Technical Report Documentation Page

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1. Report No. FHWA/TX-10/0-5948-1	2. Government Accession	n No.	3. Recipient's Catalog N	0.
4. Title and Subtitle			5. Report Date	
ROADSIDE SEDIMENT CONTROL DEVICE EVAI PROGRAM: TECHNICAL REPORT		LUATION	October 2009	
			Published: March	
			6. Performing Organizat	ion Code
7. Author(s)			8. Performing Organizat	ion Report No.
Jett McFalls, Ming-Han Li, and Aditya B. Raut Desai			Report 0-5948-1	
9. Performing Organization Name and Address			10. Work Unit No. (TRA	IS)
Texas Transportation Institute				
The Texas A&M University System			11. Contract or Grant No	
College Station, Texas 77843-3135			Project 0-5948	
12. Sponsoring Agency Name and Address			13. Type of Report and P	
Texas Department of Transportation			Technical Report	
Research and Technology Implement P. O. Box 5080	ntation Office		September 2007–	U U
Austin, Texas 78763-5080			14. Sponsoring Agency C	Code
15. Supplementary Notes Project performed in cooperation with	ith the Texas Denar	tment of Transport	ation and the Fede	ral Highway
Administration.	itil tile Texas Depai	tinent of fransport		iai ingnway
Project Title: Roadside Sediment Co	ontrol Device Evalu	nation Program		
URL: http://tti.tamu.edu/documents		action i rogram		
16. Abstract	, o c) to 1.put			
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sediment control BMP.				
17. Key Words		18. Distribution Statemen		
Sediment Control, Sediment Retention Device,		No restrictions. This document is available to the		
Erosion Control, Sediment Retention Effectiveness,		public through NTIS:		
Sediment Retention Device Testing Program		National Technical Information Service		
		Springfield, Virgi		
		http://www.ntis.g		
19. Security Classif.(of this report) Unclassified	20. Security Classif.(of th Unclassified	is page)	21. No. of Pages 110	22. Price
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ROADSIDE SEDIMENT CONTROL DEVICE EVALUATION PROGRAM: TECHNICAL REPORT

by

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Report 0-5948-1 Project 0-5948 Project Title: Roadside Sediment Control Device Evaluation Program

> Performed in cooperation with the Texas Department of Transportation Federal Highway Administration Texas Commission on Environmental Quality Environmental Protection Agency

> > October 2009 Published: March 2010

TEXAS TRANSPORTATION INSTITUTE The Texas A&M University System College Station, Texas 77843-3135

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The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Federal Highway Administration (FHWA) or the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation. Mention of trade names or commercial products does not constitute an endorsement or recommendation for use. The researcher in charge of the project was Jett McFalls.

ACKNOWLEDGMENTS

The authors would like to thank the individuals that were instrumental in the success of this project. Thanks to TxDOT Project Monitoring Committee (PMC) including John Mason (Project Director), and PMC members Amy Foster, Barry Cogburn, James Hill, Kori Rader, James Norment, and Lewis Nowlin, who actively participated in the direction of the project. The authors would also like to thank Texas Transportation Institute (TTI) staff Derrold Foster, Ben McPhearson, Rodney Jackson, and Alex Ferrazas for their project support.

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CHAPTER 1: INTRODUCTION

Transportation construction activities such as the building of highways, streets, and bridges in the U.S., represent approximately 7 percent (\$83 billion) of the total amount of dollars spent annually by the construction industry (U.S. Census Bureau 2002). In Texas, the Texas Department of Transportation (TxDOT) is responsible for construction and maintenance of the 80,000 miles network of state roadways. Construction activities associated with highway projects involve heavy earthmoving operations that disturb several square miles of undisturbed land areas. In 2007 alone, TxDOT reported 1541 active construction contracts throughout Texas that resulted in significant area of topsoil disturbance. The most detrimental environmental impact of highway construction/maintenance results from erosion of the exposed topsoil during storm events. While erosion is a naturally occurring phenomenon, construction activities disturb the natural vegetative cover causing the erosion processes at such sites to proceed at a significantly faster rate than the natural erosion rate.

Landphair et al. (1997) reported that erosion from construction sites in the U.S. deposits approximately 3.5 billion metric tons of sediment into streams and rivers annually. Sediment concentrations released from construction sites range from 10 to 20 times higher than that of agricultural land and 1,000 to 2,000 times higher than naturally forested land (USEPA 2000). Barrett et al. (1995) reported a five-fold increase in suspended solids concentration (SSC) in a creek receiving water from an active construction site during and immediately after storm events. Therefore, a few hours of discharge from a construction site can contribute more sediment to streams and rivers in comparison to what can be deposited from other natural or anthropogenic sources over a much longer time period. This accounts for a potentially large volume of sediment that could be carried off by storm water to the receiving water bodies.

Several problems are associated with soil erosion. Erosion degrades water quality of receiving water bodies and causes other problems like sedimentation in streams. Sediment increases the turbidity of water causing a nuisance to aquatic life, while also affecting the aesthetics of the receiving water body. Furthermore, pollutants like heavy metals and hydrocarbons in runoff water partition onto the soil particles and are transported with the sediments to the receiving water bodies (Viklander 1998, Liebens 2001, Lee et al. 2002). Past studies have indicated that the effects downstream from construction activities are temporary and

the total suspended solids concentration normalizes after construction activities have stopped (Barrett et al. 1995). To mitigate the problems associated with sediment migration from construction sites to receiving bodies, it is imperative that proper erosion and sediment control measures be incorporated during construction and post-construction phases of projects until adequate protective vegetative cover has re-established at the disturbed site.

Sediment laden runoff from construction sites can be minimized by either erosion control or sediment control best management practices (BMPs). Though often used interchangeably, erosion control and sediment control are different techniques and require different measures to mitigate. Erosion involves the detachment of soil particles through raindrop impact and the shearing force of overland flow. Erosion control is a source management technique in which the soil surface is protected by a cover and the detachment of soil particles is reduced. Sediment control techniques are employed as a mitigation measure once the soil particles have already been dislodged. Sediment control techniques reduce the solids loading in the runoff by shortterm retention, velocity reduction, and filtration. In this sense, erosion control techniques could be defined as prevention measures while sediment control techniques could be defined as remediation measures. Typical erosion control BMPs employed in the field includes temporary and permanent vegetation, plastic sheeting, straw and wood fiber mulches, matting, netting, chemical stabilizers, or some combination of the above. Sediment control BMPs can be further sub-divided into permanent and temporary techniques. Permanent measures include retention ponds (wet ponds), bio-retention systems, hydrodynamic separators, and underground storage tanks. Temporary measures include silt fences, geosynthetic dikes, wattles, berms, bales, and rock check dams. This study will focus on the performance of temporary sediment control devices (SCDs).

Because of environmental regulations, TxDOT, like most other Departments of Transportation (DOTs), is responsible for erosion and sediment control during and after construction. TxDOT spent approximately \$59 million on erosion and sediment control from February 2003 through January 2004. This does not include maintenance or items that may have dual purposes.

In 1989, in response to the National Pollutant Discharge Elimination System (NPDES) Phase I construction site requirements for erosion and sediment control, TxDOT, in cooperation with the Texas Transportation Institute (TTI), developed the Hydraulics and Erosion Control

Testing Laboratory (now called the Hydraulics, Sedimentation and Erosion control Laboratory). The laboratory has been in continuous operation since that time.

The purpose of the laboratory-testing program was to develop and maintain an "Approved Products List" for erosion control materials to be used on TxDOT construction and maintenance projects. Because of the unique nature of the facility and the program many other transportation agencies around the country have adopted or use TxDOT's approved materials list in specifying or approving erosion control products. However, to date, the testing protocol used by TxDOT and TTI for approving materials for use in Texas has not included sediment control devices. To assist the designer/engineer in selecting the most effective sediment control practices a formal SCD performance testing program has been developed. This issue of compliance through SCD performance evaluation has been voiced often by the other state DOTs participating in the current TxDOT Pooled Fund Program TPF-5(015).

Like most other state DOTs, TxDOT utilizes many roadside SCDs such as silt fence, straw bales, rock check dams, wattles, etc. in its design references. Despite the common practice of specifying SCDs there is little impartial or non-biased evidence regarding their performance. Since there are no recognized performance test standards for SCDs, end-users and specifiers must rely on marketing claims. In the past, SCDs were not regarded as important because they are temporary devices. However, with the increasing emphasis on construction site water quality as outlined in TxDOT's Environmental Management System, evaluating the performance of different SCDs is becoming increasingly important.

OBJECTIVES

The objective of this study was to develop a formal SCD performance evaluation program that will assist the TxDOT designer/engineer in the selection of the most effective sediment control BMPs for a site-specific application.

The specific tasks carried out during the course of this project are as follows:

- Design a facility to evaluate the performance of SCDs.
- Construct the facility according to the design specifications.
- Develop a testing protocol to evaluate performance of SCDs in the facility.
- Conduct multiple SCD performance tests to determine the ability of the facility and protocol to effectively quantify the performance of SCDs.

APPROACH

Researchers conducted the project in three phases over a period of two years.

- Phase one consisted of an extensive review of literature pertaining to temporary sediment control technologies used for storm water treatment. Concurrently, researchers also studied existing methods of evaluating the performance of SCDs and conceptualized designs for the testing facility. This phase was completed in January 2008.
- Phase two involved the selection of the testing facility design best suited for the program and construction of the testing facility at the TxDOT/TTI Hydraulics, Sedimentation and Erosion Control Laboratory (HSECL) facility at the Riverside campus. This phase was completed in December 2008.
- 3. Researchers developed a protocol for testing temporary sediment control devices in phase three of the project. This phase included intensive testing on the facility to calibrate the system as well as to determine the ability of the facility and protocol to effectively quantify the performance of SCDs. This phase was completed in July 2009.

CHAPTER 2: BACKGROUND INFORMATION

LAWS AND REGULATIONS

The 1987 amendment to the Clean Water Act (CWA) established the Non-point Source Management Program, which mandated the control of storm water, erosion, and sediment at construction sites. The Intermodal Transportation Efficiency Act of 1991 prompted the Federal Highway Administration (FHWA) to adopt Erosion and Sediment Control Rules (23 CFR 65) in 1994. The EPA Phase I rules require construction sites, greater than 5 acres, to have construction permits and pollution prevention plans. The implementation of EPA Phase II rules in 2003 extended the permitting and pollution prevention plans requirement to smaller construction sites between 1 and 5 acres. In 2003, the federally mandated National Pollution Discharge Elimination System Phase II storm water rules went into effect extending the storm water pollution prevention plan requirement to any land-disturbing activity over 0.405 ha (1 acre). Violators can be held in noncompliance with the federal Clean Water Act and can be fined up to \$100,000 per day per violation. Implementation of the NPDES and Texas Pollutant Discharge Elimination System (TPDES) requires TxDOT to adopt a variety of storm water quality measures to meet CWA requirements.

In an effort to comply with Section 304(b) of the CWA, the Environmental Protection Agency (EPA) has developed a set of national standards known as Effluent Limitation Guidelines (ELGs). ELGs are intended to reduce pollutants from entering and harming the waters of the U.S. ELGs will be developed on an industry-by-industry basis. The EPA will identify the best available technology that is economically achievable and establish the ELGs base on the performance of that particular technology. Once implemented stormwater runoff from TxDOT construction sites will be collected and analyzed to ensure turbidity does not exceed target limits set by EPA. This project will enable TxDOT engineers and designers to better understand and predict the effectiveness of various SCDs in order to stay in compliance with the ELGs.

SEDIMENT CONTROL ALTERNATIVES

Erosion involves detachment, transport, and subsequent deposition of soil. Raindrop impact and the shearing force of flowing water cause the soil particles to detach from the ground. Erosion caused by raindrop impact is classified as interill erosion, while that caused by shearing force of flowing water is classified as rill erosion. The runoff flowing from the site of detachment is primarily responsible for transporting the sediment. Erosion caused by storm water runoff from construction sites can be minimized by either erosion control or sediment control or a combination of the two. Erosion control is a source management technique in which the ground is protected by a cover and detachment of soil particles is prevented. In this sense, erosion control techniques could be defined as preventive measures. Typical erosion control techniques employed in the field include temporary and permanent vegetation, plastic sheeting, straw and wood fiber mulches, matting, netting, chemical stabilizers, or some combination of the above. Sediment control techniques are employed as a mitigation measure once the soil particles have already been dislodged. In this sense, sediment control techniques could be defined as the second line of defense. Sediment control techniques reduce the solids loading in the runoff by short term retention, velocity reduction, and filtration. Sediment control measures can be further subdivided into permanent and temporary techniques. Permanent measures are for long-term use and include sedimentation ponds, bio-filtration/retention systems, underground holding tanks, and stormwater treatment vaults. Temporary measures are designed for shorter periods of time and include silt fence, geosynthetic dike, sock, berm, bale, and rock check dams. This study will focus on temporary sediment control devices.

Temporary Sediment Control Measures

Temporary sediment control devices act as sediment barriers and are expected to prevent off-site migration of sediment by runoff discharged from sites disturbed by construction activity. This project studied five temporary sediment control devices: geosynthetic dikes, wattles without coagulant, wattles with coagulant, silt fences, and rock check dams.

Geosynthetic Dike

The Geosynthetic dike is a sediment control structure usually constructed with a triangular-shaped, polyurethane foam core, wrapped in a woven polypropylene fabric. This makes the dike lightweight and, as a consequence, easy to transport, install, and relocate.

Another advantage of the geosynthetic dike is that they are flexible, which allows them to be installed on uneven ground. Geosynthetic dikes are manufactured in sections of standard lengths that can be fit together tightly, providing a continuous barrier of any length. Storm Water Pollution Prevention Plans (SWPPPs) also utilize geosynthetic dikes to create a temporary flow path through an earthwork project. Geosynthetic dike sections are easily restored to their original condition for reuse or storage by washing them with clean water. Geosynthetic dikes serve as a sediment control device by stopping, slowing, or diverting the flow of runoff water.

