GSRDs: Phase III

Phase III
Gross Solids Removal Devices Pilot Study: 2002 - 2005

Final Report
December 2005

State of California
Department of Transportation

CTSW-RT-05-130-03.1

For individuals with sensory disabilities, this document is available in alternate forms. Please call or write to Mike Farmer, Caltrans Division of Environmental Analysis, P.O. Box 942874, MS-27, Sacramento, California 94274-0001. (916) 653-8896 Voice, or dial 711 to use a relay service.

Table of Contents

Figures

Tables

Acronyms, Abbreviations, and Units

Acronyms and Abbreviations

BMP	Best Management Practice
Caltrans	California Department of Transportation
GSRD	Gross Solids Removal Device
ROW	Right-of-Way
RWQCB	Regional Water Quality Control Board
SWMP	Caltrans Statewide Storm Water Management Plan
TMDLs	Total Maximum Daily Loads
WLA	Waste Load Allocation

VS1 I-405	I-405 at Leadwell: V-screen – Configuration #1
VS2 SR-91	SR-91 at Ardmore: V-screen – Configuration #2
IS4 I-210	I-210 at Christy: Inclined Screen – Configuration #4

Units

ac	Acre
ft	Feet
ft^3	Cubic feet
ft^3/ac	Cubic feet per acre
ha	Hectare
in.	Inch
kg	Kilogram
kg/ha	Kilograms per hectare
KP	Kilometer Post
lb	Pounds
lb/ac	Pounds per acre
m	Meter
mm	Millimeter
m^3	Cubic meter
m^3/ha	Cubic meters per hectare
PM	Post Mile

Executive Summary

The objective of the Phase III Gross Solids Removal Devices (GSRDs) Pilot study was to evaluate the performance of non-proprietary devices that can capture gross solids and that can be incorporated 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.

Three design concepts developed for this pilot study were the Forward Sloping V-screen, the Reverse Sloping V-screen, and the Direct Flow Inclined Screen. The V-Screen – Configuration #1 GSRD uses a forward sloping V-shaped 5 mm (0.2 in nominal) wedge-wire screen to remove gross solids. The screen is sloped forward so that the top of the screen is downstream from the bottom of the screen. The V-Screen – Configuration #2 GSRD uses a reverse sloping V-shaped 5 mm (0.2 in nominal) wedge-wire screen to remove gross solids. The screen is sloped backward so that the top of the screen is upstream from the bottom of the screen. The Inclined Screen – Configuration #4 uses a 5 mm (0.2 in nominal) wedge-wire screen to remove gross solids. The gross solids are captured on the screen and moved by gravity into the storage area. Installation costs for the pilot devices, not including monitoring equipment, ranged from $51,300 per hectare ($20,761 per acre) to $113,640 per hectare ($45,989) per acre).

Following a targeted storm event, each GSRD was visually inspected and assessed for screen clogging, proper drainage, and material accumulation. During each cleaning procedure, the weight and volume of gross solids removed from the device and bypass bag were measured. The performance of each GSRD was assessed by evaluating how well the GSRD met the design objectives: the criteria set by the Total Maximum Daily Load (TMDL), and criteria and goals set by Caltrans. The criteria and goals applied to the study are listed below.

Criteria (C) or Goal (G)			Description
TMDL Criteria	C1	Particle Capture	The device or system must capture all particles retained by a 5 mm (0.2 in nominal) mesh screen from all runoff generated from a one-year, one-hour storm (determined to be 0.6 in [15 mm] per hour for the Los Angeles River Watershed).
	C2	Clogging	The device or system must be designed to prevent plugging or blockage of the screening module.
Caltrans Criteria	C3	Hydraulic Capacity	The device or system must pass the Caltrans design flow. In District 7, this design flow is the 25-year peak flow.
	C4	Drainage	The device or system must drain within 72 hours to avoid vector breeding.
Caltrans Goal	G1	Gross Solids Storage Capacity	The device or system will hold the estimated annual load of gross solids, so that it requires only one cleaning per year.
	G2	Maintenance Requirements	The device or system will not require any maintenance other than inspections throughout the storm season.

Of the three configurations tested over two wet seasons, the device which best met the criteria and goals based on considerations of particle capture, clogging, passing design flow, drainage, stage capacity, and maintenance requirements, was the Inclined Screen – Configuration #4. This device meets the definition of a full capture treatment system.

Section 1
Introduction and Study Design

1.1 OBJECTIVE

The Gross Solids Removal Devices (GSRDs) Pilot Program (Program) was initiated by the California Department of Transportation (Caltrans) to develop and evaluate the performance of non-proprietary devices that can capture gross solids and that can be incorporated 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. The *Caltrans Guidance for Monitoring Storm Water Litter* (Caltrans, 2000) defines litter as "manufactured items made from paper, plastic, cardboard, glass, metal, etc. that can be retained by a 5 mm (0.2 in nominal) mesh screen."

1.2 BACKGROUND

Trash Total Maximum Daily Loads (TMDLs) for the Los Angeles River Watershed and the Ballona Creek Watershed have been adopted in Southern California. The requirements of these two TMDLs are discussed further in Section 2. The non-proprietary devices developed and evaluated in the Program may be selected to meet the requirements of these two TMDLs. The Program consists of multiple phases with each phase representing one pilot study. A pilot study consists of one or more devices that have been developed from concept, have advanced through design and construction, and two years of pilot testing have been conducted for overall performance. Each pilot study consists of the following four general tasks:

- Task 1 - Concept Development
- Task 2 - Scoping, Preliminary Design, and Site Selection
- Task 3 - Final Design and Implementation
- Task 4 - Monitoring and Performance Evaluation

The third pilot study in the Program is the Phase III GSRDs Pilot Study. Task 1 took place between December 2001 and March 2002. Task 2 took place between March 2002 and June 2002. Task 3 took place between September 2002 and March 2003. Task 4 took place between November 2002 and May 2005. No monitoring was done between October 2003 and May 2004. During this time no monitoring contract had been executed.

At the time this report was prepared, the Program included six pilot studies or phases. Figure 1-1 presents a timeline for monitoring of the six pilot studies. The Phase I GSRDs Pilot Study, consisting of eight devices, has completed monitoring and the final report has been published. The Phase II GSRDs Pilot Study, consisting of one device, has completed monitoring and the final report has been published. This report documents the Phase III GSRDs Pilot Study which consists of three devices and has completed monitoring. The Phase IV GSRDs Pilot Study has completed the first year of monitoring with one more year remaining.

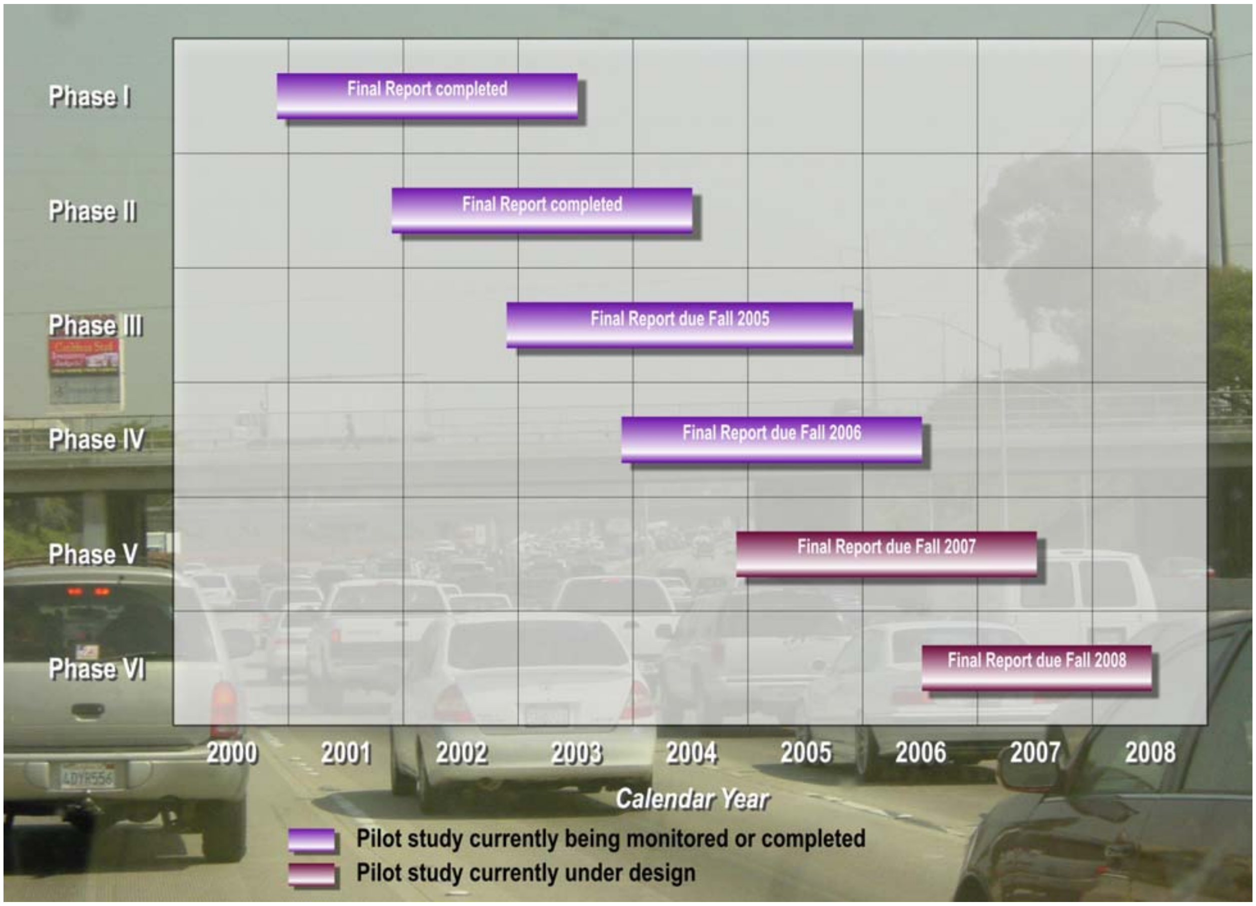

Figure 1-1
Monitoring Schedule for GSRD Pilot Studies

The Phase V and Phase VI GSRD Pilot Studies are currently in design. Figures 1-2 and 1-3 presents a summary of the devices in Phases I through IV of the study.

PHASE I DEVICES

Linear Radial - Configuration #1

This GSRD utilizes a modular well-casing with 5 mm x 64 mm (0.2 in x 2.5 in nominal) louvers to screen out gross solids. The modular well-casing is placed on a 2 percent slope. Runoff flows into the device and exits radially through the louvers.

Linear Radial - Configuration #2

This GSRD utilizes a modular 5 mm x 5 mm (0.2 in x 0.2 in nominal) rigid mesh screen housing. Nylon mesh bags, 5 mm (0.2 in) openings, are placed inside the rigid mesh screen housing to capture gross solids. Runoff flows into the device and flows out of the nylon mesh bags.

Inclined Screen - Configuration #1

This GSRD utilizes a 3 mm (0.125 in nominal) spaced parabolic wedge-wire screen. Runoff enters the device and flows into a trough where larger gross solids settle out and the runoff is distributed. The distributed runoff flows over weirs and falls onto and through the screen. The gross solids are captured on the screen and moved by gravity to the storage area.

