GSRDs: Phase IV

Caltrans

Phase IV
Gross Solids Removal Devices
Pilot Study: 2004 -2005

Final Report
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State of California
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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
LR3 US-101	US-101 at Gaviota: Linear Radial – Configuration #3

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 IV Gross Solids Removal Device (GSRD) Pilot study was to evaluate the performance of one non-proprietary device 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 Phase IV concept was developed to assess the applicability of placing Linear Radial – Configuration #1 GSRDs at a slope greater than 2-percent. The Phase IV GSRD is identical to the Linear Radial – Configuration #1 GSRD (LR1 I-10) tested in the Phase I GSRD Pilot Study. The LR1 I-10 was constructed at a 2-percent slope. The Phase IV GSRD was constructed at a 70 percent (35 degrees) slope.

Following a targeted storm event, Phase IV 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.

The Phase IV GSRD captured approximately 44 percent of the gross solids by volume during the first storm season. The low capture efficiency appears to be primarily due to the large momentum of the storm water runoff which is forcing the gross solids out of the GSRD. As a result, this GSRD is not meeting the TMDL criteria or the Caltrans goals. Design options to reduce the momentum of the storm water runoff are being evaluated for this GSRD. However, the second year of monitoring of the Phase IV GSRD will not take place.

Section 1
Introduction and Study Design

1.1 OBJECTIVE

The objective of the Gross Solids Removal Devices (GSRDs) Pilot Program (Program), initiated by the California Department of Transportation (Caltrans), was 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 have been adopted in Southern California (LA RWQCB, 2001a). Additional watersheds have been placed on the 303(d) list of impaired water bodies for trash. 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 installation, and conducted one or more years of pilot testing 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 fourth pilot study in the Program is the Phase IV GSRDs Pilot Study. Tasks 1 and 2 took place during the Summer and Fall 2003. Task 3 took place between October 2003 and December 2003. Task 4 took place between October 2004 and May 2005.

At the time this report was prepared, the Program included five pilot studies or phases. Figure 1-1 presents a timeline for monitoring of the five pilot studies. The Phase I GSRDs Pilot Study, consisting of eight devices, has completed monitoring and the final report has been published (Caltrans, 2003a). The Phase II GSRDs Pilot Study, consisting of one device, has completed monitoring and the final report has been published (Caltrans, 2003b). The Phase III GSRDs Pilot Study (Caltrans, 2003c), consisting of three devices, has completed monitoring and the final report has been published (Caltrans, 2005). The Phase IV GSRDs Pilot Study, consisting of one device, has completed the first year of monitoring. The Phase V GSRDs Pilot Study is currently in construction. Figure 1-2 presents a summary of the devices in each phase of the study.

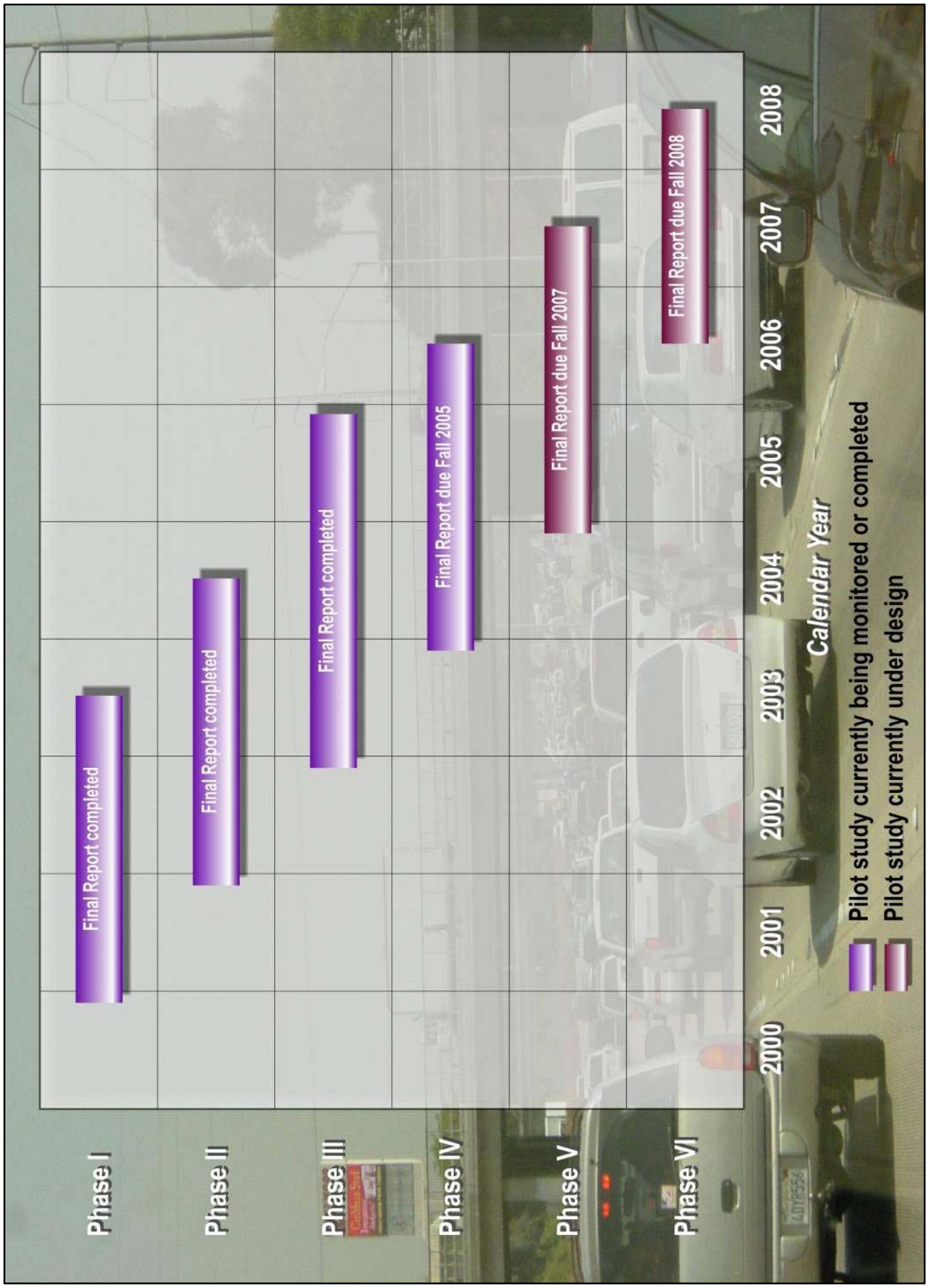

Figure 1-1
Monitoring Schedule for GSRD Pilot Studies

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.

