many temporary soil stabilization measures for construction sites. However, challenges persist in complying with construction site requirements. One issue that may limit the practices being used is that some products may have negative impacts on water quality, such as toxicity. The Department has begun to explore the effects of soil stabilization measures on stormwater quality by performing erosion control studies that also evaluate stormwater quality. One such study was the Temporary Non-Vegetative Soil Stabilization Evaluation Study completed in 2001 (CTSW-RT-01-066). The study included testing several temporary non-vegetative soil control erosion products in the field and over one wet season. The purpose was to assess the potential impacts these products had on stormwater runoff quality and their performance on reducing soil erosion. The report concluded that there were elevated levels of total metals, and organics attributed to product-related export in the stormwater runoff. The study, however, only evaluated seven products on one soil type. This

information was incorporated into the Caltrans Construction monitoring program where non-visible stormwater pollutant monitoring is required by permit when using temporary erosion control products. Monitoring can be avoided if information on the stormwater quality effect can be documented. The research questions still remaining are: What are the water quality effects of other temporary products not tested previously by Caltrans? Can research be done to document more products where findings could be used instead of construction site monitoring? Are products equally effective on various types of soils? What is the breaking point for these products, or how intense a storm can they withstand? How long do these products stay effective in the field?

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
Cal Poly Campus	1	Laboratory testing to begin 2008.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-07-0171.04	Temporary Non-Vegetative Soil Stabilization Study Plan Technical Memorandum. July 2007.

3-Year Action Plan

Overview of Approach

A "lab" component will be developed to quantify runoff and sediment from temporary soil stabilizers onto various groundcovers, grasses, or bare soil. A final report will be developed to summarize and evaluate data collected.

Product or Deliverables

- Final report

Schedule

- 2007/08 – Develop testing plan and perform testing.
- 2008/09 – Develop testing plan and perform testing.
- 2008/09 – Develop testing plan and perform testing.

3.9 EVALUATION OF EROSION CONTROL TEST TRIALS IN LAKE TAHOE

Objectives

The purpose of this study is to identify treatments that improve erosion control/revegetation results. This study will evaluate vegetative cover (perennial versus annual and native versus exotic), water infiltration, soil nutrients, organic matter, surface mulches and rainfall simulations. Evaluations will be performed at treatment areas, reference areas (native undisturbed areas), and at control areas (standard Caltrans Erosion Control Type D-surface treatments). Evaluations will compare treatments and materials at various locations in the Tahoe Basin. The Department will use the results of this study in an effort to improve revegetation success, decrease erosion and thereby improve water quality.

Quantitative evaluations are needed to identify treatments, materials, and methods that improve erosion control and revegetation results and long term monitoring is necessary to accomplish this. In many cases, data from the first three years of monitoring are not adequate to evaluate success. The Department is therefore continuing soil-based erosion control and revegetation monitoring. This monitoring will fulfills many of our regulatory permit monitoring. The final product from this work will be recommendations for modifying existing specifications or creating new specification for improving erosion control and revegetation results and meeting regulatory requirements.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
SR 267/Brockway Summit fill slopes, Lahontan, D-3	1	Monitor and develop final report in 2007/08.
SR 267/Brockway Summit erosion control project, Lahontan, D-3	1	Monitor and develop final report in 2007/08.
SR 50/Meyers Airport, Lahontan D-3	1	Monitor and develop final report in 2007/08.
SR 267/Truckee Bypass, Lahontan, D-3	1	Monitor and develop final report in 2007/08.
Heavenly Resort, Lahontan, D-3	1	Monitor and develop final report in 2007/08.
SR 267 Northstar, Lahontan, D-3	1	Monitor and develop final report in 2007/08.
Squaw Creek Resort, Lahontan, D-3	1	Monitor and develop final report in 2007/08.
SR 89/Experimental Box Trials, Lahontan, D-3	1	Monitor and develop final report in 2007/08.

Findings/Conclusions

2006 results indicate that erosion control/revegetation methods which loosened the soil to at least 12 inches and incorporated coarse organic material to that depth had the greatest increase in on-site infiltration, the largest decrease in sediment yield, and the highest cover by native perennial bunch grasses, when compared to surface treatments on cut and fill slopes. The results from 2.8 in/hr and 4.7 in/hr rainfall simulations (simulated storm events that are greater than the Tahoe 20-year, one-hour storm) on tilled, composted and mulched trials indicate that there was no runoff or sediment yield at either of these storm levels. The maximum infiltration rate is unknown. For surface treatment trials under the same simulated storm events, infiltration rates of 2.3 in/hour and a sediment yield of 407 lbs/acre/inch were measured. Tilled, composted, and mulched trials provided source control, while the surface treatments did not.

Incorporation of treatments with coarse organic material improve the soil growing conditions for long term vegetation establishment by improving infiltration, reducing runoff/sediment, providing rooting depth, improving nutrient and organic matter content, and improving watering holding capacity and water availability.

Available Documents

Department Document No.	Document Title
CTSW-RT-02-052	Rainfall Simulation: Evaluating Hydroseeding and Plug Planting Technologies for Erosion Control and Improved Water Quality. September 2002.
CTSW-RT-04-069.06.1	Performance of Erosion Control Treatments on Reapplied Topsoil. May 2005.
CTSW-RT-05-069.06.2	Native Shrub Germination Relative to Compost Type, Application Method, and Layer Depth. July 2005.
CTSW-RT-06-167.01.1	RECMS Annual Report June 2005 through May 2006. May 2006.
CTSW-RT-06-167.01.2	Legume Seed Inoculation for Highway Planting in California. July 2006.

3-Year Action Plan

Overview of Approach

Continue monitoring and develop final report with recommendation for improvements.

Product or Deliverables

- Final report

Schedule

- 2007/08 – Monitor, analyze, and develop final report.
- 2008/09 – None (study to be complete during 2007/08).
- 2009/10 – None (study to be complete during 2007/08).

3.10 EFFECT OF HIGHWAY 50 DE-ICING ALTERNATIVES ON AEROSOLS AT LAKE TAHOE

Objectives

The purpose of this study is to provide an evaluation of the relative impact of alternative atni-icing and de-icing protocols on both air quality and Lake Tahoe water clarity on a section of Highway 50 in South Lake Tahoe. The data will be compared to summer dust from diverse sources, many non-highway, for comparative impact. The data will be used to perform lake deposition and transport modeling through the United States Forest Service (USFS)-developed and field-validated Lake Tahoe Airshed Model (LTAM).

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
Hwy 50, Lahontan, D-3	2	Final Report completed. Developing proposal to better estimate the influence of Department operations on Lake Tahoe and the Basin 9/2007.

Findings/Conclusions

- Little difference was seen in phosphorus aerosols between 2003/04 (sand and salt applications) and 2004/05 (Ice Slicer ™ applications). Soils were actually somewhat larger in 2004/05 than 2003/04 in similar weather conditions.
- A major reduction in phosphorus, by a factor of four, was seen in phosphorus aerosols between 2001/02 and either of the latter years.
- The aerosols directly connected with Highway 50 were predominantly in sizes above 10 μm.
- The largest episodes of phosphorus and soil aerosols occurred several days after sanding and salting activities, generally when temperatures exceeded 40 ^{o} F.
- Summer aerosols in the basin are largely transported from upwind sources except for sites very close to Highway 50 where very coarse particles persist.

- Estimates of phosphorus deposition into Lake Tahoe from Department operations are highly uncertain due to lack of any equivalent data on the phosphorus rich volcanic soils in the northern end of the basin.

Available Documents

Department Document No.	Document Title
Document No. not assigned	Aerosol Generation before and after Ice-Slicer™ Applications to Highway 50 at South Lake Tahoe. November 2006.

3-Year Action Plan

Overview of Approach

Evaluate current proposal for extension of the measurement of impacts of Department operations on Lake Tahoe water quality and the Lake Tahoe Air Basin.

Product or Deliverables

- None identified at this time.

Schedule

- 2007/08 - Develop plan for further monitoring/evaluations of District 3 issues relating to de-icing and particulate matter (PM) aerosols, or specific issues (PM and Phosphorus) within the Lake Tahoe Basin.
- 2008/09 – Conduct studies as needed based on 2007/08 reassessment.
- 2009/10 – Conduct studies as needed based on 2007/08 reassessment.

3.11 3-YEAR ACTION PLAN SUMMARY

The 3-year plans for the new and continuing studies are summarized in Table 3.1 below.

Table 3-1. Summary of 3-Year Schedule for Source Control Studies

Source Control Study	Location (Route or Facility, RWQCB, District)	No. of Sites	Scheduled Activities		
			2006/07	2007/08	2008/09
RECM	Cal Poly Campus	1	OM&M	Reporting	None (Study Complete)

Source Control Study	Location (Route or Facility, RWQCB, District)	No. of Sites	Scheduled Activities		
			2006/07	2007/08	2008/09
SRE-1	HWY 101/ Willits, North Coast, D-1	1	Reporting	None (Study Complete)	None (Study Complete)
SRE-1	SR 299-Buckhorn summit, Central Valley, D-2	1	Reporting	None (Study Complete)	None (Study Complete)
SRE-1	I-80/near Blue Canyon, Central Valley, D-3	1	Reporting	None (Study Complete)	None (Study Complete)
SRE-2	SR 395/Conway, Lahontan, D-9	1	Design, Construct & OM&M	Reporting	None (Study Complete)
SRE-2	SR 20/Lake County, Central Valley, D-1	1	Design, Construct & OM&M	Reporting	None (Study Complete)
Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization	Indiana University/Devils Slide Greenhouse Experiment, San Francisco Bay, D-4	1	Reporting	None (Study Complete)	None (Study Complete)
Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization	SR 1/Devils Slide Field Experiment, San Francisco Bay, D-4	1	Reporting	None (Study Complete)	None (Study Complete)
Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization	SR 154/Los Olivos Cut and Fill Field Experiment, Central Coast, D-5	1	Reporting	None (Study Complete)	None (Study Complete)
Arid Region Non-Vegetative Permanent Erosion Control Study	I-15/SR 58 – Barstow, Lahontan, D-8	1	Construct	OM&M	Reporting
Arid Region Non-Vegetative Permanent Erosion Control Study	SR 58/Hinckley, Lahontan, D-8	1	Construct	OM&M	Reporting
Arid Region Non-Vegetative Permanent Erosion Control Study	I-8/Dunaway Rd., Colorado River, D-11	1	Construct	OM&M	Reporting
Ice Slicer	SR 28, Lahontan, D-3	1	None (Study Complete)	None (Study Complete)	None (Study Complete)
Ice Slicer	Hwy 50, Lahontan, D-3	1	None (Study Complete)	None (Study Complete)	None (Study Complete)
Ice Slicer	I-80/TBD, Central Valley, D-3	1	Design & Construct	OM&M	None (Study Complete)
Temporary Erosion Control Study	Cal Poly Campus	1	Testing	Testing	Testing

Source Control Study	Location (Route or Facility, RWQCB, District)	No. of Sites	Scheduled Activities		
			2006/07	2007/08	2008/09
Evaluation of Erosion Control Test Trials in Lake Tahoe	Tahoe Basin (See Section 3.9 for site details)	8	OM&M & Reporting	None (Study Complete)	None (Study Complete)
Effect of Highway 50 De-Icing Alternatives on Aerosols at Lake Tahoe	Hwy 50, Lahontan, District 3	2	TBD	TBD	TBD

RECM: Roadside Erosion Control Measures; SRE-1: Soil Resource Evaluation Process-1; SRE-2: Soil Resource Evaluation Process-2

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This section provides a brief summary and status of characterization studies that were completed or ongoing during FY 2006/07.

4.1 PREVIOUS STUDIES

Results of stormwater characterization studies completed by the Department prior to July 1, 2007, are contained in the following reports:

Department Document No.	Document Title
CTSW-RT-01-018	Monitoring Report 2000-2001: Caltrans Public Education Litter Monitoring Study. June 2001.
CTSW-RT-03-054.36.02	Caltrans Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Studies, 2002-2003. June 2003.
CTSW-RT-02-040	Small Stream Crossing Impact Research Project, North Coast River Loading Project. July 2002.
CTSW-RT-02-055	Caltrans Construction Site Runoff Characterization Study. September 2002.
CTSW-RT-03-066.51.42	Discharge Characterization Study Report. November 2003.
No Document No. assigned	Evaluation of Potential Water Quality Impacts from Different Future Growth Scenarios in the SCAG Area. June 2004.
CTSW-RT-05-073.10.1	Toxicity of Storm Water from Caltrans Facilities. June 2005.
CTSW-RT-05-130.02.2	Drain Inlet Cleaning Efficacy Study – Gross Solids Monitoring Program – 2000-01, 2003-04, 2004-05. May 2007.

Reports for ongoing and completed studies from FY 2006/07 are summarized in the following subsections. The subsections also present the general objectives and findings/conclusions of these studies. For those studies that are new or ongoing, a three year action plan is provided that addresses tasks and approaches, products or deliverables, and schedules.

4.2 LONG TERM DISCHARGE CHARACTERIZARTION STUDY

Objectives

The SWRCB has directed Caltrans to conduct long term stormwater quality monitoring at representative locations throughout California. The purpose of this study is to determine whether the quality of stormwater runoff changes over time, and to observe those changes if they exist.

Sites for this project were selected to represent the diverse geographic, climatic, geologic, demographic (urban and rural), and land use conditions within California. Sites were also selected to be representative of the various types of Caltrans facilities and the various types of stormwater BMPs utilized by Caltrans. Approximately 30 sites have been selected for inclusion

in the Long-Term Discharge Characterization Study, and two toll plaza sites will be added to the project after they are constructed. Project sites include examples of the following facility types: highways (congested, free-flowing), vehicle inspection stations, park & ride facilities, rest areas, toll plazas, and maintenance yards. Selected sites also represent the following BMP types: sand filters, sand traps, bioswales, roadside vegetated treatment sites, detention basins, multi-chambered treatment trains, and gross solids removal devices.

At the end of the 5-year Statewide Stormwater Management Plan cycle, enough data will be available to perform an initial trend analysis. Based on the results of the Long-Term Project, Caltrans will make recommendations on the need for further stormwater monitoring and may suggest modifications to the analytical suite, although differences are not expected to be observed until 15 years of data have been collected.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
San Onofre Commercial Vehicle Inspection Facility - I-5, San Diego, D-11	1	Site being developed for monitoring.
Camp Pendleton-4/Biostrip - I-5, San Diego, D-11	1	Site being developed for monitoring.
SR-56 and I-5/Detention Basin - SR-56, San Diego, D-11	1	Site being developed for monitoring.
La Costa Park and Ride/Park & Ride - I-5, San Diego, D-11	1	Site being developed for monitoring.
La Costa Park and Ride/Sand Filter - I-5, San Diego, D-11	1	Site being developed for monitoring.
SR-78 and Melrose/Bioswale - SR-78, San Diego, D-11	1	Site being developed for monitoring.
I-5 at Manchester/Detention Basin - I-5, San Diego, D-11	1	Site being developed for monitoring.
La Costa Wet Basin/Wet Basin - I-5, San Diego, D-11	1	Site is being retrofitted to prepare for development and monitoring.
Sand Canyon Toll Road Maintenance Station - I-405, Santa Ana, D-12	1	Site being developed for monitoring.
SR-299 at Old Oregon Trail/Biostrip - SR-299, Central Valley, D-2	1	Site being developed for monitoring.
Mountain Gate/Sand Filter - I-5, Central Valley, D-2	1	Site being developed for monitoring.

Location (Route, RWQCB, District)	No. of Sites	Status
Shingle Springs Park and Ride/Park & Ride - SR-50, Central Valley, D-3	1	Site being developed for monitoring.
Highway 50 at Tahoe Airport - SR-50, Central Valley, D-3	1	Site being developed for monitoring.
Highway 50 at Echo Summit - SR-50, Central Valley, D-3	1	Site being developed for monitoring.
Highway 50 at Tahoe Airport/Sand Trap - SR-50, Central Valley, D-3	1	Site being developed for monitoring.
Highway 50 at Echo Summit/Sand Trap - SR-50 , Central Valley, D-3	1	Site being developed for monitoring.
Mission Grade Commercial Vehicle Inspection Facility - SR-680 , San Francisco Bay, D-4	1	Site being developed for monitoring.
San Rafael - SR-101, San Francisco Bay, D-4	1	Site being developed for monitoring.
Año Nuevo Point and Island - SR-1 , San Francisco Bay, D-4	1	First season of monitoring completed.
Walnut Creek East Maintenance Station - SR-680, San Francisco Bay, D-4	1	Site being developed for monitoring.
US-101 Northbound, Camp Roberts Rest Area - SR-101, Central Coast, D-5	1	Site being developed for monitoring.
99S Philip S. Raine Rest Area - SR-99, Central Valley, D-6	1	Site being developed for monitoring.
I-605 and Del Amo Bioswale - SR-605, Los Angeles, D-7	1	Site being developed for monitoring.
I-605 and Del Amo Bioswale - SR-605, Los Angeles, D-7	1	Site being developed for monitoring.
Lakewood Park and Ride MCTT - SR-105, Los Angeles, D-7	1	Site being developed for monitoring.
Via Verde Park and Ride MCTT - SR-210, Los Angeles, D-7	1	Site being developed for monitoring.

Location (Route, RWQCB, District)	No. of Sites	Status
Mugu Lagoon to Latigo Point - SR-1, Central Coast, D-7	1	First season of monitoring completed.
Phase V at Filmore/GSRD, Inclined Screen - I-210, Los Angeles, D-7	1	Site being developed for monitoring.
Phase V at Cerritos/GSRD, Inclined Screen - I-605, Los Angeles, D-7	1	Site being developed for monitoring.
GSRD Site 3 - Los Angeles/GSRD, Linear Radial - I-60, Los Angeles, D-7	1	Site being developed for monitoring.
GSRD Site 20 - Commerce/GSRD, Linear Radial - I-710, Los Angeles, D-7	1	Site being developed for monitoring.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None available at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Three storms per season will be targeted for monitoring at each location. Caltrans may opt to monitor four storms per season at selected sites. Interim reports will be developed for each monitoring season. The interim reports will consist of two documents: 1) a monitoring and reporting program which describes project monitoring sites and procedures, and 2) a monitoring strategy report update which summarizes analytical data collected to date as well as any planned updates to the monitoring program. Data will be collected for the first five years of the study before any analysis of the data is performed.