Inclined Screen - Configuration #2

This GSRD utilizes a 5 mm (0.2 in nominal) spaced parabolic bars. Runoff enters the device and flows into a trough where larger gross solids settle out and the runoff is distributed. The distributed runoff flows over a weir and falls onto and through the bars while the gross solids are captured on the bars and moved by gravity to the storage area.

Baffle Box

This GSRD utilizes a two-chamber concept: the first chamber utilizes an underflow weir to trap floatable gross solids, and the second chamber uses a bar rack to capture materials that get past the underflow weir.

Figure 1-2
Summary of Phase I Devices

PHASE II DEVICES

Inclined Screen - Configuration #3

This GSRD utilizes the same screen from the Inclined Screen - Configuration #1, Phase I Devices. This Phase II device has been modified to be cleaned by a front-end loader. The Inclined Screen Configuration #1 is designed to be cleaned out by a Vactor Truck.

PHASE III DEVICES

V-screen - Configuration #1

This GSRD utilizes a forward sloping V-shaped 5 mm (0.2 in nominal) wedge-wire screen to remove gross solids. The screen is sloped forward so that the top of the screen is downstream from the bottom of the screen. Runoff flows through the screen horizontally, instead of falling on the screen as with the Inclined Screen - Configuration #1. This device does not utilize a trough.

V-screen - Configuration #2

This GSRD utilizes a reverse sloping V-shaped 5 mm (0.2 in nominal) wedge-wire screen to remove gross solids. The screen is sloped backward so that the top of the screen is upstream from the bottom of the screen. Runoff flows through the screen horizontally, instead of falling on the screen as with the Inclined Screen - Configuration #1. This device does not utilize a trough.

Inclined - Configuration #4

This GSRD utilizes a 5 mm (0.2 in nominal) wedge-wire screen to remove gross solids. Runoff flows onto and through the screen. The gross solids are captured on the screen and moved by gravity to the storage area. This device does not utilize a trough as with the Inclined Screen - Configuration #1.

PHASE IV DEVICES

Linear Radial - Configuration #3

This GSRD is generally the same design as the Linear Radial - Configuration #1, Phase IV Devices. However, for this pilot study, the device will be constructed on an approximately 35 percent (19°) slope.

Figure 1-3
Summary of Phases II, III & IV Devices

1.3 TERMINOLOGY

The following terminology is used in this report and is defined as follows:

- **Bypass Bag –** Nylon mesh bag with 5 mm (0.2 in nominal) openings, connected to the end of the downstream pipe, which collects any gross solids that pass through the screen or overflow the device. Bypass bags apply to all of the Phase III GSRDs. The bypass bag is for pilot study monitoring purposes only and is not intended to be a permanent design feature.

- **Overflow Condition –** Condition that occurs when the water level reaches beyond the maximum level in the device, and inflow overtops the device. As stated above, the gross solids that overflow the device are captured in the bypass bag. Overflow conditions can occur when 1) inflow exceeds the capacity of the GSRD screen, 2) the screen is blinded, or 3) the outflow drains are plugged.

- **Wet Weight –** Weight of the gross solids in the field without additional drying in the laboratory (as-collected weight of gross solids). Prior to transferring the gross solids to plastic trash bags, the solids are gravity drained for at least two minutes or until they are substantially drained of free water (e.g., no drips for 5 to 10 seconds).

- **Wet Volume –** Volume of the gross solids in the field without drying in the laboratory (as-collected volume of gross solids). Prior to transferring the gross solids to plastic trash bags, the solids are gravity drained for at least two minutes or until they are substantially drained of free water (e.g., no drips for 5 to 10 seconds).

1.4 REPORT ORGANIZATION

This report is organized as follows:

- **Section 1** presents the study overview and background.

- **Section 2** presents the concept development and design criteria.

- **Section 3** summarizes the site selection, design, implementation details, and installation costs.

- **Section 4** summarizes the monitoring procedures. A discussion of operations including the event summaries and general GSRD performance during the 2002–03 and 2004-05 monitoring season is also presented.

- **Section 5** presents the gross solids data collected during the 2002–03 and 2004-05 monitoring seasons.

- **Section 6** presents a summary of the overall performance of the GSRD during the 2002–03 and 2004-05 monitoring seasons.

- **Section 7** presents references cited in this report.

1.5 S.I. AND U.S. CUSTOMARY UNITS

This report provides units in both Système International (S.I.) units and U.S. Customary (U.S.) units. In general, measurements and calculations are performed in S.I. units and converted to U.S. Customary units for reporting. Additionally, nominal dimensions of pipe diameters are provided, consistent with International Standards Organization (ISO) usage. For example, a 24-inch pipe is referred to as a 600 mm pipe.

Section 2 Concept Development

2.1 DESIGN OBJECTIVES

The Phase III GSRDs Pilot Study was designed to meet both the criteria set by the Trash TMDL for the Los Angeles River and Ballona Creek Watersheds, and the criteria and goals set by Caltrans. The six design objectives listed below represent criteria and goals applied to the GSRDs. For this pilot study, meeting criteria held a higher importance than meeting goals. The following two criteria were set by the TMDL for an approved full capture treatment system:

- The device or system will capture all particles retained by a 5 mm (0.2 in. nominal) mesh screen from all runoff generated from a one-year, one-hour storm (determined to be 15 mm [0.6 in.] per hour for the Los Angeles River Watershed).
- The device or system is designed to prevent plugging or blockage of the screening module.

The following two criteria were set by Caltrans for a GSRD:

- The device or system will pass the design flow as specified in the Caltrans Highway Design Manual (Table 831.3). For this pilot study, the design flow is the 25-year peak flow.
- The device or system will drain within 72 hours to avoid vector breeding.

Additionally, the following two goals were set by Caltrans for a GSRD:

- The device or system will hold the estimated annual load of gross solids, resulting in one cleaning per year.
- The device or system will not require any maintenance other than inspections throughout the storm season.

2.2 CONCEPTUAL DESIGN

The Phase III GSRDs Pilot Study was developed to test selected non-proprietary devices designed to remove gross solids from storm water runoff highway facilities, both in new installation and in retrofit settings. The GSRDs will be monitored over two storm seasons to assess the overall performance of each device.

Multiple candidate pilot technologies for Phase III GSRDs were developed by the Caltrans team. Three design concepts were further developed and included: the Forward Sloping V-screen, the Reverse Sloping V-screen, and the Direct Flow Inclined Screen. Summaries of the design assumptions that underlie the concepts are presented in the following sections on a device-specific basis.

2.2.1 V-screen – Configuration #1

As shown in Figure 2-1, this device uses two sections of a V-shaped wedge wire screen to remove gross solids. The screens are sloped forward so that the top of screen is in the downstream direction. The GSRD utilizes 5 mm (0.2 in. nominal) spaced wedge wire screens with the slotting oriented horizontally. Key design and operational concepts are as follows:

- Inflow is directed to the center of the concrete pad and diverted to either side of the unit by a column support structure.
- Flow passes through the forward sloping screens and drops to the outlet pipe.
- The concrete pad is sloped to facilitate the movement of gross solids toward the solids storage area on both sides of the concrete pad. The solids storage areas are located at a lower elevation than the concrete pad.
- Sufficient screen area and volume are provided to accommodate an estimated once per year maintenance cycle without plugging.
- Drainage of the device is accomplished through two 610 mm (2 ft) square wedge wire plates located at the downstream end of the solids storage areas.
- Both the wedge wire plates and forward sloping screens are removable for ease of maintenance. They are supported by brackets that are bolted to the concrete walls and support structure.
- The outflow wall has an overflow weir that is designed to convey the 25-year flow in case of emergency overflow.

2.2.2 V-screen – Configuration #2

This device uses two sections of a V-shaped wedge wire screen to remove gross solids (Figure 2-2). The screens are sloped in a reverse fashion so that the top of screen is in the upstream direction. The GSRD utilizes 5 mm (0.2 in. nominal) spaced wedge wire screens with the slotting oriented horizontally. Key design and operational concepts are as follows:

- Inflow is directed to the center of the concrete pad and diverted to either side of the unit by a column support structure.
- Flow passes through the reverse sloping screens and drops to the outlet pipe.
- Gross solids collect in the solids storage area behind the screen. The solids storage area is sloped to allow for effective drainage.
- Sufficient screen area and volume are provided to accommodate an estimated once per year maintenance cycle without plugging.