Wattle

Wattle, sock, tube, or log are terms used for a sediment control structure that consists of compacted straw and/or other fibers encased in tubular netting. Wattles are commonly installed along the contours or at the base of a slope to help reduce soil erosion and retain sediment. They function as slope interruption devices and therefore shorten slope lengths reducing runoff velocity and the potential for sheet erosion and rill formation. Wattles also find use as check dams in channels and ditches, drain inlet protection, and perimeter sediment control. Wattles allow runoff/water to penetrate through the fiber while retaining the sediment. Wattles are often used in conjunction with surface roughening, straw mulching, bonded fiber matrix (BFM), hydro-seeding, and erosion control blankets to further reduce erosion and sediment migration.

Wattle with Flocculants

Wattles are also available with performance enhancing, polyacrylamide polymer powders, emulsions, and flocculants that reduce initial erosion and remove fine particles from storm water runoff. Such sediment control structures are effective in removing clay-size particles, which tend to stay in solutions and cause cloudy discharges.

Silt Fence

A silt fence (also known as filter fence) is a generic name for a sediment control structure made of woven, geo-textile filter fabric often supported by wire mesh and regularly spaced steel or wooden posts. Silt fences are commercially available as rolls of various widths with the most common widths ranging from 6 in. to 36 in. Silt fences are installed along contours or the perimeter of construction sites, with the bottom edge entrenched and backfilled with soil. At highway construction sites, silt fences are typically installed in long, linear runs parallel to a

roadway at the toe of the fill slope along the right of way (ROW). Typical highway design procedures recommend that sediment barriers be installed on the contour below the slopes disturbed by construction activity. Although filtration is considered the primary mechanism of sediment removal, silt fences can also bring about sediment removal by reducing the velocity of the runoff and retaining the sediment-laden runoff causing sedimentation and reduction of runoff volume by infiltration of water.

Rock Check Dam

A rock check dam is a temporary barrier constructed across an area of concentrated flow to capture larger soil particles by reducing the velocity of runoff. Such sediment control structures are constructed from small riprap with stone sizes ranging from 3 to 8 in., placed manually or mechanically in an organized pattern. The rip rap is often wrapped in galvanized wire mesh with 1 in. or wider diameter openings to allow water to easily pass through the structure while preventing the dislodging of the stones during concentrated flow events.

LACK OF PROPER METHOD FOR EVALUATING PERFORMANCE OF SCDS

Performance data on erosion control materials is readily available. However, information on the performance of sediment control BMPs is limited. Most designers and engineers are left with no other options other than manufacturer's claims or simple field observations. Establishment and classification of available SCD BMPs based on their measured performance would assist the designers and engineers in selecting the appropriate product and methods for site-specific application. The standard presented in this report is similar to that described by the American Society for Testing of Materials (ASTM) D7351. However, after careful review of the ASTM standard several changes were made to satisfy the needs of TxDOT roadside applications and provide a testing facility that would adequately meet the desired goals of the TxDOT SCD evaluation program.

SEDIMENT REMOVAL MECHANISMS

As discussed previously, SCDs remove sediments that have been dislocated from the site and are being carried in the runoff. Sediment barriers capture eroded solids by filtration, sedimentation, velocity reduction, and volume reduction, all of which contribute to the overall

efficiency of a system. It is important to note that more than one of the above mentioned mechanisms could occur simultaneously.

Filtration

Filtration involves interception and straining of suspended particles as the runoff passes through the SCD. Interception is the principal method of removal when the size of the suspended particle size is larger than the filter pores or void size. Particles smaller than the filter pores are removed by straining, which involves attachment of the particles to the filtering surface and bridging across openings. Filtration is often effective for only a short period following installation due to the fact that after the initial storm events clogging of the pores or voids decreases the flow-through rate of the SCD, which can result in catastrophic failure of the silt fence by overtopping. Figure 2.1 illustrates the process of filtration of the suspended sediment concentration (SSC) removed from the runoff and the accumulation accumulated near the upstream face of the SCD resulting in a decrease in SSC in the runoff.



Figure 2.1. Decrease in SSC in Runoff after Passing through the SCD. (C1 = SSC before passing through SCD and C2 = SSC after passing through SCD.)

Retention and Sedimentation

The most cost effective and widespread treatment of suspended solids in water is retention and sedimentation. When sediment-laden runoff water is retained behind an SCD, the suspended sediments tend to drop out and settle to the bottom. Stokes equation describes the

relationship between particle size and the settling velocity of a spherical particle settling in water.

Velocity Reduction

Slowing sediment laden storm water allows the settling of suspended sediment. When the sediment load is greater than its transport capacity, the suspended sediment in the runoff is deposited. Transport capacity is directly proportional to the velocity or shear stress. Thus, slowing down runoff water will decrease the transport capacity and cause sedimentation to occur. Figure 2.2 illustrates the mechanism of velocity reduction, where the velocity of flow is reduced by the SCD resulting in particles settling out of the water.



Figure 2.2. Decrease in Runoff Velocity after Passing through SCD. (v1 = runoff velocity before SCD and v2 = runoff velocity after SCD.)

Volume Reduction

Volume reduction reduces the total volume of sediment-laden water by allowing water to infiltrate into the soil. It must be noted, however, that volume reduction is dependent on the soil characteristics and geology. Porous soils will result in greater volume reduction than non-porous soils. Figure 2.3 illustrates the decrease in total volume of runoff by infiltration.



Figure 2.3. Decrease in Runoff Volume after SCD. (∀1 = runoff volume before SCD, ∀2 = runoff volume infiltrated behind SCD and ∀3 = runoff volume after SCD.)

Coagulation/Flocculation

If left untreated, soil particles suspended in water remain in continuous motion due to electrostatic charges, which causes them to repel each other. Flocculating agents neutralize these charges that cause the soil particles to collide and agglomerate into larger flocs. These larger and heavier flocs then settle to the bottom resulting in 'cleaner' water.

PERFORMANCE FACTORS OF SCDS

Some of the factors affecting the performance of SCDs include:

- sediment removal efficiency,
- flow-through rate,
- ponding volume, and
- design capacity.

Common Terminologies

Figure 2.4 illustrates the ponding depth, overtopping depth, and wetted area, as well as, the ponding volume and design capacity for an SCD installed in a testing channel. The SCD (not shown in the figure) height in the figure is assumed to be equal to the depth of the channel.



Figure 2.4. Factors Affecting Performance of SCD in the Facility.

Ponding Depth

Ponding depth is the depth of water retained behind the SCD at any given time. It is an indicator of the retention time of the SCD and the distance a sediment particle will have to travel to settle out of the water behind the SCD. Under test conditions ponding depth is dependent on the inflow rate and the permeability (or the flow-through rate) of the SCD being tested. The following conditions hold true (assuming no infiltration):

 $Q_{IN} > Q_{OUT}$; Ponding Depth will increase with time

 $Q_{IN} < Q_{OUT}$; Ponding Depth will decrease with time

 $Q_{IN} = Q_{OUT}$; Ponding Depth will remain constant with time (steady state)

where,

Q_{IN} is the inflow rate

Q_{OUT} is the outflow rate

Overtopping Depth

Overtopping depth is the depth at which water starts to flow over the SCD and can be defined as the maximum ponding depth achieved without detrimentally affecting the

performance a SCD. The height of the top of the SCD from the surface of the soil is equal to the overtopping depth. When inflow rate is greater than the outflow rate the ponding depth will exceed the overtopping depth.

Wetted Area

Wetted area is defined as the projection on a vertical plane of the upstream face of a SCD that is in contact with the water at any given time. Wetted depth is a function of the ponding depth and the SCD height.

Sediment Removal Efficiency

Sediment removal efficiency is defined as the percent decrease in sediment load of runoff after passing through a SCD (Equation 2.1).

Sediment Removal Efficiency (η) = $\frac{(M_{IN} - M_{OUT})}{M_{IN}} \times 100 = \frac{(C_{IN} - C_{OUT})}{C_{IN}} \times 100$

where,

M_{IN} is the mass of sediment in the untreated runoff before passing through a SCD,

M_{OUT} is the mass of sediment in the runoff after passing through a SCD,

C_{IN} is the SSC in untreated runoff before passing through a SCD, and

C_{OUT} is the SSC in runoff after passing through a SCD.

This criterion can be misleading if considered as the sole indicator of the quality of water treated by SCD. It is evident from Equation 2.1 that the sediment removal efficiency is a function of the initial suspended sediment concentration in runoff to be treated. Thus, the same SCD would exhibit high sediment removal efficiency with the untreated runoff water having high SSC (as compared to one with low SSC) regardless of the actual SSC in the effluent runoff. As Figure 2.5 illustrates, 80 percent sediment removal results in an effluent SSC higher than with 50 percent sediment removal.



Source: EPA http://cfpub.epa.gov/npdes/stormwater/urbanbmp/bmptopic.cfm Figure 2.5. Sediment Removal Efficiency Can Be Misleading.

Flow-through Rate

Flow-through rate is defined as the rate at which sediment-laden runoff passes through the SCD. Flow-through rate can be expected to decrease with time and additional runoff events as the sediments are retained behind the SCD and its porosity is decreased. Flow-through rate is a function of the depth of water retained behind the SCD and wetted area of the SCD at any given time.

Ponding Volume

Ponding volume is the volume of water retained behind the SCD at any given time. If the rate of water entering the channel is greater than the rate of water leaving the channel then the ponding volume will increase with time and vice versa. When the rate of water entering the channel is equal to the rate of water leaving the channel a steady state is achieved and the ponding depth will remain constant with time.

The relationship between ponding depth, ponding volume, and wetted area for any given channel can be determined mathematically. This information will give the researchers useful insight on the performance of the SCD.

Design Capacity

Design capacity is the volume of water that can be retained behind a SCD. When ponding volume exceeds design capacity the sediment-laden water will flow over the top of the SCD.

CHAPTER 3: TESTING FACILITY DESIGN

The SCD performance testing facility was constructed at the TxDOT/TTI HSECL facility located at the Texas A&M University's (TAMU) Riverside Campus.

COMPONENTS

The testing facility consists of five components, namely, the mixing tank, delivery and monitoring system, testing channel, collection and monitoring system, and the monitoring equipment. Each component is described in detail below.

Mixing Tank

The mixing tank serves the purpose of mixing and delivering the sediment into the testing channel. The mixing tank is a 1600-gal polypropylene cylindrical tank with a conical hopper bottom with a 6-in. butterfly valve. A 3-phase electric motor and double mixing paddles ensure proper mixing of the sediment-laden test water. Figure 3.1 shows the mixing tank with the motor at its present location in the testing facility.



Figure 3.1. Polypropylene Tank to Mix Sediment and Create a Slurry of Known SSC.

Delivery and Monitoring System

To deliver water to all three zones of the flume (Figure 3.2) the delivery system was designed and consists of a system of 6 in. ID pipes. A reduced T-joint was inserted in the piping to access point for the inlet turbidity probe. The contact point between the probe and the reduced T-joint was sealed with an aluminum retaining ring and the piping system includes two 90-degree elbows after the reduced T-joint to prevent light interference to the turbidity probe (Figure 3.3 a). The bubbler tube of the flow meter was secured inside the pipe about 18 in. before the falloff point (Figure 3.3 b).

Testing Channel

The testing channel is made up of three distinct zones: the retention zone, the installation zone, and the collection zone. The overall length of the channel is 18 ft.



Figure 3.2. Testing Channel from SCD Evaluation.

Retention Zone

The retention zone is a longitudinal section of a cylinder 25 ft in diameter and 12 ft long. The channel is 12 ft long, 15 ft wide with a maximum depth of 2.5 ft. The channel maintains a constant 3 percent slope. The channel was constructed of concrete and surfaced with waterproofing grout.

Installation Zone

The installation zone is a 4-ft opening between the retention zone and collection zone with metal sliding gates on either side. The installation zone can be filled with any type of test soil. The proposed soil for testing SCD's is a high plasticity index (PI) clay. The surface of the clay in the installation zone was shaped to match the profile of the channel.

Collection Zone

The shape of the collection zone was designed exactly like the retention zone except it was only 2 ft long. The collection zone provides an area to channel the flow toward the collection and monitoring system.

Collection and Monitoring System

The collection and monitoring system consists of a collection tray and 6-in. collection pipes. The collection tray was made of galvanized sheet metal and is 7.5 ft wide. The collection tray channels the water into the 6-in. pipes, which has a reduced T-joint to serve as an access point for the outlet turbidity probe. The contact point between the probe and the reduced T-joint is sealed with an aluminum retaining ring, and the piping system has one 90-degree elbow after the reduced T-joint to prevent light interference to the turbidity probe. The bubbler tube of the flow meter is secured inside the pipe about 18 in. before the falloff point.



Figure 3.3. Sediment Collection System from Testing Channel (a) Collection Tray and Port for Turbidity Probe; (b) Port for Bubbler Tube.

Monitoring Equipment

Two turbidity probes connected to a single controller system and two flow meters are used to monitor the turbidity and flow rate, respectively.

Turbidity Meter

Two turbidity sensors (Hach SOLITAX® model TS-line sc), installed at the inlet and outlet, continuously measure (5 second intervals) and record the turbidity of the water entering and leaving the channel. Both sensors are connected to a controller system (Hach model sc100). Datacom, software available on the Hach website, facilitates the retrieval of the turbidity data from the controller system to a field laptop.

Flow Meter

Two bubbler flow meters (ISCO® model 4230) are used to monitor the flow at inlet and outlet of the channel.



Figure 3.4. Monitoring System Used to Collect Data (a) ISCO® Model 4230 Bubbler Flow Meter; (b) Hach Model sc100 Controller System and Two Hach SOLITAX® model TS-line sc Turbidity Sensors.

Sediment Used for Testing

TTI researchers examined a variety of both commercially available and on-site sands and clays to use in the testing program. The desire of the research staff was to use a soil type that was readily available but also had a uniform particle size distribution (PSD). On site sands and clays were originally used in the initial calibration attempts; however, these soils proved to have
too many variations in particle size distribution and composition from batch to batch. The onsite soils also often contained small gravel and occasional large rocks that could potentially cause damage to the testing system and monitoring equipment. Because of this, the researchers decided to use commercially available sediment which was uniform in composition and graded to have a uniform PSD. The first test runs were performed using only ground silica, Sil-co-sil, as the sediment additive; however the use of only silica presented a problem for many SCDs. Several commercially available SCDs use anionic polyacrylamide (Anionic PAM) as a flocculating agent. These SCDs target the smallest soil particles, fine silts, clays, and colloidal materials (5–10 microns in size). Because these flocculating agents are routinely used, there was a need to add a fine particulate clay to the sediment mix. The TTI researchers chose a commercially available ball clay (due to its uniform PSD and uniform electrostatic charge) and decided to use this in conjunction with the ground silica as the sediment additives for the testing facility. Details regarding the exact PSD and mix ratios used for the Sil-co-sil and ball clay will be discussed in Chapter 4.