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.

Figure 1-2
Summary of Phase I, II, III & IV Devices

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 I Devices. However, for this pilot study, the device will be constructed on an approximately 35 degree slope (70 percent grade).

Figure 1-2 (Continued)
Summary of Phase I, II, III & IV Devices

1.3 TERMINOLOGY

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

- **Bypass Screen –** A bypass screen captures gross solids that have been forced through the louvers of the device. The bypass screen for the Phase IV GSRD is a 1.01 meter (3.3 feet) wide by 1.83 meter (6.0 feet) long woven wire mesh screen that is located at the outfall end of the device. The bypass screen is comprised of type 304 stainless steel (standard grade) wire that is 1.6 millimeters (0.063 inch) in diameter and has an open width of 4.75 millimeters (0.187 inch) which yields 56.0 percent open space within the bypass screen. The bypass screen is mounted onto an aluminum grate installed flush with the floor of the device so that outfall water from the linear radial GSRD screen flows through the bypass screen and gross solids are captured within the device. The bypass screen is for monitoring during the pilot study and would not be a feature of a permanent GSRD installation.

- **Overflow Condition –** Condition that occurs when the water level reaches beyond the maximum level in the device, and inflow overtops the device. Under overflow conditions, gross solids may flow out of the device. The overflowed gross solids are unaccounted for. Overflow conditions can occur when 1) inflow exceeds the capacity of the GSRD screen, 2) the GSRD screen is blinded, 3) the bypass screen is blinded or 4) 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 2004–05 monitoring season is also presented.

- **Section 5** presents the gross solids data collected during the 2004–05 monitoring season.

- **Section 6** presents references cited in this report.

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

This report provides units in both S.I. units and U.S. Customary 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 in pipe is referred to as a 600 mm pipe.

Section 2
Concept Development

2.1 DESIGN OBJECTIVES

The Phase IV GSRDs Pilot Study was designed to test a prototype GSRD that meets the criteria set by the TMDL for trash in the Los Angeles River watershed and the criteria and goals set by Caltrans. The six design objectives listed below represent criteria and goals applied to all 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 0.6 in [15 mm] 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:

- 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:

- 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 IV GSRDs Pilot Study involves modifying and testing one previously-approved non-proprietary device. The concept represents a variation from one of the GSRDs evaluated under the Phase I Pilot Study. The Phase I Pilot Study consisted of three concepts: the Linear Radial, the Inclined Screen, and the Baffle Box (Caltrans, 2003a). The Linear Radial and the Inclined Screen design concepts consisted of two variations.

The Phase IV concept was developed from the Linear Radial – Configuration #1. This Phase I GSRD was installed at a 2-percent slope. The Phase IV concept is identical to the Phase I GSRD; however, the Phase IV concept has been installed at a steeper slope—approximately 35 degree slope (70 percent grade). The Phase IV concept was developed in order to assess whether the Linear Radial – Configuration #1 concept could be applied to a 35 degree slope (70 percent grade). A summary of the design components applied to the Phase IV GSRD is presented in Section 2.2.1.

2.2.1 Linear Radial – Configuration #3

This GSRD utilizes a modular well casing with 5 mm x 64 mm (0.2 in x 2.5 in nominal) louvers to serve as the GSRD screen (Figure 2-1). Flows are routed through the louvers and into a vault. Key design and operational concepts are as follows:

- Inflow is directed into the louvered GSRD screen contained within a concrete vault. The louvered GSRD screen and vault are linear and aligned parallel to the direction of flow.
- Flows pass radially through the louvered GSRD screen and into the vault.
- The louvered GSRD screen has a smooth, solid bottom section (extending 60 degrees) to facilitate the movement of settled gross solids toward the downstream end of the pipe.
- Sufficient GSRD screen area and volume are provided to accommodate the estimated annual volume of gross solids and to pass the required design storm.
- The first section of pipe nearest the influent pipe has the same diameter as the louvered GSRD screen sections with an emergency overflow. The overflow is designed to convey flows larger than the Caltrans design flow and flows when the device is 100 percent clogged.
- The estimated annual gross solids loading rate used for this study is 0.7 m^3/ha (10 ft^3/yr).