Product or Deliverables

- Interim reports

Schedule

- 2007/08 – Continue monitoring and develop interim report.
- 2008/09 – Continue monitoring and develop interim report.

- 2009/10 – Continue monitoring and develop interim report.

4.3 CALIFORNIA TOXICS RULE (CTR) CHARACTERIZATION STUDY

Objectives

In Spring of 2000, the U.S. Environmental Protection Agency (EPA) promulgated new ambient water quality criteria for California known as the California Toxics Rule (CTR). Numerical standards were established for 100 constituents, many of which have not been previously studied in highway runoff. Objectives for this project, being conducted by the UC-Davis, include (1) developing cost effective sampling and analytical strategies to attain the low detection limits required under the CTR, (2 identifying constituents that exceed the CTR limits in runoff from Department facilities, and (3) engineering mitigation strategies for problematic compounds.

This study was undertaken to provide Caltrans with an overall comparison between CTR and the Department's characterization study. It is a conservative comparison for the purpose of planning future analysis. The resulting document (listed below) prioritizes which constituents are of the highest concern and need to be considered first.

Current Status

Location (Route, RWQCB,District)	No. of Sites	Status
UC-Davis Laboratory	NA	Final report under revision.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
To be determined	California Toxics Rule Characterization Study. Final Report. Due March 2008.

3-Year Action Plan

Overview of Approach

Complete final report.

Product or Deliverables

- Final report

Schedule

- 2007/08 – Complete final report
- 2008/09 – None (study to be completed during 2007/08 season).
- 2009/10 – None (study to be completed during 2007/08 season.

4.4 FIRST FLUSH CHARACTERIZATION STUDY

Objectives

The goal of this study is to identify constituent concentration variability with relation to storm intensity, duration, and antecedent weather patterns. The data collected will be used to develop pollutographs and, potentially, to design BMPs to remove a large fraction of pollutant mass load within a smaller drainage areas. Information on the spatial and temporal distribution of contaminant concentrations in stormwater runoff is lacking. Of particular importance is the relationship between the periodic dry season deposition of contaminants, storm intensity and duration, and the contaminant concentrations in stormwater runoff. During the previous year of the first flush characterization study, the toxicity of stormwater runoff during the entire storm event was also investigated. No additional first flush characterization (including the hydrographic toxicity evaluation of stormwater runoff) is currently planned during this monitoring period. Based on the information gathered from this study, a mathematical model was developed to predict the pollutant concentration throughout the pollutograph. The output of the model was used to simulate the first flush treatment of a detention basin. The first phase of the simulation concentrates on assessing the risks associated with effluent discharge that exceeds toxic concentrations. Additional analyses need to be performed to simulate the practical application of first flush treatment with respect to current Department detention basin design criteria before conducting a pilot field demonstration.

Current Status

Location (Route, RWQCB,District)	No. of Sites	Status
UC-Davis Laboratory	NA	Pollutograph modeling complete. First flush treatment simulations underway.

Findings/Conclusions

This study has identified several types of first flushes, and all, with the exception of "seasonal first flush," indicate the discharge of greater concentrations or mass during the early part of a storm event.

Most of the water quality parameters associated with highway runoff show a first flush with 20 to 50 percent of the pollutant mass in the first 10 to 30 percent of the runoff.

Among all constituents, aggregate organics such as TOC, DOC, oil and grease, and TKN tend to have higher first flush compared with other inorganic constituents.

Preliminary particle measurements show that 97 percent of the particles are smaller than 30 μμ. The particles tend to aggregate with time, suggesting a natural coagulation/flocculation phenomena.

Comparison of the computed EMC from grab samples, as part of the first flush characterization study, with the EMC of automatic composite sample confirmed the suitability of automatic sampler for collecting a representative runoff samples. Samples were collected from direct run off without any treatment.

Various other aspects of first flush were also investigated, including water quality during storm events, litter characteristics, correlations among contaminants, first flush of organics, litter and particles, models for the build up and wash-off of pollutants, new methods for measuring oil and grease, grab and composite sampling strategies.

Toxicity to both *C. dubia* and *P. promelas* was frequently observed, but varied between storms, species, and locations. Samples from all storms exhibited toxicity to one or both species. *P. promelas* was, however, more sensitive than *C. dubia* for most of the stormwater samples tested. Site-specific differences were apparent, with one site consistently exhibiting greater toxicity than the other two sites.

A first flush effect was almost always observed with both species and average survival at the end of a seven-day exposure period in the first grab sample of each storm series was near zero. However, toxicity was occasionally not related to the first flush samples and occurred in grab samples collected later during a storm. While both species responded to first flush, toxicity in samples collected after the first hour of each storm often differed between the two species.

A majority of the composite samples were non-toxic to both test species, even when a strong first flush effect was observed in individual grabs.

The cause of toxicity for most toxic runoff samples at three highway sites were identified as copper and zinc.

A review of analytical data collected during this study indicated that a large number of non-toxic grab samples exceeded recommended maximum water quality criteria for both dissolved copper and zinc in freshwater. Due to the complex chemistry of stormwater runoff and various parameters that may affect toxicity, results from this study show that concentration data alone should not be used to infer effects.

Available Documents

Department Document No.	Document Title
CTSW-RT-99-074	Caltrans First Flush Study Sampling and Analysis Plan. November 1999.
CTSW-RT-00-016	First Flush Study 1999-00 Report. June 2000.

Department Document No.	Document Title
CTSW-RT-00-044	Sampling & Analysis Plan, Caltrans 2000-01, First Flush Characterization Study. December 2000.
CTSW-RT-01-037	Summary Report Caltrans 2000-01 First Flush Characterization Study. July 2001
CTSW-RT-00-044U	Sampling & Analysis Plan, Caltrans 2000-01, First Flush Characterization Study. October 2001.
CTSW-RT-02-033	Caltrans First Flush Characterization Study, 2001-2002 Storm Season. June 2002.
CTSW-RT-03-064.73.02	First Flush Stormwater Runoff Characterization Study. November 2003.
CTSW-RT-05-73-02.6	First Flush Phenomenon Characterization. August 2005.
CTSW-RT-05-73-24.3	Hydrographic Toxicity Evaluation of Highway Stormwater Runoff. August 2005.
CTSW-RT-06-168-08.1	Mathematical Modeling of First Flush and Treatment Simulation for a Detention Basin. April 2007.

3-Year Action Plan

Overview of Approach

Propose to develop and validate a numerical model for evaluating performance of detention basins based on aqueous-particle transport model.

Product or Deliverables

- Final report on mathematical modeling.
- Final report for simulation based on aqueous-particle contaminant transport model.

Schedule

- 2007/08 – Develop aqueous-particle contaminant transport model.
- 2008/09 – Perform simulations and validate aqueous-particle contaminant transport model.
- 2009/10 – Prepare final report for aqueous-particle contaminant transport model.

4.5 PATHOGENS CHARACTERIZATION STUDY

Objectives

The objectives of this study are to establish quantitative and reliable methodology and QA/QC protocols for (1) the detection of human pathogens in stormwater samples, and (2) microbial source tracking to identify the contribution of human versus non-human fecal indicator bacteria

to bacterial loads. Currently used methods do not allow routine quantification of pathogens due to time constraints and associated costs. In addition, identifying sources of microbial contamination constitutes an approach towards reducing and managing inputs of fecal contamination from such sources. Quantitative methods for the detection of pathogens combined with the ability to calculate loads of land-use-specific fecal contamination in stormwater and receiving waters would give Caltrans a much-needed tool to:

- Evaluate mitigation measures that do not involve treatment of dry or wet weather flows, but can reduce specific loads from non-point sources (animal or human feces).
- Determine indicator organism and pathogen removal by approved BMPs.
- Study if removal of solids in a treatment system correlates with pathogen reduction.
- Develop advanced treatment to meet pathogen and indicator organism water quality standards.

This study includes the development of quantitative molecular methods based on polymerase chain reaction (PCR) analysis to test for a suite of human pathogens and indicator fecal bacteria in stormwater and contaminated receiving water bodies. Tasks for achieving these objectives involved:

- Continued development of a hollow-fiber ultrafiltration system to concentrate viruses, bacteria, and protozoa from large sample volumes.
- Establishment of surrogates for assessment of water filtration recovery for rapid detection of protozoa.
- Development and optimization of methodology for the quantitative PCR detection of host-specific *Bacteroidales*, in order to perform quantitative microbial source tracking.
- Comparison between the fecal *Bacteroidales* and traditional indicator measurements for total and fecal coliforms and *E. coli.*
- Lowering of detection limits for *Bacteroidales* and pathogens.
- Analysis of solids for pathogens.
- Study of the environmental persistence of *Bacteroidales* and that of traditional indicators.

The final product is a quantitative analysis tool for pathogens and land-use-specific fecal loads originating from stormwater. The task order will lead to a set of protocols that can be combined to develop standard operating procedures for testing BMPs, stormwater drains, and receiving waters. The measurement protocols and QA/QC procedures can then be executed by other parties engaged in monitoring, including commercial laboratories. The information is useful to identify the most likely contributing sources to high indicator bacteria counts in stormwater.

This study does not address the ability of treatment BMPs to reduce pathogens.

Current Status

Location (Route, RWQCB,District)	No. of Sites	Status
UC-Davis Laboratory	Not Applicable	Fecal source tracking and pathogen analysis in stormwater is ongoing.

Findings/Conclusions

The ultrafiltration systems used in this study can effectively concentrate microorganisms from large volumes of water (100 L), including viruses, bacteria, and protozoa. The systems exhibit consistent and high recoveries of internal viral standards (64 ± 9% [mean ± S.D.]). Using this method and quantitative PCR, pathogens that are present at very low concentrations may be detected and quantified. When pathogens are not detected, sample-specific detection limits can be calculated based on the recovery and inhibition of internal standards.

Specific goals included the development of a suitable surrogate that can be added to stormwater samples and used to determine filtration efficiencies for the quantitative detection of the protozoal pathogens *Cryptospridium* and *Toxoplasma*, in analogy to the viral and bacterial surrogates developed previously in the study. The main requirements for suitable surrogates are feasible growing conditions, a very low probability of finding them in the target samples, and similar transport properties/behavior in natural waters. Further, the transport of particles in aqueous media strongly depends on physicochemical properties such as specific weight, size, shape, surface potential (zeta potential) and hydrophobicity. For these reasons, yeast strains of different cell size have been tested for their suitability as surrogates in stormwater samples; their physicochemical parameters were measured and compared to those of the protozoa *Toxoplasma gondii* (10-14 μm) and *Cryptosporidium* spp. (4-6 μm) oocysts. Two yeast strains exhibited similar physicochemical properties to the target pathogens and a quantitative PCR assay has been designed to detect spiked yeast cells in water samples.

Stormwater contains many natural and anthropogenic substances that may interfere with enzymatic amplification of DNA during quantitative PCR (qPCR). Humic acids are by far the most prevalent type of inhibitors which are found in natural and impaired water bodies. Various methods have been evaluated for the treatment of humic acids according to subsequent qPCR performance. The benefit is the improved usage of quantitative pathogen data for establishing sufficient confidence in reported nondetects for pathogens or fecal source-specific bacteria. Therefore, three different reagents were tested for their ability to decrease qPCR detection limits in combination with the Qiagen method: Alum (potassium aluminum sulphate dodecahydrate ($AlK(SO_4)_2 \cdot 12\ H_2O$), 99%, Fluka), BSA (bovine serum albumin, 99 percent Sigma Aldrich), and Dax-8 (Dax-8 resin, Supelco). Based on the study, the application of alum for the removal of humic acids cannot be recommended. In contrast, both Dax-8 and BSA partially removed the inhibitory effects of humic acids in qPCR, allowing more reliable detection. For example, a decrease in inhibition factor from nine to three leads to a three-fold lowering of detection limits. Furthermore, fewer dilutions are necessary resulting in considerable savings on PCR reagents. Both methods have the potential to lower detection limits and hence increase the confidence in

reported nondetects for pathogens. None of the two methods is cost intensive and both can be applied independently of the selected extraction method. Since BSA can simply be added when PCR solutions are prepared its application involves only negligible additional effort.

Three different DNA extraction methods were compared to maximize the yield of nucleic acids. The DNA concentrations ranged from 0.1 to 0.6 ng/µL (PowerSoil), from 0.2 to 0.9 ng/µL (Bio101), and from 0.5 to 5.6 ng/µL (Qiagen) for the retentates; and for the feed samples they ranged from 0.003 to 0.01 ng/µL (PowerSoil), from 0.005 to 0.1 (Bio101) and from 0.4 to 1.2 ng/µL (Qiagen). Compared to the other methods, the modified Qiagen method showed improved efficiency, resulting in the highest nucleic acid concentrations for all measured samples.

Ultimately, UC-Davis aims to demonstrate, on behalf of the Department, how the developed pathogen monitoring and microbial source tracking methods can be used to quantify the actual impact of Caltrans facilities on bacterial contamination of watersheds versus the impact of agricultural facilities, leaking septic systems, and other nonpoint sources that may incorrectly be grouped as "municipal runoff" by stakeholders. Further, the technology will allow the identification of mitigation practices and help with the implementation of BMPs to meet guidelines for microbial contamination of receiving waters.

Available Documents

Department Document No.	Document Title
CTSW-RT-02-025	Pathogens in Urban Drainage: Results of Investigations of the Presence of Human Pathogens in Urban Storm Drains. March 2002.
CTSW-RT-05-073.19.7	Management of Pathogens Associates with Storm Water Discharge: Methodology for Quantitative Molecular Determination of Viruses, Bacteria and Protozoa. July 2005.
CTSW-RT-06-168-03.1D	Management of Pathogens Associated with Stormwater Discharge and Identification of Sources of Microbial Contamination. August 2006.

3-Year Action Plan

- 2007/08 – Completion of method development for environmental tool kit.
- 2008/09 – Preparation of standard operating procedures (SOPs).
- 2009/10 – Implementation of SOPs for storm drain and BMP monitoring.

4.6 AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) MONITORING PROJECT

Objectives

An ASBS is defined in the California Ocean Plan (Ocean Plan) as a marine area which requires "protection of species or biological communities to the extent that alteration of natural water quality is undesirable." As currently interpreted, the Ocean Plan prohibits discharges of wastes to ASBSs, including "wastes" carried by stormwater runoff from human-impacted areas, unless an exception has been granted.

The SWRCB is implementing a policy of granting exceptions to the Ocean Plan to allow the continued discharges of stormwater and other wastes into ASBSs. In a letter dated October 19, 2004, the SWRCB required that Caltrans either cease discharge to all ASBSs or request an exception. Caltrans has chosen to seek an exception since there is no practical way that it can completely cease stormwater discharge into these areas.

A request for an exception to the Ocean Plan requires, among other things, the submittal of monitoring data and other discharge information. Additional information identifying "natural water quality" may also be necessary. Natural water quality has not been defined, but is assumed to be the water quality of marine water within the boundaries of the ASBS.

The SWRCB originally requested that one grab sample be taken from the roadway runoff and another grab sample be taken from the corresponding ASBS itself. These grab samples were to be analyzed for all constituents on Table B in the Ocean Plan. This request was completed by Caltrans. However, it was the position of Caltrans that this sampling strategy would not yield useful data. Caltrans therefore decided to collect and analyze composite samples of stormwater runoff in accordance with standard Caltrans monitoring protocol, as well as grab samples of marine water from select ASBSs.

The ASBS Monitoring Project is designed to characterize stormwater runoff from Caltrans highways which are tributary to ASBSs on the California Coast. The project includes five years of collecting monitoring data (2005/06 through 2009/10) and a sixth year (2010/11) for compiling the data and developing a final report. The five ASBSs selected for this study are:

- ASBS 8 – the Redwoods National and State Parks in Del Norte County
- ASBS 9 – the James V Fitzgerald Marine Reserve in San Mateo County
- ASBS 15 – the Julia Pfeiffer Burns Underwater Park in San Mateo County
- ASBS 24 – the area located between Mugu Lagoon and Latigo Point in Ventura County
- ASBS 33 – the Irvine Coast Marine Life Refuge in Orange County

In addition to collecting and analyzing samples from stormwater runoff, the ASBS Monitoring Project includes collecting and analyzing marine water samples from the ASBSs and stream

water samples from three streams that discharge into the ocean within or adjacent to the ASBSs. The following bullets further describe the three types of samples:

- *Edge-of-pavement (EOP) samples* comprised of non-commingled stormwater runoff from Caltrans highways will be collected during all five monitoring years. One time-weighted EOP sample was targeted for collection at each project site during the first monitoring year of the study (2005/06). A minimum of eight storms are targeted for collection at each project site during each of the remaining four monitoring years of the project (2006/07 through 2009/2010). Both grab and flow-weighted composite samples are collected at each EOP site.
- *Marine water samples* collected from the surf zone were collected during the first monitoring year of the project only. Two marine samples were collected concurrently at each ASBS. The first sample was taken in the surf zone where Caltrans stormwater runoff visibly enters the ocean. The second sample was collected in the surf zone within the ASBS away from all runoff visible from the shore.
- *Stream water samples* collected from streams that flow into ASBSs will be collected during each of the remaining four monitoring years, but were not collected during the first monitoring year. Stream samples are included in the project in order to characterize the water quality of natural streams which are tributary to ASBSs. The three streams selected for this phase of the project are Wilson Creek in Del Norte County, which is near ASBS 8, and Purisima Creek and Gazos Creek in San Mateo County, which is near ASBS 9. A minimum of four storms per season are targeted for monitoring at each stream. Stream samples are collected both as grabs and as time-weighted composites.

