NJCAT TECHNOLOGY VERIFICATION

V2B1® Stormwater Treatment System
Environment 21, LLC

March, 2009

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1. Introduction

1.1 New Jersey Corporation for Advanced Technology (NJCAT) Program

NJCAT is a not-for-profit corporation to promote in New Jersey the retention and growth of technology-based businesses in emerging fields such as environmental and energy technologies. NJCAT provides innovators with the regulatory, commercial, technological and financial assistance required to bring their ideas to market successfully. Specifically, NJCAT functions to:

- Advance policy strategies and regulatory mechanisms to promote technology commercialization;
- Identify, evaluate, and recommend specific technologies for which the regulatory and commercialization process should be facilitated;
- Facilitate funding and commercial relationships/alliances to bring new technologies to market and new business to the state; and
- Assist in the identification of markets and applications for commercialized technologies.

The technology verification program specifically encourages collaboration between vendors and users of technology. Through this program, teams of academic and business professionals are formed to implement a comprehensive evaluation of vendor specific performance claims. Thus, suppliers have the competitive edge of an independent third party confirmation of claims.

Pursuant to N.J.S.A. 13:1D-134 et seq. (Energy and Environmental Technology Verification Program) the New Jersey Department of Environmental Protection (NJDEP) and NJCAT have established a Performance Partnership Agreement (PPA) whereby NJCAT performs the technology verification review and NJDEP certifies the net beneficial environmental effect of the technology. In addition, NJDEP/NJCAT work in conjunction to develop expedited or more efficient timeframes for review and decision-making of permits or approvals associated with the verified/certified technology.

The PPA also requires that:

- The NJDEP shall enter into reciprocal environmental technology agreements concerning evaluation and verification protocols with the United States Environmental Protection Agency, other local required or national environmental agencies, entities or groups in other states and New Jersey for the purpose of encouraging and permitting the reciprocal acceptance of technology data and information concerning the evaluation and verification of energy and environmental technologies; and

- The NJDEP shall work closely with the State Treasurer to include in State bid specifications, as deemed appropriate by the State Treasurer, any technology verified under the Energy and Environment Technology Verification Program.

1.2 Technology Verification Report

On March 17, 2008, Environment 21, LLC (8713 Read Road, East Pembroke, NY 14056-0055) submitted a formal request for participation in the NJCAT Technology Verification Program. The technology proposed – The V2B1® Stormwater Treatment System – is a centrifuge hydrodynamic separator designed to remove suspended solids, floatables and hydrocarbons from stormwater, as well as sediment associated constituents, e.g. nitrogen, phosphorus.

The request (after pre-screening by NJCAT staff personnel in accordance with the technology assessment guidelines) was accepted into the verification program. This verification report covers the evaluation based upon the performance claim of the vendor, Environment 21 (see Section 4). The verification report differs from typical NJCAT verification reports in that final verification of the Environment 21 V2B1® Stormwater Treatment System (and subsequent NJDEP certification of the technology) awaits completed field testing that meets the full requirements of the Technology Acceptance and Reciprocity Partnership (TARP) – Stormwater Best Management Practice Tier II Protocol for Interstate Reciprocity for stormwater treatment technology. This verification report is intended to evaluate the Environment 21 V2B1® performance claim for the technology based on carefully conducted laboratory studies. The performance claim is expected to be modified and expanded following completion of the TARP required field-testing.

This verification project primarily involved the evaluation of a laboratory test report to verify that the V2B1® Stormwater Treatment System satisfies the performance claim made by Environment 21, LLC.

1.3 Technology Description

1.3.1 Technology Status: general description including elements of innovation/uniqueness/ competitive advantage.

In 1990, Congress established deadlines and priorities for EPA to require permits for discharges of stormwater that is not mixed or contaminated with household or industrial wastewater. Phase I regulations established that a NPDES (National Pollutant Discharge Elimination System) permit is required for stormwater discharge from municipalities with a separate storm sewer system that serves a population greater than 100,000 and certain defined industrial activities.

To receive a NPDES permit, the municipality or specific industry has to develop a stormwater management plan and identify Best Management Practices for stormwater treatment and discharge. Best Management Practices (BMPs) are measures, systems, processes or controls that reduce pollutants at the source to prevent the pollution of stormwater runoff discharge from the site. Phase II stormwater discharges include discharges from classes of smaller municipalities than those specifically classified as Phase I discharge.

The nature of pollutants in stormwater emanating from differing land uses is diverse. The Environment 21 V2B1® Stormwater Treatment System is designed to trap these pollutants within its confines until they are properly removed via regular maintenance. Due to the shallow sump of the V2B1®, maintenance can be performed from above with a standard vacuum truck (13' of lift) without personnel entry into the system. Additionally there are no internal parts that require removal and no horizontal obstructions that impede the maintenance.