CHAPTER 4: CALIBRATION OF TESTING FACILITY

Before testing SCDs in the testing facility, researchers characterized the channel and sediment and calibrated the measuring instruments. Researchers studied the geometry of the channel to determine the relationship between ponding depth and factors that would help quantify the performance of SCDs tested in the channel. The particle size distribution of sediment was determined based on information provided by manufactures. The flow meters and turbidity meters were calibrated to determine their ability to accurately measure the flow rate and turbidity, respectively.

CHANNEL

The testing channel has a known geometry for which the ponding volume, wetted area, and length of SCD can be determined from the ponding depth. Figure 4.1 shows the testing facility with a channel designed as a longitudinal section of a 25 ft (D = 300 in.) diameter cylinder inclined at a 3 percent slope ($\Phi = 1.72$ degrees).





The x, y, and z-axis are aligned with the cylinder and the z-axis runs longitudinal to the cylinder. The length of channel (L) can range from 12 to 16 ft (or 144 to 192 in.) depending on the location of the SCD within the installation zone.

Ponding Volume

Ponding volume is the volume of water retained behind a SCD and is a function of ponding depth at any given time. Figure 4.2 shows the water retained behind SCDs of five different ponding depths.



Figure 4.2. Water Ponding behind SCD Set Up in the Center of Installation Zone.

Figure 4.3 shows the water retained behind a 1-ft tall SCD installed at different locations in the installation zone. Ponding volume will also vary depending on the location of the SCD within the installation zone.



Figure 4.3. Water Ponding behind 1-ft Tall SCD Set Up at Different Locations within the Installation Zone.

The liquid in the cylinder, shown in Figure 4.1, is the volume bounded by four surfaces: the liquid surface, the cylinder wall, the bottom end of the cylinder, and the top end of the cylinder. The relationship between SCD height and ponding volume for the testing channel used to evaluate SCDs in this study was determined by mathematically solving the following equation.

$$\forall = \int_{-\left(S + \frac{r}{\tan \emptyset} - \frac{2r}{\sin \emptyset}\right)}^{r} \tan \emptyset} \int_{-\sqrt{r^2 - y^2}}^{\sqrt{r^2 - y^2}} \int_{0}^{\frac{y}{\tan \emptyset} + S + \frac{r}{\tan \emptyset} - \frac{2r}{\cos \emptyset} - H} dx dy dz$$

where, \forall is the ponding volume,

- y is the coordinates along y-axis as shown in figure (inches),
- r is the radius of the cylinder (inches),
- Ø is the slope of the channel (radians),
- S is the distance along channel bottom from SCD to depth measurement location (inches), and
- *H* is the ponding depth measured at a distance S from the SCD (inches).

Solving this equation using the online software created by LMNO Engineering, Research, and Software, Ltd. (available at http://www.lmnoeng.com/Volume/InclinedCyl.htm) and substituting different values of H and L, we can develop a set of curves defining the relationship between ponding volume and ponding depth (Figure 4.4).



Figure 4.4. Relationship between Ponding Depth and Ponding Volume for Different Lengths of Channel.

Wetted Area

The wetted area is mathematically computed by using simple geometry. Figure 4.5 shows the wetted area (blue color) of a SCD of height equal to ED.

Wetted Area (ADBE) = Area of Sector (ADBO) – Area of Triangle (AOB)

Wetted Area (ADBE) =
$$r^2 \times \tan^{-1}\left(\frac{\sqrt{r^2 - (r - ED)^2}}{(r - ED)}\right) - \sqrt{r^2 - (r - ED)^2} \times (r - ED)$$

where, r is the radius of the cylinder (= 150 inches) and

ED is the ponding depth (inches).



Figure 4.5. Diagramatic Representation of Wetted Area.

The relationship between wetted area and ponding depth developed in equation above is illustrated graphically in Figure 4.6.



Figure 4.6. Relationship between Ponding Depth and Wetted Area of SCD.

Length of SCD

The length of SCD can be used to convert the data acquired from testing into performance per unit length of SCD.

Length of SRD =
$$\alpha \times \cos^{-1} \frac{(r - ED)}{r} \times r$$

where, α is a factor ($\alpha = 1$ for channel application; $\alpha = 0.5$ for perimeter application) r is the radius of the cylinder (inches), and

ED is the ponding depth (inches).

The relationship between ponding depth and length of SCD developed in equation above is illustrated graphically in Figure 4.7.



Figure 4.7. Relationship between Ponding Depth and Length of SCD.

SEDIMENT

As discussed in Chapter 3, researchers determined that a combination of two types of sediments, silica and ball clay, were the best candidates for creating runoff having known suspended solids concentrations and uniform composition. These two types of sediment would

provide uniform and repeatable sediment mixing and would also provide consistent electrostatic charge properties when evaluating the performance of SCD containing flocculent(s).

The particle size distributions of four different silica sediment combinations, as provided by the manufacturer, are shown in Figure 4.8. Figure 4.9 shows the particle size distribution of the ball clay, as provided by the manufacturer. After examining the particle size distribution of each of the silica sands and performing laboratory standardization tests of the turbidity probes with each of the silica grades, it was determined that SIL-CO-SIL[®] 49 was the most accurate, potential sediment to be used for testing. Because of the need to mix the silica with ball clay, a 50-50 mixture (by weight) of SIL-CO-SIL[®] 49 and ball clay was also examined as potential sediment to be used for testing. Figure 4.10 provides the particle size distribution (PSD) of such a mixture.



Figure 4.8. Particle Size Distribution of Silica Examined for Use as Sediment in the Testing.



Figure 4.9. Particle Size Distribution of Ball Clay Examined for Use as Sediment in the Testing.



Figure 4.10. Particle Size Distribution of Silica, Ball Clay, and a 50-50 Mixture (by Weight) of SIL-CO-SIL®49 and Ball Clay.

MONITORING EQUIPMENT

The turbidity meters and probes were calibrated to determine the ability of these instruments to accurately measure the turbidity and flow rate, respectively.

Turbidity Meter

The turbidity meters and probes were calibrated by measuring the turbidity of known concentrations of water using SIL-CO-SIL®49, ball clay, and a 50-50 mixture (by weight) of SIL-CO-SIL®49 and ball clay. A 2-ft long section of a 6-in. diameter PVC pipe was cut and the ends of the pipe were capped to form a watertight chamber. A hole was drilled in this chamber 1 ft from either ends to insert the turbidity probe. A predetermined amount of SIL-CO-SIL®49 was weighed and mixed thoroughly with 2 L of water to prepare artificial sediment-laden water with known suspended solids concentration. This artificial sediment-laden water was poured into this chamber and the turbidity was measured using both the probes. Turbidity was measured for suspended solids concentrations ranging from 0 to 5000 mg/L or until the measurement limit of the turbidity probes was exceeded. This process was repeated using ball clay and a 50-50 mixture (by weight) of SIL-CO-SIL®49 and ball clay.

Figures 4.11, 4.12, and 4.13 show the relationship between suspended solids concentrations and turbidity for both probes using SIL-CO-SIL®49, ball clay, and a 50-50 mixture (by weight) of SIL-CO-SIL®49 and ball clay, respectively.



Figure 4.11. Relationships between Turbidity and SSC for the Inlet and Outlet Turbidity Probes Using SIL-CO-SIL®49.



Figure 4.12. Relationship between Suspended Solids Concentration and Turbidity for Ball Clay.



Figure 4.13. Relationship between Suspended Solids Concentration and Turbidity for 50-50 Mixture of SIL-CO-SIL®49 and Ball Clay.

After the turbidity meters were calibrated in the laboratory, multiple test runs were conducted in the SCD testing facility with actual sediment control devices to further evaluate the effectiveness and accuracy of these instruments. The trial runs, which will be discussed in Chapter 5, verified the results of the turbidity calibration experiments from the laboratory and showed that the turbidity probes were accurate and consistent during the testing trials.

Flow Meters

The ISCO 4230 flowmeters were calibrated by conducting clear water runs in the sediment retention device facility. The sediment mixing tank was filled with a known volume of water and the flowmeters were inserted into their ports in the inlet and outlet pipes, respectively. The water was then released from the mixing tank at a known rate of flow and the flow meters were calibrated for both total flow volume accuracy and for instantaneous flow accuracy. These runs were conducted multiple times to ensure the accuracy and repeatability of the ISCO flowmeters.

CHAPTER 5: TESTING PROTOCOL DEVELOPMENT

EFFECT OF TESTING CONDITIONS ON PERFORMANCE OF SCDS

Calibration tests were conducted on various SCDs to determine the effect of sediment type, initial sediment concentration, and overtopping on removal efficiency. For the initial runs a geosynthetic dike was used as the sediment retention device. It was not critical what type of device was used during these initial experiments, as they were conducted simply to evaluate the effect that various testing conditions would have regarding performance. A geosynthetic dike was chosen simply to evaluate the performance using one type of SCD.

Effect of Sediment type

Researchers conducted tests with three types of sediments;

- 1. Silica sediment (SIL-CO-SIL[®]49),
- 2. Ball clay sediment, and
- 3. 50:50 mixture (by weight) of silica and ball clay sediment.

The runoff slurry used in this experiment had an inlet SSC of 2000 mg/L. Figure 5.1 shows that the removal efficiency of the SCD was highest for the silica sediment and lowest for the ball clay sediment. The 50:50 mixture (by weight) of the silica and the ball clay sediment results in a sediment removal efficiency between that for the silica and ball clay sediment.



Figure 5.1. Removal Efficiency Measured Using Geosynthetic Dikes for Three Sediment Types (SSC_{IN}=2000 mg/L): SIL-CO-SIL[®]49, SIL-CO-SIL[®]49+Ball Clay, and Ball Clay.

Silica particles are larger than ball clay particles and thus settle faster. Many SCDs, due to their composition, target these large particles. However, many SCDs use flocculants and are designed to remove finer ball clay particles that have a surface electrostatic charge. Researchers decided that because of the many variations in sediment control devices, a sediment mix prepared by combining silica and ball clay would be the best option for evaluating and comparing the performance of all SCDs.

Effect of Sediment Concentration

As discussed in Chapter 2, the SSC in the runoff to be treated affects the removal efficiency of the SCD. Researchers tested two concentrations of silica sediment with and without overtopping to determine the effect of initial SSC concentration on removal efficiency of the SCD. Figure 5.2 illustrates that the removal efficiency of the geosynthetic dike increased when the SSC in the runoff to be treated was doubled from 2000 mg/L to 4000 mg/L.



Figure 5.2. Removal Efficiency Measured Using Geosynthetic Dikes for SIL-CO-SIL[®]49 (Overtopping and No Overtopping) at 2000 and 4000 mg/L.

Effect of Overtopping

Overtopping can cause water to leave the site without getting treated. Researchers conducted experiments using silica sediment (SIL-CO-SIL[®]49) on a SCD (geosynthetic dike). The overtopping experiments delivered 1500 gal of sediment-laden water into the channel. The experiments with no overtopping delivered sediment-laden water into the channel until overtopping was observed. Once overtopping was observed, the delivery of sediment-laden water into the channel water into the channel water into the channel was stopped. Figure 5.3 shows that the removal efficiency increased when water was not allowed to overtop the SCD (geosynthetic dike).



Figure 5.3. Removal Efficiency Measured Using Geosynthetic Dikes for SIL-CO-SIL[®]49 (C_{IN}=2000 and 4000 mg/L) under Two Conditions: Overtopping and No Overtopping.

SCD TESTING

After examining the effects of various sediment concentrations and examining results of overtopping versus non-overtopping tests, researchers decided to conduct comparative testing on five different types of SCDs. These SCDs were not tested to evaluate their individual sediment retention effectiveness but to evaluate the testing protocol itself. Geosynthetic dikes, untreated wattles, wattles treated with flocculants, silt fences, and rock check dams were evaluated during these test runs.

Ponding Volume

Figure 5.4 shows that the geosynthetic dike, and wattles (untreated and treated) retained water equal to their design capacity, while silt fence and rock check dam did not retain water equal to their design capacity. Both silt fence and rock check dam had a very high design capacity and flow-through rate, which resulted in a smaller volume of sediment-laden water retained behind these SCDs than the design capacity.



Figure 5.4. Design Capacity and Ponding Volume for Five SCDs. Values below SCD Name Indicate the Total Volume of Sediment-Laden Water Treated.

Table 5.1 contains the data comparing the design capacity and ponding volume from the tests conducted on the five SCDs.

Sediment Control Device	Height	Design capacity	Ponding Volume
	cm (in.)	L (gal)	L (gal)
Geosynthetic Dike	22.5 (9)	1170 (309)	1090 (288)
	22.5 (9)	1170 (309)	1052 (278)
	22.5 (9)	1170 (309)	1011 (267)
Wattle – untreated	10.8 (4.25)	246 (65)	223 (59)
	10.8 (4.25)	246 (65)	227 (60)
	10.8 (4.25)	246 (65)	238 (63)
Wattle – treated	10.8 (4.25)	246 (65)	250 (66)
	10.8 (4.25)	246 (65)	250 (66)
	10.8 (4.25)	246 (65)	250 (66)
Silt Fence	45.7 (18)	3994 (1055)	2635 (696)
	45.7 (18)	3994 (1055)	2695 (712)
	45.7 (18)	3994 (1055)	2143 (566)
Rock Check Dam	45.7 (18)	3994 (1055)	223 (59)
	45.7 (18)	3994 (1055)	238 (63)
	45.7 (18)	3994 (1055)	307 (81)

Table 5.1. Design Capacity and Ponding Volume of the Five SCDs Tested at the Channel.

Sediment Removal Efficiency

Two sediment types (silica and ball clay) were examined to determine which sediment to use in testing. Figure 5.5 indicates the sediment removal efficiency of each of the five SCDs. To further evaluate the performance of each of the 5 SCDs the mass load sediment removal needs to be examined. This can be calculated through determining the influent and effluent sediment load. Figures 5.6 and 5.7 indicate these values.