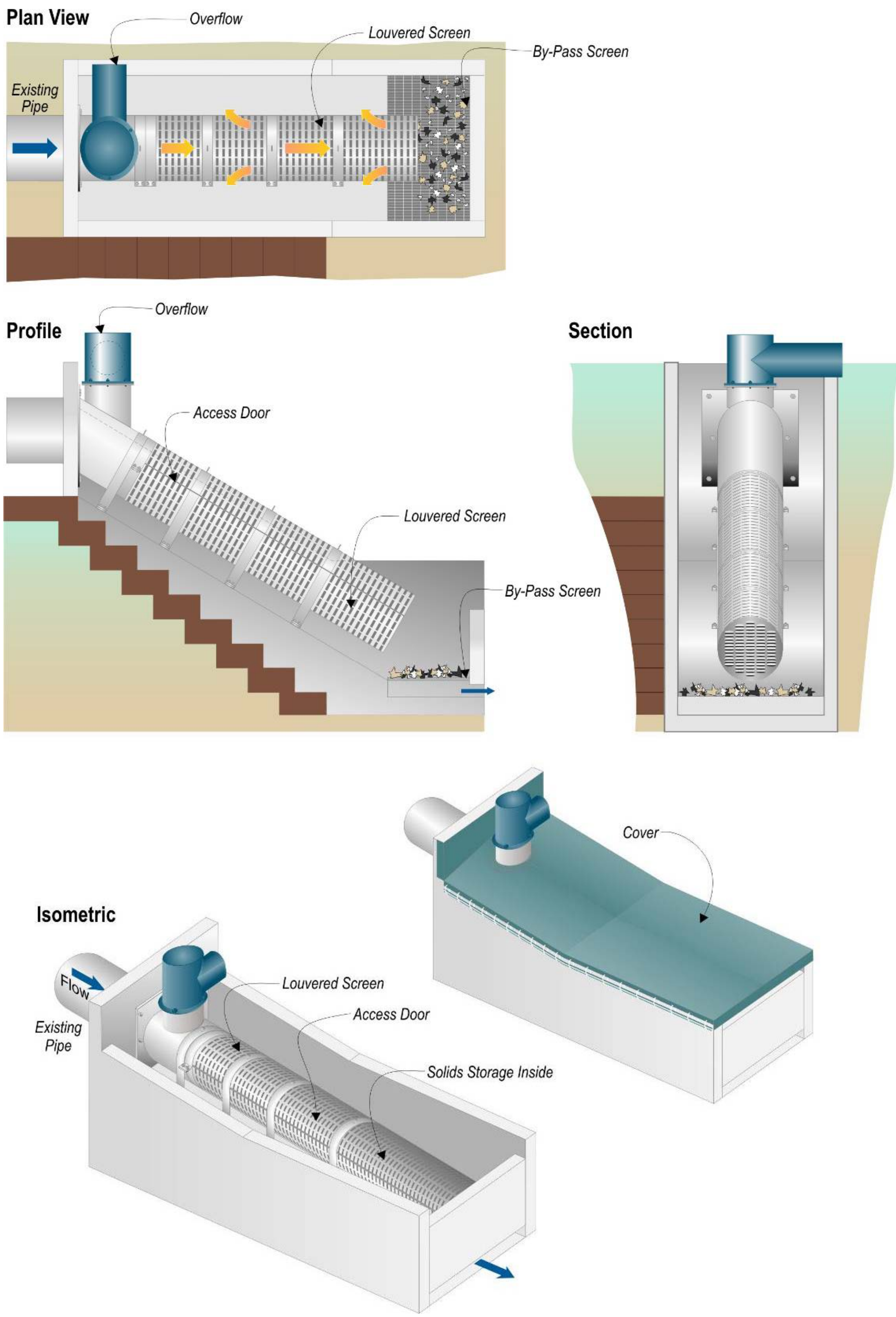

Figure 2-1
Concept Linear Radial – Configuration #3

Section 3
Site Selection and GSRD Installation

3.1 SITE SELECTION

The Phase IV GSRD replaces an existing Inclined Screen – Configuration #2 installed as part of the Phase I Pilot Study. For the Phase I Pilot Study, the site selection process identified and ranked over 70 candidate sites (Caltrans, 2003a). From these candidate sites, eight sites were selected for installation of Phase I GSRDs.

3.2 SITE DESCRIPTION

The site selected for the construction of the Phase IV GSRD is located within District 7 and within the Los Angeles River Watershed. Figure 3-1 shows the approximate site location. Table 3-1 provides the naming convention that will be used throughout the rest of the report along with the drainage area characteristics. A description of the site is presented in the following subsection. Figure 3-2 is a photo of the Phase IV GSRD after construction.

3.2.1 LR3 US-101: Linear Radial – Configuration #3

This site is located in the community of Encino just north of Magnolia Boulevard near Gaviota Avenue below the eastbound side of US-101 Freeway. Access to the site for installation, maintenance, and monitoring purposes is from Magnolia Boulevard at the intersection with Gaviota Avenue. This site is characterized by:

- Five inlets located along the freeway shoulder and 10 inlets along the centerline of the freeway
- Two outlets, 300 mm (12 in) and 450 mm (18 in) in diameter
- Drainage area of approximately 0.8 ha (2.1 ac)

The site is a sloped, grassy parcel with many trees, located in the Caltrans right-of-way below the sound wall on the eastbound US-101 Freeway.

At the beginning of the 2004-05 storm season, a temporary cover was installed over the GSRD to prevent wind-blown material from entering the GSRD. The temporary cover was replaced with a permanent cover in December 2004 as shown in Figure 4-2.

Table 3-1
Phase IV GSRD 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	LR3 US-101	Linear-Radial Configuration #3	LR3 US-101	Los Angeles River	0.8 (2.1)[1]	100	15[(2)]