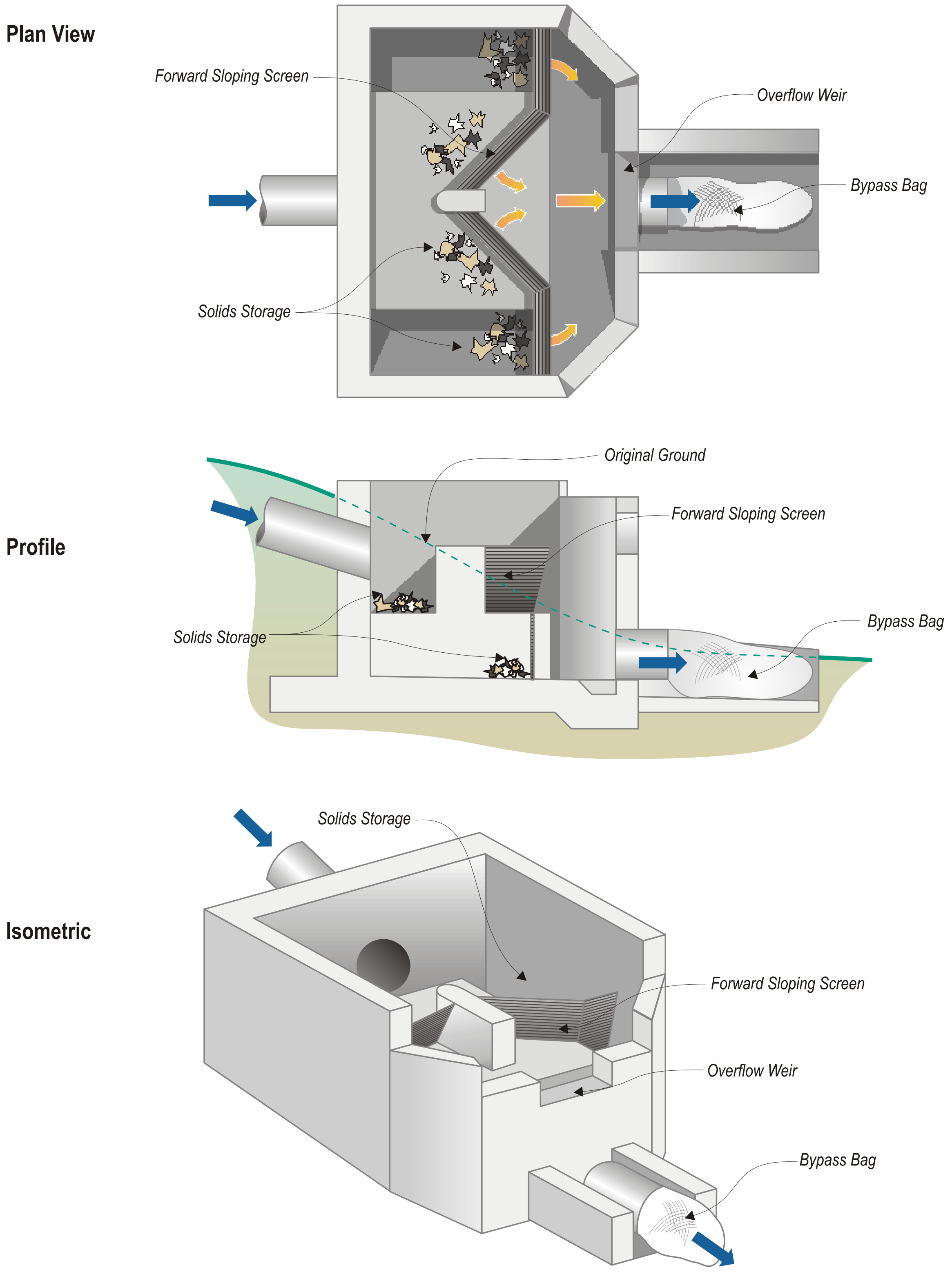

Figure 2-1
Concept V-screen – Configuration #1

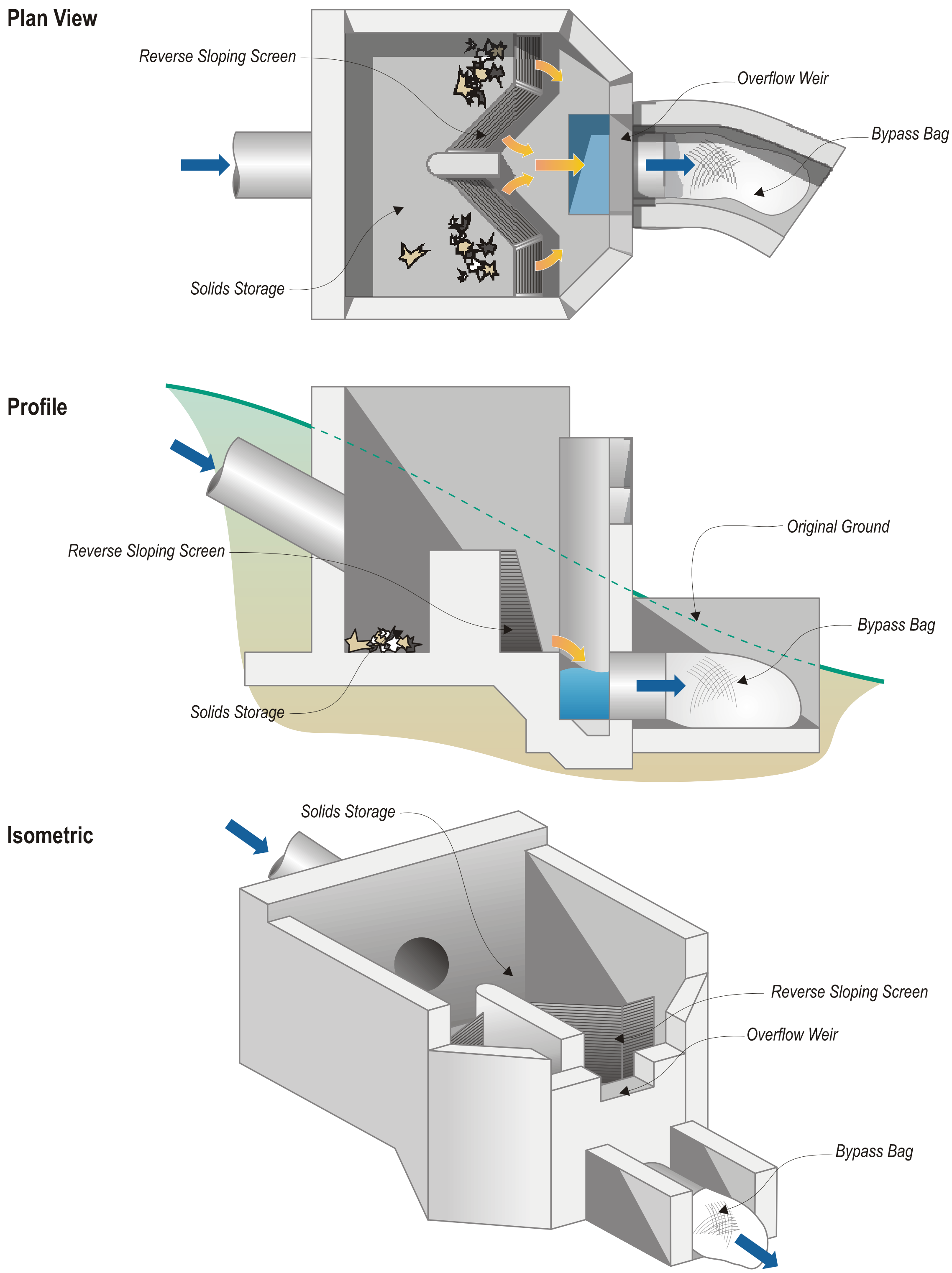

Figure 2-2
Concept Reverse Sloping V-screen – Configuration #2

DCN I03559

- The reverse sloping screens are removable for ease of maintenance. Each screen is supported by brackets that are bolted to the concrete wall and support structure.

- The outflow wall has an overflow weir that is designed to convey the 25-year flow in case of emergency overflow.

2.2.3 Inclined Screen – Configuration #4

As shown in Figure 2-3, this device uses a 1.5 m (5 ft) square wedge wire screen to remove gross solids. Key design and operational concepts are as follows:

- The inclined screen slots are spaced at 5 mm (0.2 in. nominal) with the "tines" oriented vertically.

- Inflow enters the device and directly drops onto the inclined screen.

- Flow passes through the inclined screen and flows to the outlet pipe and channel.

- Gross solids are moved down the screen by storm water flow and collected in the solids storage adjacent to the screen. The solids storage area is slightly sloped to allow for effective drainage.

- Sufficient screen area and volume are provided to accommodate an estimated once per year maintenance cycle without plugging.

- Drainage of the device is accomplished through a 1.5 m (5 ft) by 318 mm (1 ft) wedge wire plate located at the bottom of the inclined screen. The wedge wire plate is removable for ease of maintenance and is held in place by brackets bolted on opposite walls.

- The inclined screen is hinged at the top to allow the screen to be lifted during maintenance activities.

- The outflow wall has an overflow weir that is designed to convey the 25-year flow in case of emergency overflow.

2.3 DESIGN CRITERIA AND FINAL DESIGN

The design criteria applied for the Phase III Pilot Study included: primary design goals; hydrology; hydraulics; vector control; operation and maintenance objectives; and an estimated annual gross solids loading rate. The estimated annual gross solids loading rate used for this study is 0.7 m^3/ha (10 ft^3/yr). The gross solids loading rate and the other design elements applied to the Phase III GSRDs are discussed in the *Basis of Design Report* (Caltrans, 2003c).

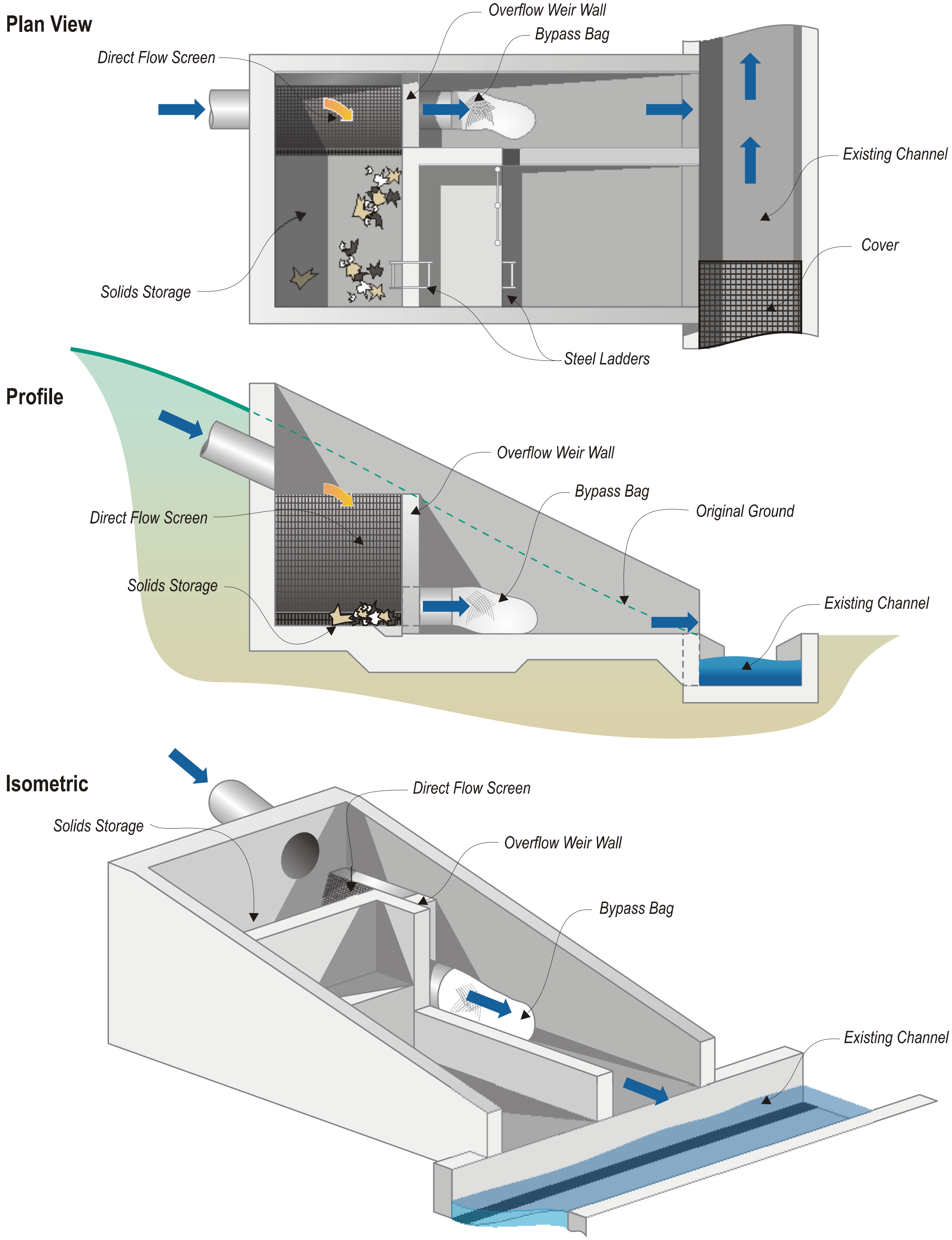

Figure 2-3
Concept Inclined Screen – Configuration #4

Section 3
Site Selection and GSRD Installation

3.1 SITE SELECTION

The site selection process for the Phase III Pilot Study, including the siting criteria, is discussed in the *Basis of Design Report* (Caltrans, 2003c). For the Phase I Pilot Study, the site selection process identified and ranked over 70 candidate sites (Caltrans, 2003b). From these candidate sites, eight sites were selected for installation of Phase I GSRDs. The candidate sites not selected for installation of the Phase I GSRDs were evaluated for the Phase III Pilot Study. The three Phase III GSRDs consist of two replacements of existing Baffle Boxes installed as part of the Phase I Pilot Study, and one new site location.