The second of five monitoring seasons of the ASBS Monitoring Project is complete. Automatic composite sampling equipment has been installed at all of the study locations.

Collection of reference stream samples has been performed at all three reference streams.

Collection of marine water samples has been completed. Both types of marine water samples were collected successfully at ASBS 24 and ASBS 33. At ASBS 8, ASBS 9, and ASBS 15, no points could be located where non-commingled EOP runoff entered the ocean, so these samples were not colleted. Ambient marine water samples were successfully collected at ASBS 9 and ASBS 15. Two attempts were made to collect an ambient marine water sample at ASBS 8, but surf conditions made sampling unsafe. No marine samples at all were collected at ASBS 8.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
ASBS 8/Redwoods National and State Parks – SR-101, North Coast, D-1	1	Second of 5 monitoring seasons completed.

Location (Route, RWQCB, District)	No. of Sites	Status
ASBS 9/James V Fitzgerald Marine Reserve – SR-1, San Francisco Bay, D-4	1	Second of five monitoring seasons completed.
ASBS 15/Julia Pfeiffer Burns Underwater Park – SR-1, Central Coast, D-4	1	Second of five monitoring seasons completed.
ASBS 24/between Mugu Lagoon and Latigo Point – SR-1, Los Angeles, D-7	1	Second of five monitoring seasons completed.
ASBS 33/Irvine Coast Marine Life Refuge – SR-1, Santa Ana, D-12	1	Second of five monitoring seasons completed.
Wilson Creek – SR-101, North Coast, D-1	1	First of four monitoring seasons complete.
Waddell Creek – SR-1, San Francisco Bay, D-4	1	First of four monitoring seasons complete.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

Department Document No.	Document Title
CTSW-RT-06-132.18.2	Recommended Areas of Special Biological Significance Monitoring Locations. May 2006.
CTSW-RT-06-127.03.3	Storm Water Monitoring Areas of Special Biological Significance Interim Report. May 2006.
CTSW-RT-06-132.18.3	Additional Information for Consideration of Exceptions to Discharges into Areas of Special Biological Significance Monitoring. May 2006.
CTSW-TM-06-131.05.1	Areas of Special Biological Significance 33 (ASBS) Study Storm Water Monitoring-Site Selection. September 2006.
CTSW-TM-07-127.06.1	Areas of Specialized Biological Significance (ASBS) Study--Reference Stream Siting Technical Memorandum. March 2007.
CTSW-PL-07-127.03.2	Areas of Special Biological Significance (ASBS) Study. May 2007.
CTSW-RT-07-127.04.2	Final Interim Report of Special Biological Significance Monitoring Program Monitoring Season 2006-2007. May 2007.

Department Document No.	Document Title
CTSW-RT-07-130.11.1	Areas of Special Biological Significance 24 (ASBS 24) Study 2006-07 Wet Season Interim Report. May 2007.
CTSW-RT-07-131.06.1	Areas of Special Biological Significance 33 (ASBS 33) Study. May 2007.

3-Year Action Plan

Tasks/Approach

Monitor EOP and stream sites for the remaining three monitoring years (2007/08 through 2009/10) and develop interim reports. Compile data and develop final report during sixth year of project (2010/11).

Product or Deliverables

- Interim reports
- Final report

Schedule

- 2007/08 – Continue monitoring and develop interim report.
- 2008/09 – Continue monitoring and develop interim report.
- 2009/10 – Continue monitoring and develop interim report.

The final report will be developed in 2010/11.

4.7 SOURCE IDENTIFICATION STUDIES

4.7.1 Source Identification – Laboratory Method Development

Objectives

The objective of this study is to develop and test a variety of methods to identify the sources of highway derived contaminants. Each method is targeted at the identification of a single chemical (e.g., lead or mercury) or a broader class of chemicals (e.g., trace elements, including cadmium, copper, and zinc). Source samples (brakes, tires, soils, exhaust particles, lubricating fluids) are analyzed to determine their chemical composition. Methods are tested using existing runoff water quality field data to determine source contributions for these constituents. Rather than assume that Caltrans must remove problematic constituents from its stormwater runoff via end-of-the-pipe treatments, this project invests in developing source identification techniques. These techniques will assist in comparing the source reduction schemes (i.e., source control) to BMP development and implementation (i.e., treatment).

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
Labs at UC-Davis; field collections at I-880, San Francisco Bay, D-4	1	Analysis and interpretation is ongoing. Final report anticipated in late 2007.

Findings/Conclusions

Multi-element source characterization can be used to identify source contributions, though progress is still needed for meaningful interpretation. Copper and zinc occurring within runoff early in a storm can be of predominantly brake and tire origin, but over the entire duration of a storm, large amounts are from soil.

Lead isotopes can distinguish minor sources, but they cannot distinguish tire weights from the dominant residual fuel-additive, lead. The only samples with enough lead to make accurate isotope ratio measurements were those with highly elevated concentrations, as was expected.

Carbon-14 data indicates that for particulate carbon, 60-70 percent of the first few hours of storm runoff is not fossil fuel derived – rather it must be 'young' biogenic carbon such as from soil, plant material or wood smoke.

Mercury is too labile for the original approach to identify sources. Currently, methyl mercury measurements are being developed to assist Caltrans in managing the San Francisco Bay urban runoff portion of the RWQCB's planned TMDL.

Available Documents

None available at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Develop a follow-up project on metal fingerprinting and on Carbon-14 isotope ratios, as tools worth developing for identifying the sources of runoff constituents.

Products or Deliverables

- Final report

Schedule

- 2007/08 – Complete final report and develop follow-up project.

- 2008/09 – Plan and implement follow-up project.
- 2009/10 – Plan and implement follow-up project.

4.7.2 Source Identification and Quantification Studies

Objectives

These studies were designed to determine the source of a broad range of highway pollutants commonly found in runoff from Department highways and associated facilities. The studies will include development of pilot studies that will quantify the relative contribution of various sources to the targeted pollutants.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
To be determined	To be determined	Potential pilot studies have been recommended. Selection of pilot studies to be implemented is ongoing.

Findings/Conclusions

The following presents findings from literature reviews as to various sources, origins, and geographic extent of various target constituents. To date, the relative contribution of stormwater constituents from each origin is undetermined, but future quantification studies should provide this information.

Constituent	Origin	Geographic Extent	Sources
Zinc, Total and Dissolved	Transportation Related	Statewide	Tires, Galvanized metal (highway guardrails, signs, posts, roofs of maintenance facilities, etc.), motor oil, diesel fuel, brake pads, miscellaneous plated parts in vehicles, Portland cement concrete, various asphalt concrete formulations, ammonia-copper-zinc-arsenate(ACZA), copper-chromated-zinc (CCA)
Copper, Total and Dissolved	Transportation Related	Statewide	Brake pads, diesel fuel, shingle asphalt, PCC with plasticizer, ammoniacal-copper-zinc,arsenate (ACZA), copper-chromated-zinc (CCA), atmospheric deposition (from exhaust emissions and windblown dust), fertilizers
Lead, Total and Dissolved	Transportation Related	Statewide	Tire weights, brakes, tires, diesel fuel, gasoline, used motor oil, paint, methyl methacrylate, residual contamination from soils contaminated by leaded

Constituent	Origin	Geographic Extent	Sources
			gasoline exhaust
Cadmium, Total and Dissolved	Transportation Related	Statewide	Tires, used motor oil, brake pads, methyl methacrylate
Mercury, Total	Various	Statewide	Long range atmospheric transport/dry deposition (coal burning), diesel fuel, crumb rubber asphalt, batteries in litter
Nickel, Total	Transportation Related	Tahoe and Ocean Plan	Brake pads, diesel fuel, deicing salts, asphalt (?), concrete, methyl methacrylate
Chromium, Total and Dissolved	Transportation	Statewide	Brake pads, metal plating, wear material in motor oil, diesel fuel, atmospheric dry deposition, shingle asphalt, rubber
Iron, Total	Various	Tahoe	Steel, soil (not widely evaluated)
Aluminum, Total	Various	Tahoe	Soil (vehicle tracking and atmospheric deposition), asphalt, Portland cement concrete, PCC with plasticizer, phosphogypsum aggregate, methyl methacrylate
Coliform Bacteria, Total	Non-transportation	Statewide	Ubiquitous
Coliform Bacteria, Fecal	Non-transportation	Statewide	Ubiquitous
Diazinon	Non-transportation	Statewide	Atmospheric deposition, vehicle tracking
Chlorpyrifos	Non-transportation	Statewide	Atmospheric deposition, vehicle tracking
Nitrate	Non-transportation	Statewide	Atmospheric deposition
Nitrate	Non-transportation	Statewide	Atmospheric deposition
Ammonia	Fertilizers	Statewide	Atmospheric deposition

Constituent	Origin	Geographic Extent	Sources
Phosphorus, Total and Dissolved	Various	Statewide	Soil, fertilizer, atmospheric deposition (wet and dry), road sanding: crumb rubber asphalt
Gross Solids	Non-transportation	Statewide	Litter
Suspended Solids, Total	Various	Statewide	Atmospheric deposition, vehicle tracking, deicing applications, vehicle and highway wear
Chloride	Various	Mountains	Deicing activities, atmospheric deposition (near coast)
Dissolved Solids, Total	Various	Mountainous Areas	Deicing activities
Turbidity	Various	Statewide	Atmospheric dry deposition, vehicle tracking, deicing applications, vehicle and highway wear
PCB's	Non-transportation	Statewide	Atmospheric deposition, building sealants, vehicle tracking

Available Documents

Department Document No.	Document Title
Appendix in Caltrans Stormwater Strategic Plan (Document No. not available)	Research Project Work Plans. November 2006.
CTSW-RT-06-182-08.1	Identification and Sources of Target Pollutants in Highway Runoff. July 2006.

3-Year Action Plan

Overview of Approach

Source Identification and Quantification studies have been divided into three categories: High Priority Studies, Low Priority Studies, and Ongoing Research. Specific studies within each category include:

Category 1: High Priority Studies

- Evaluation of existing data
- Contribution of zinc from highway fixtures: targeted monitoring
- Evaluation of sanding and deicing materials: lab testing

- Evaluation of sanding and deicing materials: use reduction

Category 2: Low Priority Research Plans

- Evaluation of paving materials: field testing
- Evaluation of preserved wood
- Evaluation of the use of lead based paints
- Contribution of tire weights to lead in runoff
- Evaluation of the chemistry of vehicle fuels and lubricants

Category 3: Ongoing Research

- Evaluation of paving materials: laboratory testing
- Contribution of tire wear debris to runoff pollutants
- Pathogens and indicator organisms in runoff,
- Impacts of brake pad debris

Products or Deliverables

These studies are still in the planning and selection phase. Products and deliverables have not yet been determined, but may include various interim and final reports.

Schedule

- 2006/07 – Plan and implement pilot studies.
- 2007/08 – Plan and implement pilot studies.
- 2008/09 – Plan and implement pilot studies.

4.7.3 METHODOLOGY TO IDENTIFY THE SOURCES OF NITROGEN AND PHOSPHOROUS IN HIGHWAY RUNOFF FOR THE TAHOE BASIN

Objectives

The specific objectives of this project were: (1) to identify and collect possible contributing sources of nitrogen (N) and phosphorous (P) in highway runoff in the Tahoe Basin, (2) measure the chemical and isotopic characteristics of all source samples, soluble solutions produced from the source samples, and synthetic runoff samples, and (3) develop source identification methodology using statistical, isotopic and diagnostic approaches.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
UC-Davis Laboratory	None	Completing the remaining isotope and elemental analysis of mixed samples and preparing the final report.

Findings/Conclusions

Seventy-nine possible contributing source samples were collected in the Tahoe Basin. Some of these samples are from the same source family (e.g. soil, vegetation). In general, they were grouped as 15 source contributing samples. All 79 samples were mixed with synthetic rain water to prepare a solution that was analyzed for elemental analysis, nitrogen compounds, and phosphorous compounds. Based on the results of nitrogen and phosphorous, about 37 samples were selected for isotope analysis. Five virgin and used oils of different brand names were analyzed to determine a marker compound that is unique to one or more of the engine oils.

The results are currently being analyzed to develop methods that can be used to identify the sources of nitrogen and phosphorous from highway runoff.

Available Documents

Department Document No.	Document Title
TBD	Methodology to Identify the Sources of Nitrogen and Phosphorus in Highway Runoff. Due May 2008.

3-Year Action Plan

Overview of Approach

Complete elemental and isotopic analysis. Perform statistical analysis and develop source identification methods.

Product or Deliverables

- Phase I Final Report
- Phase II Final Report

Schedule

- 2007/08 – Prepare final report for Phase I of the project.
- 2008/09 – Prepare follow-on work plan for Phase II of the project.
- 2009/10 – Prepare Phase II Final Report for Phase II of the project

4.8 SAN DEGUITOS CREEK PROJECT

Objectives

Caltrans plans to add a high occupancy vehicle (HOV) lane to a portion of I-5 near the San Deguitos River. The San Diego RWQCB is requiring Caltrans to monitor runoff from this construction site in order to evaluate the quality of runoff generated by the portions of this project that are not treated by treatment control BMPs.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
I-5, San Diego, D-11	To be determined	Project in preliminary planning phase; no sites developed yet.

Findings/Conclusions

None to report at this time (study ongoing).

Available Documents

None available at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Flow-weighted composite samples will be collected from highway construction site runoff and receiving water.

Product or Deliverables

- Sampling and Analysis Plan
- Interim reports
- Final report

Schedule

- 2007/08 – Develop Sampling and Analysis Plan, monitor, and develop interim report.
- 2008/09 – Monitor and develop interim report.
- 2009/10 – Monitoring and develop interim and final reports.

4.9 WATER QUALITY AND TOXICITY EVALUTION OF DISHCARGE GENERATED FROM ASPHALT PAVEMENT SURFACING MATERIALS

Objectives

This study was performed to evaluate the water quality of leachate produced from ten different pavement specimens under controlled laboratory conditions. Three replicates of each specimen were tested at three constant temperatures of 4, 20, and 45 °C, representing cold, mild and hot environmental conditions. The specimens were placed in a stainless steel tray and clean water was pumped over the specimen at a constant flow rate. The flow rate was based on 12.7 mm rainfall for two days and surface area of the specified specimen. All water percolated through the pavement specimens and surface runoff was collected in a separate stainless steel carboy. The composite sample from each carboy was processed for wide range of water quality constituents including: conventional water quality parameters, aggregate constituents, nutrients, dissolved metals, organics and toxicity. The variability of metal constituents during the first eight hours was also investigated.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
UC-Davis Laboratory	30	Performing laboratory pilot investigation. Final Report anticipated for May 2008.

Findings/Conclusions

Results obtained from our laboratory investigation revealed that leachate generated from both fresh and aged specimens produced no contribution to stormwater loading of constituents of concern. From these results, one can summarize that the chemical constituents from leachate of pavement materials are generally negligible and most pollutants in highway stormwater runoff are associated with other sources.

Available Documents

None available at this time (study ongoing).

3-Year Action Plan

Overview of Approach

Develop a follow-up project on identifying possible contribution of pollutants from each pavement ingredients (e.g., asphalt, aggregate, binding polymer, etc.).

Product or Deliverables

- Final report

Schedule

- 2007/8 – Complete final report and develop follow-up project.
- 2008/09 – Plan and implement follow-up project.
- 2009/10 – Plan and implement follow-up project.

4.10 PERFORMANCE EVALUATION OF PERMEABLE PAVEMENT MATERIALS FOR WATER QUALITY UNDER HEAVY TRAFFIC

Objectives

The objectives of this study were: (1) to conduct a literature review of the field of permeable pavements, examining all relevant information from journals, books, and reports on permeable pavements, (2) to determine a strategy for siting future permeable pavement test locations, (3) to develop a detailed work plan for construction and evaluation of controlled permeable pavement structures.

Current Status

Location (Route, RWQCB, District)	No. of Sites	Status
UC-Davis Laboratory	None	Developed final report addressing all three objectives stated above.

Findings/Conclusions

Task1-Literature Review:

There is minimal literature that explores the functionality of permeable pavement structures under heavy vehicle traffic. The existing literature focuses on low-volume, light-vehicle traffic areas and neglects the application of permeable pavements on highways or slow-speed heavy vehicle routes. The feasibility of using permeable pavements on highways and heavy vehicle routes will require their design use the same methods as those applied to conventional pavements.

Permeable pavements used for other paved surface types with light traffic have been shown to improve stormwater runoff issues by decreasing volume and improving quality. For instance, the infiltrated water passing through a permeable pavement has been shown to have reduced concentrations of oil and grease, heavy metals, and various nutrients that accumulate on the surface.

The retention of water inside the permeable structure helps mitigate issues such flooding and accelerated erosion.

Task 2 – Determine Best Strategy for Siting of Test Section:

Three options were presented to locate test sections for the follow-on study in Phase 2. The feasibility of constructing and testing of the following test sections has been confirmed. The three location options are:

1. Heavy vehicle simulation (HVS) site on the University of California Pavement Research Center (UCPRC)/Advanced Highway Maintenance and Construction Technology (AHMCT) site at UC-Davis. This option was dependent on other funding for development of this site.
2. UCD campus roads trafficked by heavy vehicles.
3. Construct, instrument and test both sites 1 and 2 simultaneously for direct comparison of HVS and actual traffic conditions.

Option 3, use of both the UCPRC/AHMCT site and UCD campus roads, was selected after funding for the UCPRC/AHMCT site became available. Plans for permeable pavement testing for both types of test section are included in Chapter 3 of this report.

Task 3 – Develop Detailed Work Plan for Construction and Evaluation:

The three main components of the work plan are laboratory material testing, full scale test sections on the UCPRC/AHMCT site for HVS testing and environmental monitoring, and UCD Campus Truck/Bus route testing.