Figure 5.5. Sediment Removal Efficiency for Five SCDs. Values below SCD Name Indicate the Total Volume of Sediment-Laden Water Treated.



Figure 5.6. Influent and Effluent Sediment Load from Tests Conducted on Five SCDs. Values below SCD Name Indicate the Total Volume of Sediment-Laden Water Treated.



Figure 5.7. Mass of Sediment Removed by Five SCDs. Values below SCD Name Indicate the Total Volume of Sediment-Laden Water Treated.

Sediment Control Device	Mass In	Mass Out	Removal Efficiency
	kg (lb)	kg (lb)	%
Geosynthetic Dike	2.8 (6.1)	2.2 (4.8)	20
	3.3 (7.2)	2.7 (6.0)	16
	3.3 (7.2)	2.7 (6.0)	17
Wattle – untreated	0.58 (1.3)	0.31 (0.69)	46
	0.65 (1.4)	0.36 (0.79)	45
	0.71 (1.6)	0.39 (0.85)	46
Wattle – treated	0.67 (1.47)	0.24 (0.54)	63
	0.70 (1.54)	0.28 (0.61)	61
	1.47 (1.47)	0.30 (0.67)	54
Silt Fence	14.3 (31.4)	12.2 (26.9)	14
	14.3 (31.6)	12.7 (28.0)	11
	13.7 (30.1)	11.5 (25.3)	16
Rock Check Dam	12.7 (28.0)	12.4 (27.3)	2
	12.5 (27.6)	12.2 (27.0)	2
	12.9 (28.4)	12.7 (27.9)	2

Table 5.2. Sediment Removal of the Five SCDs Tested at the Channel.

Flow-through Rate

Two bubbler flow meters (ISCO® model ts-line sc) were used to monitor the turbidity at inlet and outlet of channel. Data were downloaded using FlowLink software. Figure 5.8 indicates the flow-through rates of the SCDs evaluated in the calibration process.



Figure 5.8. Flow-Through Rate of Five SCDs. Values below SCD Name Indicate the Total Volume of Sediment-Laden Water Treated.

CHAPTER 6: RECOMMENDATIONS AND FUTURE WORK

TESTING PROTOCOL

Based on the 2008–2009 test results discussed above the TTI researchers have developed an evaluation protocol for SCDs. This protocol is designed to effectively, consistently, and fairly test the many various types of SCDs available to TxDOT construction and maintenance divisions.

1. Preparing the channel:

The testing channel shall be cleaned and the soil in the installation zone shall be resurfaced to match the channel profile.

2. Installing the SCD:

The SCD shall be installed in the installation zone according to manufacturer's instructions. (Note: In the absence of specific instruction from manufacturer, SCD installation shall be carried out according to technicians' discretion). The installation details like number of stakes, spacing between stakes, presence/absence of apron, trenching depth, and height of SCD after installing shall be recorded.

3. Testing:

3.1. Instrumentation:

The turbidity probes and bubbler tubes shall be connected to the appropriate locations at inlet and outlet. Technicians shall ensure that the flow meters and turbidity meter are recording data correctly (Note: While connecting the turbidity probes and bubbler tubes, special attention shall be directed to ensure that the locations are dirt free.).

- 3.2. <u>Test to determine SCD flow-through characteristics: This step is optional if the</u> <u>manufacturer can provide TTI staff with the product's established flow-through</u> <u>rate(s).</u>
 - 3.2.1. Sediment preparation:

No sediment shall be added to 1500 gal of water in the mixing during this process.

3.2.2. *Test Flow:*

Water shall be released into the channel at a flow rate of ~ 60 gpm by controlling the butterfly valve on the mixing tank. The valve shall be closed and flow of water into the channel shall be stopped when water begins to overtop the SCD. The maximum flow rate at the outlet shall be recorded and shall determine the inflow rate to be applied during performance testing on the SCD. For example, if the maximum flow rate observed at the outlet in 15 gpm, then the SCD falls in the 10–20 gpm flow category and a maximum inflow rate of 20 gpm will be applied during performance testing on the SCD.

3.3. Performance testing on SCD:

Three repetitions of this test will be conducted on SCD before removing it from the installation zone.

3.3.1. Sediment preparation:

Mix 12.5 lb of SIL-CO-SIL[®]49 and 12.5 lb of ball in 1500 gal of water to create sediment-laden water having a SSC of 2000 mg/L. The sediment-laden water shall be kept stirred in the mixing tank until the test has ended.

3.3.2. *Testing Flow:*

Water shall be released into the channel, at a flow rate defined by the SCD flow category, by controlling the butterfly valve on the mixing tank. The entire 1500 gal of sediment-laden water shall be emptied into the channel. The test will continue until there is no water retained behind the SCD.

3.4. Data processing:

Data from the flow meter and turbidity meter shall be downloaded to the field laptop. All relevant calculations will be performed using excel spreadsheet.

4. Data Recording

The following data will be reported to TxDOT following each product evaluation:

- Product installation details,
- Flow-through rate (cfs),
- Maximum Flow Rate (gpm),
- Ponding Volume (gal),

- Turbidity (NTU) at inlet and outlet,
- SSC (mg/L) at inlet and outlet,
- Mass Loading (lb), and
- Removal Efficiency (%).

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APPENDIX A: WATER QUALITY TEST TABLES

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	pacity Silica Ball Clay Volume Concentration Sil-Co-Sil®49 V _{IN} C _{IN} C _{IN} Sil-Co-Sil®49 V _{IN} C _{IN} C _{IN} 50 0 1500 4000 50 0 1500 4000 600 3000 1000 1000 90 1000 90 300 90 120 0 300 90 120 300 60 91 1300 0 30 90 120 30 60 91 120 30 60 91 120 120 30 60 91 120 120 120 120	- - 		Sediment	nent		Slurry	Testing	ng
Sall [lb] [lb] [lb] [lb] [lb] [mg/L] (09 50 0 1500 4000 4000 1 3500 3500 4000 4000 4000 1 <	[lb] [lb] [lb] [mg/L] 50 0 1500 4000 Overtopping 3500 3500 4000 Inlet 0utlet 3500 3000 1000 1000 0 0 120 1000 0 30 60 90 120 1000 0 30 60 90 120 Figure A-1.2. Turbidity Measured at Inlet and Outlet - Run I. Figure A-1.2. Turbidity Measured at Inlet and Outlet - Run I.	-	Capacity	Silica Sil-Co-Sil®49	Ball Clay	Volume V _{IN}	Concentration C _{IN}	Condi	tion
(09 50 0 1500 4000 Overtopping t 3500 3000 3000 1000 1000 1000 90 1200 30 60 90 90 1200 90	50 0 1500 4000 Overtopping 3500 3000 1000	-	gal]	[Ib]	[Ib]	[gal]	[mg/L]		
t <u>3500</u> <u>3500</u> <u>3500</u> <u>3000</u> <u>3000</u> <u>1000</u> <u>1000</u> <u>500</u> <u>0</u> <u>0</u> <u>0</u> <u>0</u> <u>0</u> <u>0</u> <u>0</u>	4000		309	50	0	1500	4000	Overto	ping
90 120 00 120 00 0 0 0 0 0 0 0 0 0 0 0 0	3500 3000 3000 3000 1000 1500 500 0 500 0 1000 0 1000 0 1100 0 1100 0 1100 0 1100 0 1100 0 1100 0 1100 0 1100 0 1100 100 1100 <td>Internet</td> <td>t.</td> <td></td> <td>4000</td> <td>-</td> <td>InletOutlet</td> <td>t.</td> <td></td>	Internet	t.		4000	-	InletOutlet	t.	
90 120 000 00 00 00 00 00 00 00 00 00 00 00	120 1500 1500 1500 500 500 60 90 120 30 60 90 Figure A-1.2. Turbidity Measured at Inlet and Outlet - Run 1.								
500 500 90 120 90 120 0 30 60 90	1000 500 500 500 0 30 60 90 120 0 30 60 90 Figure A-1.2. Turbidity Measured at Inlet and Outlet – Run 1.						مر		
90 120 0 30 60 90 Time [minutes]	120 0 30 60 90 Time [minutes] Figure A-1.2. Turbidity Measured at Inlet and Outlet – Run 1.	C			1000 - 500 -	2	/	}	
			60	120		30	- 09	06	
		S					Time [minutes]		
Table A-1.2. Results Describing SCD Performance from Run 1.			Turbidity (Avg.±SD)	SSC (A	vg.±SD)	Mass Loadi	ing	Remov
A-1.2. Results Describing SCD Performance from Run 1. Turbidity (Avg.±SD) SSC (Avg.±SD) Mass Loading	Mass Loading		LN]	U]	[m]	g/L]	[Ib]		Efficiency
A-1.2. Results Describing SCD Performance from Run 1.Turbidity (Avg. ± SD)SSC (Avg. ± SD)Mass Loading[NTU][mg/L][1b]	Mass Loading [lb]		$\mathbf{T}_{\mathbf{IN}}$	$\mathbf{T}_{\mathbf{OUT}}$	$\mathbf{C}_{\mathbf{IN}}$	COUT	M _{IN} N	Mour	%
A-1.2. Results Describing SCD Performance from Run 1.Turbidity (Avg. ± SD)SSC (Avg. ± SD)Mass Loading[NTU][mg/L][lb]T _{IN} T _{OUT} C _{IN} C _{OUT}	Mass Loading [lb] M _{IN} M _{OUT}		1935 ± 354	953 ± 752	3392 ± 527	2054 ± 1131	44.27 3	36.17	18

		1			Removal Efficiency	[%]	38
Testing	Condition	Overtopping	4000 3500 Outlet Outlet 3500 Outlet 1500 Outlet 1500 Outlet 1500 Outlet Outlet - Run 2.		Mass Loading [lb]	$\mathbf{M}_{\mathbf{OUT}}$	33 80
	Concentration C _{IN} [mg/L]	4000	-Inlet Outle		Mass	\mathbf{M}_{IN}	1716
Slurry	Volume Co V _{IN} [gal]	1500	2.2. Turbidity	ce from Run 2.	SSC (Avg.±SD) [mg/L]	Cour	JJ40 ± 1005
	Ball Clay V([Ib] [0	Figure A-	CD Performan	SSC (A Im	CIN	090 + 9672
Sediment	Silica Ba Sil-Co-Sil®49 [lb]	50		A-2.2. Results Describing SCD Performance from Run 2.	Turbidity (Avg.±SD) [NTU]	$\mathbf{T}_{0\mathbf{U}\mathbf{T}}$	2 1040 ± 606
			Outlet 90 nutes]	Table A-2.2. Res	Turbidity []	T_{IN}	2007 + 663
	Design Capacity [gal]	309	-inlet Outle 60 Time [minutes]	Ta	Ponding Volume [gal]	V_{θ}	477
SCD	Height H _{SCD} [in.]	6	30 m Rates M				1
	Type	Geosynthetic Dike	¹⁰⁰ ¹⁰⁰		Maximum Flow Rate gpm (cfs)	Q _{IN} Q _{OUT}	51 (0 115) 33 (0 074)

2. Testing details and results from Run 2

3. Testing details and results from Run 3.

	SCD			Sediment	ent		Slurry		Testing	
Type	Height H _{SCD} [in.]	Design Capacity [gal]		Silica Sil-Co-Sil®49 IIbl	Ball Clay IIbl	Volume V _{IN} [gall		Concentration C _{IN} [mg/L]	Condition	
Geosynthetic Dike	6	309		50	0	1500		4000	Overtopping	ae
100	Ē	- Inlet Outlet	let		4(4000 3500 -	l	-Inlet	Outlet	
	Ĕ	ŕ			[UT3] (JibidiuT 8 2 2 2 2 2 6 2	3000		1		
4 0	30	60	- 06	120		0	30	- 09	06	0 120
		Time [minutes]	[;					Time [minutes]	inutes]	
Figure A-4.1. Flow Rates Measured at Inlet and Outlet – Run 4.	v Rates Me	asured at Inlet	and Outlet –	Run 4.	Fig	ure A-4.2.	Furbidity M	easured at I	Figure A-4.2. Turbidity Measured at Inlet and Outlet – Run 4.	et – Run 4.
		Table	e A-4.2. Resu	lts Describi	A-4.2. Results Describing SCD Performance from Run 4.	rmance fro	om Run 4.			
Maximum Flow Rate		Ponding Volume	Turbidity (Avg.±SD)	(Avg.±SI) SS	SSC (Avg.±SD)	SD)	Mass I	Mass Loading	Removal
gpm (cfs)		[gal]	[N	[NTU]		[mg/L]		[]	[lb]	Efficiency
QIN QOUT		$\mathbf{V}_{\mathbf{\theta}}$	$\mathbf{T}_{\mathbf{IN}}$	$\mathbf{T}_{0\mathbf{U}\mathbf{T}}$	CIN		Cour	\mathbf{M}_{IN}	$\mathbf{M}_{\mathbf{OUT}}$	[%]
35 (0 077) 26 (0 057)		306	1075 - 100					02.07	01.00	<i>c c</i>