3.2 SITE DESCRIPTIONS

The two replacement sites selected for the installation of the Phase III GSRDs are located within District 7 and within the Los Angeles River Watershed. The new site at SR-91 at Ardmore is located within District 7 and within the San Gabriel River Watershed. Site descriptions are provided in Table 3-1 and in the following section. Figure 3-1 shows the approximate site locations. Table 3-2 provides the naming convention that will be used throughout the rest of the report along with the drainage area characteristics. Descriptions and photos of the sites are presented in the following subsections.

Table 3-1
Phase III GSRDs Site Location Summary

Site ID	Site Name	GSRD Type & Configuration	City/Community	Route	Direction	Kilometer Post KP (PM)
1	I-405 at Leadwell	V-screen Configuration #1 (Forward Sloping)	Van Nuys	405	Southbound	68.5 (42.6)
2	SR-91 at Ardmore	V-screen Configuration #2 (Reverse Sloping)	Bellflower	91	Westbound	24.8 (15.4)
3	I-210 at Christy	Inclined Screen Configuration #4 (Direct Flow)	Lake View Terrace	210	Eastbound	14.7 (9.1)

Table 3-2
Phase III GSRDs Site Characteristics Summary

Site ID	Site Name	GSRD Type & Configuration	Site Name Used in this Report	Watershed	Drainage Area ha (ac)	% Roadway Runoff	Roadway Inlets
1	I-405 at Leadwell	V-screen Configuration #1 (Forward Sloping)	VS1 I-405	Los Angeles River	1.2 (3.0) (a)	100%	3[1]
2	SR-91 at Ardmore	V-screen Configuration #2 (Reverse Sloping)	VS2 SR-91	San Gabriel River	0.8 (2.0) (b)	100%	3[2]
3	I-210 at Christy	Inclined Screen Configuration #4 (Direct Flow)	IS4 I-210	Los Angeles River	0.9 (2.3) (a)	100%	3[1]

(a) Based on available record ("As-Built") drawings. Detailed site surveys were not performed

(b) Based on detailed site survey.

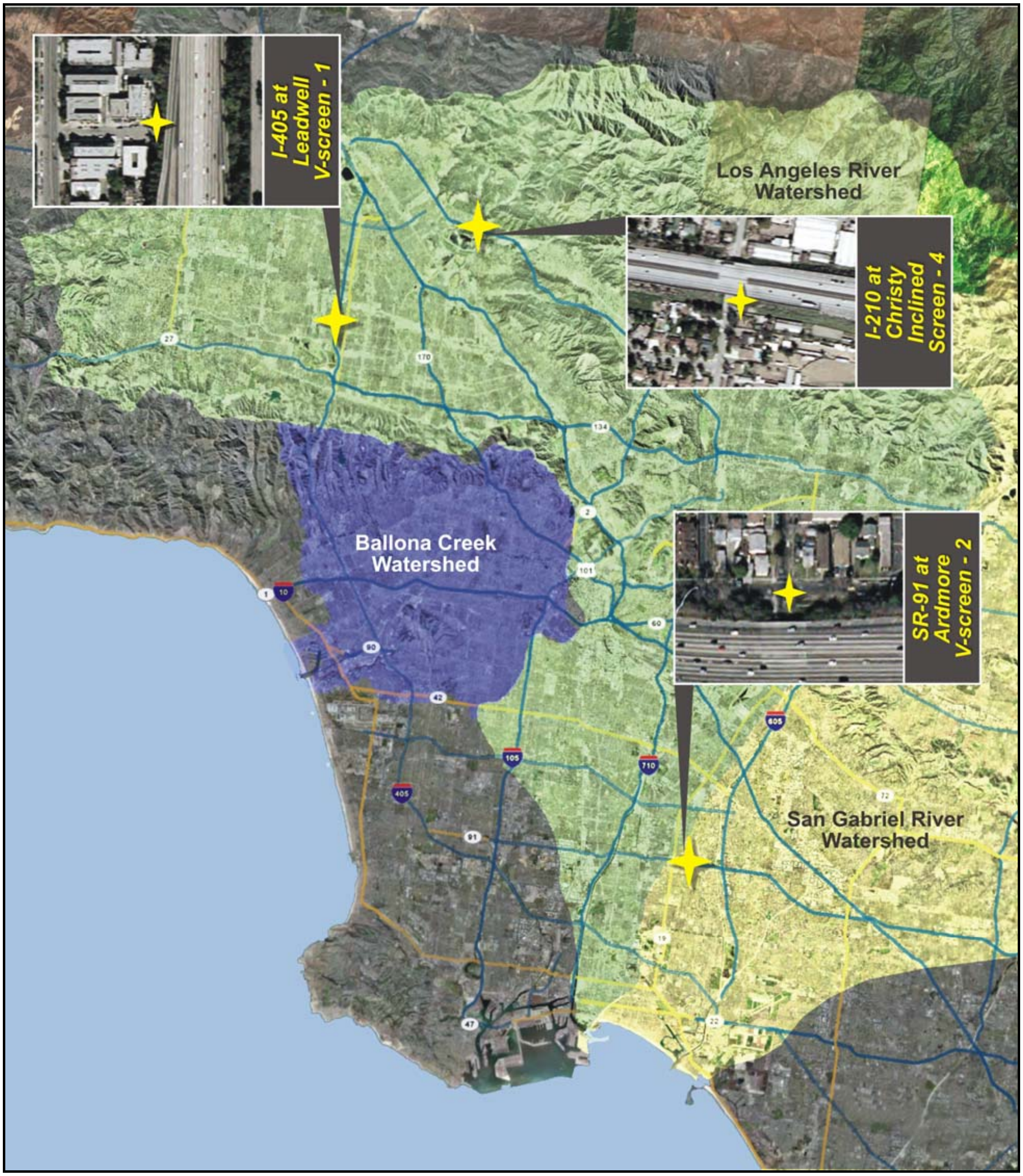

Figure 3-1
Phase III GSRDs Location Map

3.2.1 I-405 at Leadwell: V-screen – Configuration #1

This site is located in the City of Van Nuys at the end of a cul-de-sac on Leadwell Street below the southbound side of Interstate 405. Access to the site for installation, maintenance, and monitoring purposes is from Leadwell Street. This site is characterized by:

- Two inlets located along the freeway shoulder and 1 inlet along the freeway centerline
- One outlet, 450 mm (18 in) in diameter
- Drainage area of approximately 1.2 ha (3.0 ac)

The site is a grassy parcel in the Caltrans right-of-way below the sound wall along southbound Interstate 405. An existing Baffle Box was demolished and removed for the installation of the Phase III GSRD.

Figure 3-2
VS1 I-405 After Installation

3.2.2 SR-91 at Ardmore: V-screen – Configuration #2

This site is located in the City of Bellflower on the westbound side of SR-91 at Beach Street, east of Ardmore Avenue. Access to the site for installation, maintenance, and monitoring purposes is from Beach Street. This site is characterized by:

- Two inlets located along the freeway shoulder and 1 inlet along the freeway centerline
- One outlet, 610 mm (24 in) in diameter

- Drainage area of approximately 0.8 ha (2.0 ac)

The site is a sloped, ivy-covered parcel in the Caltrans right-of-way below the edge of traveled way on westbound SR-91. The site was selected due to: (1) adequate space available within the ROW; and (2) convenient access from secondary streets.

Figure 3-3
VS2 SR-91 After Installation

3.2.3 I-210 at Christy: Inclined Screen – Configuration #4

This site is located in the City of Lake View Terrace just off Christy Avenue below the eastbound side of Interstate 210. Access to the site for installation, maintenance, and monitoring purposes is from Christy Avenue via Foothill Boulevard. This site is characterized by:

- Three inlets located along the freeway shoulder
- One outlet, 450 mm (18 in) in diameter
- Drainage area of approximately 1 ha (2.5 ac)

The site is a sloped, grassy parcel in the Caltrans right-of-way below the sound wall on eastbound Interstate 210. An existing Baffle Box was demolished and removed for the installation of the Phase III GSRD.

Figure 3-4
IS4 I-210 After Installation

3.2.4 GSRD Screen Comparison

As previously mentioned in Section 2, two configurations of V-screens and one configuration of an inclined screen were utilized for the Phase III GSRDs Pilot Study. Figure 3-5 presents a comparison of the screens. Runoff flows horizontally through both configurations of V-Screens. Runoff flows vertically through the inclined screen.

3.3 INSTALLATION SUMMARY

3.3.1 Installation Schedules

Installation schedules for the Phase III GSRDs are presented in Table 3-3. The installation periods ranged from 38 days at the VS1 I-405 site to 57 days at the IS4 I-210 site.

Table 3-3
Phase III GSRDs Installation Schedules

Site	Start Date	Finish Date	Working Days
VS1 I-405	10/21/02	01/22/03	38
VS2 SR-91	09/10/02	11/08/02	45
IS4 I-210	12/05/02	03/05/03	57