Available Documents

Department Document No.	Document Title
CTSW-RT-07-168.16.2	Performance Evaluation of Permeable Pavements for Water Quality under Heavy Traffic. November 2007.

3-Year Action Plan

Overview of Approach

Conduct hydraulic simulations and laboratory testing to evaluate the structural integrity of permeable materials.

Product or Deliverables

- Final report

Schedule

- 2007/08 – Conduct laboratory testing and hydraulic simulations.
- 2008/09 – Prepare final report for Phase II of the project.
- 2009/10 – Prepare follow-on work plan for Phase III of the project.

4.11 3-YEAR ACTION PLAN SUMMARY

The 3-year plan for the new and continuing characterization studies are summarized below.

Study	Location (Route or Facility, RWQCB, District)	Scheduled Activities		
		2007/08	2008/09	2009/10
Long Term Discharge Characterization Study	~30 locations – see Section 4.2 for full listing	Construct & Monitoring	Monitoring	Monitoring
California Toxics Rule Characterization Study	UC-Davis Laboratory	Reporting	None (study complete)	None (study complete)
First Flush Characterization Study	UC-Davis Laboratory	Modeling	Modeling	Reporting
Pathogens Characterization Study	UC-Davis Laboratory	Testing	TBD	TBD/ Monitoring
Areas of Special Biological Significance Characterization Study	7 locations – see Section 4.6 for full listing	Monitoring	Monitoring	Monitoring
Source Identification – Laboratory Method Development	UC-Davis Laboratory & Field collections at I-880, San Francisco Bay, D-4	Reporting	None (study complete)	None (study complete)
Source Identification and Quantification Studies	TBD	TBD	TBD	TBD
Methodology to Identify the Sources of Nitrogen and Phosphorous in Highway Runoff for Tahoe Basin	UC-Davis Laboratory	Reporting	TBD	TBD
San Deguitos Creek Project	I-5, San Diego, D-11	Monitoring	Monitoring	Monitoring and Reporting
Water Quality and Toxicity Evaluation of Discharge Generated from Asphalt Pavement Surfacing Materials	UC-Davis Laboratory	Reporting	TBD	TBD
Performance Evaluation of Permeable Pavement Materials for Water Quality Under Heavy Traffic	UC-Davis Laboratory	Testing	Reporting	TBD

TBD: to be determined

This section provides a brief summary of how research findings conducted to date have been incorporated into Caltrans' stormwater management program.

5.1 PREVIOUS STUDIES

Table 5-1 provides a key to the implementation categories that are assigned to each Stormwater Treatment Technology Study, Source Control Study, and Characterization Study, as listed in Tables 5-2 through 5-4, respectively.

Table 5-1. Implementation Category Key

Implementation Category	Explanation
A	Study findings resulted in changes to maintenance program.
B	Study findings resulted in changes to PPDG or other supplemental design guidance.
C	Study is complete and results did not justify changes to program based on the information generated.
D	Study is ongoing.
E	Study findings resulted in approval of BMP
F	Study findings resulted in changes to construction practices/management.
G	Study is long-term and the management implications have yet to be determined.
H	Study findings provided information for regulatory compliance or BMP planning.
I	Study's field/laboratory effort is complete, but incorporation into program is still under assessment.

Table 5-2. Summary of Implementing Research Findings for Stormwater Treatment Technology Studies

Study Title	Report Section	Implementation Category	Notes
Evaluation of Compost Storm Filters	2.1 (Previous Studies)	C	Manufacturer discontinued product. Results for treatment and maintenance were not promising.
Tahoe Highway Runoff Characterization and Sand Trap Effectiveness Study	2.1 (Previous Studies)	H	Established parameters to calculate loads. Documented performance of existing BMPs.
BMP Retrofit Pilot Program	2.1 (Previous Studies)	B & E	Findings resulted in substantial changes to PPDG. MCCTs, Wet Basins, and Sand Filters were approved as treatment BMPs.
Tahoe Basin Highway 267 Sand Trap with Filter Fabric 2-Year Pilot Study	2.1 (Previous Studies)	D	Led to further research on small footprint media filters (see Section 2.10.6)
Statewide/District 2 Sand Filter Study	2.1 (Previous Studies)	B & E	Confirmed cost and performance benefits of partial, earthen construction sand filters, as listed in PPDG.
Mechanical Cleaning Design Concepts Reconnaissance Study	2.2 (Reconn. Study)	C	
San Francisco/Oakland Bay Bridge – Bioretention	2.4.1 (Bioretention)	D	
District 12 SR73 Pilot Program – Bioretention	2.4.2 (Bioretention)	D	
Tahoe Basin Small-Scale Pilot Studies – Chemical Treatment	2.5.1 (Chemical Treatment)	D	Reporting
District 12 SR73 Pilot Program – Bypass Detention Basins	2.6.1 (Detention Basins)	D	
District 12 SR73 Pilot Program – Overflow Detention Basins	2.6.2 (Detention Basins)	D	
District 12 SR73 Pilot Program – Semi-Batch (Hold & Release) Detention Basins	2.6.3 (Detention Basins)	D	

Table 5-2. Summary of Implementing Research Findings for Stormwater Treatment Technology Studies

Study Title	Report Section	Implementation Category	Notes
District 12 SR73 Pilot Program – Surface Drained (Floating Skimmer) Detention Basins	2.6.4 (Detention Basins)	D	
District 12 SR73 Pilot Program – Alternative Inlet Detention Basins	2.6.5 (Detention Basins)	D	
Particle Based Pollutant Removal BMPs	2.6.6 (Detention Basins)	D	
District 3 Semi-Batch (Hold & Release) Detention Basins	2.6.7 (Detention Basins)	D	
Drain Inlet Inserts	2.7 (self-titled)	D	
District 7 GSRD Pilot Program	2.8.1 (GSRDs)	E	Linear Radial and Inclined Screen GSRDs were approved as BMPs
District 12 SR73 Pilot Program – GSRDs	2.8.2 (GSRDs)	D	
District 11 Continuous Deflection Separators	2.8.3 (GSRDs)	I	Field effort complete. Assessment ongoing.
Laboratory Testing of Gross Solids Removal Devices	2.8.4 (GSRDs)	D	
Infiltration Basin Model – Effects on Soil and Groundwater	2.9.1 (Infiltration)	D	
Alternative Infiltration Trench Studies	2.9.2 (Infiltration)	D	
Tahoe Basin Small-Scale Pilot Studies – Sand Filters	2.10.1 (Filtration)	D	Led to further studies: Hwy 50 & Hwy 267 alternative media filters (see Section 2.10.6)
Low Cost Adsorbent Materials for Dissolved Metals Removal	2.10.2 (Filtration)	D	

Table 5-2. Summary of Implementing Research Findings for Stormwater Treatment Technology Studies

Study Title	Report Section	Implementation Category	Notes
District 12 SR73 Pilot Program – Sand Filters	2.10.3 (Filtration)	D	
Linear Filtration BMPs	2.10.4 (Filtration)	D	
Tahoe Basin Small-Scale Pilot Studies – Alternative Media Filters	2.10.5 (Filtration)	D	Led to full scale studies (see Sections 2.10.4 & 2.10.6)
Tahoe Basin Full-Scale Pilot Studies – Alternative Media Filters	2.10.6 (Filtration)	D	
RVTS Study	2.11.1 (Vegetated Treatment Systems)	B & D	Changes made to PPDG
Ornamental RVTS Study	2.11.2 (Vegetated Treatment Systems)	D	
District 7 Bioswale	2.11.3 (Vegetated Treatment Systems)	D	
Vector Studies	2.12 (self-titled)	A	Changes made for statewide maintenance, including increasing maximum time for addressing larval development (for much of California) from 72 to 96 hours.
Open Graded Asphalt Pavement	2.13 (self-titled)	D	
Inclined Plate and Tube Settlers	2.14 (self-titled)	D	

Table 5-3. Summary of Implementing Research Findings for Source Studies

Study Title	Report Section	Implementation Category	Notes
District 7 Erosion Control Pilot Study	3.1 (Previous Studies)	C	
Temporary Non-Vegetative Soil Stabilization Evaluation Study	3.1 (Previous Studies)	F	
Statewide Erosion Control Review	3.1 (Previous Studies)	C	
Caltrans Hydraulic Application Study	3.1 (Previous Studies)	C	
Erosion Control New Technology Report	3.1 (Previous Studies)	H	
The Use of Mycorrihizal Fungi in Erosion Control Applications	3.1 (Previous Studies)	D	
RECM Study (formerly VEMS)	3.3 (self-titled)	D & F	
SRE-1	3.4.1 (SRE)	D	Led to SRE-2
SRE-2	3.4.2 (SRE)	D	
Use of Native Plants and Mycorrihizal Fungi for Slope Stabilization	3.5.1 (Mycorrihizal Fungi Studies)	D	
Arid Region Non-Vegetated Permanent Erosion control Study	3.6 (self-titled)	D	
Ice Slicer	3.7 (self-titled)	D	
Temporary Erosion Control Study	3.8 (T self-titled)	D	
Evaluation of Erosion Control Test Trials in Lake Tahoe	3.9 (self-titled)	D	
Effect of DeIcing Alternatives on Aerosols at Lake Tahoe	3.10 (self-titled)	D	

Table 5-4. Summary of Implementing Research Findings for Discharge Characterization Studies

Study Title	Report Section	Implementation Category	Notes
Public Education Liter Monitoring Study	4.1 (Previous Studies)	C	Data inconclusive
Small Stream Crossing Impact Research Project	4.1 (Previous Studies)	C	
Construction Site Runoff Characterization Study	4.1 (Previous Studies)	H	
Discharge Characterization Study	4.1 (Previous Studies)	H	
Toxicity of Stormwater from Caltrans Facilities	4.1 (Previous Studies)	H	Added toxicity testing to Long Term Discharge Characterization Study
Drain Inlet Cleaning Efficacy Study – Gross Solids Monitoring	4.1 (Previous Studies)	H & I	
LongTerm Characterization Study	4.2 (self-titled)	G	
California Toxics Rule Characterization Study	4.3 (self-titled)	I	
First Flush Characterization Study	4.4 (self-titled)	D	
Pathogens Characterization Study	4.5 (self-titled)	D	
ASBS Monitoring Project	4.6 (self-titled)	G	
Source Identification – Laboratory Method Development	4.7.1 (Source ID)	D	
Source Identification and Quantification Studies	4.7.2 (Source ID)	D	Literature search complete. Pilot study planning underway.
Characteristics and Source Identification for Tahoe Basin	4.7.3 (Source ID)	D	
San Deguitos Creek Project	4.8 (self-titled)	D	

Table 5-4. Summary of Implementing Research Findings for Discharge Characterization Studies

Study Title	Report Section	Implementation Category	Notes
Water Quality and Toxicity Evaluation of Discharge Generated from Asphalt Pavement Surfacing Materials	4.9 (self-titled)	D	
Performance Evaluation of Permeable Pavement Materials for Water Quality Under Heavy Traffic	4.10 (self-titled)	D	

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Caltrans, 1999. National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Discharge from the State of California, Department of Transportation (Caltrans) on Properties, Facilities and Activities.

Caltrans, 2003. Statewide Storm Water Management Plan. May 2003. CTSW-RT-03-008.

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Over the last several years the Department has implemented an impressively diverse and intensive stormwater monitoring program. Much effort has been invested into ensuring that the monitoring data produced by the Department's stormwater monitoring program will be scientifically defensible. As a result, the Department has developed the following manuals and software tools:

- Comprehensive Monitoring Protocols Guidance Manual
- Data Reporting Protocols
- Automated Data Validation (ADV) and Laboratory EDD Error Checker
- Hydrologic software utility
- Data analysis tool
- Stormwater Database

The above manuals and software tools are available through an electronic tool box (CTSW-OT-03-002) and mandated its use by all monitoring teams collecting data. The application of each manual and software tool is briefly described below.

Comprehensive Monitoring Protocols Guidance Manual

This comprehensive manual is a compendium of individual guidance manuals covering each of the four types of monitoring conducted under the Department's Stormwater Monitoring and Research Program: Stormwater Runoff Water Quality Monitoring, Particle/Sediment Quality Monitoring, Litter Monitoring, and Toxicity Studies.

A technical committee was established to guide production of each of the individual subject area Guidance Manuals, led by experts experienced in the field. The principal aims of the Guidance Manuals are to:

- Ensure consistency in monitoring methods throughout the state
- Specify scientifically-sound sampling and analytical techniques
- Minimize contamination of environmental samples
- Produce data of verified quality

The *Guidance Manual: Stormwater Monitoring Protocols* (Caltrans, 2000), which contains the runoff water quality protocols, is available on the Department's Stormwater Management Program web site: http://www.dot.ca.gov/hq/env/stormwater/special/newsetup/index.htm

Data Reporting Protocols

To ensure uniformity of data, the Department has established data reporting protocols designed for use with Microsoft Access. Data fields were standardized for both analytical and non-analytical data. The data reporting protocols provide detailed specifications for data fields and instructions for content. The protocols help ensure that data from all projects will be reported in consistent format – and that the data records will include sufficient information to permit their full use within the Department's Stormwater Database. Once data is submitted to the Department according to data reporting protocols, data are imported into an Access database that holds statewide monitoring data. These data are extracted for statistical analysis and data evaluation.

Automated Data Validation (ADV) software

A thorough data quality evaluation is performed following receipt of the laboratory data, in which the results of QA/QC sample analyses are compared to the project's data quality objectives, and suspect data are qualified (flagged) as necessary, following guidelines established by the EPA for evaluation of inorganic and organic analyses.

The automated program permits quick and efficient evaluation of lab data against data quality objectives and standard measures of data quality, and provides extensive error-checking for a standard set of possible analytical or data transcription errors. The resulting electronic data deliverable (EDD) is then ready for final checking prior to entry into the Department's stormwater quality database. The final data validation step involves checking that the EDD conforms to the Department's Data Reporting Protocols for the specific data type; corrections are made as necessary to provide information for any missing or improperly-populated data fields.

Hydrologic software utility

This software assists monitoring managers in determining whether the sample representativeness criteria have been met for a given monitoring event. The purpose of the Department's Hydrologic Utility is to standardize consultant calculation of important storm and sampling parameters, such as total flow volume, total event rain, estimated percent capture, and others. In addition, the utility generates a hydrograph and a hyetograph from measured hydrologic data.

The hydrologic utility is installed as an "Add In" in Microsoft Excel and is composed of a number of Visual Basic subroutines. The calculations and graphs are created from user-controlled input parameters as well as datalogger exports of rainfall, flow rate, and sample data records. The utility output is in two parts; a new worksheet and a new plot (chart) are added to the workbook. The output worksheet contains the processed input data that acts as the source data for the plot and a summary table of important calculations. The output hydrograph and hyetograph plot notes the timing of the primary composite sample aliquots, when they are provided, and includes a table of important summary data. The plot and the calculated parameters are output to a worksheet page that can be printed and added to event reports.

Data Analysis Software Tool (DAT)

The Department has developed a software tool as a means to efficiently generate descriptive statistics for monitoring data. The DAT can be run on user-selected data sets directly from the database interface screen, or used as a stand-alone Excel Add-In. The DAT employs a Regression on Order Statistics (ROS) technique for appropriate statistical treatment, including handling of non-detect data. This tool uses the detected values and a combination of regression and probability analysis to determine a "fill-in" concentration value to assign to all data points below the reporting limit (non-detects), based upon an assumed log-normal probability distribution The filled-in values are then used in statistical analysis.

Stormwater Database

Once the error-checking and data validation process is complete, EDDs (in the form of Excel spreadsheets) are delivered to the Department, and the data is imported into an Access database. Data are stored in three main tables: sample description, event description, and site description.

The fields and content guidelines for each of these tables are described in the Data Reporting Protocols for each category of data (runoff water quality, particle/sediment, litter, toxicity).

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APPENDIX B

FACT SHEETS FOR REPORTS COMPLETED DURING 2006/07 SEASON

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APPENDIX B FACTSHEET INDEX

Document Number	Document Title	Month	Year	Page
CTSW-RT-06-127.01.2	Final Summary Report 2006 Report Roadside Vegetated Treatment Sites (RVTS) Study	Nov	2006	B-1
CTSW-RT-06-128.01.1	Caltrans Statewide Sand Filter Study Final 2006 Storm Water Monitoring Report	Jan	2007	B-5
CTSW-RT-06-157.02.1	Caltrans Tahoe Basin Highway 50 Activated Alumina Media Filter Pilot Study	May	2007	B-9
CTSW-RT-06-157.04.01	Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project Phase V Final Report - February 2007	Feb	2007	B-13
CTSW-RT-07-172.31.2	Mechanical Cleaning Design Concepts Reconnaissance Study	June	2007	B-15
CTSW-RT-06-168.05.1	Performance Evaluation of a Detention Basin based on Removal of Particles and Associated Pollutants	April	2007	B-17
CTSW-RT-06-131.01.2	District 12 State Route 73 BMP Pilot Program 2005-2006 GSRDs Wet Season Volumes I & II (Interim Report and Lab Data: Volume II summarized Detention Basins)	Feb	2007	B-19
CTSW-RT-07-650.151.1	Annual Report 2006-2007: State Route 56 CDS & Receiving Water Monitoring	May	2007	B-21

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **Final Summary Report 2006 Report Roadside Vegetated Treatment Sites (RVTS) Study**

DOCUMENT #: **CTSW-RT-06-127.01.2**

DOCUMENT DATE: **November 2006**

OBJECTIVES

- Determine if standard roadway design requirements result in vegetated side slopes with stormwater treatment capabilities equivalent to biofiltration strips specifically engineered for water quality performance.
- Compare quantity and quality of the runoff discharged from each vegetated side slope to that observed at the edge of pavement (EOP).
- Evaluate performance of each of the vegetated side slopes in terms of (1) the changes in concentration for contaminants commonly found in highway runoff, and (2) the load reduction caused by stormwater infiltration into these areas.