4. Testing details and results from Run 4.
| | _ | | a | | | | | i. | | 90 120 | | et – Run 5. | | Removal | Efficiency | [%] | οr |
|----------|----------------------------------|----------|-------------------|----------------|--------|------|-------------------------------|----------------------|---------|----------|----------------|--|---|--------------------------|--------------|--------------------------------|----------------|
| Testing | Condition | | Overtopping | Outlet | | | | | | | inutes] | nlet and Outl | | Mass Loading | [IIb] | $\mathbf{M}_{\mathbf{OUT}}$ | 0,00 |
| | Concentration
C _{IN} | [mg/L] | 4000 | - Inlet | | | _ | 1 | ; | 09 | Time [minutes] | Measured at I | | Mass | | $\mathbf{M}_{\mathbf{IN}}$ | |
| Slurry | Volume Con
V _{IN} | [gal] | 1500 | | | { | , | م
م
=== | ŝ | 30 | | Figure A-5.2. Turbidity Measured at Inlet and Outlet – Run 5. | e from Run 5. | g.±SD) | / L] | Cour | |
| | lay | [lb] [g] | 0 1 | 4000 | 3500 - | | ііty [FT
2500
11th 2000 | 1500
1000
1000 | 500 - | + 0
0 | | Figure A-5 | D Performance | SSC (Avg.±SD) | [mg/L] | $\mathbf{C}_{\mathbf{IN}}$ | |
| Sediment | Silica Bal
Sil-Co-Sil®49 | [lb] | 50 | | | | | | | 120 | | Run 5. | A-5.2. Results Describing SCD Performance from Run 5. | Avg.±SD) | lui | T_{oUT} | |
| | | | | tlet | | | | | | 06 | s] | and Outlet – J | le A-5.2. Resul | Turbidity (Avg.±SD) | [NTU] | T_{IN} | |
| | Design Capacity | [gal] | 309 | - Inlet Outlet | | | | | / | 60 | Time [minutes] | asured at Inlet | Table . | Ponding Volume | [gal] | $\mathbf{V}_{\mathbf{\theta}}$ | 1.0 |
| SCD | Height
H _{scn} | [in.] | 6 | Ī | | | | J. | <u></u> | 30 | | v Rates Me | | | | | |
| | Type | | Geosynthetic Dike | 100] | | - 08 | - 09 | ₹ <u></u> | - 07 | 0 | | Figure A-5.1. Flow Rates Measured at Inlet and Outlet – Run 5. | | Maximum Flow Rate | gpm (cfs) | Qour | 15/ 10 /0 000/ |
| | | | Geosy | | | [w | q3] əts | r wolf | | | | E | | Maxin | | \mathbf{Q}_{IN} | E1 (011E) |

5. Testing details and results from Run 5.

				120	– Run 6.		Removal Efficiency	[0/]	26
Testing	Condition	Overtopping	Outlet	90 Dutesl	Figure A-6.2. Turbidity Measured at Inlet and Outlet – Run 6.		Mass Loading [lb]	$\mathbf{M}_{\mathbf{OUT}}$	33.62
on for Run 6.	Concentration C _{IN}	[mg/L] 4000	- Inlet	00 Time [minutes]	Measured at I			\mathbf{M}_{IN}	45.68
esting Conditio Slurry	le	[gal] 1500		30	6.2. Turbidity	ce from Run 6.	SSC (Avg.±SD) [mg/L]	$\mathbf{C}_{0\mathbf{U}\mathbf{T}}$	2360 ± 833
Volume, and T	lay	[Ib] 0	Turbidity [FTU] 7000 1500 1000 15000 1000 15000 1000 1000 1000 1000 1000 1000 100	0	Figure A-	CD Performan	SSC (A	$\mathbf{C}_{\mathbf{IN}}$	3574 ± 355
ls of SCD, Sediment, Water Volume, and Testing Condition for Run 6. Sediment Slurry	a 11 [®] 49	[lb] 50		071	Run 6.	A-6.2. Results Describing SCD Performance from Run 6.	Turbidity (Avg.±SD) [NTU]	T_{our}	1057 ± 478
ails of SCD, Se			4	90 es]	Figure A-6.1. Flow Rates Measured at Inlet and Outlet – Run 6.	ole A-6.2. Resul	Turbidity [N	$\mathbf{T}_{\mathbf{IN}}$	2095 ± 368
Table A-6.1. Detail	Design Capacity	[gal] 309	-Inlet Outlet	00 Time [minutes]	easured at Inle	Table	Ponding Volume [gal]	V_{θ}	384
SCD T	Height H _{SCD}	[in.] 9		00	w Rates Me				(6
	Type	Geosynthetic Dike		D	ure A-6.1. Flo		Maximum Flow Rate gpm (cfs)	$\mathbf{Q}_{\mathbf{OUT}}$	(7) 22 (0.049)
		Geosyn	Flow rate [gpm]		Fig		Maxim	$\mathbf{Q}_{\mathbf{IN}}$	30 (0.067)

6. Testing details and results from Run 6.

ing	ition	topping		90 120		Figure A-7.2. Turbidity Measured at Inlet and Outlet – Run 7.		Removal Efficiency	UT [%]	
Testing	n Condition	No Overtopping	Outlet	60	Time [minutes]	it Inlet and O		Mass Loading [Ib]	Mour	
'ry	Concentration C _{IN} [mg/L]	4000	l lipet	30	Time [ty Measured a	7.		M_{IN}	
Slurry	Volume C V _{IN} Igall	330		0		-7.2. Turbidit	nce from Run	SSC (Avg.±SD) [mg/L]	Cour	
	Ball Clay	0	Turbidity [FTU] 3500 - 1000 - 1500 - 1500 - 1500 - 1500 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000 - 1000			Figure A	CD Performan	SSC (2	CIN	
Sediment Slurry	Silica Ba Sil-Co-Sil®49 IIbl	50		120		t – Run 7.	A-7.2. Results Describing SCD Performance from Run 7.	Turbidity (Avg.±SD) [NTU]	$\mathbf{T}_{\mathbf{OUT}}$	
			- Outlet	06	utes]	ilet and Outle	Table A-7.2. Re		$\mathbf{T}_{\mathbf{IN}}$	
	Design Capacity Igall	309	let	60	Time [minutes]	leasured at In	T	Ponding Volume [gal]	V_{θ}	
SCD	Height H _{scb} Iin.l	6	Ī	30		w Rates M				
	Type	Geosynthetic Dike		0		Figure A-7.1. Flow Rates Measured at Inlet and Outlet – Run 7.		Maximum Flow Rate gpm (cfs)	A QOUT	
		Geosy	Flow rate [gpm]			Ð		Maxir	QIN	

7. Testing details and results from Run 7.

	E	ping			120		t – Run 8.		Removal Efficiency	[%]	
Testing	Condition	No Overtopping	Outlet	W	- 06 (inutes]	Figure A-8.2. Turbidity Measured at Inlet and Outlet – Run 8.		Mass Loading [lb]	Mout	
on tor Kun 8. y	Concentration C _{IN} [mg/L]	4000	-Inlet	ļ		Time [minutes]	Measured at]		Ma	M _{IN}	
esting Condition Slurry	Volume Co V _{IN} [gal]	330			30		8.2. Turbidity	ce from Run 8.	SSC (Avg.±SD) [mg/L]	Cour	
Volume, and To	Ball Clay V. [lb]	0	4000	Turbidity [FTU]	- 0		Figure A-	CD Performance	SSC (A	C _{IN}	
1 able A-8.1. Details of SCD, Sediment, Water Volume, and Testing Condition for Kun 8. Sediment Sediment	Silica Ba Sil-Co-Sil®49 [lb]	50			120		Run 8.	e A-8.2. Results Describing SCD Performance from Run 8.	Turbidity (Avg.±SD) NTU	$\mathbf{T}_{0\mathbf{U}\mathbf{T}}$	
ails of SCD, Se			tlet		- 06	[s]	t and Outlet – Run 8.	le A-8.2. Resul	Turbidity ([N]	$\mathbf{T}_{\mathbf{IN}}$	
able A-8.1. Det	Design Capacity [gal]	309	- Inlet Outlet		60	Time [minutes	asured at Inlet	Table	Ponding Volume [gal]	V_{θ}	
SCD 1a	Height H _{SCD} [in.]	6	-		30		w Rates Me				
	Type	Geosynthetic Dike	100	Flow rate [gpm]	- 0		Figure A-8.1. Flow Rates Measured at Inlet		Maximum Flow Rate gpm (cfs)	Q _{IN} Q _{OUT}	

×.	
Run	
from	
d results	
details ai	
sting	

			ng								120		- Run 9.		Removal	Efficiency	[%]	
Testing	Condition		No Overtopping		Outlet						90	inutes]	Figure A-9.2. Turbidity Measured at Inlet and Outlet – Run 9.		Mass Loading	[lb]	$\mathbf{M}_{\mathbf{OUT}}$	
	Concentration C _{IN}	[mg/L]	4000		-Inlet					~	60	Time [minutes]	leasured at l		Ma		$\mathbf{M}_{\mathbf{IN}}$	
Slurry			0						}		30		. Turbidity N	rom Run 9.	(,±SD)	L]	COUT	
	lay Volume V _{IN}	[gal]	330		3500		2500 -		1000 - 500 -	-	0		Figure A-9.2	e A-9.2. Results Describing SCD Performance from Run 9.	SSC (Avg. ± SD)	[mg/L]	$\mathbf{C}_{\mathbf{IN}}$	
Sediment	Ball Clay 9	[IIb]	0			ιn	τy [FT	Turbidi		Г	120			ibing SCD P	SD)		$\mathbf{T}_{\mathbf{OUT}}$	
Sed	Silica Sil-Co-Sil [®] 49	[lb]	50								60		and Outlet – Run 9.	Results Descr	Turbidity (Avg.±SD)	[NTU]		
		[]	6		– Outlet						6	utes]	nlet and Out	Table A-9.2.]			$\mathbf{T}_{\mathbf{IN}}$	
	Design Capacity	[gal]	309		- Inlet						60	Time [minutes	easured at In	L	Ponding Volume	[gal]	$\mathbf{V}_{\mathbf{\theta}}$	000
SCD	Height H _{SCD}	[in.]	6		Ī					/	30		w Rates M					í
	Type		Geosynthetic Dike	3	100	80 -	- 09	40 -	20 -	, <u>, ,</u> ,	0		Figure A-9.1. Flow Rates Measured at Inlet		Maximum Flow Rate	gpm (cfs)	Qour	
	Τ		Geosynt		,			ilow ra					Figu		Maximu	gp	$\mathbf{Q}_{\mathbf{IN}}$	

9. Testing details and results from Run 9.

~ 4	SCD			Sediment	ent		Slurry	Testing	
Type	Height H _{SCD}	Design Capacity		Silica Sil-Co-Sil®49	Ball Clay	Volume V _{IN}	Concentration C _{IN}	n Condition	
	[in.]	[gal]		[lb]	[lb]	[gal]	[mg/L]		ĺ
Geosynthetic Dike	6	309		25	0	330	2000	No Overtopping	ŋg
100	Ē	- Inlet Outl	let		4000	00	- Inlet	Outlet	
Flow rate [gpm]					Turbidity [FTU] 3500 500 1000 5000 1000 5000 5000 5000	200		$\langle \rangle$	
0	30	60	- 06	120		0	30		120
		Time [minutes	-				Time	Time [minutes]	
Figure A-10.1. Flow Rates Measured at Inlet	Rates Me	asured at Inlet	and Outlet	and Outlet – Run 10.	Figure	e A-10.2. Tui	rbidity Measured	Figure A-10.2. Turbidity Measured at Inlet and Outlet – Run 10.	- Run 10.
		Table	A-10.2. Res	sults Describi	A-10.2. Results Describing SCD Performance from Run 10.	mance from	Run 10.		
Maximum Flow Rate		Ponding Volume	Turbidit	Turbidity (Avg.±SD)) SS	SSC (Avg. ± SD)		Mass Loading	Removal
gpm (cfs)		[gal]	<u> </u>	[NTU]		[mg/L]		[Ib]	Efficiency
Q _{IN} Q _{OUT}		$\mathbf{V}_{\mathbf{\theta}}$	$\mathbf{T}_{\mathbf{IN}}$	T_{OUT}	$\mathbf{C}_{\mathbf{IN}}$		Cour N	M _{IN} M _{OUT}	[0/]
57 (0.127) 12 (0.028)		205	873 + 158	C2V + LC3 = 8	$50 1807 \pm 707$		15	5 61 1 53	10

10. Testing details and results from Run 10.

		ല്പ				120		- Run 11.		Removal	Efficiency	[%]	26
Testing	Condition	No Overtopping	Outlet		مرجز ا	06	nutes]	Figure A-11.2. Turbidity Measured at Inlet and Outlet – Run 11.		Mass Loading	[lb]	$\mathbf{M}_{0\mathbf{U}\mathbf{T}}$	4.31
A	Concentration C _{IN}	2000	-Inlet			60	Time [minutes]	Measured at II	ι.	Mas		\mathbf{M}_{IN}	0 5.86
Sediment Slurry	Volume Co V _{IN}	3 30		5	/	30		1.2. Turbidity	ce from Run 1	SSC (Avg.±SD)	[mg/L]	COUT	1411 ± 600
	Ball Clay V		4000	Turbidity [FTU]	500	0		Figure A-1	-11.2. Results Describing SCD Performance from Run 11.	SSC (A	<u>u</u>]	$\mathbf{C}_{\mathbf{IN}}$	1897 ± 454
Sediment	Silica Ba Sil-Co-Sil®49 IIb1	25			Ī	120		Run 11.	ts Describing S	Turbidity (Avg.±SD)	[NTU]	$\mathbf{T}_{\mathbf{OUT}}$	558 ± 291
			ıtlet		F	06	[sa]	t and Outlet – Run 11.	e A-11.2. Resul	Turbidity ([N]	$\mathbf{T}_{\mathbf{IN}}$	882 ± 239
	Design Capacity	309	let Outlet			60	Time [minutes]	Figure A-11.1. Flow Rates Measured at Inlet a	Table A	Ponding Volume	[gal]	$\mathbf{V}_{\mathbf{\theta}}$	285
SCD	Height H _{SCD} Iin 1	6	- Inlet			30		w Rates Me					(9)
	Type	Geosynthetic Dike	100	80 - 60 - 20 -	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	0		re A-11.1. Flo		Maximum Flow Rate	gpm (cfs)	Qour) 11 (0.026)
	F	Geosynt	Ţ	Flow rate [gpm]				Figur		Maximu	gp	$\mathbf{Q}_{\mathbf{IN}}$	53 (0.119)