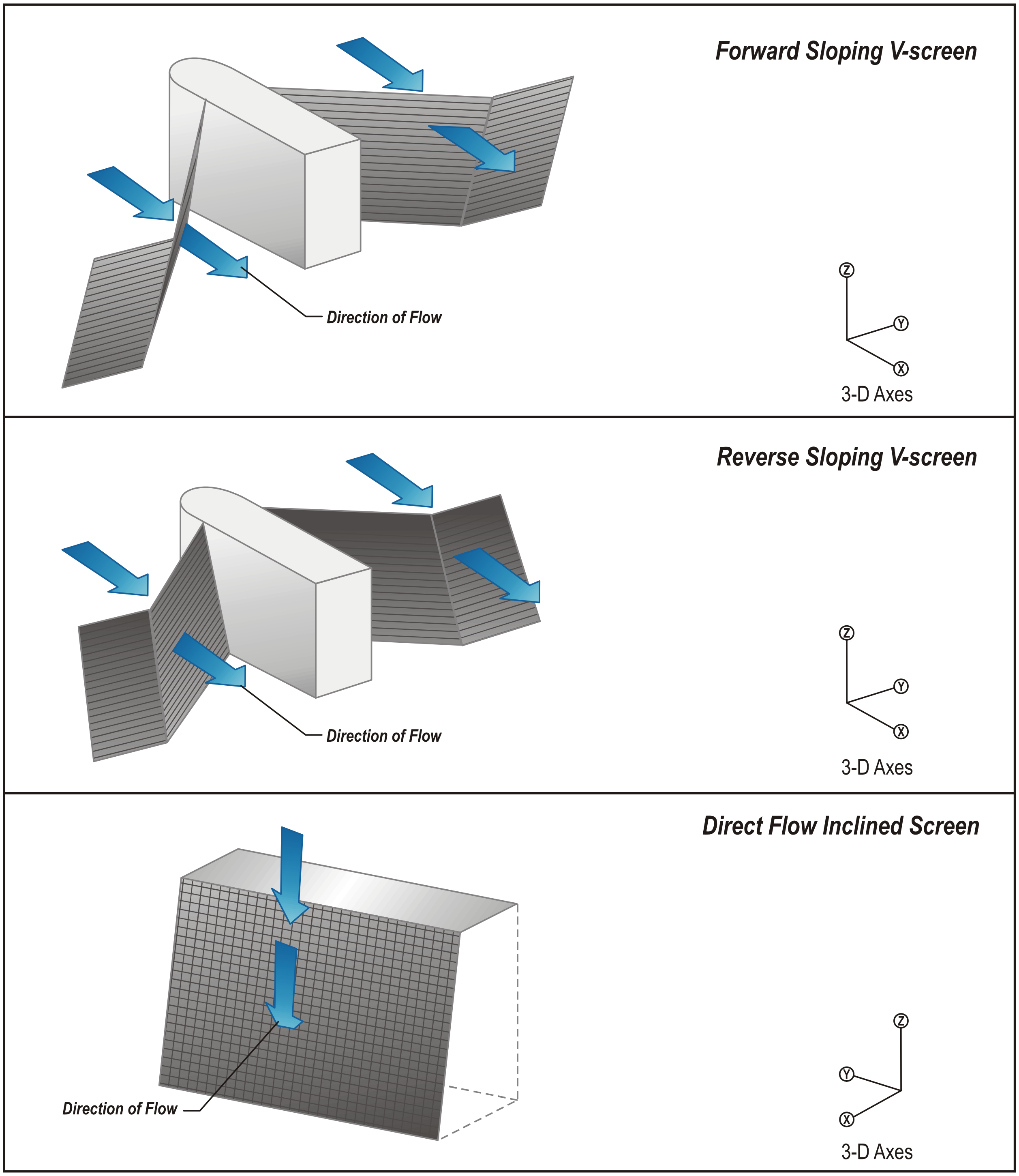

Figure 3-5
GSRD Screen Comparison

3.3.2 Installation Costs

Installation costs for the Phase III GSRDs are presented in Table 3-4. These costs represent retrofit situations, not new installations.

Table 3-4
Phase III GSRDs Installation Costs

Site	Drainage Area ha (ac)	Total Cost	Cost per hectare (acre)
VS1 I-405	1.2 (3.0)	$61,560	$51,300 ($20,761)
VS2 SR-91	0.8 (2.0)	$75,881	$94,851 ($38,386)
IS4 I-210	1.0 (2.5)	$113,640	$113,640 ($45,989)

3.3.3 Installation Issues

The installation of the Phase III GSRDs proceeded as planned, with few unforeseen issues arising. Circumstances affecting the installation effort are described below, grouped by common issues.

3.3.3.1 Material Availability

There were lengthy shop drawing and manufacturing lead times associated with the custom fabrication of the stainless steel wedge wire screens and the galvanized ladders at each site. The screens and ladders were ordered well in advance of the timeframe in which they were needed, so there were no installation delays due to material availability. In addition, modifications to the screens and supports were incorporated during the installation process, with the purpose of securing the screens in place. The modifications included welding extension tabs to the support brackets at VS2 SR-91 and adding removable pins to the screens at VS1 I-405 to prevent the screens from dislodging during high storm water flows. These modifications were made in the field and did not delay or impact the installation work. There were also associated lead times related to the acquisition of specific pre-cast concrete forms and fittings that allow for the forming of the concrete structures.

3.3.3.2 Field Conditions

Unidentified underground utilities, extensive site excavation, grading requirements, and removal of site vegetation, led to additional field installation time and effort at some sites. Over-excavation, backfill, and compaction were required at some of the sites. Although Underground Service Alert was notified of the installation, unidentified utilities were exposed at a number of the sites.

The VS2 SR-91 and IS4 I-210 sites encountered electrical conduit lines that were temporarily disconnected for the implementation of the devices and re-connected once installation activities were completed. Installation activities at VS2 SR-91 were not impacted by the discovery of the electrical conduit. Installation work at IS4 I-210 was suspended once the electrical conduit line was discovered while local Caltrans representatives assisted in determining the contents (i.e. voltage). Installation activities resumed at the site after approximately ten working days.

Installation activities at VS1 I-405 revealed an abandoned manhole that was not identified during the preliminary utility review of the existing drawings. The manhole was located beneath the existing GSRD Baffle Box at the upstream end of the drainage channel. The abandoned manhole was cleaned, properly documented and brought to the attention of Caltrans. Installation activities were suspended for 10 working days until direction from Caltrans was received on how to proceed. A section of the manhole riser was removed and a steel plate installed and properly secured over the abandoned manhole before installation activities resumed at the site.

3.3.3.3 Public Impact

The Phase III GSRDs in general caused minimal impact to the local neighborhoods during the implementation of the devices. However, the resident of a home adjacent to the IS4 I-210 site expressed concern over the installation schedule, noise, and unsightliness of the GSRD. The installation inspector and supervisor resolved the concerns with the neighbor and informed all other adjacent residents of the installation schedule. In order to minimize soil transportation off-site, excess backfill was temporarily stored near the access gate. Field crews conducted additional grading and stabilization of the backfill to increase the aesthetic value of the site.

The VS1 I-405 site is located at the end of a cul-de-sac and surrounded on two sides by large apartment complexes. This layout resulted in several vehicles parking directly in front of the site access gate and impeded work and the delivery of equipment and supplies. To avoid further impact, the apartment managers were notified of the implementation of the device. Temporary “No Parking” signs were also ordered from the City of Los Angeles, placed on the site, and removed once the installation was completed.

No disruption to the public was caused at the VS2 SR-91 site other than minor interference with neighborhood street parking. Although this impact was temporary, the installation crews always attempted to minimize the number of vehicles at each site.

3.3.3.4 Other Issues

During the installation of the IS4 I-210, a temporary water permit was obtained from the City of Los Angeles Department of Water and Power in order to use water during installation. Obtaining the permit had a minimal impact to the schedule and project budget. The VS2 SR-91 site was equipped with an on-site water source that was used as needed. The VS1 I-405 site utilized water from the nearby apartment complex (at a small cost).

Section 4
Monitoring and Operational Observations

4.1 OVERVIEW

This section summarizes the monitoring procedures for the Phase III Pilot Study and the operational observations for the devices during the 2002-03 and 2004-05 storm seasons. The Phase III GSRDs were not monitored during the 2003-04 storm season.

4.2 GROSS SOLIDS MONITORING

Monitoring procedures for the 2002-03 and 2004-05 storm seasons are presented in the *Operations and Maintenance Plan* (Caltrans, 2003a). In summary, the following tasks were conducted after a targeted storm event:

- Took digital photos of the device
- Assessed device for clogging
- Estimated the amount of gross solids accumulation within the device to assess if an interim cleaning would be required
- Observed the accumulation of gross solids within the device
- Checked the bypass bag for material accumulation
- Verified that the device was draining properly

Data on accumulated gross solids was obtained whenever the device was cleaned and gross solids were removed from the device for measurements and ultimate disposal off the highway ROW. The device was designed to be cleaned only once per storm season. However, if the device reached approximately 85 percent of capacity by visual observation, or if extensive clogging or overflow was observed at the device, an additional cleaning or interim cleaning was performed during the season. During the cleaning procedures, four measurements were taken:

- Wet weight of the gross solids removed from the device
- Wet volume of the gross solids removed from the device
- Wet weight of the gross solids removed from the bypass bag
- Wet volume of the gross solids removed from the bypass bag

Weight and volume measurements were taken only during a cleaning procedure. If multiple cleanings were required at the site, the data from each interim cleaning and the end-of-season cleaning were summed together for an annual gross solids loading for the site. Measurements were not taken on a per storm event basis. Section 5 summarizes the data wet weight and wet volume measurements.

4.2.1 Field Measurements

The volume of gross solids was estimated by placing the bags of gross solids (one at a time) into a container of known volume. The bag was made as level as possible across the entire surface area of the container. The amount of freeboard was then measured and multiplied by the surface area of the container to obtain the remaining volume. This quantity was then subtracted from the total known volume of the container to yield the estimated volume of gross solids. Field volume measurements from all bags for a single GSRD device were added together and the total volume calculated for that device.

The weight of gross solids was estimated by first placing the empty container on an electronic scale and taking the tare weight of the scale. The bags of gross solids (one at a time) were placed in the container, and weighed on the scale. Field weight measurements from all bags for a single GSRD device were added together and the total weight calculated for that device.

4.2.2 Mobilization Criteria

The field inspections during the storm season consisted of both post-storm inspections and during-storm inspections. Post-storm field inspections were conducted after a rain event which produced at least 13 mm (0.50 in.) of rain. During-storm field inspections were conducted when at least 13 mm (0.50 in.) of rain was forecast with a minimum of 50 percent probability, and it had started raining. Forecasts from the National Weather Service (NWS) website for the Los Angeles-Oxnard area, and Fox Weather Service were used to decide whether to mobilize. During storm and post-storm inspections were conducted only during daylight hours.

4.3 GSRD OPERATION AND CLEANINGS

A summary of the operation and cleaning of the GSRDs during the 2002-03 and 2004-05 storm seasons is presented in the following section. The average time required and equipment used for the post-season cleanings are summarized in Table 4-1. This data represents the effort needed to clean the GSRDs; collect the captured and bypassed gross solids; take field measurements of the weight and volume of gross solids; and dispose of the gross solids outside the Caltrans right-of-way.

Table 4-1
Phase III GSRDs Pilot Study Cleaning Requirements

Site	Total Number of Cleanings		Average Person hours per Storm Season	Equipment
	2002-03	2004-05		
VS1 I-405	1	N/A [a]	4	Shovels, Brooms, Brushes, Waste Bin, Pick-Up Truck
VS2 SR-91	1	1	6	Shovels, Brooms, Brushes, Waste Bin, Pick-Up Truck
IS4 I-210	1	1	4	Shovels, Brooms, Brushes, Waste Bin, Pick-Up Truck

[a] Due to continual screen blinding and volume of gross solids that overflowed the device, the screens were removed and monitoring at the site was discontinued.

For pilot project operations, gross solids are shoveled into bags and field measurements taken. Many times during cleaning, the gross solids are still partially wet, therefore taking longer to shovel and move the heavier material. The devices are also swept clean to account for any remaining gross solids. The screens are cleaned with a wire brush to remove and collect any accumulated material on the screens. Gross solids from these various locations are shoveled, bagged, and measured. Gross solids are also scraped and collected from the bypass bags. The bypass bags are checked for visible signs of any holes or rips.

Near the end of the 2002-03 storm season, the IS4 I-210 site was inadvertently cleaned by Caltrans Maintenance before field measurements were taken to estimate the weight and volume of gross solids that had accumulated in the device. Therefore, there is no cleaning information or gross solids data for that site.

At the start of the 2004-05 storm season, the screen module at the VS1 I-405 site was removed due to persistent clogging. Therefore, there is no cleaning information or gross solids data for that site.

The cleaning efforts required for the pilot project are much greater than the level of effort expected for normal cleaning of the device due to the monitoring aspect of the pilot study. In the event that the device is approved by Caltrans for permanent use, and transferred to the District for operations and maintenance, the expected cleaning method for each GSRD is a Vactor truck.

4.3.1 I-405 at Leadwell: V-screen – Configuration #1

During the 2002-03 storm season, the VS1 I-405 was inspected seven times and cleaned once at the end of the season. No interim cleanings were needed for this site. However, the device experienced overflow during 4 different storms. On those occasions, the screens were blinded by a layer of solids, and storm water overflowed the top of the screens. As part of the post-storm inspection, solids were scraped from the screen modules and moved to the back of the solids storage area. Even though the screen modules blinded, standing water was not a problem as the device drained in less than 24 hours.