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

[2] Ten inlets are located along the centerline of the freeway

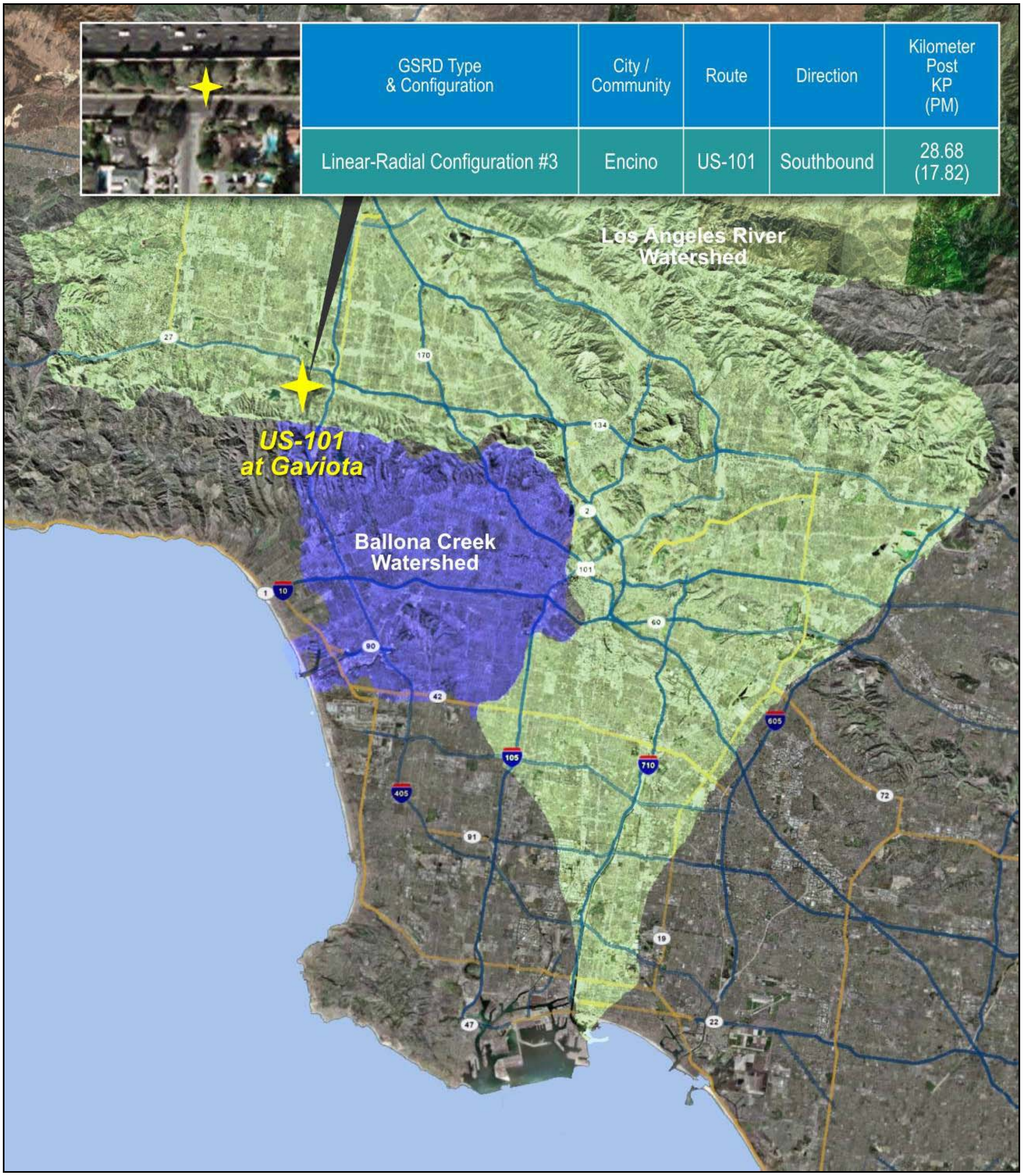

Figure 3-1
Phase IV GSRD Site Location Map

Figure 3-2
LR3 US-101 After Installation

Section 4
Monitoring and Operational Observations

4.1 OVERVIEW

This Section summarizes the monitoring procedures for the Phase IV Pilot Study and the operational observations for the device during the 2004-05 storm season.

4.2 GROSS SOLIDS MONITORING

Monitoring procedures for the 2004-05 storm season are presented in the *Phase III and IV Gross Solids Removal Devices, Operations, Maintenance and Monitoring Plan* (Caltrans, 2004). In summary, the following tasks were conducted after each targeted storm event:

- Took digital photos of the device.
- Assessed device for clogging.
- Observed the accumulation of gross solids within the device.
- Estimated the amount of gross solids accumulation within the device to assess if an interim cleaning would be required.
- Checked the bypass screen 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 interim cleaning was performed during the season. Interim cleaning was not required for the Phase IV GSRD itself during the 2004-05 storm season. However, the bypass screen was cleaned three times to remove gross solids that blocked the bypass screen. Gross solids were not removed from the GSRD until the end of season cleaning. During each cleaning procedure, four measurements were taken:

- Wet weight of the gross solids removed from the device (if any).
- Wet volume of the gross solids removed from the device (if any).
- Wet weight of the gross solids removed from the bypass screen.
- Wet volume of the gross solids removed from the bypass screen.

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 wet weight and wet volume measurement data.

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 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 were added together and the total weight was 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.

4.3 GSRD OPERATION AND CLEANINGS

A summary of the operation and cleaning of the GSRD during the 2004-05 storm season 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 datum represents the effort needed to clean the GSRD; 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 IV GSRD Pilot Study Cleaning Requirements

Site	Average Person-hours per Storm Season	Equipment
LR3 US-101	12.25	Shovels, Brooms, Brushes, Waste Bin, Pick-Up Truck

For pilot project operations, gross solids were shoveled into bags and field measurements taken. During cleaning, it was often observed that the gross solids were still partially wet, therefore taking longer to shovel and move the heavier material. The devices were also swept clean to collect any remaining gross solids. The louvers of the GSRD were cleaned with a wire brush to remove and collect any accumulated material. Gross solids from these various locations were shoveled, bagged, and measured. Gross solids were also scraped and collected from the bypass screen. The bypass screen was checked for visible signs of excessive wear or damage. If this GSRD is deployed statewide, the expected cleaning method is a Vactor™ truck.

4.3.1 LR3 US-101: Linear-Radial – Configuration #3

During the 2004-05 storm season, the LR3 US-101 was inspected 11 times. While the GSRD did not require an interim cleaning during the 2004-05 storm season there was evidence on multiple occasions that gross solids had been forced through the linear radial GSRD screen during storms and flowed over the top of the vault (Figure 4-3). The bypass screen often became clogged with fine gross solids which had been forced through the louvers of the linear radial GSRD. Since this material was too large to pass through the bypass screen, the vault filled with water, overflowed the device, and required cleaning three times during the season. Standing water was also a problem since the clogging of the bypass screen did not allow the device to drain within 72 hours (see Figure 4-1). Once the bypass screen was cleaned, however, the device drained quickly.