ACTIVITIES

- 23 vegetated side slopes statewide
- 3 wet seasons
- 497 total storm events
- Constituents:

Analyte	Analytical Procedure	Reporting Limits
Conventional		
Hardness as calcium carbonate ($CaCO_3$)	EPA 130.2	2 milligrams per liter (mg/L)
Total Dissolved Solids (TDS)	EPA 160.1	2 mg/L
Total Suspended Solids (TSS)	EPA 160.2	2 mg/L
Conductivity	EPA 120.1	1.0 micromhos per centimeter (µmhos/cm)
Temperature	Field	0.1ºC
pH	EPA 150.1	0.1 unites
Dissolved Organic Content (DOC)	EPA 415.1	1 mg/L
Total Organic Content (TOC)	EPA 415.1	1 mg/L
Nutrients		
Ammonia as Nitrogen	EPA 350.3	0.1 mg/L
Nitrate as Nitrogen (NO_3-N)	EPA 300.0	0.1 mg/L
Total Kjeldahl Nitrogen (TKN)	EPA 351.3	0.1 mg/L

Analyte	Analytical Procedure	Reporting Limits
Total Phosphorus	EPA 365.2	0.03 mg/L
Dissolved Ortho-Phosphate	EPA 365.2	0.03 mg/L
Metals (Total and Dissolved)		
Arsenic	EPA 206.3 or 200.8	1 micrograms per liter (µg/L)
Cadmium	EPA 200.8	0.2 µg/L
Chromium	EPA 200.8	1 µg/L
Copper	EPA 200.8	1 µg/L
Iron[a]	EPA 236.1 or 200.7	25 µg/L
Lead	EPA 200.8	1 µg/L
Nickel	EPA 200.8	2 µg/L
Zinc	EPA 200.8	5 µg/L

A: Iron was tested at the District 2 (Redding and Cottonwood) sites only

GENERAL CONCLUSIONS/RECOMENDATIONS

- According to the vegetation assessment that was performed during the first two years of the study, data from the assessment indicated that vegetation species and height were similar at most sites. Consequently, these parameters could not be correlated to differences in pollutant removal performance.
- In general, the amount of infiltration increased with increasing widths of RVTS (i.e., an increased distance from the EOP). Additionally, infiltration was generally responsible for a greater portion of the load reduction than the change in concentration. The Moreno Valley RVTS had the lowest infiltration rates due to the area being situated on cut soils that consistently had high dry densities and high percentages of relative compaction.
- The test sites at three of the four Southern California RVTS had substantial gopher activity, which likely affected the stormwater sampling results. Gopher activity created exposed dirt mounds within the vegetated side slopes and along the edges of the collection ditches resulting in increased suspended sediment concentrations. However, observations have also shown that gopher activity within the vegetated side slopes enhanced the infiltration of runoff, thus enhancing pollutant removal. Study sites with sufficient vegetation and not overrun by gophers produced an effluent quality that was equal to, or better than, that observed from vegetated buffer strips engineered and operated specifically for water quality improvement.
- Roadside vegetated side slopes in all similar situations (e.g., with similar slopes, soil characteristics, and vegetative cover to those monitored in this study) can be considered as the functional equivalent of n biostrip specifically engineered for water quality treatment.
- Vegetation type alone is not an important factor in performance.
- Based on evaluation of the data collected during the four-year RVTS study, it was found that a minimum vegetative cover of approximately 65 percent is required for

concentration reduction to occur. A rapid decline in performance occurs below approximately 80 percent.

- Concentration reductions frequently occur for TSS and total metals and occasionally for dissolved metals. Concentration increases occasionally for dissolved solids, conductivity, hardness and organic carbon. Concentration increases occasionally for dissolved ortho-phosphate and total phosphorous. Concentration reductions occasionally occur for ammonia, TKN, nitrate, with one increase observed for nitrate. A moderate to substantial load reduction is evident for most constituents, even some that exhibit no change or an increase in concentration, because of the low runoff coefficients at most of the sites. The exception is Moreno Valley where the sparse vegetation coverage, soils with high dry densities and high percentages of relative compaction, and low infiltration rates lead to high runoff coefficients and an inability to reduce loads for some constituents.
- At sites with greater than 80 percent vegetation coverage (as established by the vegetation assessment conducted in the first two years), the following buffer widths resulted in shortest effective widths for those constituents whose concentrations decreased (the optimum pollutant removal widths):
    - 4.2 meters for slopes equal to 10 percent (6 degrees): Redding
    - 4.6 meters for slopes between 5 percent (3 degree) and 33 percent (18 degrees): Sacramento
    - 8.3 meters for a slope of 50 percent (27 degrees): San Rafael.
- At sites with less than 80 percent vegetation coverage, but more than 65 percent coverage, (as established by the vegetation assessment conducted in the first two years), the following buffer widths were identified as the shortest effective widths:
    - 9.3 meters for a slope of 52 percent (27 degrees): Cottonwood
    - 1.3 meters for slopes between 8 percent (5 degrees) and 16 percent (9 degrees): San Onofre
    - 13 meters for slopes of 11 percent (6 degrees): Irvine
    - 7.6 meters for slopes of 14 percent (8 degrees): Yorba Linda.
- In general, concentrations were observed to decrease with increasing hydraulic residence times.

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **Caltrans Statewide Sand Filter Study**
Final 2006 Storm Water Monitoring Report

DOCUMENT #: **CTSW-RT-06-128.01.1**

DOCUMENT DATE: **January 2007**

OBJECTIVES

- Compare the performance of different sand filter configurations; "full-sedimentation" sand filters with separate sedimentation and filtration units, and one "partial-sedimentation" sand filter with a combined unit.
- Compare pollutant removal performance of earthen-walled construction versus concrete-walled construction.
- Assess the effect of climate on pollutant removal performance and operations.
- Document the life cycle cost in relation to the water quality volume (WQV) treated.

ACTIVITIES

- Seven Austin Sand Filters: two in Northern California and five in Southern California
- Northern California: five wet seasons
- Southern California: three wet seasons
- 130 total storm events
- Constituents:

Analyte	Analytical Procedure	Reporting Limits
Conventional		
Hardness as calcium carbonate ($CaCO_3$)	EPA 130.2	2 milligrams per liter (mg/L)
Total Dissolved Solids (TDS)	EPA 160.1	2 mg/L
Total Suspended Solids (TSS)	EPA 160.2	2 mg/L
Total Coliform	SM 9221B	2 MPN per 100 mL *
Fecal Coliform	SM 9221E	2 MPN per 100 mL *
Dissolved Conductivity	EPA 120.1	1.0 micromhos per centimeter (µmhos/cm)
Turbidity	EPA 180.1	0.05 normal turbidity units (NTU)
Dissolved Organic Content (DOC)	EPA 415.1	1 mg/L
Total Organic Content (TOC)	EPA 415.1	1 mg/L

Analyte	Analytical Procedure	Reporting Limits
Nutrients		
Ammonia as Nitrogen	EPA 350.3	0.1 mg/L
Nitrate as Nitrogen (NO_3-N)	EPA 300.1	0.1 mg/L
Total Kjeldahl Nitrogen (TKN)	EPA 351.3	0.1 mg/L
Total Phosphorus	EPA 365.2	0.03 mg/L
Dissolved Ortho-Phosphate	EPA 365.2	0.03 mg/L
Metals (Total and Dissolved)		
Arsenic	EPA 200.8/200.9	1 micrograms per liter (µg/L)
Cadmium	EPA 200.8/200.9	0.2 µg/L
Chromium	EPA 200.8/200.9	1 µg/L
Copper	EPA 200.8/200.9	1 µg/L
Iron	EPA 200.7/200.8	25 µg/L
Lead	EPA 200.8/200.9	1 µg/L
Nickel	EPA 200.8/200.9	2 µg/L
Zinc	EPA 200.8/200.9	5 µg/L

Note:
* Maximum enumeration at 2x10 MPN per 100 mL (i.e., 6 dilutions)
EPA U.S. Environmental Protection Agency
MPN Most probable number
SM Standard Method

GENERAL CONCLUSIONS/RECOMENDATIONS

- Two earthen-banked sand filter systems in northern California (Mountain Gate and Mount Shasta) were compared to determine the effect of partial- and full-sedimentation basin design on load reduction for 13 selected constituents. Based on data obtained during the course of the study, statistical analysis indicated only minimal differences in removal efficiencies between the two sites.
- The southern California sand filters at two maintenance stations and three P&R sites were compared to assess the relative differences in performance at different facilities under similar climatic conditions. Comparison of influent and effluent loads for the two groups indicated that influent loads for six of 13 constituents were significantly greater for the maintenance station group. Results obtained indicate that a first flush of gross pollutants was generally observed.
    - The statistical comparisons tests indicate that removal efficiencies are greater at the northern California sites for five of 13 constituents (total phosphorus, total and dissolved copper, and total and dissolved zinc)
    - Capital construction costs for the earthen-banked sand filters were significantly less than those for the concrete-walled sand filters.
    - At the southern California sites, the majority of the maintenance effort was spent on vector controls (dewatering) and pump maintenance. In the future, all Austin sand filters should be constructed at sites where runoff can flow through the system by gravity only. In the case that future sand filters are

designed with pumping mechanisms, a more robust pumping system needs to be designed with sufficient power available to run the system.

- Standing water continued to be a problem in the overflow structure at the Mount Shasta sand filter. In the future, the drop inlet should be constructed with a sloped floor that would not allow pooling of water. Sediment in the overflow structure effluent pipeline appeared to be left during construction. The contractor should be responsible for removing sediment at the time of construction or corrective maintenance should be performed before the next rain event in order to prevent standing water.
- BMP sizing could be more fully evaluated. Water quality and/or flow volume from the overflow structures should be more closely monitored in future similar studies.
- Cleaning of the screen around the drop inlet from the sedimentation basin to the sand filter should be performed monthly during the wet season. This could decrease drainage time and standing water that allow mosquito breeding and other vector control issues associated with standing water.

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **Caltrans Tahoe Basin Highway 50 Activated Alumina Media Filter Pilot Study Final Report**

DOCUMENT #: **CTSW-RT-06-157.02.1**

DOCUMENT DATE: **May 2007**

OBJECTIVES

- Evaluate the treatment effectiveness of two activated alumina media filters in the Tahoe Basin in terms of being able to meet surface effluent limits for turbidity, TSS, phosphorus, nitrogen, iron, and oil and grease.
- Document operations and maintenance requirements for the new media filters under various environmental conditions that occur in the Tahoe Basin.

ACTIVITIES

- Two pilot sites (B103 & B111): Partial Sedimentation Austin Filters
- Water quality and operational monitoring were conducted to evaluate the performance and overall feasibility of these new technology stormwater treatment controls.
- Three wet seasons
- Thirty storm events
- Constituents:

➢ Minimum Constituent List per Table F-7 of SWMP	➢ Total & Dissolved Aluminum	➢ Total & Dissolved Iron
➢ Turbidity	➢ Dissolved Phosphorous	➢ Oil and Grease

GENERAL CONCLUSIONS/RECOMENDATIONS

- The quality of stormwater measured during this study was variable in both influent and effluent samples, as expected. There was no obvious trend in the water quality between Basin B103 and Basin B111, nor between that collected in 2003-04, 2004-05, and 2005-06. Differences existed among individual parameters.
- Effluent constituent concentrations were significantly lower than influent concentrations for the key constituents. (Note that metals were not included in the statistical assessment of the date). The mean influent and effluent levels, mean removal percentages, and statistical difference at each basin for the key constituents are summarized in the table below.

Treatment Performance Summary		
Parameter	***Basin B103***	***Basin B111***
TSS		
Mean influent, mg/L	262	149
Mean effluent, mg/L	13	14
Mean removal	92%	83%
Statistical Difference	Effluent lower	Effluent lower
Turbidity		
Mean influent, NTU	359	163
Mean effluent, NTU	25	29
Mean removal	80%	67%
Statistical Difference	Effluent lower	Effluent lower
Phosphorus (T)		
Mean influent, mg/L	0.34	0.32
Mean effluent, mg/L	0.05	0.06
Mean removal	52%	68%
Statistical Difference	Effluent lower	Effluent lower
Phosphorus (D)		
Mean influent, mg/L	0.05	0.11
Mean effluent, mg/L	<0.03	0.03
Mean removal	16%	41%
Statistical Difference	Effluent lower	Effluent lower
Nitrogen (T)		
Mean influent, mg/L	1.28	0.85
Mean effluent, mg/L	0.61	0.41
Mean removal	40%	46%
Statistical Difference	Effluent lower	Effluent lower
Iron (T)		
Mean influent, µg/L	6120	3950
Mean effluent, µg/L	760	900
Mean removal	77%	55%
Statistical Difference	Effluent lower	Effluent lower
Iron (D)		
Mean influent, µg/L Mean	1320	979
effluent, µg/L	400	310
Mean removal	63%	56%
Statistical Difference	Effluent lower	Effluent lower

- Comparing the effluent data to the regulatory stormwater effluent limits showed that the activated alumina media filters produced effluent discharges that met the regulatory surface water effluent limits in many cases. All effluent discharge results from both basins met the regulatory limits for infiltration to groundwater. The percentage of the effluent samples that met the surface water effluent limits were: 100 percent for TSS, 55 percent for turbidity (although over 79 percent of samples were below 50 NTU), 83 percent for total phosphorus, 95 percent for dissolved phosphorus, 61 percent for total nitrogen (although over 86 percent of samples were below 1 mg/L), 37 percent for total iron, and 76 percent for dissolved iron.

- Based on the available flow data, estimated annual loads were reduced on average by 92 percent for TSS, 74 percent for total phosphorus, 51 percent for total nitrogen, and 80 percent for total iron. Load reductions varied on an individual event basis. Average event-based load reductions were 83 percent for TSS, 72 percent for total phosphorus, 44 percent for total nitrogen, and 61 percent for total iron. Event-based average values are slightly lower than the annual estimated load. These lower values are most likely due to the extended overflow events in 2005-06 which were not included in the annual load estimates. Load based evaluations using the existing flow

data should be used with the knowledge that flow measurements may be inaccurate. Flow data was sufficient to collect quality, flow-weighted composite samples for determination of Event Mean Concentrations. Load reductions may be higher for unlined basins having good underlying infiltration.

- An ANOVA statistical analysis investigated the difference between influent and effluent quality among the three monitoring seasons (2003-04, 2004-05, and 2005-06). The results suggest the difference between influent and effluent did not vary significantly over the three-year monitoring period for most of the constituents of concern. There were significant differences for total phosphorus and total iron, which were the result of higher influent levels for these two parameters in 2004-05 at Basin B103. In all cases, the effluent quality remained consistent and increases in the influent quality did not significantly impact the effluent levels. Effluent TSS and turbidity data at Basin B111 had statistically significant decreasing trends over the three years that indicated improving treatment performance.

- The duration the filter media remains effective has not been established during this study because there has been no filter bed "breakthrough" or deterioration in treatment performance observed at the sites. The results of this pilot study indicate that the treatment effectiveness of activated alumina media is at least three years, but may be as long as 9 years of more.

- Higher levels of effluent pH and dissolved aluminum were noted during the first year. Washing of the activated alumina media is required after installation to help prevent this.

- Recommendations include further monitoring to determine media life.

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **Caltrans Lake Tahoe Storm Water Small-Scale Pilot Treatment Project**
Phase V Final Report- February 2007

DOCUMENT #: **CTSW-RT-06-157.04.01**

DOCUMENT DATE: **February 2007**

OBJECTIVES

- The overall goal of the Lake Tahoe Stormwater Small-Scale Pilot Project is to evaluate suitable stormwater treatment technologies for use in the Lake Tahoe Basin.
- For sites without the space to accommodate low-rate filters, Caltrans has started to focus on treatment devices with smaller footprints capable of higher loadings.
- The main thrust of the Phase V studies relates to testing the performance of these small-footprint devices. Phase V studies included:
  - Filtration Optimization Study
  - Testing of Sand Cap Viability
  - Testing of Dual Media
  - Testing of Chemically Enhanced Settling

ACTIVITIES

- Twenty-seven 4-inch granular media filter columns were operated six times to evaluate the effects that loading rate, media grain size and level of stormwater pretreatment had on filter media performance.
- Chemically-Enhanced Settling Rate Experiments. For each stormwater sample collected, a series of jar and settling tests were conducted.
- Sand Cap Viability (Low-Rate) Filter Columns. Two 4-inch diameter granular media filters were operated in four runs to evaluate the effect of the sand cap on filter treatment and hydraulic performance.
- Dual Media (Low-Rate) Filter Columns**.** Three 3-inch diameter granular media filter columns were operated to evaluate the performance of two-stage dual media filters.
- Constituents:

➢ Total & Dissolved Phosphorous
➢ Turbidity
➢ Total & Dissolved Nitrogen
➢ Total & Dissolved Aluminum
➢ TSS

GENERAL CONCLUSIONS/RECOMENDATIONS

- With the media and loading rates used in Phase V filter optimization testing, filter columns fed with geotextile pretreated water, on average, operated the equivalent of

at least one year in the field before hydraulic failure. Without any pretreatment, only the medium and course grain media, loaded at the two lower rates (0.25 and 0.50 gpm/ft^2), lasted the equivalent of one year in the field without hydraulic failure. Using a chemical clarifier pretreatment, only the coarse grain size media loaded at the low rate lasted the equivalent of one year. In general, as the filter loading rate increased or grain size decreased, the filter hydraulic failure rate increased, regardless of the means of pretreatment.