During the 2004-05 storm season, the VS1 I-405 was inspected eight times and cleaned once when the screen modules were removed. During the first two storms of the season, the screens were observed to be completely blinded by a layer of solids, resulting in storm water overflowing the top of the screens (see Figure 4-1). As a result, large amounts of gross solids filled the bypass bag, causing it to become detached from the downstream pipe. The 4-foot bypass bag was replaced with an 8-foot bag. The gross solids from the 4-foot bag were transferred to the 8-foot bag. The second storm of the season resulted in the 8-foot bypass bag being full of gross solids (Figure 4-2). The screen modules were cleaned after the first two storm events to remove solids and allow normal flow of water. The solids removed from the screens were placed in the solids storage portion of the GSRD.

Despite the complete blinding of the screens (Figure 4-3) and overflow of storm water, standing water did not appear to be a problem as the device was observed to drain in less than 24 hours.

On November 30, 2004, the screen modules were removed, the device was cleaned (Figure 4-4).

Figure 4-1
VS1 I-405 During Monitoring

Figure 4-2
VS1 I-405 During Monitoring

Figure 4-3
VS1 I-405 Before Cleaning and Removal of Screens

Figure 4-4
VS1 I-405 After Cleaning and Removal of Screens

4.3.2 SR-91 at Ardmore: V-screen – Configuration #2

During the 2002-03 storm season, the VS2 SR-91 was inspected 8 times and cleaned once at the end of the season. No interim cleanings were required for this site. However, during the first storm of the season on December 16, 2002, the site received 30.48 mm (1.2 in. of rain), and one side of the reverse sloping screen dislodged from the wall bracket due to the high hydraulic and solids loading. As a result, the bypass bag was also forced off the outflow pipe as it was receiving the full load of solids and water flow. After the storm, the screen modules were reinforced by welding extension tabs to the brackets and adding bottom supports. The reinforcements helped the screen modules stay in position throughout the rest of the storm season. The VS2 SR-91 did not encounter any other operational or performance problems.

During the 2004-05 storm season, the VS2 SR-91 was inspected 12 times and cleaned once at the end of the season. No interim cleanings were required for this site. The lower portion of the screen module became clogged with gross solids, causing water to drain slowly through the GSRD (see Figure 4-5). Standing water behind the screen generally took more than 72 hours to drain from the GSRD following storm events. There was no evidence that water or gross solids larger than 5 mm (0.2 in.) overflowed the screen. Figures 4-7 and 4-8 show the site before and after the end of season cleaning.

4.3.3 I-210 at Christy: Inclined Screen – Configuration #4

During the 2002-03 storm season, the IS4 I-210 was inspected 4 times. The site was inadvertently cleaned by Caltrans maintenance at the end of the season. No interim cleanings were required for this site. A portion of the inclined screen had vegetation caught on it. However, no major clogging occurred, and the device performed as designed. The IS4 I-210 did not encounter any other operational or performance problems.

During the 2004-05 storm season, the IS4 I-210 was inspected 12 times and cleaned once at the end of the season. No interim cleanings were required for this site. There was no evidence that water or gross solids larger than 5 mm (0.2 in.) escaped the GSRD. The bypass bag trapped gross solids smaller than 5 mm (0.2 in.), while the lower portion of the inclined screen was observed to have vegetation caught on it (see Figure 4-9). However, the screen did not appear to be clogged, and the device appeared to be performing as designed. The IS4 I-210 did not encounter any other operational or performance problems. However, due to the large amount of sediment at this site, weed seeds sprouted and began growing in the sediment in the gross solids capture area and in the bypass bag (see Figure 4-10). During the end of season cleaning, on May 25, 2004, the bypass bag contained sediment, but no gross solids. Figures 4-11 and 4-12 shows the site during and after the end of season cleaning. There was a small quantity of sediment (< 1 cu.ft.) located beneath the screen which was subsequently removed during the end of season cleaning.

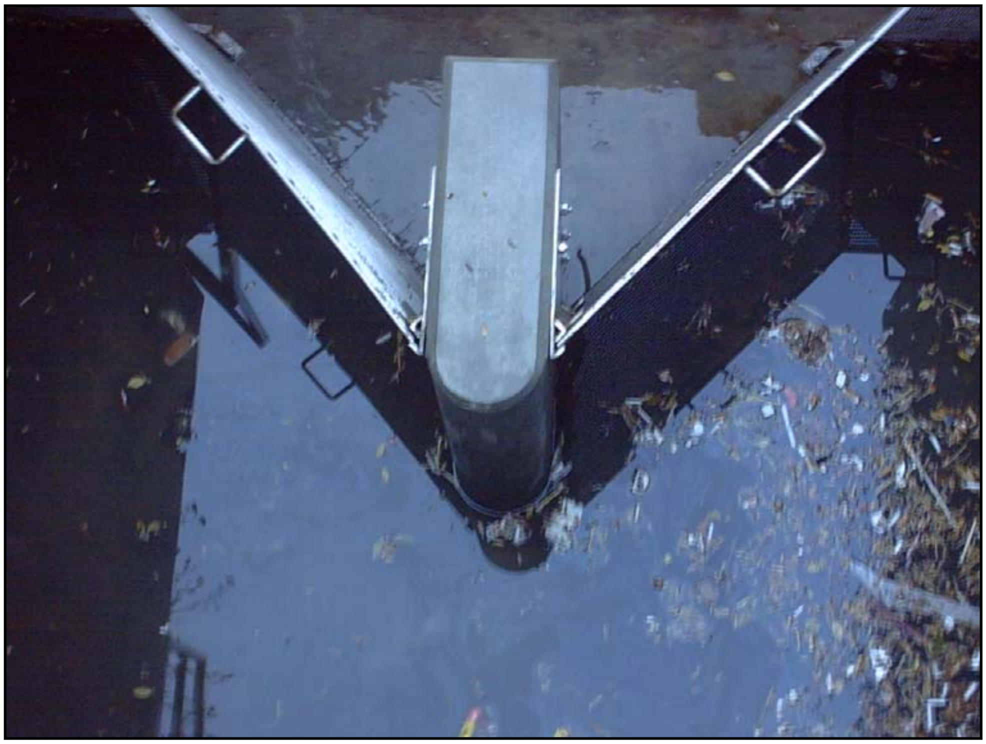

Figure 4-5
VS2 SR-91 During Monitoring

Figure 4-6
VS2 SR-91 During Monitoring

Figure 4-7
VS2 SR-91 Before End of Season Cleaning

Figure 4-8
VS2 SR-91 After End of Season Cleaning

Figure 4-9
IS4 I-210 Screen During Monitoring

Figure 4-10
IS4 I-210 Bypass Bag During Monitoring

Figure 4-11
IS4 I-210 End of Season Cleaning

Figure 4-12
IS4 I-210 End of Season Cleaning

4.3.4 Gross Solids Disposal

Gross solids were not tested before disposal, since most of the collected material consisted of vegetation, sediment and litter such as cardboard and plastic. The gross solids were placed in a bin and disposed of as municipal waste by Waste Management Company. No special handling techniques, e.g., hazardous suits or breathing apparatuses, were required during the cleaning operations.

4.4 VECTOR CONTROL

For the Phase III Pilot Study, the Greater Los Angeles County Vector Control District (GLACVCD) was contracted to provide vector surveillance and control services at the GSRDs from May 2004 through April 2005. The sites were monitored on a weekly basis. The numbers of potential and actual mosquito sources, as well as the number of dips taken at each individual source were recorded. Larval samples were identified to species. The size of the areas treated and amounts of control agents applied were also recorded. In summary:

- No breeding activity was detected.
- No abatement was required.

Section 5
Annual Gross Solids Loading and Capture Efficiency

5.1 GROSS SOLIDS DATA

The Phase III GSRDs Pilot Study monitored three devices over the 2002–03 and 2004-05 storm seasons. The data collected consisted of measuring the wet weight and wet volume of the captured gross solids during post season cleanings.

The total gross solids weight and volume collected at the GSRD site is presented in Table 5-1. The captured gross solids included the gross solids contained within the device and within the bypass bag, Table 5-1 also presents the number of cleanings required at the GSRD during each storm season. The IS4 I-210 was inadvertently cleaned by Caltrans maintenance staff at the end of the 2002-03 storm season. Therefore, there is no gross solids data available for this device for 2002-03. During the 2004-05 season, the screen modules at VS1 I-405 were removed so there is no end of season data for this site. Table 5-2 summarizes the annual gross solids loading, normalized by area, by wet weight and wet volume.

Table 5-1
Annual Wet Weight and Wet Volumes of Gross Solids and Cleaning Performance

Site	2002-03			2004-05		
	No. of Cleanings	Total Wet Weight [a] kg (lb)	Total Wet Volume [b] m^3 (ft^3)	No. of cleanings	Total Wet Weight [a] kg (lb)	Total Wet Volume [b] m^3 (ft^3)
VS1 I-405	1	539.1 (1,188.6)	0.65 (23.1)	N/A	No data[d]	No data[d]
VS2 SR-91	1	138.3 (305.0)	0.32 (11.2)	1	134.9 (297.3)	0.23 (7.9)
IS4 I-210	N/A	No data [c]	No data [c]	1	354.4 (781.2)	0.57 (20.1)

[a] Total wet weight includes the weight of gross solids captured within the device; within the bypass bag; and within the overflow structure (if applicable). As previously discussed in Section 4, the weight of gross solids was measured by placing each bag of collected gross solids on an electronic scale.

[b] Total wet volume includes the volume of gross solids captured within the device, within the bypass bag, and within the overflow structure (if applicable). As previously discussed in Section 4, the volume of gross solids was estimated by placing each bag of collected gross solids into a container of known volume. The gross solids were hand-leveled. The amount of freeboard was then measured and multiplied by the surface area of the container. This quantity was subtracted from the known volume to yield the estimated volume of gross solids.

[c] The site was inadvertently cleaned by Caltrans maintenance at the end of the 2002-03 season before any data was collected.

[d] At the request of Caltrans, the screen was removed from this site on November 30, 2004, therefore there are no season totals for this site.

Note: For reporting purposes, total wet weight for both S.I. units and U.S. Customary have been reported to the nearest tenth. Total wet volume in S.I. units has been reported to the nearest hundredth and to the nearest tenth in U.S. Customary units.

Table 5-2
Area-Normalized Annual Gross Solids Loading by Wet Weight and Wet Volume

Site	Total Area ha (ac)	2002-03		2004-05	
		Weight per Unit Area kg/ha (lbs/ac)	Volume per Area m^3/ha (ft^3/ac)	Weight per Unit Area kg/ha (lbs/ac)	Volume per Area m^3/ha (ft^3/ac)
VS1 I-405	1.2 (3.0)	449.3 (396.2)	0.58 (8.0)	No data[b]	No data[b]
VS2 SR-91	0.8 (2.0)	172.9 (152.5)	0.40 (5.6)	168.6 (148.7)	0.28 (4.0)
IS4 I-210 [a]	1.0 (2.5)	No data	No data	354.4 (312.5)	0.57 (8.0)

[a] The site was inadvertently cleaned by Caltrans maintenance at the end of the season and before any data was collected.