The end of season cleaning was performed on May 25, 2005. As shown in Figure 4-3, gross solids had been forced through the linear radial GSRD screen during storms and flowed over the top of the vault.

4.3.2 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 Inc. No special handling techniques, e.g., hazardous suits or breathing apparatuses, were required during the cleaning operations.

4.4 VECTOR CONTROL

For the Phase IV Pilot Study, the Greater Los Angeles County Vector Control District (GLACVCD) was contracted to provide vector surveillance and control services at the GSRD from May 2004 through April 2005. The site was 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 as to species. The sizes of the areas treated and amounts of control agents applied were also recorded. In summary:

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

Figure 4-1
LR3 US-101 During Monitoring

Figure 4-2
LR3 US-101 Cover Installation

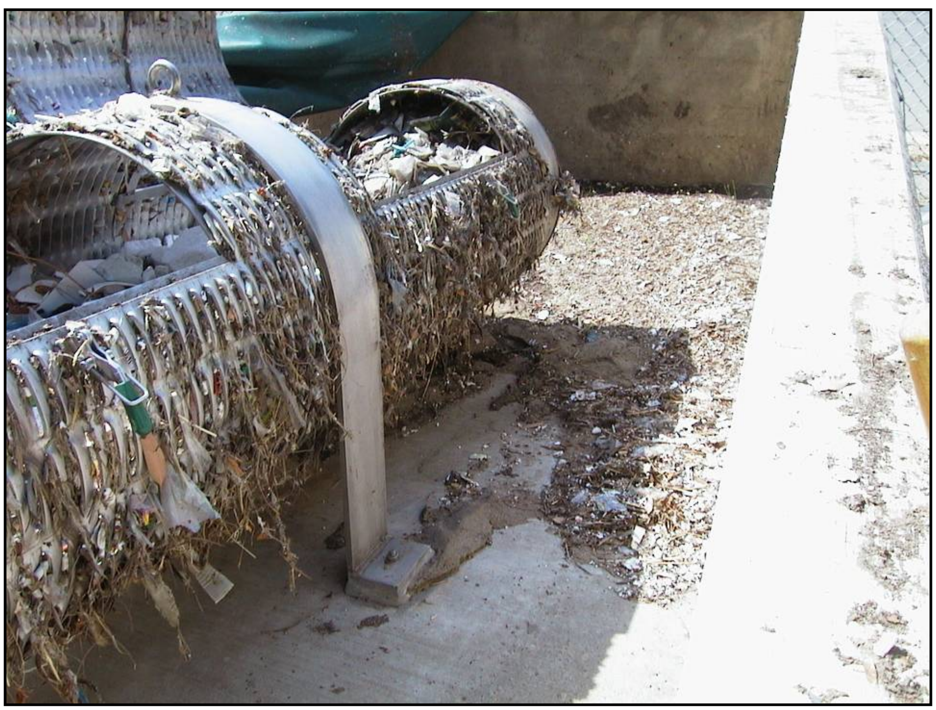

Figure 4-3
Gross Solids Protruding through GSRD Screen

4.5 NOISE CONSIDERATION

During the pre-season cleaning of the LR3 US-101 on October 14, 2004, a decibel meter was used to monitor the noise emitting from the maintenance equipment that may potentially be used to clean out the gross solids from the GSRD. For this pre-season cleaning, a Vactron™ was selected. The Vactron™ is a smaller version of the Vactor™ truck which utilizes a smaller pump to remove the gross solids. The results of the noise monitoring are illustrated in Figure 4-4.

Figure 4-4
Results of Noise Monitoring

Section 5
Annual Gross Solids Loading and Capture Efficiency

5.1 GROSS SOLIDS DATA

The Phase IV GSRD Pilot Study monitored one device over the 2004–05 storm season. The data collected consisted of measuring the wet weight and wet volume of the captured gross solids during post season cleanings. The gross solids included those captured within the device and removed from the bypass screen.

The total gross solids weight and volume collected at the GSRD site is presented in Table 5-1. As mentioned before, the total gross solids measurement includes the gross solids captured within the device as well as those collected on the bypass screen. Table 5-1 also presents the number of cleanings required at the GSRD during each storm season. 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	2004-2005		
	Number of Cleanings [a]	Total Wet Weight [b] kg (lb)	Total Wet Volume [c] m^3 (ft^3)
LR3 US-101	3	528.4 (1,164.9)	0.71 (25.1)

[a] A total of three cleanings of the bypass screen were performed and one end of season cleaning of the device was performed (at the same time as the third bypass screen cleaning).

[b] Total wet weight includes the weight of gross solids captured within the device; within the bypass screen; 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.

[c] Total wet volume includes the volume of gross solids captured within the device, within the bypass screen, 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 know 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.

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 Drainage Area ha (ac)	2004-2005	
		Wet Weight per Unit Area kg/ha (lb/ac)	Wet Volume per Unit Area m^3/ha (ft^3/ac)
LR3 US-101	0.8 (2.1)[a]	660.5 (554.7)	0.89 (11.9)

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

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.

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 screen 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 and weight for the device over the 2004-05 storm season is presented in Table 5-3. 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 on the bypass screen, during an entire storm season.

Table 5-3
Gross Solids Capture Efficiency by Wet Volume and Weight

Site	2004-2005							
	Captured Gross Solids		Bypass Gross Solids [a]		Total Gross Solids		Capture Efficiency %	
	kg (lb)	m^3 (ft^3)	kg (lb)	m^3 (ft^3)	kg (lb)	m^3 (ft^3)	Weight	Volume
LR3 US-101	47.0 (103.6)	0.31 (10.9)	481.4 (1,061.3)	0.40 (14.1)	528.4 (1,164.9)	0.71 (25.1)	8.89	43.66

[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..