11.
Run
from
results
and
details
Testing

ల్	ion		pping							·	90 120		tlet – Run 12.		Removal	Efficiency	JT [%]	
Testing	Condition		No Overtopping	Outlet					<='	1 p		inutes]	Inlet and Out		Mass Loading	[Ib]	Mour	
	Concentration C _{IN}	[mg/L]	2000	-Inlet							90	Time [minutes]	Measured at]				$\mathbf{M}_{\mathbf{IN}}$	
Slurry	Volume Con V _{IN}		330								30		Figure A-12.2. Turbidity Measured at Inlet and Outlet – Run 12.	from Run 12	3. ± SD)	/L]	Cour	
		<u>8</u>	33	4000	3500 -	3000 -		2000 - 1500 -		500	- 0		Figure A-12.2	erformance	SSC (Avg. ± SD)	[mg/L]	$\mathbf{C}_{\mathbf{IN}}$	
Sediment	Ball Clay 9	[dl]	0			[UT1] ·	rbidity	nŢ	T	120			ribing SCD F	SD)		Tour	
Sediment Slurry	Silica Sil-Co-Sil [®] 49	[lb]	25								06		and Outlet – Run 12.	A-12.2. Results Describing SCD Performance from Run 12.	Turbidity (Avg.±SD)	[NTU]		
		ll	6(- Outlet							6	iutes]	nlet and Out	Table A-12.2.]			T_{IN}	
	Design Capacity	[gal]	309	- Inlet							60	Time [minutes	leasured at I	T	Ponding Volume	[gal]	$\mathbf{V}_{\mathbf{\theta}}$	
SCD	Height H _{scn}	[in.]	6	Ī							30		w Rates M					
	Type		Geosynthetic Dike	100		- 08	- 09	40 -	20 -	:	- 0		Figure A-12.1. Flow Rates Measured at Inlet		Maximum Flow Rate	gpm (cfs)	Qour	
			Geosy	A-00113		[u	ud3]	w rate	비				Fig		Maxin	•*	$\mathbf{Q}_{\mathbf{IN}}$	

12. Testing details and results from Run 12.

	_		50				120		: – Run 13.		Removal	Efficiency	[%]	1
Testing	Condition		Overtopping	Outlet			- 06	nutes]	nlet and Outlet		Mass Loading	[lb]	$\mathbf{M}_{\mathbf{OUT}}$	
	Concentration C _{IN}	[mg/L]	2000	-Inlet			- 09	Time [minutes]	Measured at Ir		Mas		\mathbf{M}_{IN}	
Slurry	Volume Con V _{IN}	[gal]	1500				30		Figure A-13.2. Turbidity Measured at Inlet and Outlet – Run 13.	from Run 13.	SSC (Avg.±SD)	[mg/L]	Cour	
	Ball Clay Vo	5] [q]]	0 1:	4000	3500 3700 2500 2000 2000 2000 2000 2000 2000 2		+ 0 0		Figure A-13.) Performance	SSC (A)	[m	$\mathbf{C}_{\mathbf{IN}}$	
Sediment	Silica Ball Sil-Co-Sil®49		25 (120		un 13.	-13.2. Results Describing SCD Performance from Run 13.	vg.±SD)	[]	$\mathbf{T}_{0\mathbf{U}\mathbf{T}}$	
		Ē	5	at .			- 06		ind Outlet – Run 13.	V-13.2. Results	Turbidity (Avg.±SD)	[NTU]	$\mathbf{T}_{\mathbf{IN}}$	
	Design Capacity	[gal]	309	- Inlet Outle			- 09	Time [minutes]	Figure A-13.1. Flow Rates Measured at Inlet a	Table A	Ponding Volume	[gal]	$\mathbf{V}_{\mathbf{\theta}}$	
SCD	Height H _{scn}	[in.]	6	Ī	[.	i i	30		ow Rates M					Í
	Type		Geosynthetic Dike	100	vrate [gpm]		a 0 0		Figure A-13.1. Flo		Maximum Flow Rate	gpm (cfs)	QIN QOUT	

13. Testing details and results from Run 13.

I			5	120		- Run 14.		Removal Efficiency	[%]	0
Testing	Condition	Overtopping	Outlet	- 06	utes]	Figure A-14.2. Turbidity Measured at Inlet and Outlet – Run 14.		Mass Loading [lb]	$\mathbf{M}_{0\mathbf{U}\mathbf{T}}$	23.75
n for Run 14.	Concentration C _{IN}	[mg/L] 2000		60	Time [minutes]	Aeasured at In			\mathbf{M}_{IN}	23.68
sting Condition Slurry	le	[gal] 1500	{	30		.2. Turbidity N	e from Run 14.	SSC (Avg.±SD) [mg/L]	Cour	1747 ± 360
⁷ olume, and Te	lay	25 1	Turbidity [FTU]	+ 0		Figure A-14	D Performance	SSC (A) [m]	$\mathbf{C}_{\mathbf{IN}}$	1821 ± 285
Table A-14.1. Details of SCD, Sediment, Water Volume, and Testing Condition for Run 14. Sediment Sediment	a ll [®] 49	0 0		120		kun 14.	A-14.2. Results Describing SCD Performance from Run 14.	Avg.±SD) U]	$\mathbf{T}_{0\mathbf{U}\mathbf{T}}$	1907 ± 508
ills of SCD, Sec		_	tlet	- 06	s]	and Outlet – F		Turbidity (Avg.±SD) [NTU]	$\mathbf{T}_{\mathbf{IN}}$	2197 ± 395
le A-14.1. Deta	Design Capacity	[gal] 309	let Outlet	99	Time [minutes]	asured at Inlet	Table.	Ponding Volume [gal]	V_{θ}	405
Tab SCD	Height H _{scb} 	[iii]	Inlet	30		w Rates Me				(1
	Type	Geosynthetic Dike	Flow rate [gpm]	0		Figure A-14.1. Flow Rates Measured at Inlet and Outlet – Run 14.		Maximum Flow Rate gpm (cfs)	Q _{IN} Q _{OUT}	51 (0.115) 41 (0.092)

14. Testing details and results from Run 14.

Silica Sil-Co-Sil [®] 49
Outlet – Run 15.
Table A-15.2. Results Describing SCD Performance from Run 15.
urbidity (Avg.±SD)
[NTU]
2762 ± 455

15.
n Run 1
from
results
and
details
[esting

ay 3500 3000 2500 1500 500 500	Turbidity [FTU]		€ [®] 49
The period works where ordered where solared	E 2 [51]		(II) 0 0 0
the period works works that want works	C. Turbidity [FTU]		0
1.56 24-275 462-32 240-675 V.C. 9463 275.07	Turbidity [FTU]	Turbidity [FTU]	
3500 3000 2500 2500 2500 1000 500	Turbidity [FTU]		Turbidity [FTU]
3000 2500 2000 1500 1000 500			
2500 2000 1500 1000 500			
2000 1500 1000 500	Turbidity	Turbidity	Turbidity
1000 500	пŢ	nΤ	υT
500			
;			
5		120	90 120
			Time [minutes]
Figure A-16.2. Turbidity Measured at Inlet and Outlet – Run 16.	Ξ.		Figure A-16.1. Flow Rates Measured at Inlet and Outlet – Run 16.
erform	ig SCD P	esults Describing SCD P	Table A-16.2. Results Describing SCD Performance from Run 16.
SSC (Avg.±SD)	((lity (Avg.±SD)	Turbidity (Avg.±SD)
		[NTU]	[NTU]
$\mathbf{C}_{\mathbf{IN}}$,	$\mathbf{T}_{0\mathbf{U}\mathbf{T}}$	T _{IN} T _{OUT}
2333 ± 244	794	$56 2400 \pm 794$	3380 ± 556 2400 ± 794

16. Testing details and results from Run 16.

I					[120		tun 17.		Removal	Efficiency	[%]	20
Testing	Condition		No Overtopping	Outlet		96	nutes]	nlet and Outlet – F		Mass Loading	[q]]	IN MOUT	15 4 84
Slurry	Concentration C	CIN [mg/L]	2000			30 60	Time [minutes]	Figure A-17.2. Turbidity Measured at Inlet and Outlet – Run 17.	un 17.			C _{OUT} M _{IN}	$\frac{1}{1}$
S	Volume V	v IN [gal]	330	4000	3500 3000 2500 1500 1000 500 0	0		e A-17.2. Turbi	rmance from R	SSC (Avg. ± SD)	[mg/L]	C _{IN}	7030 + 775 157
nent	Ball Clay	[Ib]	12.5	40	Turbidity [FTU] אילאולאולץ (FTU] אילאולא אילאילא אילאילא אילאילא אילאילא אילאילא אילא אילא אילא אילא אילא אילא אילא אילא אילא א	0		Figu	bing SCD Perfo	SD)		Tour	1040 ± 584 2030
Sediment	Silica Sil_Co_Sil®40		12.5			90 120		Outlet – Run 17.	Table A-17.2. Results Describing SCD Performance from Run 17.	Turbidity (Avg.±SD)	[NTU]		
	Design Capacity	[gal]	309	Outlet		60	Time [minutes]	ed at Inlet and Ou	Table A-17.2.	olume Tur		$\mathbf{T}_{\mathbf{IN}}$	$3UC \pm 3VV$
SCD	Height Des Harr	lin.]	9	- Polet 		30	Time	Rates Measure		Ponding Volume	[gal]	$\mathbf{V}_{\mathbf{\theta}}$	788
	Type		Geosynthetic Dike	100]		0		Figure A-17.1. Flow Rates Measured at Inlet and		Maximum Flow Rate	gpm (cfs)	Qout	15
			Geosyn		Flow rate [gpm]			Figu		Maxim	8	\mathbf{Q}_{IN}	68 (0152)

17. Testing details and results from Run 17.

Testing	tration Condition	Z	L]	00 No Overtopping		t Outlet				Your Your			60 90 120	Time [minutes]	Figure A-18.2. Turbidity Measured at Inlet and Outlet – Run 18.		Mass Loading Removal	[lb] Efficiency	
Slurry	me Concentration	CIN	[] [mg/L]) 2000									30	• .0-	Turbidity Meas	rom Run 18.	SSC (Avg.±SD)	[mg/L]	
	Ball Clay Volume	VIN	[lb] [gal]	12.5 330	0000	3500 -		[FTU]	- 2000	Turbio 1500 2000	200 -	••	0		Figure A-18.2.	D Performance fi	SSC (A	[m]	
Sediment		Sil-Co-Sil [®] 49	[]] [1]	12.5 12								ſ	120		Run 18.	Table A-18.2. Results Describing SCD Performance from Run 18.	Turbidity (Avg.±SD)	[NTU]	
		Sil-C				– Outlet						-	06	tes]	et and Outlet – Run 18.	le A-18.2. Resul	Turbidity	Z	
	t Design Capacity		[gal]	309		- Inlet 0							60	Time [minutes]	Measured at Inl	Tab	Ponding Volume	[gal]	
SCD	Height	$\mathbf{H}_{\mathbf{SCD}}$	[in.]	9		,							30		low Rates l				
	Type			Geosynthetic Dike	007	OOT	- 08	- 09 wd3]		1 wola 40	20 -		0		Figure A-18.1. Flow Rates Measured at Inlet and		Maximum Flow Rate	gpm (cfs)	

18. Testing details and results from Run 18.

Testing	Concentration Condition	C _{IN}	[mg/L]	2000 No Overtopping	etOutlet					•			60 90 120	Time [minutes]	Figure A-19.2. Turbidity Measured at Inlet and Outlet – Run 19.		Mass Loading Removal		[lb] Efficiency
Slurry	Volume Concen	V _{IN} C			- Inlet				~	/			30		2. Turbidity Mea	from Run 19.	SSC (Avg.±SD)		[mg/L]
	Ball Clay Volu	V	[lb] [gal]	12.5 330	4000	3500 -		[FTU]	7 5000 14	1500 -	н 1000 -	500	0		Figure A-19.2	D Performance	SSC (A		
Sediment		Sil-Co-Sil [®] 49	[Ib]	12.5									120		Outlet – Run 19.	Table A-19.2. Results Describing SCD Performance from Run 19.	Turbidity (Avg.±SD)		
	Design Capacity	Sil-	[gal]	309	- Outlet								06	nutes]	Inlet and Outlet	able A-19.2. Res	le Turbidi		_
0	Height Design C	$\mathbf{H}_{\mathbf{s}\mathbf{C}\mathbf{D}}$	[in.] [g:	9 3(Inlet							/	30 60	Time [minutes]	Figure A-19.1. Flow Rates Measured at Inlet and		Ponding Volume	[ชล]]	[56]
SCD		H	[i				1	- 1		_		1	0		A-19.1. Flow Ra		Maximum Flow Rate	(rfs)	(erra)
	Type			Geosynthetic Dike	100		8	09 [8bw		9 9	년 20	c	5		Figure .		Maximum	gnm (cfs)	Jo

19. Testing details and results from Run 19.

				120		- Run 20.		Removal	Efficiency	[%]	
Testing	Condition	Overtopping	Outlet	- 06	nutes]	ilet and Outlet -		Mass Loading	[lb]	N Mout	
Slurry	Concentration C _{IN} [mg/L]	2000		30 60	Time [minutes]	Figure A-20.2. Turbidity Measured at Inlet and Outlet – Run 20.	1 20.			C _{OUT} M _{IN}	
Slu	Volume (V _{IN} [gal]	750	0000 5000 - 5000 - 500 - 50	+ 0		e A-20.2. Turbidi	0.2. Results Describing SCD Performance from Run 20.	SSC (Avg.±SD)	[mg/L]	C _{IN} C	
Sediment	Ball Clay [Ib]	12.5	Turbidity [FTU]	120		Figur	bing SCD Perfor			T _{our} C	
Sedi	Silica Sil-Co-Sil®49 [Ib]	12.5		1 1 06		Outlet – Run 20.	2. Results Descri	urbidity (Avg. ± SD)	[NTU]	T _{IN} T ₀	
	Design Capacity [gal]	60	et Outlet	60	Time [minutes]	sured at Inlet and O	Table A-20.2	Ponding Volume Tu	[gal]	ν _θ Τ	
SCD	Height H _{SCD} [in.]	4.12	lulet	30	F	w Rates Mea			1		
	Type	Wattle (Untreated)	Flow rate [gpm]	- 0		Figure A-20.1. Flow Rates Measured at Inlet and		Maximum Flow Rate	gpm (cfs)	QIN QOUT	