[b] At the request of Caltrans, the screen was removed from this site on November 30, 2004, therefore there are no season totals for this site.

Note: For reporting purposes, total wet weight for both S.I. units and U.S. Customary have been reported to the nearest tenth. Total wet volume in S.I. units has been reported to the nearest hundredth and to the nearest tenth in U.S. Customary units.

This pilot study did not investigate the seasonal variability of gross solids deposition. Some possible reasons for the seasonal variation are annual amount of rainfall, intensity and duration of storm events, and amount of wind blown material deposited.

5.2 CAPTURE EFFICIENCY

The gross solids capture efficiency was calculated by comparing the weight or volume of gross solids captured in the downstream bypass bag and overflow basket (if applicable) with the gross solids captured in the device:

$$Capture\ Efficiency = \frac{\begin{pmatrix} Solids\ Caught \\ in\ GSRD \end{pmatrix}}{\begin{pmatrix} Solids\ Caught \\ in\ GSRD \end{pmatrix} + \begin{pmatrix} Solids\ Caught \\ in\ Bypass\ Bag \end{pmatrix}} \times 100\%$$

Capture efficiency by volume for the devices over the two storm seasons is presented in Table 5-3. Additionally, capture efficiencies by weight for the devices over the same period are presented in Table 5-4. The volumes and weights presented in these tables and figures are the annual sum of the volumes and weights of gross solids captured within the device and within the bypass bag, during an entire storm season.

Table 5-3
Gross Solids Capture Efficiency by Wet Volume

Site	2002-03				2004-05			
	Captured Gross Solids m^3 (ft^3)	Bypass Gross Solids[c] m^3 (ft^3)	Total Gross Solids m^3 (ft^3)	Capture Efficiency %	Captured Gross Solids m^3 (ft^3)	Bypass Gross Solids[c] m^3 (ft^3)	Total Gross Solids m^3 (ft^3)	Capture Efficiency %
VS1 I-405	0.58 (20.4)	0.08 (2.7)	0.65 (23.1)	88[a]	No data[e]	No data[e]	No data[e]	No data[e]
VS2 SR-91	0.30 (10.7)	0.02 (0.5)	0.32 (11.2)	95[b]	0.21 (7.2)	0.02 (0.7)	0.23 (7.9)	91
IS4 I-210	No data[d]	No data[d]	No data[d]	No data[d]	0.38 (13.5)	0.19[f] (6.6)	0.57 (20.1)	100[g]

[a] Site experienced overflows throughout the monitoring period. Therefore, some amount of gross solids left the system unaccounted for. As a result, the calculated removal efficiency may be inaccurate—refer to Section 4.3.1 for a discussion of the operation of the GSRD.

[b] Site experienced overflows during the first storm of 2002-03 when the screen and bypass bag dislodged. Therefore, some amount of gross solids left the system unaccounted for. As a result, the calculated removal efficiency may be inaccurate—refer to Section 4.3.2 for a discussion of the operation of the GSRD.

[c] Bypassed gross solids" is the amount of gross solids that was captured in the bypass bag.

[d] The site was inadvertently cleaned by Caltrans maintenance at the end of the season and before any data was collected.

[e] At the request of Caltrans, the screen was removed from this site on November 30, 2004, therefore there are no season totals for this site.

[f] The material in the bypass bag consisted of sediment, which is not a target constituent (see discussion in Section 5.2).

[g] Material collected in the bypass bag was characterized as sediment which is not a target constituent of the trash TMDLs.

Note: For reporting purposes, total wet volume in S.I. units has been reported to the nearest hundredth and to the nearest tenth in U.S. Customary units.

Table 5-4
Gross Solids Capture Efficiency by Wet Weight

Site	2002-03				2004-05			
	Captured Gross Solids kg (lb)	Bypassed Gross Solids[c] kg (lb)	Total Gross Solids kg (lb)	Capture Efficiency %	Captured Gross Solids kg (lb)	Bypassed Gross Solids[c] kg (lb)	Total Gross Solids kg (lb)	Capture Efficiency %
VS1 I-405	528.9 (1,166.0)	10.2 (22.6)	539.1 (1,188.6)	98[a]	No data[e]	No data[e]	No data[e]	No data[e]
VS2 SR-91	135.6 (299.0)	2.7 (6.0)	138.3 (305.0)	98[b]	125.4 (276.5)	9.4 (20.8)	134.9 (297.3)	93
IS4 I-210[d]	No data	No data	No data	No data	162.7 (358.7)	191.7[f] (358.7)	354.4 (781.2)	46[f]

[a] Site experienced overflows throughout the monitoring period. Therefore, some amount of gross solids left the system unaccounted for. As a result, the calculated removal efficiency may be inaccurate—refer to Section 4.3.1 for a discussion of the operation of the GSRD.

[b] Site experienced overflows during the first storm of 2002-03 when the screen and bypass bag dislodged. Therefore, some amount of gross solids left the system unaccounted for. As a result, the calculated removal efficiency may be inaccurate—refer to Section 4.3.2 for a discussion of the operation of the GSRD.

[c] Bypassed gross solids" is the amount of gross solids that was captured in the bypass bag.

[d] The site was inadvertently cleaned by Caltrans maintenance at the end of the season and before any data was collected.

[e] At the request of Caltrans, the screen was removed from this site on November 30, 2004, therefore there are no season totals for this site.

[f] The material in the bypass bag consisted of sediment, which is not a target constituent (see discussion in Section 5.2).

Note: For reporting purposes, total wet weight for both S.I. units and U.S. Customary have been reported to the nearest tenth.

For the 2004-05 season, the reported capture efficiency for the IS4 I-210 is 46 percent by weight and 67 percent by volume. However, the material collected in the bypass bag was completely sediment, as seen in Figure 5-1. Since sediment is not a target constituent of the Trash TMDLs, the IS4 I-210 capture efficiency should be 100 percent by weight and volume.

Figure 5-1
IS4 I-210 Bypass Material

The GSRDs were designed to meet the requirements of a full capture treatment system defined by the Los Angeles River TMDL for trash. The TMDL defines a "full capture treatment system" as "*…any device or system that traps all particles retained by a 5 mm mesh screen and has a design treatment capacity of not less than the peak flow resulting from a one-year, one-hour storm (determined to be 0.6 inch per hour for the Los Angeles River watershed)*" (LARWQCB, 2001). The monitoring strategy employed for this study specified measuring the gross solids at the time cleanings were performed at each device, but not after every storm event.

The pilot project study was not designed to determine the amount of gross solids that were bypassed on a per-storm event basis. Consequently, it is not possible to determine if the bypasses occurred during storm events greater than the design storm that would be allowed under the TMDL or less than the design storm which would violate the TMDL. Furthermore, it is not possible to tell whether the gross solids captured in the downstream bypass bag and overflow basket escaped the GSRD during bypass events or normal operations. The presumption is that these gross solids escaped only during high flows and that a very small amount of material may have been wind-blown into the device.

Section 6
Discussion and Summary

6.1 COMPLIANCE WITH TMDL

The California Regional Water Quality Control Board, Los Angeles Region (LA RWQCB) has developed a total maximum daily load (TMDL) that is designed to attain the water quality standards for trash in the Los Angeles River (LA RWQCB, 2001). A TMDL represents the total amount of a given pollutant that can be released into a water body consistent with the goal of restoring and ultimately maintaining beneficial uses designated for the water body. A waste load allocation (WLA) allocates this total maximum daily load among all dischargers of that pollutant to a particular waterway. The Final WLA for the TMDL for trash in the Los Angeles River Watershed is set at zero for storm events up to the design storm and will be met over a period of 12 years through a phased reduction.

As indicated in the TMDL regulation, areas served by a full capture treatment system will be considered in compliance with the final WLA, provided that the full capture treatment system is adequately sized and maintained, and maintenance records are available for inspections by the LA RWQCB (LA RWQCB, 2001). Additionally, the TMDL regulation identifies the vortex separation system as an approved full capture treatment system. The TMDL regulation allows for the deployment of other devices or systems, such as the eight GSRDs tested in this study. However, these devices or systems need to be certified by the LA RWQCB before removal credit is granted. The criteria for a full capture treatment system are provided in Section 2.1 and in the next section.

6.2 OVERALL GSRD PERFORMANCE

The overall performance of each GSRD was assessed by evaluating how well the GSRD met the different design objectives listed in Section 2.1 and repeated below. The design objectives must include four performance criteria established by the TMDL and Caltrans, and two additional performance goals set by Caltrans. A GSRD cannot be considered a success unless it meets all four performance criteria. Beyond this consideration, the extent to which a GSRD meets the two performance goals assesses its desirability as compared with another GSRD.

The following two performance criteria were set by the TMDL for an approved full capture treatment system:

C1	Particle Capture	The device or system must capture all particles retained by a 5 mm (0.2 in nominal) mesh screen from all runoff generated from a one-year, one-hour storm (determined to be 0.6 in [15 mm] per hour for the Los Angeles River Watershed).
C2	Clogging	The device or system must be designed to prevent plugging or blockage of the screening module.

The following two performance criteria were set by Caltrans:

C3	Hydraulic Capacity	The device or system must pass the Caltrans design flow. In District 7, this design flow is the 25-year peak flow.
C4	Drainage	The device or system must drain within 72 hours to avoid vector breeding.

Additionally, the following two performance goals were set by Caltrans:

G1	Gross Solids Storage Capacity	The device or system will hold the estimated annual load of gross solids, so that it requires only one cleaning per year.
G2	Maintenance Requirements	The device or system will not require any maintenance other than inspections throughout the storm season.

6.3 GSRD PERFORMANCE CRITERIA

The TMDL and Caltrans criteria represent design objectives for the pilot study that must be met by the three GSRDs for consideration for future deployment.

6.3.1 Criterion C1 – Particle Capture

For this pilot study, the word “all” stated in the first TMDL criterion is interpreted to mean 100 percent of the particles at or greater than the targeted size. Furthermore, it is assumed that particles captured during one storm event are not allowed to be re-suspended and released back into the storm drain system by subsequent storms. In this pilot study, particles retained by a 5 mm (0.2 in. nominal) mesh screen are assumed to be the same particles retained by a 5 mm (0.2 in. nominal) spaced wedge –wire screen.

The IS4 I-210 captured 67 percent (by volume) of the gross solids during the 2004-05 season. As discussed in Section 5.2, it is thought that the device actually captured 100 percent of the gross solids since the bypass material was completely sediment. No measurement of gross solids took place during the 2002-03 season. Based on the observations in Section 4.3.3, it is assumed that the device would have captured 100 percent of the gross solids during the 2002-03, not including sediment. If true, the IS4 I-210 captured 100 percent of the gross solids during both storm seasons and this GSRD met the first criterion of the TMDL (gross solids captured during storm events less than or equal to the design storm was 100 percent).

The measured capture efficiencies of VS1 I-405 and VS2 SR-91 were each less than 100 percent. However, these values may be overstatements since there were indications that the GSRDs overflowed and it is likely that gross solids escaped the system and were not captured by the bypass bag. This overflow condition appears to have occurred at least once during one or both storm seasons. It is presumed that the GSRDs bypassed gross solids or overflowed due to the blinding of the V-screen. Since it appears that 100 percent of the gross solids were captured by the V-screen GSRDs to the point where the screen became blinded and the GSRD overflowed, the V-screen configuration GSRDs met the first criterion of the TMDL (gross solids captured during storm events less than or equal to the design storm was 100 percent). They did not, however, meet Caltrans criteria for annual cleanings.