- Based on the results of the Sand Cap Viability study, a protective sand cap can be effective in extending the hydraulic lifetime of a granular media filter. However, there was no apparent improvement in treatment performance with the sand cap.
- A Dual Media filter consisting of a layer of activated alumina over a layer of iron modified activated alumina may help mitigate the high effluent pH commonly associated with activated alumina filters. However, the pH from the dual media system may be somewhat lower than desired when influent stormwater pH is also low. The Dual Media concept was successful in mitigating the elevated dissolved aluminum commonly present in activated alumina filter effluents.
- Based on differing results obtained for many of the stormwaters collected in Phase V, as compared to results from previous phases, it is evident that fixed chemical dosing can not be expected to provide effective treatment results in all cases. Using the historical average doses of two promising polyaluminum chlorides (100 and 75 mg/L, respectively), only two of six Phase V stormwaters would have been treated. Additionally, even at optimal dose, the settled turbidities after 15 minutes were not as low in the Phase V waters as observed in previous project phases. The 2005/2006 winter season was one of the wettest years on record. Four of six stormwaters collected had atypically low levels of alkalinity and electrical conductivity, which may have contributed to overall poor coagulant performance.
- Settling rates in jar testing do not necessarily represent the performance in the larger scale settling columns, likely due to energy input and settling distance. Dosing the settling columns at the low end of the treatment range was generally ineffective. Chemical doses at the best turbidity dose (BTD) and the upper end of the treatment range generally provided effective treatment. Even with the difficulties noted in treating the Phase V stormwaters, chemical treatment with the promising polyaluminum chlorides in the settling columns was able to reduce the stormwater turbidity to below the 20 NTU benchmark after 6.1 hours of settling or less in all cases. Although the polyacrylanide tested was able to treat the Phase V stormwater, it was unable to reduce the turbidity to below 20 NTU in any of the six settling column experiments.

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **Mechanical Cleaning Design Concepts Reconnaissance Study**

DOCUMENT #: **CTSW-RT-07-172.31.2**

DOCUMENT DATE: **June 2007**

OBJECTIVES

- Investigate alternative cleaning designs for the existing, approved Caltrans gross solids removal devices (GSRDs) Best Management Practices (BMPs). The cleaning designs incorporate mechanical cleaning components.

ACTIVITIES

- Conduct a literature review to identify mechanical cleaning concepts currently used in the wastewater industry and elsewhere that may be applied to the approved GSRDs.
- Perform a comparative analysis, based on information provided in the literature review, to identify potential mechanical concepts. For each design proposed concept, the analysis included a best engineering judgment of: (i) applicability, (ii) level of design development, (iii) capital cost, and (iv) operation and maintenance costs.

GENERAL CONCLUSIONS/RECOMENDATIONS

- The "cinch-sack" concept, developed for the Inclined Screen-Configuration #1, is recommended for further pilot testing.

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **Performance Evaluation of a Detention Basin based on Removal of Particles and Associated Pollutants.**

DOCUMENT #: **CTSW-RT-06-168.05.1**

DOCUMENT DATE: **April 2007**

OBJECTIVES

- Measure Particle Size Distribution (PSD) in detention basin influent and effluent.
- Measure total suspended solids (TSS) and suspended-sediment concentration (SSC) of runoff samples and correlate them with PSD.
- Measure major metal constituents associated with different particle size ranges in centrifuged solid particles from detention basin influent and effluent samples.
- Measure the toxicity of detention influent and effluent samples.
- Evaluate the performance of detention basin based on removal of particles, metals, and toxicity.

ACTIVITIES

- Monitoring of influent and effluent stormwater quality at the I-605/SR-91 detention basin.
- Five storms monitored during the 2005-06 wet season—organic and inorganic constituents, and toxicity.
- Influent and effluent samples were centrifuged to collect representative solids to evaluate PSD and fractionate particles into different size ranges.
- Concentrations of metal pollutants associated with the various particle size ranges were measured.
- The performance of the detention basin was assessed based on particle concentration, pollutant mass, and level of toxicity removal.

GENERAL CONCLUSIONS/RECOMENDATIONS

- The majority of the particles, greater than 90-percent, in the influent samples were less than 2μm in diameter. However, the particles less than 2μm in diameter contributed less than 3-percent of the total particle mass.
- Metal mass concentrations in the centrifuged solids were measured in the following decreasing order: Zn > Pb > Cu > Ni > Cd.
- Calculated pollutant mass removal efficiencies indicate that significant portions of the particle-bound constituent mass was removed from the detention basin after a 24-hour holding time (e.g., > 80-percent of TSS, total copper and lead).
- Results obtained from monitored storm events revealed that particles with diameters greater than 50 μm were completely removed from the detention basin within 24 hours.

No measurable toxicity was observed from the detention basin effluent during these storm events.

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **District 12 State Route 73 BMP Pilot Program 2005-2006 GSRDs Wet Season Volumes I & II (Interim Report and Lab Data; Volume II summarizes Detention Basins)**

DOCUMENT #: **CTSW-RT-06-131.01.2**

DOCUMENT DATE: **February 2007**

OBJECTIVES

- Develop and test detention basin Best Management Practices (BMPs) of different design volumes to assess if a decrease in detention basin size affects the water quality of the effluent.
- Develop and test detention basin BMPs with different operational methods (overflow vs. bypass vs. semi-batch) to assess which one produces the best water quality effluent.
- Develop and test detention basin BMPs with different outlet structures to assess which one produces the best water quality effluent.
- Develop and test detention basin BMPs with different inlet structures to evaluate if any design leads to a reduction in maintenance.
- Develop and test trash BMPs that comply with the Southern California trash Total Maximum Daily Load requirements—Gross Solids Removal Devices (GSRDs).
- Develop and test media filter BMPs (bioretention area, partial-sedimentation Austin sand filters, full-sedimentation Austin sand filters) and compare the performance results to standard detention basins.

ACTIVITIES

- Water quality monitoring of influent, effluent, and overflow or bypass of detention basins.
- Gross solids monitoring of GSRD BMPs.
- Vector monitoring at all sites to assess if any of the pilot BMPs lead to the breeding of vectors.

GENERAL CONCLUSIONS/RECOMENDATIONS

None—study on-going.

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CALTRANS STUDY FACT SHEET

DOCUMENT NAME: **Annual Report 2006-2007: State Route 56 CDS & Receiving Water Monitoring**

DOCUMENT #: **CTSW-RT-07-650.15.1**

DOCUMENT DATE: **May 2007**

OBJECTIVES

- Document downstream water quality during and following the completion of construction of the east-west linkage of State Route 56 (SR-56) to evaluate potential water quality impacts in accordance with the requirements of Special Condition No. 5 of the Notice of Intent to Issue Permit Application No. 6-98-127, California Coastal Commission.
- Document the gross solids removal effectiveness of two CDS units per the California Coastal Commission permit granted for the project.

ACTIVITIES

- Gross solids monitoring: floatable, debris and sediment quantification and sediment analysis.
- Receiving water quality monitoring in Carmel Valley Creek at four locations.

GENERAL CONCLUSIONS/RECOMENDATIONS

Receiving Water Monitoring

- Year 5 of 5 of the monitoring program.
- No metals water quality objectives for Carmel Valley Creek were exceeded at any of the sites.
- Phosphorous concentrations exceeded water quality objectives for all 4 sites.
- Nitrate (NO_2-N) concentrations were all below reporting limits.
- Oil and grease data were below detection.

Gross Solids Monitoring

- Influent zinc concentrations at both CDS sites were above water quality objectives, but effluent zinc concentrations were below.
- Influent copper concentrations at both CDS sites were above water quality objectives. Effluent copper concentration remained the same at one CDS site while below at the other CDS site.
- Total phosphorous influent and effluent concentrations at both CDS sites were above the Carmel Valley Creek water quality objective.

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APPENDIX C

SUMMARY OF MONITORING SITES AND PROJECT STATUS

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Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
1	Bioretention	San Francisco - Oakland Bay Bridge Bioretention	SFOBB East Span Seismic Safety Project (ESSSP) Bioretention Basin	TBD	I-80	10.1	4	Alameda	San Francisco Bay	Complete	Complete	Complete	Monitoring to begin Fall 08 and will continue through Spring 13	Monitoirng to continue for 5 years as agreed to with RWQCB	NS
2	Bioretention	San Francisco - Oakland Bay Bridge Bioretention	SFOBB East Span Seismic Safety Project (ESSSP) Bioretention Basin	TBD	I-80	12.3	4	Alameda	San Francisco Bay	Complete	Complete	Complete	Monitoring to begin Fall 08 and will continue through Spring 13	Monitoirng to continue for 5 years as agreed to with RWQCB	NS
3	Bioretention	District 12 SR73 Pilot Program - Bioretention	Bioretention Filter	12-329 to 330	SR73	23.6	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 2006, and will continue through 2010.		NS
4	Chemical Treatment	Chemical Treatment: Tahoe Small-Scale Studies	Tahoe Basin Small-Scale Pilot Studies: Chemical Treatment	NA	NA	NA	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring began Fall 01 and will continue through Spring 08	Study being conducted at Meyers Maintenance Station Small-Scale Test Facility	pH, EC, turbidity, phosphorous, and others depending on specific study
5	Detention Basins	District 12 SR73 Pilot Program - Bypass Detention Basins	Bypass Detention Basin: 100% Design Volumen (Basin 930)	12-248 to 250	SR73	19.61	12	Orange	San Diego/Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
6	Detention Basins	District 12 SR73 Pilot Program - Bypass Detention Basins	Bypass Detention Basin: 75% Design Volume (Basin 883)	12-236 to 238	SR73	18.77	12	Orange	San Diego/Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
7	Detention Basins	District 12 SR73 Pilot Program - Bypass Detention Basins	Bypass Detention Basin: 50% Design Volume (Basin 893)	12-239 to 241	SR73	18.96	12	Orange	San Diego/Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
8	Detention Basins	District 12 SR73 Pilot Program - Bypass Detention Basins	Bypass Detention Basin: 25% Design Volume (Basin 922R East)	12-242 to 244	SR73	19.51	12	Orange	San Diego/Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
9	Detention Basins	District 12 SR73 Pilot Program - Overflow Detention Basins	Overflow Detention Basin: 100% Design Volume (Basin 1143)	12-257 to 259	SR73	23.62	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
10	Detention Basins	District 12 SR73 Pilot Program - Overflow Detention Basins	Overflow Detention Basin: 75% Design Volume (Basin 1137)	12-254-256	SR73	23.51	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
11	Detention Basins	District 12 SR73 Pilot Program - Overflow Detention Basins	Overflow Detention Basin: 50% Design Volume (Basin 922R West)	12-245 to 247	SR73	19.51	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
12	Detention Basins	District 12 SR73 Pilot Program - Overflow Detention Basins	Overflow Detention Basin: 25% Design Volume (Basin 1032)	12-251 to 253	SR73	21.53	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
13	Detention Basins	District 12 SR73 Pilot Program - Semi-Batch Detention Basins	Semi-Batch Detention Basin: 100% Design Volume (Basin 535)	12-308 to 310	SR73	12.17	12	Orange	San Diego	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
14	Detention Basins	District 12 SR73 Pilot Program - Semi-Batch Detention Basins	Semi-Batch Detention Basin: 75% Design Volume (Basin 613)	12-311 to 313	SR73	13.65	12	Orange	San Diego	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
15	Detention Basins	District 12 SR73 Pilot Program - Semi-Batch Detention Basins	Semi-Batch Detention Basin: 50% Design Volume (Basin 457)	12-305 to 307	SR73	10.7	12	Orange	San Diego	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
16	Detention Basins	District 12 SR73 Pilot Program - Semi-Batch Detention Basins	Semi-Batch Detention Basin: 25% Design Volume (Basin 654)	12-314 to 316	SR73	14.43	12	Orange	San Diego	Complete	Complete	Complete	Monitoing began Fall 04 And will continue through Spring 09.		NS
17	Detention Basins	District 12 SR73 Pilot Program - Surface Drained Detention Basins (Floating Skimmer Outlet)	Surface Drained Detention Basin (Floating Skimmer Outlet): 100% Design Volume (Basin 859)	12-323 to 325	SR73	18.31	12	Orange	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 09.		NS
18	Detention Basins	District 12 SR73 Pilot Program - Surface Drained Detention Basins (Floating Skimmer Outlet)	Surface Drained Detention Basin (Floating Skimmer Outlet): 75% Deisgn Volume (Basin 878)	12-320 to 322	SR73	18.67	12	Orange	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 09.		NS
19	Detention Basins	District 12 SR73 Pilot Program - Surface Drained Detention Basins (Floating Skimmer Outlet)	Surface Drained Detention Basin (Floating Skimmer Outlet): 50% Design Volume (Basin 780)	12-332 to 334	SR73	16.81	12	Orange	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 09.		NS

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
20	Detention Basins	District 12 SR73 Pilot Program - Surface Drained Detention Basins (Floating Skimmer Outlet)	Surface Drained Detention Basin (Floating Skimmer Outlet): 25% Design Volume (Basin 808)	12-317 to 319	SR73	17.34	12	Orange	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 09.		NS
21	Detention Basins	District 12 SR73 Pilot Program - Alternative Inlet Detention Bains	Alternative Inlet Detention Basin: Linear Radial Device Config 1 (1076R)	NA	SR73	23.42	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring (operational and gross solids only) began Fall 05 and will continue through Spring 08.	no water quality monitoring	Litter
22	Detention Basins	District 12 SR73 Pilot Program - Alternative Inlet Detention Bains	Alternative Inlet Detention Basin: two Linear Radial Devices Config 1 (1081L)	NA	SR73	22.51	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring (operational and gross solids only) began Fall 05 and will continue through Spring 08.	no water quality monitoring	Liter
23	Detention Basins	District 12 SR73 Pilot Program - Alternative Inlet Detention Bains	Alternative Inlet Detention Basin: V Screen Config 1 (1085L)	NA	SR73	22.5	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 05 and continued through Spring 07	Converting pilot project to SWMP-approved detention basin.	Litter
24	Detention Basins	District 12 SR73 Pilot Program - Alternative Inlet Detention Bains	Alternative Inlet Detention Basin: IS3 (1180L)	NA	SR73	24.4	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 05 and continued through Spring 07	Device being turned over to District Maintenance.	Litter
25	Detention Basins	District 3 Tahoe - Semi Batch Detention Basins	Semi-Batch (Hold & Release) Detention Basin	TBD	Hwy 267	8.03	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring to begin Fall 2008 and continue through Spring 11		NS
26	Detention Basins	District 3 Tahoe - Semi Batch Detention Basins	Semi-Batch (Hold & Release) Detention Basin	TBD	Hwy 267	7.73	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring to begin Fall 2008 and continue through Spring 11		NS
27	Detention Basins	District 3 Tahoe - Semi Batch Detention Basins	Semi-Batch (Hold & Release) Detention Basin	TBD	Hwy 267	7.61	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring to begin Fall 2008 and continue through Spring 11		NS
28	Detention Basins	District 3 Tahoe - Semi Batch Detention Basins	Semi-Batch (Hold & Release) Detention Basin	TBD	Hwy 267	7.5	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring to begin Fall 2008 and continue through Spring 11		NS
29	Detention Basins	Particle Based Pollutant Removal BMPs	Semi-Batch (Hold & Release) Detention Basin	NA	SR605	4.7	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoirng began Fall 05 and continued through Spring 06	Phase I included methodology development. Phase II included detention basin monitoring. Phase III includes lab studies	Particle Size Distribution (dimensions, shape, elemental composition); TSS; Turbidity; Heavy Metals; DOC
30	Detention Basins	Particle Based Pollutant Removal BMPs	Laboratory Study	NA	NA	NA	NA	NA	NA	NA	NA	NA	Testing began Fall 07 and will continue through Spring 08	Phase I included methodology development. Phase II included detention basin monitoring. Phase III includes lab studies	Particle Size Distribution (dimensions, shape, elemental composition); TSS; Turbidity; Heavy Metals; DOC
31	Detention Basins	First Flush Characterization Study	Laboratory Study	NA	NA	NA	NA	NA	NA	NA	NA	NA	Testing began Fall 00 and conitnued through Spring 05	modeling ongoing	Particle Size Distribution (dimensions, shape, elemental composition); TSS; Turbidity; Heavy Metals; DOC
32	Detention Basins	Detention Basin Outlet Device Development	Hold & Release Valve & Surface Discharge Device Development	NA	NA	NA	NA	NA	NA	NA	To be completed Spring 08	TBD	TBD		TBD
33	Drain Inlet Inserts	Drain Inlet Inserts	Drain Inlet Inserts	NA	NA	NA	3	Sacramento	Central Valley	Complete	Complete	Complete	Monitoring began Fall 2005 and was continued through 2007.	4 DIIs have been constructed at CSUS. Future monitoring of modified DIIs likely.	Cu & Zn
34	GSRDs	District 7 GSRD Pilot Program	Inclined Screen (IS5)	7-305 & 300	I-210/Orcas	8.63	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring began Fall 06 and will continue through Spring 08		Litter