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.

The GSRD was 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)*" (LA RWQCB, 2001a). 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 screen 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.

5.3 COMPARISON TO PREVIOUS STUDIES

Gross solids data comparable to Tables 5-1, 5-2, and 5-3 (presented herein) from the Phase I GSRD Pilot Study: 2000-2002 Final Report (Caltrans 2003a) is presented in Appendix A, from the Phase II GSRD Pilot Study: 2001-2003 Final Report (Caltrans 2003b) is presented in Appendix B, and from the Phase III Pilot Study: 2002-2005 Final Report (Caltrans 2005) is presented in Appendix C.

Section 6 Discussion and Summary

6.1 COMPLIANCE WITH THE TMDL

The California Regional Water Quality Control Board, Los Angeles Region (LA RWQCB) has developed TMDLs that are designed to attain the water quality standards for trash in the Los Angeles River (LA RWQCB, 2001a). 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 Trash TMDLs for the Los Angeles River watershed is set at zero, up to the design storm, and will be met over a period of 12 years through a phased reduction.

The TMDL regulations state that 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 inspection by the LA RWQCB (LA RWQCB, 2001a). The TMDLs identify the vortex separation system as an approved full capture treatment system. Other devices or systems, such as the GSRD tested in this study, may be employed, but must be approved by the Executive Officer of 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 a GSRD to be considered 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 GSRD screen are assumed to be the same as particles retained by the linear radial device with 5 mm x 64 mm (0.2 in x 2.5 in nominal) louvers.

The LR3 US-101 captured approximately 44 percent, by volume, of the gross solids during the 2004-05 season. The capture efficiency by weight was approximately 9 percent. There were indications that gross solids were forced through the GSRD. The accumulation of gross solids forced through the GSRD, clogged the bypass screen and resulted in an overflow of the structure where it is likely that gross solids escaped the bypass capture device. As discussed in Section 4.3.1, this overflow condition appears to have occurred several times during the 2004-05 storm season. Based on these observations and low capture efficiencies, it was determined that the LR3 US-101 did not meet the criteria for particle capture.

6.3.2 Criterion C2 – Clogging

The GSRD at LR3 US-101 did not experience clogging. However, as discussed in Section 4.3.1, the bypass screen became clogged on several occasions with gross solids that had escaped the GSRD screen. Since the bypass screen would not be a feature of a permanent GSRD installation, the LR3 US-101 meets the criterion for clogging.

6.3.3 Criterion C3 – Hydraulic Capacity

In general, the 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 the GSRD was designed to safely bypass flows in excess of the 25-year peak flow, the GSRD is presumed to meet this criterion.

6.3.4 Criterion C4 – Drainage

The Phase IV GSRD was designed to drain within 72 hours to prevent vector breeding. Clogging of the bypass screen at LR3 US-101 would result in the likelihood of standing water being present for more than 72 hours. Periodic maintenance during post-storm monitoring was required to remove the material from the bypass screen. When the gross solids were removed from the bypass screen, the standing water drained completely within a few minutes. Since the bypass screen would not be a feature of a permanent GSRD installation, the LR3 US-101 could be presumed to meet the criterion for drainage.

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

In general, each GSRD was designed to capture the estimated annual load of gross solids, which would result in one cleaning per year. As discussed in Section 4.2, a trigger for cleaning was the observation of extensive clogging or overflow. At LR3 US-101, the gross solids storage area was not full. However, the bypass screen became clogged with gross solids, resulting in overflow of water and gross solids. Since not all the gross solids were captured by the device, it is unknown whether the GSRD would be able to hold the entire annual load of gross solids.

6.4.2 Goal G2 – Maintenance Requirements

During the 2004-05 storm season, the LR3 US-101 required gross solids to be scraped from the bypass screen several times. Since the bypass screen would not be a feature of a permanent GSRD installation, the LR3 US-101 is presumed to meet the criterion for drainage. However, since not all the gross solids were captured by the device, it is unknown whether the GSRD would be able to hold the entire annual load of gross solids without requiring maintenance.

6.5 SUMMARY EVALUATION

Table 6-1 summarizes how well the GSRD met the performance criteria and goals discussed in Sections 6.3 and 6.4. Table 6-2 summarizes the strong points, weak points, and potential to correct deficiencies of the GSRD. Overall, the LR3 US-101 GSRD did not meet all the criteria of the TMDLor the Caltrans goals.

6.6 REGIONAL BOARD APPROVAL

As mentioned in Section 6.1, any full capture treatment system that is not a vortex separation system will need approval from the RWQCB's Executive Officer before removal credit will be granted. 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 LR3 US-101 did not meet the criteria of the TMDL for a full capture treatment system. The criteria of a full capture treatment system are defined in Section 2.1.

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
Linear Radial Configuration #3	No. Annual capture efficiency much less than 100%.	Yes. Although bypass screen clogged and overflowed, the GSRD screen did not clog.	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.	Presumably. Although bypass screen clogged and caused standing water, without the bypass screen the GSRD would most likely have drained within 72 hours.	Uncertain. The gross solids storage area was not full. However, the bypass screen became clogged with gross solids, resulting in overflow of water and gross solids. Since not all the gross solids were captured by the device, it is unknown whether the GSRD would be able to hold the entire annual load of gross solids.	Uncertain. Gross solids had to be scraped from the bypass screen on several occasions. Since the bypass screen would not be a feature of a permanent GSRD installation (therefore no solids would collect outside the gross solids capture device itself) and the gross solids storage area was not full at the end of the season, the LR3 US-101 may meet the goal for maintenance. However, since not all the gross solids were captured by the device, it is unknown whether the GSRD would be able to hold the entire annual load of gross solids without requiring maintenance.