6.3.2 Criterion C2 – Clogging

As discussed in section 4.3.3, IS4 I-210 had no observable problems with clogging or blinding. As discussed in Section 4.3.1 and 4.3.2, the VS1 I-405 and VS2 SR-91 GSRDs experienced observable problems with clogging and blinding of the screen modules. The screen in the VS1 I-405 became completely blinded by a layer of gross solids, which caused storm water to flow over the top of the screen. At VS2 SR-91, the lower portion of the screen became partially clogged, resulting in slow drainage of water through the screen.

6.3.3 Criterion C3 – Hydraulic Capacity

Each GSRD was designed to capture the estimated annual amount of gross solids and convey the Caltrans design flow. For this pilot study, the criteria in the Caltrans Highway Design Manual and local Caltrans district, District 7, required each GSRD to convey the 25-year peak flow. The purpose of this requirement is to prevent storm water from backing up onto the freeway. Because each GSRD was designed to safely bypass flows in excess of the 25-year peak flow, all three GSRDs are presumed to meet this criterion.

6.3.4 Criterion C4 – Drainage

All of the Phase III GSRDs were designed to drain within 72 hours to prevent vector breeding. Both the VS1 I-405 and IS4 I-210 were observed to meet the 72-hour drain time. Clogging of the lower portion of the screen module at the VS2 SR-91 resulted in standing water being present for more than 72 hours. As a result, periodic maintenance was required to remove the clogged material. This GSRD could meet the criterion if a maintenance schedule were put in place.

6.4 GSRD PERFORMANCE GOALS

The purpose of the two Caltrans goals was to reduce the maintenance effort, time and equipment needed for each GSRD. The goals represent desirable features to maintain and operate the approximately 2,600 outfalls that will need to be retrofitted for compliance with the TMDLs. As a result, GSRDs that do not meet the goals may not necessarily be disqualified, though they would not be preferred devices.

6.4.1 Goal G1 – Gross Solids Storage Capacity

Both the VS2 SR-91 and IS4 I-210 met the goal of one cleaning per year. The VS2 SR-91 site was cleaned once at the end of the 2002-03 season and once at the end of the 2004-05 season. At IS4 I-210, the GSRD was inadvertently cleaned by a Caltrans District 7 maintenance crew at the end of the 2002-03 season before gross solids data were collected. However, based on observations throughout the 2002-03 season, and subsequent monitoring during the 2004-05 season, this device meets the gross solids storage capacity goal. The IS4 I-210 site was cleaned once at the end of the 2004-05 season.

As discussed in Section 4.3, a trigger for cleaning was the observation of extensive clogging or overflow. At VS1 I-405, the gross solids storage area was not full. However, the screen modules became clogged with gross solids, resulting in overflow of water and gross solids.

During the 2002-03 storm season, and the first storm of the 2004-05 season, the screen modules were cleaned by scraping the gross solids from the screen and moving them to the back of the gross solids storage area. Following the second storm of the 2004-05 season, the screen modules were removed and the GSRD was cleaned.

6.4.2 Goal G2 – Maintenance Requirements

During the two storm seasons, the IS4 I-210 GSRD was the only device that did not require any maintenance except for the end-of-season cleaning. The VS1 I-405 required gross solids to be scraped from the screen modules several times during the 2002-03 and 2004-05 seasons. The VS2 SR-91 required limited cleaning to remove clogged material from the lower portion of the screen module. The IS4 I-210 best meets the goal of requiring only inspections throughout the storm season.

6.5 SUMMARY EVALUATION

Table 6-1 summarizes how well each GSRD met the performance criteria and goals discussed in Sections 6.3 and 6.4. Table 6-2 on the following page summarizes the strong points, weak points, and potential to correct deficiencies, if applicable, of each GSRD. Overall, the IS4 I-210 performed the best of the three Phase III GSRDs. This GSRD met the criteria of the TMDL and Caltrans, and it best met the Caltrans goals.

6.6 REGIONAL BOARD APPROVAL

The GSRDs evaluated in this pilot study will need to be certified, as indicated in the TMDL regulation, by the LA RWQCB before they can be used to obtain credit towards meeting the WLA. Coordination with the RWQCB will be required to start the process of getting any of the proposed GSRDs approved. As mentioned in Section 6.5, the IS4 I210 performed the best of the three GSRDs. Additionally, as shown in Table 6-2, this device met the criteria of a full capture treatment system. The criteria of a full capture treatment system are defined in Section 2.1.

6.7 ADDITIONAL PILOT STUDY OBSERVATIONS

After monitoring the Phase III GSRD for two storm seasons, important observations were made which can be applied to future GSRD designs.

6.7.1 Gross Solids Loading Rate

The estimated annual gross solids loading by volume for design was 0.7 m^3/ha (10 ft^3/ac). This design number was applied to all three sites so that each GSRD would need to be cleaned only once per storm season. When the estimated annual loading of gross solids is exceeded at a site, additional cleanings may be required.

Over the two storm seasons, all of the sites exhibited annual gross solids loadings that were less than the estimated annual gross solids loading of 0.7 m^3/ha (10 ft^3/ac). What is interesting is the range of annual gross solids loading observed, from 0.28 m^3/ha (4.0 ft^3/ac) to 0.58 m^3/ha (8.0 ft^3/ac)—about double.

Due to the variations in calculated annual gross solids loading from each GSRD, further investigation and refinement of the estimated annual gross solids loading for design may be warranted to meet the target of one cleaning per storm season. Additionally, designs that are easily expanded in the field should be investigated due to the variations in annual gross solids loading.

6.7.2 Overall GSRD System

The Phase III GSRDs Pilot Study focused only on the design of non-proprietary collection devices, which is only one of three components of the overall Gross Solids Collection System. The three components of the Gross Solids Collection System are listed below:

1. On-Site Collection
2. Inspections and Maintenance
3. Solids Disposal

On-Site Collection includes non-proprietary devices that can capture gross solids to meet the requirements of the TMDL and the requirements and goals of Caltrans. This component has been the focus of this pilot study. The second component, Inspections and Maintenance, ensures that the devices continue to capture gross solids throughout each storm season, convey storm water runoff away from the roadway, and collect the captured gross solids for disposal. In the third component, Solids Disposal, the collected gross solids are transported from the collection device to the appropriate disposal site.

This study has not considered how the overall system would operate once all of the approximately 2,600 GSRDs were installed within two watersheds. A number of issues within the overall system remain to be addressed in future studies. One issue that affects the design of GSRDs is site access and is discussed below.

6.7.2.1 Site Access

This study utilized sites with sufficient access for construction equipment, monitoring vehicles, and cleaning vehicles. It is likely that many sites within the watershed will not have sufficient access for construction equipment and cleaning vehicles. Sites with limited access will dictate the type of cleaning vehicle that can be used which in turn affects design. For example, if a Vactor Truck cannot access a site due to height restrictions, a GSRD that can only be cleaned by a Vactor Truck would not be appropriate. This issue has not played an important role to date in establishing design criteria and goals. An examination of site characteristics and problems may be warranted to determine their effects on future designs.

Table 6-1
GSRD Pilot Performance Summary in Relation to Design Criteria and Goals

Device	Criterion (C) or Goal (G)					
	C1 Particle Capture	C2 Clogging	C3 Hydraulic Capacity	C4 Drainage	G1 Solids Storage	G2 Maintenance Requirements
V-Screen Configuration #1	Possibly. Annual capture efficiency < 100% but gross solids bypass thought to occur due to blinding of the V-screen.	No. The device clogged and overflowed.	Presumably. Device designed to pass peak flow from a 25-yr storm. No event equivalent to a 25-year, 24-hour storm was observed during the study period.	Yes.	Uncertain. Device experienced bypass during both 2002-03 and 2004-05 storm seasons. Screen module removed at start of 2004-05 season.	No. Maintenance required to unclog screen modules and drainage fixtures.
V-Screen Configuration #2	Possibly. Annual capture efficiency < 100% but gross solids bypass thought to occur due to blinding of the V-screen.	No. The device clogged and caused standing water.	Presumably. Device designed to pass peak flow from a 25-yr storm. No event equivalent to a 25-year, 24-hour storm was observed during the study period.	No. Periodic maintenance needed to clear drainage fixtures.	Yes.	No. Maintenance required to unclog screen modules and drainage fixtures.
Inclined Screen Configuration #4	Presumably. Missing first year cleaning data. Based on observations throughout first storm season, particle capture assumed to be 100%.	Yes.	Presumably. Device designed to pass peak flow from a 25-yr storm. No event equivalent to a 25-year, 24-hour storm was observed during the study period.	Yes.	Yes	Yes.

Table 6-2
Summary of Performance Characteristics for Each GSRD

Device	Strong Points	Weak Points	Potential to Correct Deficiencies
V-Screen Configuration #1	▪ Met C4 (Drainage) ▪ Presumed to have met C1 (Partical Capture) and C3 (Hydraulic Capacity)	▪ Did not meet C2 (Clogging), or G2 (Maintenance Requirements) ▪ Not known if met G1 (Solids Storage)	▪ None
V-Screen Configuration #2	▪ Met G1 (Solids Storage) ▪ Presumed to have met C1 (Particle Capture) and C3 (Hydraulic Capacity)	▪ Did not meet C2 (Clogging), C4 (Drainage) or G2 (Maintenance Requirements)	▪ None
Inclined Screen Configuration #4	▪ Met C1 (Particle Capture), C2 (Clogging), C4 (Drainage), G1 (Solids Storage, and G2 (Maintenance Requirements) ▪ Presumed to have met C3 (Hydraulic Capacity)	▪ Screen module is hinged at bottom to access area under it	▪ Place hinge at top of screen module to open up

Section 7
References

Caltrans, 2000. California Department of Transportation [Caltrans]. Guidance for Monitoring Storm Water Litter. October 2000. CTSW-RT-00-025.

Caltrans, 2001a. Caltrans. Statewide Storm Water Management Plan. August 2001. CTSW-RT-01-024.

Caltrans, 2003a. Caltrans. Phase II & III Gross Solids Removal Devices Operations and Maintenance Plan, Monitoring Season 2002-2003. November 2002. CTSW-RT-02-071.

Caltrans, 2003b. Caltrans. Phase I Gross Solids Removal Devices Pilot Study 2000-2002 Final Report. October 2003. CTSW-RT-03-072.31.22.

Caltrans, 2003c. Caltrans. Phase III Gross Solids Removal Devices Basis of Design Report. October 2003. CTSW-RT-03-098.31.17.

LA RWQCB, 2001a. Trash Total Maximum Daily Loads for the Los Angeles River Watershed. September 19, 2001. California Regional Water Quality Control Board – Los Angeles Region. 320 West Fourth Street, Los Angeles, California 90013.

LA RWQCB, 2001b. Trash Total Maximum Daily Loads for the Ballona Creek and Wetland. September 19, 2001. California Regional Water Quality Control Board – Los Angeles Region. 320 West Fourth Street, Los Angeles, California 90013.