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status					Constituents List
										Site Selection	Design	Construction	Monitoring/Testing	Comments	
35	GSRDs	District 7 GSRD Pilot Program	Inclined Screen (IS5)	7-306 & 309	I-210/Filmore	6.44	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring began Fall 06 and will continue through Spring 08		Litter
36	GSRDs	District 7 GSRD Pilot Program	Inclined Screen (IS5)	7-307	SR91/Cerritos	17.06	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring began Fall 06 and will continue through Spring 08		Litter
37	GSRDs	District 7 GSRD Pilot Program	Forward Sloping V Screen (VS1)	7-301	I-405/Leadwall	42.5	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring began Fall 08 And was discontinued.	Concept abandonned after first year of monitoring. Currently under operational monitoring due to excessived clogging.	NA
38	GSRDs	District 7 GSRD Pilot Program	Steep-Slope Linear Radial Device 9LR3)	7-302	SR101/Gaviota	17.8	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring began Fall 08 And was discontinued.	Concept abandonned after first year of monitoring. Currently under operational monitoring due to excessived clogging.	NA
39	GSRDs	District 7 GSRD Pilot Program	Linear Radial	7-317 & 7-318	60	4.4	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08 and will continue through ???		NS, Litter
40	GSRDs	District 7 GSRD Pilot Program	Linear Radial	7-319 & 7-320	60	5.22	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
41	GSRDs	District 7 GSRD Pilot Program	Linear Radial	7-323 & 7-324	710	22.54	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
42	GSRDs	District 7 GSRD Pilot Program	Inclined Sceen Type 1	7-311 & 7-312	405	32.52	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
43	GSRDs	District 7 GSRD Pilot Program	Inclined Screen Type 1	7-313 & 7-314	405	35.99	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
44	GSRDs	District 7 GSRD Pilot Program	Inclined Screen Type 1	7-315 & 7-316	405	36.15	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
45	GSRDs	District 7 GSRD Pilot Program	Inclined Screen Type 2	7-321 & 7-322	60	6.64	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
46	GSRDs	District 7 GSRD Pilot Program	Inclined Screen Type 2	7-325 & 7-326	710	23	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
47	GSRDs	District 7 GSRD Pilot Program	Inclined Screen Type 2	7-327 & 7-328	710	23	7	Los Angeles	Los Angeles	Complete	Complete	Complete	Monitoring to begin Spring 08. Further years of monitoring TBD.		NS, Litter
48	GSRDs	District 12 SR73 Pilot Program - GSRDs	Incline Screen (IS5, Basin 630)	NA	SR73	13.8	12	Orange	San Diego	Complete	Complete	Complete	Monitoring began Fall 05 aand will continue through Spring 08	no water quality monitoring	Litter
49	GSRDs	District 11 - Continuous Deflection Separators	Continuous Deflection Separator	11-7I1 & 7E1	SR56	0.87	11	San Diego	San Diego	Complete	Complete	Complete	Monitoring began Fall 2002 and will be continued through Spring 08.		NS, Litter
50	GSRDs	District 11 - Continuous Deflection Separators	Continous Deflection Separator	11-7I2 & 7E2	SR56	1.6	11	San Diego	San Diego	Complete	Complete	Complete	Monitoring began Fall 2002 and will be continued through Spring 08.		NS, Litter
51	GSRDs	Laboratory Testing of Modified Linear-Radial GSRDs	Linear Radial GSRDs	NA	NA	NA	NA	NA	NA	NA	NA	NA	Monitoring began Summer 06 and will continue through Spring 08	Study being conducted at UC-Davis Hydraulics laboratory	Litter
52	Infiltration	Alternative Infiltration Trench Structures	Alternative InfiltrationTrench Structures	TBD	TBD	TBD	TBD	TBD	Central Valley	To be completed Spring 08	To be completed Spring 08	To be completed Summer 08	To begin Fall 08 and continue through Spring 11		NA
53	Infiltration	Alternative Infiltration Trench Structures	Alternative InfiltrationTrench Structures	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Spring 08	To be completed Spring 08	To be completed Summer 08	To begin Fall 08 and continue through Spring 11		NA
54	Infiltration	Alternative Infiltration Trench Structures	Alternative InfiltrationTrench Structures	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Spring 08	To be completed Spring 08	To be completed Summer 08	To begin Fall 08 and continue through Spring 11		NA
55	Infiltration	Alternative Infiltration Trench Structures	Alternative InfiltrationTrench Structures	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Spring 08	To be completed Spring 08	To be completed Summer 08	To begin Fall 08 and continue through Spring 11		NA

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
56	Filtration	District 2 - Austin-Type Sand Filters	Austin-Type Sand Filter	2-209 & 208 & 211	I-5	65.73	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Spring 01 and continued through Spring 06	Being handed over to District,. Effluent monitoring is continuing under Long-Term Project	NS
57	Filtration	District 2 - Austin-Type Sand Filters	Austin-Type Sand Filter	2-209 & 210	I-5	15.29	2	Siskiyou	Central Valley	Complete	Complete	Complete	Monitoring began Spring 01 and continued through Spring 06	Being handed over to District.	NS
58	Filtration	District 12 SR73 Pilot Program - Sand Filters	Separate (Full) Sedimentation Austin-Type Sand Filter (Basin 1194)	TBD	SR73	24.7	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		Litter
59	Filtration	District 12 SR73 Pilot Program - Sand Filters	Combined (Partial) Sedimentation Austin-Type Sand Filter (Basin 506)	12-326 to 328	SR73	11.8	12	Orange	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		Litter
60	Filtration	Distric 3 Linear Filtration Trenches	Bioretention Trench	TBD	I-5	13.8-14.8	3	Sacramento	Central Valley	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
61	Filtration	Distric 3 Linear Filtration Trenches	Linear Filtration Trench	TBD	I-5	13.8-14.8	3	Sacramento	Central Valley	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
62	Filtration	Distric 3 Linear Filtration Trenches	Linear Sand Filter	TBD	I-5	13.8-14.8	3	Sacramento	Central Valley	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
63	Filtration	Distric 3 Linear Filtration Trenches	Ecology Embankment	TBD	I-5	13.8-14.8	3	Sacramento	Central Valley	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
64	Filtration	Distric 3 Linear Filtration Trenches	Low Head Ecology Embankment	TBD	I-5	13.8-14.8	3	Sacramento	Central Valley	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
65	Filtration	Distric 3 Linear Filtration Trenches	Full-Draining Delaware Filter	TBD	I-5	13.8-14.8	3	Sacramento	Central Valley	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
66	Filtration	Distric 3 Linear Filtration Trenches	Vegetated Rock Filter	TBD	I-5	13.8-14.8	3	Sacramento	Central Valley	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
67	Filtration	District 7 Linear Filtration Trenches	Bioretention Trench	TBD	I-210	5.0-6.0	7	Los Angeles	Los Angeles	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
68	Filtration	District 7 Linear Filtration Trenches	Linear Filtration Trench	TBD	I-210	5.0-6.0	7	Los Angeles	Los Angeles	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
69	Filtration	District 7 Linear Filtration Trenches	Linear Sand Filter	TBD	I-210	5.0-6.0	7	Los Angeles	Los Angeles	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
70	Filtration	District 7 Linear Filtration Trenches	Ecology Embankment	TBD	I-210	5.0-6.0	7	Los Angeles	Los Angeles	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
71	Filtration	District 7 Linear Filtration Trenches	Low Head Ecology Embankment	TBD	I-210	5.0-6.0	7	Los Angeles	Los Angeles	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
72	Filtration	District 7 Linear Filtration Trenches	Full-Draining Delaware Filter	TBD	I-210	5.0-6.0	7	Los Angeles	Los Angeles	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
73	Filtration	District 7 Linear Filtration Trenches	Vegetated Rock Filter	TBD	I-210	5.0-6.0	7	Los Angeles	Los Angeles	Complete	To be completed Spring 08	To be completed Summer 08	Monitoring to begin Fall 08 and continue through Spring 11		NS, turbidity, Selenium, & Bacteria
74	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Activated Alumina (12-inch depth)	3-234 to 236 & 341	Hwy 50	73.1	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring began Fall 03 and will continue through Spring 08		NS, Iron, Turbidity, Oil/Grease
75	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Activated Alumina (12-inch depth, reduced area)	3-237 to 239	Hwy 50	73.65	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring began Fall 03 and will continue through Spring 08		NS, Iron, Turbidity, Oil/Grease
76	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Limestone (24-inch depth)	3-309 to 311	SR267	7.23	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring began Fall 05 and will continue through Spring 09		NS, Iron, Turbidity, Oil/Grease

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
77	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Activated Alumina (24-inch depth)	3-312 to 314	SR267	7.13	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring began Fall 05 and will continue through Spring 09		NS, Iron, Turbidity, Oil/Grease
78	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Iron-modified Activated Alumina (24-inch depth)	3-315 to 317	SR267	7.06	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring began Fall 05 and will continue through Spring 09		NS, Iron, Turbidity, Oil/Grease
79	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Iron-modified Activated Alumina (12-inch depth, reduced area)	3-318 to 320	SR267	6.08	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring began Fall 05 and will continue through Spring 09		NS, Iron, Turbidity, Oil/Grease
80	Filtration	Alternative Media Filters: Northern California	Media TBD	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Summer 08	To be completed Fall 08	To be completed Fall 08	Monitoirng to begin Fall 09 and continue through Spring 12		TBD
81	Filtration	Alternative Media Filters: Northern California	Media TBD	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Summer 08	To be completed Fall 08	To be completed Fall 08	Monitoirng to begin Fall 09 and continue through Spring 12		TBD
82	Filtration	Alternative Media Filters: Northern California	Media TBD	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Summer 08	To be completed Fall 08	To be completed Fall 08	Monitoirng to begin Fall 09 and continue through Spring 12		TBD
83	Filtration	Alternative Media Filters: Northern California	Media TBD	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Summer 08	To be completed Fall 08	To be completed Fall 08	Monitoirng to begin Fall 09 and continue through Spring 12		TBD
84	Filtration	Alternative Media Filters: Northern California	Media TBD	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Summer 08	To be completed Fall 08	To be completed Fall 08	Monitoirng to begin Fall 09 and continue through Spring 12		TBD
85	Filtration	Alternative Media Filters: Northern California	Media TBD	TBD	TBD	TBD	TBD	TBD	TBD	To be completed Summer 08	To be completed Fall 08	To be completed Fall 08	Monitoirng to begin Fall 09 and continue through Spring 12		TBD
86	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Small Footprint Media Filter with Activated Alumina	3-301 to 303 & 333 & 334 & 345	SR267	6.87	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10	Old TR2000 site that was converted. BMP will be re-configured each year	NS & turbidity
87	Filtration	Alternative Media Filters: Tahoe Basin Full-Scale Pilot Studies	Small Footprint Media Filter with Activated Alumina	3-304 to 306 & 335 & 336 & 346	SR267	6.78	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10	Old TR2000 site that was converted. BMP will be re-configured each year	NS & turbidity
88	Filtration	Alternative Media Filters: Tahoe Small-Scale Studies	Large Footprint Filter Development	NA	NA	NA	3	El Doarado	Lahontan	Complete	Complete	Complete	Monitoirng began Winter/Spring 02 and will continue through Spring 08	Study being conducted at Meyers Maintenance Station Small-Scale Test Facility	NS, Iron, Turbidity, Oil/Grease
89	Filtration	Alternative Media Filters: Tahoe Small-Scale Studies	Small Footprint Filter Development	NA	NA	NA	3	El Doarado	Lahontan	Complete	Complete	Complete	Monitoring began Fall 05 and will continue through Spring 08	Study being conducted at Meyers Maintenance Station Small-Scale Test Facility	NS, Iron, Turbidity, Oil/Grease
90	Filtration	Sand Filters: Tahoe Small-Scale Studies	Tahoe Basin Small-Scale Pilot Studies: Sand Filters	NA	NA	NA	3	El Doarado	Lahontan	Complete	Complete	Complete	Monitoring began Fall 01 and will continue through Spring 08	Study being conducted at Meyers Maintenance Station Small-Scale Test Facility	phosphorous, and others depending on specific study
91	Vegetated Treatment Systems	District 7 Bioswale	Bioswale	7-171 to 172	I-5/I605	6.95	7	Los Angeles	Los Angeles	Complete	Complete	Retrofit to be completed Spring 08	Monitoring to begin Spring 08. Continued monitoring unknown at this time.	Study plan to be reassessed Summer 07	TBD
92	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slope with flat slope with good potentinal for sheetflow	TBD	Hwy 89	0.45	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		TBD
93	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slope with moderate slope with moderate potential for sheetflow	TBD	Hwy 89	1.24	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
94	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slope with moderate slope with some potential for sheetflow	TBD	Hwy 89	0.89 - 1.20	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
95	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slopee with moderate slope and little potential for sheetflow	TBD	Hwy 89	1.24	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
96	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slope with moderate slope with moderate potential for sheetflow	TBD	Hwy 50	72.06	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
97	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slope with moderate slope with moderate potential for sheetflow	TBD	Hwy 50	72.06	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
98	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slope with moderate slope with some potential for sheetflow	TBD	Hwy 50	72.06	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
99	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Roadside slope with moderate slope with some potential for sheetflow	TBD	Hwy 50	71.89	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
100	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Influent station (Sand Trap)	TBD	Hwy 89	TBD	3	El Dorado	Lahontan	To be completed Spring 08	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
101	Vegetated Treatment Systems	District 3 Tahoe Roadside Treatment Systems	Influent Station (Sand Trap)	TBD	Hwy 50	CDM	3	El Dorado	Lahontan	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11	Need to get PM from CDM	NS
102	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	3-213	I-5	13.5	3	Sacramento	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and will be monitored through at least Spring 08		NS
103	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 1.1 m strip	3-214	I-5	13.5	3	Sacramento	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and will be monitored through at least Spring 08		NS
104	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 4.6 m strip	3-215	I-5	13.5	3	Sacramento	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
105	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 6.6 m strip	3-216	I-5	13.5	3	Sacramento	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
106	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 8.4 m strip	3-217	I-5	13.5	3	Sacramento	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
107	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	2-201	I-5	1.5	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
108	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 9.3 m strip	2-202	I-5	1.5	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
109	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	2-203	SR299	26	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and will be monitored through at least Spring 08		NS
110	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 2.2 m strip	2-204	SR299	26	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and will be monitored through at least Spring 08		NS
111	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 4.2 m strip	2-205	SR299	26	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and will be monitored through at least Spring 08		NS
112	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 6.2 m strip	2-206	SR299	26	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06	Site is still being monitored under Long-Term Characteization Study	NS
113	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	4-213	Hwy 101	15	4	Marin	San Francisco Bay	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS

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114	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 8.3 m strip	4-214	Hwy 101	15	4	Marin	San Francisco Bay	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
115	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	12-225	SR91	15	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and will be monitored through at least Spring 08		NS
116	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 2.3/1.4 m strip	12-226	SR91	15	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
117	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 5.4/4.4 m strip	12-227	SR91	15	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
118	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 7.6 m strip	12-228	SR91	15	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
119	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 13.0 m strip	12-229	SR91	15	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and will be monitored through at least Spring 08		NS
120	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	12-230	I-405	2.5	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and conintued through Fall 03		NS
121	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 3.0 m strip	12-231	I-405	2.5	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and conintued through Fall 03		NS
122	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 6.0 m stirp	12-232	I-405	2.5	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began and ended Spring 03		NS
123	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 13.0 m strip	12-233	I-405	2.5	12	Orange	Santa Ana	Complete	Complete	Complete	Monitoring began and ended Spring 03		NS
124	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	8-201	SR60	14	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
125	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 2.6 m strip	8-202	SR60	14	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
126	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 4.9 m strip	-203	SR60	14	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
127	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 8.0 m strip	8-204	SR60	14	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
128	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 9.9 m strip	8-205	SR60	14	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
129	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	11-204	I-5	70.4	11	San Diego	San Diego	Complete	Complete	Complete	Monitoring began Fall 01 and will continue through at least Spring 08		NS
130	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 1.3 m stirp	11-205	I-5	70.4	11	San Diego	San Diego	Complete	Complete	Complete	Monitoring began Fall 01 and will continue through at least Spring 08		NS
131	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 5.3 m strip	11-206	I-5	70.4	11	San Diego	San Diego	Complete	Complete	Complete	Monitoring began Fall 01 and continued through Spring 06		NS
132	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 9.9 m strip	11-207	I-5	70.4	11	San Diego	San Diego	Complete	Complete	Complete	Monitoring began Fall 01 and will continue through at least Spring 08	Site is still being monitored under Long-Term Characteization Study	NS
133	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	8-305	I-15	8.5	8	Riverside	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
134	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 4 m strip	8-306	I-15	8.5	8	Riverside	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS

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135	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 4 m strip	8-307	I-15	8.5	8	Riverside	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
136	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 8 m strip	8-308	I-15	8.5	8	Riverside	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
137	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 8 m strip	8-309	I-15	8.5	8	Riverside	San Diego	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
138	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: EOP (0 m strip)	8-300	I-215	35.5	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
139	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 4 m strip	8-301	I-215	35.5	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
140	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 4 m strip	8-302	I-215	35.5	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
141	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 8 m strip	8-303	I-215	35.5	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
142	Vegetated Treatment Systems	Roadside Vegetated Treatment Sites (RVTS) Study	RVTS: 8 m strip	8-304	I-215	35.5	8	Riverside	Santa Ana	Complete	Complete	Complete	Monitoring began Fall 07 and will continue through Spring 10		NS
143	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation Acacia redolens, Myoporum parvifolium, & Hedera helix	TBD	I-5	13.5	3	Sacramento	Central Valley	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
144	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation Acacia redolens, Myoporum parvifolium, & Hedera helix	TBD	I-5	13.5	3	Sacramento	Central Valley	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
145	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation Acacia redolens, Myoporum parvifolium, & Hedera helix	TBD	I-5	13.5	3	Sacramento	Central Valley	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
146	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation Baccharis pilularis, Hedera helix, & Rosmarinus officinalis	TBD	SR299	26	2	Shasta	Central Valley	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
147	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation Baccharis pilularis, Hedera helix, & Rosmarinus officinalis	TBD	SR299	26	2	Shasta	Central Valley	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
148	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation Baccharis pilularis, Hedera helix, & Rosmarinus officinalis	TBD	SR299	26	2	Shasta	Central Valley	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
149	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation TBD	TBD	SR91	15	12	Orange	Santa Ana	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
150	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation TBD	TBD	SR91	15	12	Orange	Santa Ana	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
151	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Expanded RVTS: 5 m strip, with vegetation TBD	TBD	SR91	15	12	Orange	Santa Ana	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
152	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ice plant	TBD	SR680	17.6	4	Santa Clara	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS

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153	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing icpelant	TBD	SR680	17.6	4	Santa Clara	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
154	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing iceplant	TBD	SR680	17.6	4	Santa Clara	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
155	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ivy	TBD	SR 280	0.4	4	San Francisco	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
156	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ivy	TBD	SR 280	0.4	4	San Francisco	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
157	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ivy	TBD	SR 280	0.4	4	San Francisco	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
158	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip) with existing iceplant	TBD	380	not availabe	4	San Mateo	San Francisco Bay	To be completed spring 08	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11	located just west of El Camino Real onramp to WB380	NS
159	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	380	not availabe	4	San Mateo	San Francisco Bay	To be completed spring 08	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11	located just west of El Camino Real onramp to WB380	NS
160	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	380	not availabe	4	San Mateo	San Francisco Bay	To be completed spring 08	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11	located just west of El Camino Real onramp to WB380	NS
161	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ivy	TBD	SR299	10.4	4	Napa	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
162	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing Ivy	TBD	SR299	10.4	4	Napa	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
163	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing Ivy	TBD	SR299	10.4	4	Napa	San Francisco Bay	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
164	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ivy	TBD	SR101	30	5	San Luis Obispo	Central Coast	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
165	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing Ivy	TBD	SR101	30	5	San Luis Obispo	Central Coast	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
166	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing Ivy	TBD	SR101	30	5	San Luis Obispo	Central Coast	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
167	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ice plant	TBD	SR101	N/A	5	San Luis Obispo	Central Coast	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
168	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR101	N/A	5	San Luis Obispo	Central Coast	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
169	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR101	N/A	5	San Luis Obispo	Central Coast	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
170	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ice plant	TBD	SR101	15.8	7	Ventura	Los Angeles	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
171	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR101	15.8	7	Ventura	Los Angeles	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
172	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR101	15.8	7	Ventura	Los Angeles	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
173	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ice plant	TBD	SR101	14.5	7	Ventura	Los Angeles	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS

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174	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR101	14.5	7	Ventura	Los Angeles	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
175	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR101	14.5	7	Ventura	Los Angeles	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
176	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: swale, with existing ice plant	TBD	SR101	7	7	Ventura	Los Angeles	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
177	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ice plant	TBD	I-5	22	11	San Diego	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
178	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	I-5	22	11	San Diego	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
179	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	I-5	22	11	San Diego	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
180	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ice plant	TBD	SR52 or 78	0.2 or 9.5	11	San Diego	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
181	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR52 or 78	0.2 or 9.5	11	San Diego	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
182	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	SR52 or 78	0.2 or 9.5	11	San Diego	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
183	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: swale, with existing ice plant	TBD	I-5	47	11	San Diego	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
184	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: EOP (0 m strip), with existing ice plant	TBD	I-405	N/A	12	Orange	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
185	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	I-405	N/A	12	Orange	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
186	Vegetated Treatment Systems	Oranmental Roadside Vegetated Treatment Sites (RVTS) Study	Groundcover RVTS: 5 m strip, with existing ice plant	TBD	I-405	N/A	12	Orange	San Diego	Complete	To be completed spring 08	To be completed spring 08	To begin Fall 08 and continue through Spring 11		NS
187	Vector Studies	Vector Studies: SR73 Pilot Studies	Vector Studies: SR73 Pilot Studies	Various	SR73	Various	12	Various	San Diego & Santa Ana	Complete	Complete	Complete	Monitoring began Summer 04 and will continue through Summer 08	Study includes all SR73 pilot sites; 23 sites in all	NA
188	Vector Studies	North Lake Tahoe Vector Production of Existing Storm Drain Structures and BMPs	North Lake Tahoe Vector Production of Existing Storm Drain Structures and BMPs Hwy 89	Various	Hwy 89	Various	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring began Summer 05 and continued through Summer 06	Includes Drain Inlets, Drain Inlets with a sump or sand trap, and double-barrel sand traps	NA
189	Vector Studies	North Lake Tahoe Vector Production of Existing Storm Drain Structures and BMPs	North Lake Tahoe Vector Production of Existing Storm Drain Structures and BMPs Hwy 28	Various	Hwy 28	Various	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring began Summer 05 and continued through Summer 06	Includes Drain Inlets, Drain Inlets with a sump or sand trap, and double-barrel sand traps	NA
190	Vector Studies	South Lake Tahoe Vector Production Study	South Lake Tahoe Vector Production Study	Various	Hwy 50	Various	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring began Winter 04 and continued through Spring 06	includedvarious Hwy 50 pilots	NA
191	Vector Studies	Statewide Larval Development Study	Statewide Larval Development Study	Various	Various	Various	Various	Various	Various	Complete	Complete	Complete	Monitoring began Summer 06 and continued through Spring 07	Statewide locations	NA
192	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	Hwy 101	86	5	Mendocine	Central Coast	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
193	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	Hwy 128	28	1	Mendocine	North Coast	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
194	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	Hwy 101	38	1	Monterey	San Francisco Bay	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
195	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	Hwy 41	0	5	San Luis Obispo	Central Coast	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
196	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	I-5	35	2	Tehama	Central Valley	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
197	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	I-5	45	2	Tehama	Central Valley	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
198	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	Hwy 70	15	3	Sutter	Central Valley	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
199	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	I-80	0.4	3&4	Yolo & Solano	Central Valley	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11	Site is on District and County border	NS
200	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	I-5	12	10	Fresno	Central Coast	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
201	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	Hwy 140	27	10	Fresno	Central Coast	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
202	Porous Pavement	Open Graded Asphalt Pavements	Open Graded Asphalt Pavement	TBD	Hwy 99	40	6	Tulare	Central Valley	Complete	Complete	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 11		NS
203	Porous Pavement	Porous Pavement Development	Full-Depth Porous Pavement Development	NA	NA	NA	3	Yolo	Central Valley	TBD	TBD	TBD	TBD	UC-Davis Study	TBD
204	Source/Erosion Control	RECM (VEMS)	RECM (VEMS)	NA	NA	NA	NA	NA	NA	Complete	Complete	Complete	Testing began 02 and will continue through Spring 09	Studies being conducted at Cal Poly Campus	TSS, turbidity
205	Source/Erosion Control	Development of Erosion Control Methods for Adverse Soil Conditions	Soil Regeneration - 1	NA	SR101/Willitz	38.4	1	Mendocino	North Coast	Complete	Complete	Complete	Monitoring began Fall 03 and continued throug Spring 04	Vic Claussen study - UC-Davis	NA
206	Source/Erosion Control	Development of Erosion Control Methods for Adverse Soil Conditions	Soil Regeneration - 1	NA	SR20/Colusa	1.5	3	Colusa	Central Valley	Complete	Complete	Complete	Monitoring began Fall 03 and continued throug Spring 04	Vic Claussen study - UC-Davis	NA
207	Source/Erosion Control	Development of Erosion Control Methods for Adverse Soil Conditions	Soil Regeneration -1	NA	SR299/Buck horn Summit	0.06	2	Shasta	Central Valley	Complete	Complete	Complete	Monitoring began Fall 03 and continued throug Spring 04	Vic Claussen study - UC-Davis	NA
208	Source/Erosion Control	Development of Erosion Control Methods for Adverse Soil Conditions	Soil Regeneneration - 1	NA	I-80/Blue Canyon	51.5	3	Placer	Central Valley	Complete	Complete	Complete	Monitoring began Fall 03 and continued throug Spring 04	Vic Claussen study - UC-Davis	NA
209	Source/Erosion Control	Development of Erosion Control Methods for Adverse Soil Conditions	Soil Regeneration - 2	NA	SR49/SR398 /Conway	24.1	9	El Dorado	Lahontan	Complete	to be completed Spring 08	to be completed Spring 08	Monitoring to be conducted Spring 08		% plant cover, species, infiltration rate, runoff, & sediment
210	Source/Erosion Control	Development of Erosion Control Methods for Adverse Soil Conditions	Soil Regeneration - 2	NA	SR20/Lake County	46	1	Lake	Central Valley	Complete	to be completed Spring 08	to be completed Spring 08	Monitoring to be conducted Spring 08		% plant cover, species, infiltration rate, runoff, & sediment
211	Source/Erosion Control	Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization	Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization: Devil's Slide Greenhouse Experiment	NA	NA	NA	4	NA	San Francisco Bay	Complete	Complete	Complete	Monitoring began Fall 05 and continued through Spring 07	Study conducted at Indiana University	NA
212	Source/Erosion Control	Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization	Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization: Devil's Slide Field Experiment	NA	SR1	NA	4	NA	San Francisco Bay	Complete	Complete	Complete	Monitoring began Fall 05 and continued through Spring 07	Study conducted at Indiana University	NA

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
213	Source/Erosion Control	Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization	Use of Native Plants & Mycorrhizal Fungi for Slope Stabilization: Los Olivos Cut and Fill Field Experiment	NA	SR154	NA	5	NA	Central Coast	Complete	Complete	Complete	Monitoring began Fall 06 and continued through Spring 07	Study conducted at Indiana University	NA
214	Source/Erosion Control	Arid Region Erosion Control Study	Permanent Erosion Control Testing: Barstow Site	NA	SR 58	35.2	8	San Bernardino	Lahonton	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Summer 08 and will continue through Spring 10		TSS
215	Source/Erosion Control	Arid Region Erosion Control Study	Permanent Erosion Control Testing: Hinkley Site	NA	SR 58	11.5	8	San Bernardino	Lahonton	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Summer 08 and will continue through Spring 10		TSS
216	Source/Erosion Control	Arid Region Erosion Control Study	Permanent Erosion Control Testing: Imperial Site	NA	Rte 8	23.3	11	San Diego	San Diego	Complete	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Summer 08 and will continue through Spring 10		TSS
217	Source/Erosion Control	Anti-Icing/De-Icing Studies	Ice Slicer	3-219	SR28	9	3	El Dorado	Lahontan	Compelte	Complete	Complete	Monitornig began Fall 04 and continued throug Spring 05	Monitoring discontinued due to operational issues	Nutrients, Total Orthophosphate, Nitrite, Ammonia-N, Fe, Na, Cl, Ca, Mg, K, Turbidity, Solids, % Moisture
218	Source/Erosion Control	Anti-Icing/De-Icing Studies	Ice Slicer	3-201	Hwy 50	79.79	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitornig began Fall 04 and continued throug Spring 05	Monitoring discontinued due to operational issues	Nutrients, Total Orthophosphate, Nitrite, Ammonia-N, Fe, Na, Cl, Ca, Mg, K, Turbidity, Solids, % Moisture
219	Source/Erosion Control	Anti-Icing/De-Icing Studies	Ice Slicer	TBD	TBD	TBD	3	Placer	TBD	TBD	To be completed Spring 08	To be completed Spring 08	Monitoring to begin Spring 08 and continue through Spring 09		TBD
220	Source/Erosion Control	Temporary Erosion Control Study	Temporary Erosion Control Study	NA	NA	NA	NA	NA	NA	NA	NA	NA	Monitoring to begin Fall 08 and continue through Spring 11	Studies being conducted at Cal Poly Campus	NS
221	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	SR 267/ Brockway Summit fill slopes	NA	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment
222	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	SR 267/Brockway Summit Erosion Control Project	NA	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment
223	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	SR 50/ Meyers Airporpt	NA	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment
224	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	SR 267/Truckee Bypass	NA	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment
225	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	NA/Heaveny Resort	NA	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment
226	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	SR 267/Northstar Resort	NA	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment
227	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	NA/Squaw Creek Resort	NA	3	Placer	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment

1. Does not include completed BMP Pilot Studies

Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
228	Source/Erosion Control	Evaluation of Erosion Control Test Trials in Lake Tahoe	Evaluation of Erosion Control Test Trials	NA	SR 89/Experimental Box Plat	NA	3	El Dorado	Lahontan	Complete	Complete	Complete	Monitoring conducted June - Nov 05 and June-Nov 07.	Study being conducted by UC-Davis . Will be requesting continued monitoring	% plant cover, species, infiltration rate, runoff, & sediment
229	Source/Erosion Control	Inclined Plate and Tube Settlers	Inclined Pate and Tube Settlers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Studies being conducted at UC-Davis Laboratory	NA
230	Characterization Study	Long Term Characterization Study	Long Term Characterization Study	Various	Various	Various	Various	Various	Various	Complete	Complete	To be completed Spring 08	Monitoring began Fall 06 and will continue through Spring 12	~30 locations statewide	Nutrients (plus Nitrite-N) Metals (except As and Cr) Conventionals (except TDS, DOC, Temperature; plus Turbidity) Toxicity (three species, acute and chronic) Pesticides (Chlorpyrifos and Diazinon) Microbiologicals (Total and Fecal Coliform, Enterococcus)
231	Characterization Study	California Toxics Rule Characterization Study	California Toxics Rule Characterization Study	Various	Various	Various	Various	Various	Various	Complete	Complete	Complete	Testing began Fall 04 and continued through Spring 04	UC-Davis Study	Metals & ~ 90 other constituents on CTR list
232	Characterization Study	First Flush Characterization Study	First Flush Characterization Study	NA	NA	NA	NA	NA	NA	NA	NA	NA	Monitoring began Fall 01 and continued through Spring 04. No monitoring currently.	Study being conducted at UC-Davis Laboratory	pH, EC, hardness, alkalinity, TSS, TDS, TOC, DOC, Oil & Grease, PAHs, nutrients, metals
233	Characterization Study	Pathogens Characterization	Pathogens Characterization	NA	NA	NA	NA	NA	NA	NA	NA	NA	Testing began 2003. Standard Operating Procedures currently being developed.	Study being conducted at UC-Davis Laboratory	viral pathogens (human entero- and adenoviruses), cryptosporidium (not always) & microbial source tracking markers based on the bacteria Bacteroidales

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Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status: Site Selection	Status: Design	Status: Construction	Status: Monitoring/Testing	Status: Comments	Constituents List
234	Characterization Study	ASBS Characterization Study	ASBS Characterization Study	NA	NA	NA	NA	NA	NA	Complete	Complete	Complete	Monitoring began Fall 05 and will continue through Spring 10	8 sites statewide	Nutrients (except TKN; plus Nitrite-N, Ammonia-N) Metals (plus Sb, Be, Hg, Se, Ag, Tl, Cr+6) Conventionals (except TDS, Temperature; plus Turbidity) Oil & Grease PAH's Toxicity (three species, acute) Microbiologicals (Total and Fecal Coliform, Enterococcus)
235	Characterization Study	Source Identification - Laboratory Method Development	Source Identification - Laboratory Method Development	NA	NA	NA	NA	NA	NA	NA	NA	NA	Sampling conducted Winter 06. Lab testing continued through Spring 07	Study being conducted at UC-Davis Laboratory	Metals, Pb, Hg, elemental carbon, organic carbon
236	Characterization Study	Source Identification and Quantification Methods	Source Identification and Quantification Methods	NA	NA	NA	NA	NA	NA	NA	NA	NA	Study to be implemented Spring 08. Length of study TBD.	Study being conducted at UC-Davis Laboratory	TBD
237	Characterization Study	Methodology to Idnetify the Sources of Nitrogen and Phosphorous in Highway Runoff for Tahoe Basin	Methodology to Idnetify the Sources of Nitrogen and Phosphorous in Highway Runoff for Tahoe Basin	NA	NA	NA	NA	NA	NA	NA	NA	NA	Source samples tested Winter 06 and will continue through Spring 08	Study being conducted at UC-Davis Laboratory	elemental analysis, dissolved, TKN, dissolved inorganics nitrogen & phosphorous constituents, isotopes of N & P compounds
238	Characterization Study	San Deguito Creek Project	San Deguito Creek Project	NA	NA	NA	NA	NA	NA	Complete	Complete	Complete	Monitoring began Spring 08 and will continue thorugh Spring 10		Nutrients (plus Nitrite-N) Metals Conventionals (except DOC and TDS; plus Turbidity and Salinity) Toxicity (three species, acute only) Oil & Grease TPH-Gas, BTEX, Oxygenates TPH-Diesel, Motor Oil Microbiologicals (Total and Fecal Coliform, Enterococcus)
239	Characterization Study	Water Quality and Toxicity Evaluation of Discharge Generated from Asphalt Pavement Surfacing Materials	Water Quality and Toxicity Evaluation of Discharge Generated from Asphalt Pavement Surfacing Materials	NA	NA	NA	NA	NA	NA	NA	NA	NA	Testing began Fall 06 and will continue throug Spring 08	Study being conducted at UC-Davis Laboratory	Metals, vanadium, nutrients, oil & grease, TPH, TOC, DOC, TSS, TDS, EC, hardness, PAHs

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Line #	Study/BMP Category	Study Name	BMP Description	Site ID #(s)	Route	Post Mile	District	County	RWQCB	Status					Constituents List
										Site Selection	Design	Construction	Monitoring/Testing	Comments	
240	Characterization Study	Performance Evaluation of Permeable Pavement Materials for Water Quality under Heavy Traffic	Performance Evaluation of Permeable Pavement Materials for Water Quality under Heavy Traffic	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Study being conducted at UC-Davis Laboratory	NA
241	Characterization Study	Effect of Highway 50 De-Icing Alternatives on Aerosols at Lake Tahoe	Effect of Highway 50 De-Icing Alternatives on Aerosols at Lake Tahoe	NA	50	NA	NA	NA	NA	NA	NA	NA	Monitoring began Fall 04 and continued throug Fall 05	Study being conducted at UC-Davis Laboratory	Na, Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Zr, Mo, Pb

NS: Normal Suite (Conventionals, + Nutrients + Metals
Conventionals: DOC, TOC, Hardness, TDS, TSS, Conductivity, Temperature, pH
Nutrients: Nitrate-N, TKN, Total Phosphorous, Dissolved Ortho-Phosphate
Metals: As, Cd, Cr, Cu, Pb, Ni, Zn
NA; Not Applicable
RWQCB: Regional Water Resources Control Board
CTR: California Toxics Rule
TBD: To Be Determined
SR: State Route
I: Interstate
TSS: Total Suspended Solids

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