Table 6-2
Summary of Performance Characteristics for Each GSRD

Device	Strong Points	Weak Points	Potential to Correct Deficiencies
Linear Radial Configuration #3	▪ Met C2 (Clogging). ▪ Presumed, to have met,C3 (Hydraulic Capacity) and C4 (Drainage).	▪ Did not meet C1 (Particle Capture). Linear Radial GSRD Screen installed on a steep slope. Force of water running through screen pushes particles out through screen louvers. ▪ Uncertain whether device met G1 (Gross Solids Storage) or G2 (Maintenance) goals due to unkown volume of gross solids that overflowed the device.	▪ Further testing is needed to develop design features that will reduce the momentum of the incoming water to prevent gross solids from being forced out of the louvers.

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 I Gross Solids Removal Devices Pilot Study: 2000 – 2002, Final Report. CTSW-RT-03-072.31.22

Caltrans, 2003b. Caltrans. Phase II Gross Solids Removal Devices Pilot Study: 2001 – 2003, Final Report. CTSW-RT-03-097.31.22

Caltrans, 2003c. Caltrans. Phase III Gross Solids Removal Devices Pilot Study: 2002 – 2003, Interim Report. CTSW-RT-03-0999.31.24

Caltrans, 2004. Caltrans. Phase III and IV Gross Solids Removal Devices, Operations, Maintenance and Monitoring Plan, Monitoring Season 2004-2005. July 2004. CTSW-RT-04-0130.03.1.

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.

Caltrans, 2005. Caltrans. Phase III Gross Solids Removal Devices Pilot Study: 2002 – 2003, Final Report. CTSW-RT-03-072.31.22

APPENDIX A

GROSS SOLIDS DATA:
PHASE I PILOT STUDY: 2000-2002

APPENDIX A

Gross Solids Data:
Phase I Pilot Study: 2000-2002

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

Site	2000-01			2001-02		
	Number of Cleanings	Total Wet Weight[1] kg (lb)	Total Wet Volume[2] m^3 (ft^3)	Number of Cleanings	Total Wet Weight[1] kg (lb)	Total Wet Volume[2] m^3 (ft^3)
LR1 I-10	1	111.9 (246.7)	0.40 (14.1)	1	172.7 (380.7)	0.65 (23.0)
LR2 I-210	1	410.2 (904.5)	1.10 (38.8)	2	1,310.0 (2,888.0)	1.73 (61.1)
LR2 I-5	2	191.6 (422.5)	0.20 (7.1)	2	197.4 (435.1)	0.19 (6.7)
IS1 SR-170	1	97.6 (214.7)	0.36 (12.7)	1	95.9 (211.4)	0.61 (21.5)
IS2 I-210	2	134.4 (296.4)	0.18 (6.4)	1	89.0 (196.2)	0.19 (6.7)
IS2 US-101	2	308.4 (680.0)	0.44 (15.5)	2	125.8 (277.3)	0.45 (15.9)
BB I-405	2	531.3 (1,171.5)	1.10 (38.8)	2	436.8 (963.0)	1.12 (39.6)
BB I-210	2	413.2 (911.1)	0.45 (15.9)	1	188.9 (416.5)	0.30 (10.6)

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

[2] Total wet volume includes the volume of gross solids captured within the device, within the bypass bag, and within the overflow structure (if applicable). 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 (see Section 4).

For the 2000-01 storm season, the data in this report supercedes data in the Interim Report (Caltrans, 2001e).

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 Volume

Site	Total Drainage Area ha (ac)	2000-01		2001-02	
		Weight per Unit Area kg/ha (lb/ac)	Volume per Area m^3/ha (ft^3/ac)	Weight per Unit Area kg/ha (lb/ac)	Volume per Area m^3/ha (ft^3/ac)
LR1 I-10	1.5 (3.7)	74.6 (66.7)	0.27 (3.8)	115.1 (102.9)	0.43 (6.2)
LR2 I-210	2.5 (6.2)	164.1 (145.9)	0.44 (6.3)	524.0 (465.8)	0.69[1] (9.9)
LR2 I-5	0.4 (0.9)	479.0 (469.4)	0.50 (7.1)	493.4 (483.4)	0.48 (7.4)
IS1 SR-170	1.0 (2.5)	97.6 (85.9)	0.36 (5.1)	95.9 (84.6)	0.61 (8.6)
IS2 I-210	1.4 (3.4)	96.0 (87.2)	0.13 (1.9)	63.6 (57.7)	0.14 (2.0)
IS2 US-101	0.8 (2.1)	385.5 (323.8)	0.55 (7.9)	157.2 (132.0)	0.56 (7.6)
BB I-405	1.2 (3.0)	442.8 (390.5)	0.92[1] (13.1)	364.0 (321.0)	0.93[1] (13.2)
BB I-210	0.9 (2.3)	459.1 (396.1)	0.50 (7.1)	209.9 (181.1)	0.33 (4.6)

[1] Approaches or exceeds the design value of 0.7 m^3/ha/yr (10 ft^3/ac/yr), presented in Section 2.3.

For the 2000-01 storm season, the data in this report supercedes data in the Interim Report (Caltrans, 2001e).

Note: For reporting purposes, total drainage area for both S.I. units and U.S. Customary has been reported to the nearest tenth. The weight per unit area for both S.I. units and U.S. Customary has been reported to the nearest tenth. The volume per unit area in S.I. units has been reported to the nearest hundredth and to the nearest tenth in U.S. Customary units.