20. Testing details and results from Run 20.

Testing	Condition		Overtonning	Sundonia	utlet								90 120	ites]	Figure A-21.2. Turbidity Measured at Inlet and Outlet – Run 21.		Mass Loading Removal	[lb] Efficiency	%
Slurry	Concentration		2000	00007	Inlet						7	,	30 60	Time [minutes]	idity Measured at Inl	un 21.			
SI	Volume V	V _{IN}	[gai] 750	000	4000	3500 -	3000 -	2500 -	2000 -	1500	1000	500 -	+ 0		re A-21.2. Turbi	ormance from Ru	SSC (Avg. ± SD)	[mg/L]	ر د
Sediment	Ball Clay	ر المال	[un] 12.5	0.71	4	35		етл] [ЕТЛ]		urbic		-,	120			1.2. Results Describing SCD Performance from Run 21.	± SD)		E
Sed	Silica c:1 Co c:1®40	SII-CO-SII 49 IIAI	[un] 12.5										- 06		Outlet – Run 21.	.2. Results Descr	Turbidity (Avg.±SD)	[NTU]	L.
	Design Capacity	المم	[190]	8	- Inlet Outlet								- 09	Time [minutes]	Figure A-21.1. Flow Rates Measured at Inlet and C	Table A-21	Ponding Volume Tı	[gal]	N.
SCD	Height 11	H _{SCD} Fin 1	4 12	71.F	[30		w Rates Me				
	Type		Wattle (Untreated)		100		- 80	- 100 قەس] əte	40 -	н 20 - 1		4 0		Figure A-21.1. Flo		Maximum Flow Rate	gpm (cfs)	00

21. Testing details and results from Run 21.

for Run 22.	Testing	Concentration C _{IN}	[mg/L]	2000 No Overtopping	- Inlet Outlet								60 90 120	Time [minutes]	-	Figure A-22.2. Turbidity Measured at Inlet and Outlet – Run 22.	easured at Inlet and Outlet – Run 22.	easured at Inlet and Outlet – Run 22. Mass Loading Removal	easured at Inlet and Outlet – Run 22. Mass Loading Removal [1b] Efficiency	easured at Inlet and Outlet – Run 22. Mass Loading Removal [1b] Efficiency M _{IN} M _{OUT} [%]
Table A-22.1. Details of SCD, Sediment, Water Volume, and Testing Condition for Run 22.	Slurry	Volume Conc V _{IN}		70						_	/) 30		MFibidura C.C.	22.2. I urbiaity M	22.2. I urbuny M ace from Run 22.	22.2. I urbiany № nce from Run 22. (Avg.±SD)	e A-22.2. Iurblully M mance from Run 22. SSC (Avg. ± SD) [mg/L]	22.2. Iurbunty M nce from Run 22. C (Avg. ± SD) [mg/L] Cour
	lt	Ball Clay V	[lb]	12.5	4000	3500 -	3000 -	[FTU [FTU			500	- 0	0		Figure A-2		SCD Performan	SCD Performan SSC	SCD Performan SSC	SCD Performan SSC C _{IN}
	Sediment	Silica Sil-Co-Sil®49	[Ib]	12.5									90 120		Outlet – Run 22.		Results Describing	Table A-22.2. Results Describing SCD Performance from Run 22.meTurbidity (Avg. ± SD)SSC (Avg. ± SD)	<u>2.2. Results Describing</u> `urbidity (Avg. ± SD) [NTU]	Results Describing oidity (Avg. ± SD) [NTU] Tour
		Design Capacity	[gal]	60	Outlet								60 09	Time [minutes]	ed at Inlet and Out		Table A-22.2.	Table A-22.2. olume Turb	Table A-22.2. olume Turb	Table A-22.2. F olume Turbi T _{IN}
	SCD	Height Des H _{SCD}	[in.]	4.12									30	Time	Rates Measure			Ta Ponding Volume		
		Type		Wattle (Untreated)	100]		- 80 [1	60 - 60 - 8pm	rate		20 -	0	0		Figure A-22.1. Flow Rates Measured at Inlet and			Maximum Flow Rate	faximum Flow Rate gpm (cfs)	1aximum Flow Rate gpm (cfs) Q _{IN} Q _{OUT}

22. Testing details and results from Run 22.

1				120		kun 23.		Removal	Efficiency	[%]	15
Testing	Condition	No Overtopping	Outlet	- 06	nutes]	nlet and Outlet – F		Mass Loading	[lb]	N Mour	
Slurry	Concentration C _{IN} [mg/L]	2000		30 60	Time [minutes]	Figure A-23.2. Turbidity Measured at Inlet and Outlet – Run 23.	ın 23.			C _{OUT} M _{IN}	
SI	Volume V _{IN} [gal]	70	4000	0		e A-23.2. Turbio	rmance from Ru	SSC (Avg. ± SD)	[mg/L]	C _{IN}	
Sediment	Ball Clay [Ib]	12.5	[UT∃] vîlbidîuT 8 ੴ ੴ ੴ 8 ੴ	120		Figur	bing SCD Perfo	SD)		Tour	
Sediment Slurry	Silica Sil-Co-Sil [®] 49 [lb]	12.5		90 12		Outlet – Run 23.	Table A-23.2. Results Describing SCD Performance from Run 23.	urbidity (Avg.±SD)	[NTU]	T _{IN} T ₀	
	Design Capacity [gal]	60	Outlet	- 09	Time [minutes]	red at Inlet and O	Table A-23.2	L	u)		
SCD	Height D H _{SCD} [in.]	4.12		30	Tin	w Rates Measu		e Ponding Volume	[gal]	$\mathbf{V}_{\mathbf{\theta}}$	
	Type	Wattle (Untreated)	Flow rate [gpm]	0		Figure A-23.1. Flow Rates Measured at Inlet and		Maximum Flow Rate	gpm (cfs)	Q _{IN} Q _{OUT}	

23. Testing details and results from Run 23.

	SCD			Sediment	ent		Slurry	Testing	
Type	Height H _{SCD}	Design Capacity		Silica Sil-Co-Sil [®] 49	Ball Clay	Volume V _{IN}	Concentration C _{IN}	on Condition	
	[in.]	[gal]		[lb]	[Ib]	[gal]	[mg/L]		
Wattle (Untreated)	4.12	60		12.5	12.5	70	2000	No Overtopping	ing
100]	=	- Inlet Outlet	tlet		4000	L 00	■ 	Outlet	
					3500	- 0			
ے و0 و1					: у [гт∪] 2500 2500				
low rat 40					Turbidit		~		
2					100 50			ŗ	
0	30	60	- 06	120			30	- 60 90	120
		Time [minutes]	s]				Time	Time [minutes]	
Figure A-24.1. Flow Rates Measured at Inlet and	/ Rates Me	asured at Inlet		Outlet – Run 24.	Figure	e A-24.2. Tu	irbidity Measured	Figure A-24.2. Turbidity Measured at Inlet and Outlet – Run 24.	– Run 24.
		Table	e A-24.2 Resu	lts Describin	Table A-24.2 Results Describing SCD Performance from Run 24.	mance from	Run 24.		
Maximum Flow Rate		Ponding Volume	Turbidit	Turbidity (Avg. ± SD)) (O	SSC (Avg.±SD)	± SD)	Mass Loading	Removal
gpm (cfs)		[gal]		[NTU]		[mg/L]		[II]	Efficiency
QIN QOUT		V_{θ}	T_{IN}	$\mathbf{T}_{\mathbf{OUT}}$		$\mathbf{C}_{\mathbf{IN}}$	Cout	M _{IN} M _{OUT}	т [%]
54 (0.119) 3 (0.007)		63	1610 ± 622	798 ± 338		2150 + 698	1228 + 490	1.56 0.85	46

24. Testing details and results from Run 24.

		Sed	Sediment		Slurry	Testing	
_	Design Capacity	Silica Sil-Co-Sil [®] 49	Ball Clay 9	Volume V _{IN}	Concentration C _{IN}	on Condition	
	[gal]	[qI]	[Ib]	[gal]	[mg/L]		
	60	12.5	12.5	750	2000	Overtopping	50
	- Inlet Outlet		4000	00	- Inlet	Outlet	
			3500	- 00			
			3000	- 00			
				- 08			
			rbidity 1500	00			
				8	/	ſ	
			ι Γ	500			2
	60	06	120	- 0	30	60 90	120
F	Time [minutes]				Time	Time [minutes]	
<u> </u>	Figure A-25.1. Flow Rates Measured at Inlet and	Outlet – Run 25.		e A-25.2. Tur	bidity Measured	Figure A-25.2. Turbidity Measured at Inlet and Outlet – Run 25.	– Run 25.
	Table A-25	5.2. Results Desci	Table A-25.2. Results Describing SCD Performance from Run 25.	mance from	Run 25.		
	Ponding Volume T	urbidity (Avg.±SD)	± SD)	SSC (Avg. ± SD)	ESD)	Mass Loading	Removal
	[gal]	[NTU]		[mg/L]		[q]]	Efficiency
	$\mathbf{V}_{\mathbf{\theta}}$	T _{IN} 7	T _{our} ($\mathbf{C}_{\mathbf{IN}}$	Cout	M _{IN} M _{OUT}	[%]
	00			C	1/01 - 101		10

25. Testing details and results from Run 25.

	SCD			Sediment	nt		Slurry	Testing	
Type	Height	Design Capacity		Silica	Ball Clay	Volume	Concentration	Den Condition	
	$\mathbf{H}_{\mathbf{s}\mathbf{C}\mathbf{D}}$		Sil-C ₀	Sil-Co-Sil [®] 49		$\mathbf{V}_{\mathbf{IN}}$	CIN		
	[in.]	[gal]		[lb]	[lb]	[gal]	[mg/L]		
Wattle (Treated)	4.12	60	11	12.5	12.5	70	2000	No Overtopping	lg
100	- Inlet	let Outlet	tlet		4000	L 0	- Inlet	Outlet	
					3500	- 0			
- 08					3000	- 0			
- 09 [8bu					[FTU]	- 0			
ete					ity	V- 0			
ow ra					urbid 1500	0			
ш 20 -					Γ			Ĺ.	
0					500	1.1			5
- 0	30	60	96	120		- 0	30	06 09	120
		Time [minutes]	[5				Time	Time [minutes]	
Figure A-26.1. Flow Rates Measured at Inlet and	v Rates Me	asured at Inlet	and Outlet – Run 26.	Run 26.	Figure	A-26.2. Tur	bidity Measured	Figure A-26.2. Turbidity Measured at Inlet and Outlet – Run 26.	- Run 26.
		Table A-2		s Describin	6.2. Results Describing SCD Performance from Run 26.	mance from	Run 26.		
Maximum Flow Rate		Ponding Volume	Turbidity (urbidity (Avg.±SD)		SSC (Avg. ± SD)	: SD)	Mass Loading	Removal
gpm (cfs)		[gal]		[NTU]		[mg/L]		[q]]	Efficiency
QIN QOUT		$\mathbf{V}_{\mathbf{\theta}}$	$\mathbf{T}_{\mathbf{IN}}$	$\mathbf{T}_{\mathbf{OUT}}$		C _{IN}	Cout	M _{IN} M _{OUT}	[%]

26.
Run
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and
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Testing

~~	SCD			Sediment	nt		Slurry	Testing	
Type	Height H _{SCD} [in.]	Design Capacity [gal]	city Silica Sil-Co-Sil®49 [lb]	ica Sil®49 0]	Ball Clay [lb]	Volume V _{IN} [gal]	Concentration C _{IN} [mg/L]	on Condition	
Wattle (Treated)	4.12	60	12.5	.5	12.5	70	2000	No Overtopping	50
100 7	 	- Inlet Outlet	et		4000	0]	- Inlet	Outlet	
- 80 -					3500 3000	0			
- 9 8 8 1 8 1 9									
Flow rate					Turbiditi 1500 1000 1000				
					500				
0	30	60	06	120		+ 0	30	06 09	120
		Time [minutes]	_				Time	Time [minutes]	
Figure A-27.1. Flow Rates Measured at Inlet and	Rates Me	asured at Inlet	and Outlet – Run 27.	un 27.	Figure	A-27.2. Turt	oidity Measured	Figure A-27.2. Turbidity Measured at Inlet and Outlet – Run 27.	- Run 27.
		Table A-2	A-27.2. Results	Describin	7.2. Results Describing SCD Performance from Run 27.	mance from F	kun 27.		
Maximum Flow Rate	Pondi	Ponding Volume	Turbidity (Avg.±SD)	Avg.±SI	6 (0	SSC (Avg.±SD)	SD)	Mass Loading	Removal
gpm (cfs)		[gal]	[NTU]	[U]		[mg/L]		[q]]	Efficiency
Q _{IN} Q _{OUT}		$\mathbf{V}_{\mathbf{\theta}}$	$\mathbf{T}_{\mathbf{IN}}$	$\mathbf{T}_{\mathbf{OUT}}$		C _{IN}	Cout	M _{IN} M _{OUT}	[0%]
43 (0.096) 1 (0.003)		66	1002 ± 364	11 + 212			01 - 101	154 071	5

Run 27.
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l results
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sting det
Te

$\overline{\mathbf{n}}$	SCD		Sediment	nent		Slurry	Testing	
-ie -i	Height Design Capacity H _{SCD}		Silica Sil-Co-Sil [®] 49	Ball Clay	Volume V _{IN}	Concentration C _{IN}	1 Condition	
• -	[in.] [gal]		[IIb]	[Ib]	[gal]	[mg/L]		
	4.12 60		12.5	12.5	70	2000	No Overtopping	
	Inlet	utlet		4000	0		Outlet	
				3500	- 0			
				3000	- 0			
				[FTU נידט	- 0			
				dity 2000	V- 0			
				urbid 1500	- 0			
				T 1000				
		5		500				
0.000	30 60	- 06	0 120	0	+ 0	30	90 90	120
	Time [minutes]	es]				Time [Time [minutes]	
Ä	Figure A-28.1. Flow Rates Measured at Inlet and		Outlet – Run 28.	Figure	e A-28.2. Tur	bidity Measured a	Figure A-28.2. Turbidity Measured at Inlet and Outlet – Run 28.	tun 28.
	Tabl	Table A-28.2. I	Results Describ	8.2. Results Describing SCD Performance from Run 28.	mance from]	Run 28.		
	Ponding Volume	Turb	urbidity (Avg.±SD)		SSC (Avg.±SD)	:SD)	Mass Loading	Removal
	[gal]		[NTU]		[mg/L]		[Ib]	Elliciency
	$\mathbf{V}_{\mathbf{\theta}}$	$\mathbf{T}_{\mathbf{IN}}$	Tour		C _{IN}	Cour	M _{IN} M _{OUT}	%
	уу	300 - 0001			0100-010			τ.