Table 5-3
Gross Solids Capture Efficiency by Wet Volume

Site	2000-01				2001-02			
	Captured Gross Solids m³ (ft³)	Bypassed Gross Solids[1] m³ (ft³)	Total Gross Solids m³ (ft³)	Capture Efficiency (%)	Captured Gross Solids m³ (ft³)	Bypassed Gross Solids[2] m³ (ft³)	Total Gross Solids m³ (ft³)	Capture Efficiency (%)
LR1 I-10	0.39 (13.8)	0.01 [2] (0.4)	0.40 (14.1)	100 [2]	0.65 (23.0)	0.00 (0.0)	0.65 (23.0)	100
LR2 I-210	0.61 (21.5)	0.49 (17.3)	1.10 (38.8)	56	1.32 (46.6)	0.41 (14.5)	1.73 (61.1)	76[3]
LR2 I-5	0.18 (6.4)	0.02 (0.7)	0.20 (7.1)	90	0.19 (6.7)	0.00 (0.0)	0.19 (6.7)	100
IS1 SR-170	0.36 (12.7)	0.00 (0.0)	0.36 (12.7)	100	0.61 (21.5)	0.00 (0.0)	0.61 (21.5)	100
IS2 I-210	0.12 (4.2)	0.06 (2.1)	0.18 (6.3)	69[3]	0.19 (6.7)	0.00 (0.0)	0.19 (6.7)	100
IS2 US-101	0.34 (12.0)	0.10 (3.5)	0.44 (15.5)	77[3]	0.38 (13.4)	0.07 (2.5)	0.45 (15.9)	84[3]
BB I-405	0.96 (33.9)	0.14 (4.9)	1.10 (38.8)	87[3]	1.00 (35.3)	0.12 (4.2)	1.12 (39.5)	90[3]
BB I-210	0.43 (15.2)	0.02 (0.7)	0.45 (15.9)	97[3]	0.30 (10.6)	0.00 (0.0)	0.30 (10.6)	100[3]

[1] "Bypassed gross solids" is the amount of gross solids captured in the bypass bag and overflow basket (if applicable) at each GSRD.

[2] Material collected in the bypass bag is presumed to be wind blown.

[3] GSRD overflowed. Gross solids escaped the overflow structure and were unaccounted for. As a result, the calculated capture efficiencies are overstated.

For the 2000-01 storm season, the data in this report supercedes data in the Interim Report (Caltrans, 2001e).

Note: For reporting purposes, volume measurements in S.I. units have been reported to the nearest hundredth and to the nearest tenth in U.S. Customary units. This rounding may introduce small errors in the reported values.

APPENDIX B

GROSS SOLIDS DATA:
PHASE II PILOT STUDY: 2001-2003

APPENDIX B

Gross Solids Data:
Phase II Pilot Study: 2001-2003

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

Site	2001-02			2002-03		
	Number of Cleanings	Total Wet Weight[1] kg (lbs)	Total Wet Volume[2] m^3 (ft^3)	Number of Cleanings	Total Wet Weight[1] kg (lbs)	Total Wet Volume[2] m^3 (ft^3)
IS3 I-10	1	186.5 (411.2)	0.75 (26.4)	1	1,411.8 (3,112.4)	1.97 (69.4)

[1] Total wet weight includes the weight of gross solids captured within the device, within the bypass bag, and within the overflow basket (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.

[2] Total wet volume includes the volume of gross solids captured within the device, within the bypass bag, and within the overflow basket (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 know 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.

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)	2001-02		2002-03	
		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)
IS3 I-10	1.3 (3.3)	143.5 (124.6)	0.58 (8.0)	1,086.0 (943.2)	1.52 [1] (21.0) [1]

[1] Approaches or exceeds the design value of 0.7 m^3/ha/yr (10 ft^3/ac/yr), presented in Section 2.3.

Note: For reporting purposes, total drainage area for both S.I. units and U.S. Customary has been reported to the nearest tenth. The weight per unit area for both S.I. units and U.S. Customary has been reported to the nearest tenth. The volume per unit area in S.I. units has been reported to the nearest hundredth and to the nearest tenth in U.S. Customary units.

Table 5-3
Gross Solids Removal Efficiency by Wet Volume

Site	2001-02				2002-03			
	Captured Gross Solids m^3 (ft^3)	Bypass Gross Solids [1, 2] m^3 (ft^3)	Total Gross Solids m^3 (ft^3)	Removal Efficiency (%)	Captured Gross Solids m^3 (ft^3)	Bypass Gross Solids[1, 2] m^3 (ft^3)	Total Gross Solids m^3 (ft^3)	Removal Efficiency (%)
IS3 I-10	0.71 (25.1)	0.04 (1.31)	0.75 (26.4)	95	1.76 (62.2)	0.20 (7.2)	1.97 (69.4)	90

[1] Site experienced overflows at the GSRD and at the bypass basket or bag. Therefore, a limited amount of gross solids left the system unaccounted for. As a result, the calculated removal efficiency may be overstated.

[2] "Bypassed gross solids" is the amount of gross solids that was captured in the bypass structure or bag at each GSRD.

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 Removal Efficiency by Wet Weight

Site	2001-02				2002-03			
	Captured Gross Solids kg (lb)	Bypass Gross Solids** kg (lb)	Total Gross Solids kg (lb)	Removal Efficiency (%)	Captured Gross Solids kg (lb)	Bypass Gross Solids** kg (lb)	Total Gross Solids kg (lb)	Removal Efficiency (%)
IS3 I-10	177.8 (392.0)	8.7 (19.2)	186.5 (411.2)	96	1,266.8 (2,792.8)	145.0 (319.7)	1,411.8 (3,112.5)	90

[1] Site experienced overflows at the GSRD and at the bypass basket or bag. Therefore, a limited amount of gross solids left the system unaccounted for. As a result, the calculated removal efficiency may be overstated.

[2] "Bypassed gross solids" is the amount of gross solids that was captured in the bypass structure or bag at each GSRD.

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

APPENDIX C

GROSS SOLIDS DATA:
PHASE III PILOT STUDY: 2002-2005

APPENDIX C

Gross Solids Data:
Phase III Pilot Study: 2002-2005

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.

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.