Testing details and results from Run	
details and results	Run
details and result	from
details	results
	and
Testing	\mathbf{v}_{2}
	Testing

Testing	Condition		No Overtopping	let			90 120	s]	Figure A-29.2. Turbidity Measured at Inlet and Outlet – Run 29.		ading	[lb] Efficiency	[0/2] [7/0]
ĺ	I			Outlet		\int	09	Time [minutes]	ed at Inlet a		Mass]]	M
Slurry	Concentration C _{IN}	[mg/L]	2000	- Inlet			30	Tir	rbidity Measur	Run 29.	ŧ SD)		Court
	Volume V _{IN}	[gal]	1500		-	, , , , , , , , , , , , , , , , , , ,	- 0		A-29.2. Tui	nance from	SSC (Avg. ± SD)	[mg/L]	
nt	Ball Clay	[Ib]	12.5	4000	3500	Turbidity [FTU]	2		Figure	9.2. Results Describing SCD Performance from Run 29.) S		Ŭ
Sediment	Silica Sil-Co-Sil [®] 49	[lb]	12.5				120		un 29.	Describin	`urbidity (Avg.±SD)	ruj	Tour
		[]	12				90		Outlet – Run 29.	9.2. Results	urbidity ([NTU]	Tn
	Design Capacity	[gal]		- Inlet Outlet			60	Time [minutes]	Figure A-29.1. Flow Rates Measured at Inlet and	Table A-29	Ponding Volume T	[gal]	Va
SCD	Height H _{SCD}	[in.]	18	Ē		and the second s	30		Rates Me				
	pe		ence		2.4		- 0		A-29.1. Flow		Maximum Flow Rate	gpm (cfs)	Onir
	Type		Silt Fence	100		⊃ 20 49 20 % ۲اه ۲ate [ghu]			Figure		Maximun	gpn	OIN

29. Testing details and results from Run 29.

					un 30. Efficiency	[%]	
Testing	Condition		No Overtopping	- Outlet	50 90 minutes] Mass Loading [lb]	Nour	
Slurry	Concentration C _{IN}	[mg/L]	2000	Inlet	Time [C _{oUT} M _{IN}	
Sh	Volume V _{IN}	[gal]	1500	- 0	500	C _{IN} (
nent	Ball Clay	[Ib]	12.5	4000	3500 3500 3500 3500 3500 3500 3500 3000 2000 2		
Sediment	Silica Sil-Co-Sil [®] 49	[lb]	12.5		3500 = 3000 = 3000 = 3000 = 3000 = 3000 = 3000 = 3000 = 1500 = 1500 = 500 = 500 = 500 = 500 = 500 = 500 = 500 = 500 = 500 = 500 = 0 =	N T _{OUT}	
	Design Capacity	[gal]		Outlet	Time [minutes] 60 9 71me [minutes] 71able A-30.2. 71able A-30.2. 12 Volume Turl [gal]	T_{IN}	
SCD	Height Des H _{SCD}	[in.]	18	- Inlet	30 60 Time [minu Rates Measured at In Ponding Volume [gal]	\mathbf{V}_{0}	
	Type		Silt Fence	100	80 90 60 40 20 0 20 0 30 60 Figure A-30.1. Flow Rates Measured at Inlet and Table A-3 Maximum Flow Rate Ponding Volume 3pm (cfs) [gal]	QIN QOUT	

30. Testing details and results from Run 30.

50	п	ping			90 120		et – Run 31.		g Removal Efficiency	M _{oUT} [%]	
Testing	Condition	No Overtopping	Outlet		6 09	Time [minutes]	Inlet and Outl		Mass Loading [Ib]	M _{IN} M ₆	
Slurry	Concentration C _{IN}	[mg/L] 2000			30 6	Time [n	Figure A-31.2. Turbidity Measured at Inlet and Outlet – Run 31.	Run 31.		Cour	
	Volume V _{IN}	[gal] 1500	4000] 3500]	3000 - 2500 - 2000 - 1500 - 500 -	+ 0		re A-31.2. Tur	rmance from	SSC (Avg.±SD) [mg/L]	C _{IN}	
ent	Ball Clay	[Ib] 12.5	40	[UT4] YibidiuT 8 2 2 2 5 6 2			Figur	ing SCD Perfo	(D)		
Sediment	Silica Sil-Co-Sil®49	[Ib] 12.5			0 120		Outlet – Run 31.	1.2. Results Describing SCD Performance from Run 31.	'urbidity (Avg.±SD) [NTU]		
	pacity	[gal]	Outlet	أرجر	06 0	iinutes]	t Inlet and Out	Table A-31.2.]	L	T _{IN}	
(<u>н</u>		- Inlet		0 60	Time [minutes]	es Measured at		Ponding Volume [gal]	V_{θ}	
SCD		[in.] ce 18			30		Figure A-31.1. Flow Rates Measured at Inlet and			Qour	
	Type	Silt Fence	100	Flow rate [gpm]			Figure A-		Maximum Flow Rate gpm (cfs)	QIN	

31. Testing details and results from Run 31.

			1									120		un 32.		Removal	Efficiency	[%]	
Testing	Condition		No Overtopping	Outlet								90	nutes]	nlet and Outlet – R		Mass Loading	[Ib]	N Mour	
Slurry	Concentration C _{IN}	[mg/L]	2000					1			• •	30 60	Time [minutes]	Figure A-32.2. Turbidity Measured at Inlet and Outlet – Run 32.	un 32.			Cout MIN	
SI	Volume V _{IN}	gal]	1500	4000 -	3500 -	3000 -	2500 -	2000 -	1500 - (****	500 -	0	0		ıre A-32.2. Turbi	ormance from Ru	SSC (Avg. ± SD)	[mg/L]	C _{IN}	
Sediment	Ball Clay 49	[q]	12.5	1	8			vility ⊿		1	T	120			Table A-32.2. Results Describing SCD Performance from Run 32.	.±SD)		Tour	
Se	y Silica Sil-Co-Sil®49	[dl]	12.5									06		l Outlet – Run 32.	2.2. Results Des	Turbidity (Avg.±SD)	[NTU]	T_{IN}	
	Design Capacity	[gal]		- Inlet Outlet							,	09	Time [minutes]	Figure A-32.1. Flow Rates Measured at Inlet and	Table A-3	Ponding Volume	[gal]	$\mathbf{V}_{\mathbf{\theta}}$	
SCD	Height H _{sch}	[in.]	n 24					,	f			30		Flow Rates Me				Qour	
	Type		Rock Check Dam	100]		- 8 [u	G ud3]	rate 5		20 -	• 0	0		Figure A-32.1.		Maximum Flow Rate	gpm (cfs)	Q _{IN} Q ₀	

32. Testing details and results from Run 32.

Ball Clay [lb] 12.5		Design Capacity Silica J Sil-Co-Sil [®] 49 [gal] [lb] 12.5
		[Ib] 12.5
		12.5
		- Outlet
	120	90 120
		Time [minutes]
	n 33.	Figure A-33.1. Flow Rates Measured at Inlet and Outlet – Run 33.
	Jescribing	Table A-33.2. Results Describing SCD Performance from Run 33.
-	vg.±SD	Turbidity (Avg. ± SD)
		[NTU]
	TOUT	T_{IN} T_{OUT}
	1406 ± 344	1538 ± 271 1406 ± 3

33. Testing details and results from Run 33.

	SCD		Sedi	Sediment		Slurry	Testing	
	Height Dea H _{SCD}	Design Capacity	Silica Sil-Co-Sil [®] 49	Ball Clay	Volume V _{IN}	Concentration C _{IN}	Condition	
	[in.]	[gal]	[Ib]	[Ib]	[gal]	[mg/L]		
Rock Check Dam	24		12.5	12.5	1500	2000	No Overtopping	1 1
	 Inlet	Outlet		40	4000		Outlet	
	J. A.			3500 Turbidity [FTU] 1000 500 500	3500 - 3000 - 2500 - 1500 - 1000 - 500 -			
	30	60	90 1	120	• •	30	06 09	120
	Time	Time [minutes]				Time [Time [minutes]	
-34.1. Flow l	Rates Measur	Figure A-34.1. Flow Rates Measured at Inlet and C	Outlet – Run 34.	Figur	e A-34.2. Tui	bidity Measured at	Figure A-34.2. Turbidity Measured at Inlet and Outlet – Run 34.	un 34.
		Table A-34	.2. Results Descr	Table A-34.2. Results Describing SCD Performance from Run 34.	rmance from	Run 34.		
Maximum Flow Rate	Ponding Volume	L	urbidity (Avg.±SD)	: SD)	SSC (Avg. ± SD)	ESD)	Mass Loading	Removal
gpm (cfs)	[gal]		[NTU]		[mg/L]		[Ib]	Efficiency
Qour	$\mathbf{V}_{\mathbf{\theta}}$		T _{IN} T	T _{our} (C _{IN}	Cour	M _{IN} M _{OUT}	[%]
48 (0.106)	81	163	1639 + 98 2238	2238 ± 102 1460	1460 + 386 2	2062 + 533 2	28 36 27 85	2

34. Testing details and results from Run 34.

APPENDIX B: DATA RECORDING TEMPLATE

Sediment Control Device:	_pg 1 of 5
remohing donth:	Time:
igure 0.1. Installation details (stak	

Sediment Control Device:	100	pg 2 01
Test to determine flow category:	Date:	Time:
Max. flow rate at outlet:		
Comments:		
Performance testing on SCD:	0004	
Run: 1	Date:	Time:
inflow start time:		12) 82
inflow end time:		
Outflow start time:		
Outflow end time:		
Comments:		
Run: 2 Inflow start time: Inflow end time: Dutflow start time: Dutflow end time: Comments:		Time:
Run: 3	Date:	Time:
nflow start time:		3 / <i></i>
inflow end time:		
Outflow start time:		
Outflow end time:		
Comments:		

							90		- Run 1.		Removal Efficiency	%
			Outlet				60	Time [minutes]	Figure 1.2 Turbidity measured at inlet and outlet - Run 1		Mass Loading Ib	Mour
	Testing	Condition	let				30	Tin	measured at		Mar	M _{IN}
	Ţ		-						Turbidity		± SD)	Cour
-Run I.	Surry	Concentration C _{IN} mg/L	4000	3500 3000 2500	Turbidity [500	o		Figure 1.2		SSC(Avg.±SD) mg/L	ى
condition		Volume Vr ggl									â	Е
and testing		Ball Clay Ibs					120		-Run I.	un I.	Turbidity (Avg. ± SD) NTU	Tour
er volume	Sediment						90		rd outlet-	mance - R	Turbidity	T _E
iment, wate		Silica Sil-Co-Sil ² 49 Ibs	Outlet				60	Time [mirutes]	ed at inlet a	CD perfor	olume	
Table 1.1 Details of SCD, sediment, water volume and testing condition – Run 1.		Design Capacity [gal.]	- Inlet				30	Time	Figure 1.1 Flow rates measured at inlet and outlet – Run 1.	Table 1.2 Results describing SCD performance – Run L.	Ponding Volume [gal.]	V.
1.1 Details	SC								1.1 Flows	1.2 Result	ow Rate	Qour
Table l		Haight Hand in.	101	i a tbw]	ij ətsi woli Ə	a	•		Figure	Table 1	Maximurn Flow Rate spin (cfs)	N ^N O

					120		Run 2.		Removal Efficiency	%
				7.58	96		and outlet		ading	Mour
ľ	ы	8	1	Outlet	. 09	Time [minutes]	isured at inlet		Mass Loading Ib	Mn
F	Testing	Condition		Inlet	30	=	bidity mes		â	Corr
- Run 2.	Slurry	Concentration C _N mg/L		4000	0		Figure 2.2 Turbidity measured at inlet and outlet - Run 2.		SSC (Avg. ± SD) mg/L	C.
condition-		Volume V _{IN} ggl.		Turbidity [FTU]					â	Ŀ
and te sting		Ball Clay Ibs			120		Run 2.	un 2.	Turbidity (Avg. ± SD) NTU	Tour
r volumes	Sediment	17			6		id outlet -	nance - R	Turbidity	Tw
nent, wate	2	Silica Bil-Co-Bil ² 49 Ibs		Outlet	60	Time [minutes]	l at inlet an	CD perfor		
Table 2.1 Details of SCD, sediment, water volume and testing condition – Run 2. con		Design Capacity [ggl.]		lulet	30	Time	Figure 2.1 Flow rates measured at inlet and outlet – Run 2.	Table 2.2 Results describing SCD performance – Run 2.	Ponding Volume [gal.]	Va
2.1 Detail	SCD						2.1 Flow	2.2 Result	ow Rate	Qourt
Table 2		Height H _{SRD} in.		Flow rate [gpm] 6 8 8 8 9 9			Figure.	Table 2	Maximum Flow Rate gggg (sf3)	On

			120	- Run 3.		Removal Efficiency	%
			06	and outlet		ading	Mour
ы	F	— Inlet Outlet	60	Time [minutes] easured at inlet		Mass Loading Ib	Mn
Testing	Condition	Inlet	30	Ti bidity mea		â	Cour
– Run 3. Slurty	Concentration C _{Di} mg/L	4000	• •	Figure 3.2 Turbidity measured at inlet and outlet - Run 3.		SSC (Avg. ± SD) mgL	C _N
condition-	Volume V _E i	Turbidity [FTU]	0			â	E
and testing	Ball Clay Ibs		120	-Run 3.	un 3.	Turbidity (Avg. ± SD) NTU	Tour
er volume: Sediment			- 06	nd outlet –	nance - R	Turbidity 1	T _{IN}
iment, wate	Stitca Stit-Co-Stit [#] 49 Ibs	Outlet	60	e [minutes] red at inlet ar	SCD perform	Volumo []	
Table 3.1 Details of SCD, sediment, water volume and testing condition – Run 3. ScD Sediment	Design Capacity [g9].]	- Inlet	30	Time [minutes] Figure 3.1 Flow rates measured at inlet and outlet – Run 3.	Table 3.2 Results describing SCD performance – Run 3.	Pending Vol [234.]	Va
3.1 Details SCD		3.62) 		3.1 Flow	3.2 Result	ow Rate	Qour
Table	Hetght H _{spb} in.	Flow rate (gtm) 20 5 6 8 9		Figure	Table 3	Maximum Flow Rate \$233. (SES)	SPN 1