The V2B1® technology is a centrifuge hydrodynamic separator and is comprised of two precast concrete chambers. The site stormwater runoff enters through a tangentially mounted inlet pipe in the first chamber, inducing a centrifuge action. In combination with the centrifuge action, the defined flow path allows for an extended settling time of the Total Suspended Solids (TSS). This causes most of the TSS to be trapped in the first chamber. Unique to the V2B1®, the discharge of the first chamber is in the center of the chamber maximizing the impact of the centrifuge. The discharge is at the design elevation and acts as a weir/orifice directing flow to the second chamber. The second chamber is comprised of two compartments. The first compartment captures additional TSS, floatable debris and hydrocarbons. The second compartment captures additional TSS and directs the outflow.

The V2B1® site specific design is based on requirements established by the local regulatory agency, the site project engineering requirements, and the V2B1® design program. The technology employed in the design allows for a small footprint for the V2B1® requiring minimal excavation and increased land usage.

1.3.2 Specific Applicability

The V2B1® has been designed to be installed on a wide range of sites and applications where control of TSS is necessary based on regulatory requirements. In addition the V2B1® is an effective enhancement to products such as filter cartridge systems and functions as a pretreatment in these applications, thereby increasing the life of the filter system.

These applications include:

- Parking lots for any facility (commercial or industrial)
- Residential areas
- Transportation-roadways, bridges, and transit facilities
- New development or re-development applications
- Construction sites
- Vehicle maintenance wash-down yards
- Wetlands protection
- Retrofit to existing sites
- Airport taxi-ways and runways
- Gas and service stations

1.3.3 Range of Contaminant Characteristics

The V2B1® has been shown to capture a wide range of sediment particle sizes, floatable debris and hydrocarbons. In addition, phosphorus and other pollutants in stormwater that adhere to the sediment will be captured in the system.

1.3.4 Range of Site Characteristics

The V2B1® system can be designed to treat a variety of flow rates. Depending on the project requirements the system can be designed online with or without an internal bypass to treat up to and including the design flow or with the internal bypass to handle the treatment or water quality flow rate. Should the project require, the V2B1® can be designed offline utilizing a bypass structure so that only the treatment flow rate is directed to the system allowing the design flow to bypass the system. Because of the unique design of the V2B1® it can be configured to accommodate pipe connections and junctions from a multitude of angles or more than one inlet or outlet pipe.

If there is a demand for increased treatment to remove a higher percentage of pollutants a filter system may be required after the V2B1®. The V2B1® can work virtually with any filter system.

Depending on the desired treatment flow rate a standard model can be selected from Table 1 below. Should a larger system be required due to higher treatment flows or site sizes the V2B1® can be sized to accommodate cast-in place application or can utilize two or more systems in parallel utilizing a junction structure to direct specific flows to each system.

In site applications where an exceptional amount of hydrocarbons is expected the V2B1® can function as a pretreatment unit to a high efficiency oil water separator such as a coalescing system. In this application the V2B1® would decrease gross and fine pollutants that could potentially plug the coalescing plates. The oil/water separator would be sized to the V2B1® to ensure that flow turbulence was within the oil/separator manufacturer's specifications. This configuration of the V2B1® has, according to the vendor, been successfully used in Europe. In addition the V2B1® contains storage for hydrocarbons thereby decreasing the maintenance interval in the oil/water separator.

There are 23 standard model sizes available in Precast or Cast-In Place. Non-Standard sizes can be designed specifically for a project. Table 1 indicates the standard model sizes and treatment rates based on removal of the NJDEP specified sediment particle size distribution.

Table 1 V2B1 Treatment Rates (Based on NJDEP PSD)

V2B1® Model Number[a]	M1 Diameter (ft)	M2 Diameter (ft)	Minimum Depth Below Invert (ft)	Treatment Rate (cfs)	Maximum Inlet Pipe Diameter (in)
2	4	4	3.5	0.51	12
3	4	5	3.5	0.66	16
4[b]	5	5	5.5	0.80	21
6	6	5	4.5	0.98	24
7	6	6	4.5	1.15	24
8	7	6	4.5	1.36	30
9	7	5	4.5	1.18	30
10	8	5	4.5	1.42	36
11	8	6	4.5	1.60	36
12	8	7	4.5	1.81	36
13	8	8	5.0	2.05	36
14	10	5	5.0	2.00	42
15	10	6	5.0	2.18	42
16	10	7	5.0	2.38	42
17	10	8	5.0	2.62	42
18	10	10	5.5	3.20	42
19	12	5	5.0	2.70	48
20	12	6	5.0	2.88	48
21	12	7	5.5	3.09	48
22	12	10	5.5	3.90	48
25	12	8	5.5	3.33	48
50	16	10	6.0	5.70	72
60	20	10	6.0	8.00	80

Note: [a] Above models are based on standard precast product availability. System design allows for flows higher than the treatment rate to be bypassed. Custom designs may be provided for cast-in–place applications or alternative precast sizes. [b] V2B1 model tested.

1.3.5 Material Overview, Handling and Safety

V2B1® access for inspection and maintenance is achieved via a minimum of one 30”diameter access cover in each chamber; however standard practice is to provide two 24”diameter access covers in each chamber. This feature combined with the use of vertical inserts provides access to the floor in all areas of the chambers without the need for confined space entry

Material disposal can typically be handled at local landfills for the solid sediment removed and wastewater facilities for all liquids removed from the V2B1®. With increased environmental regulations, local laws and regulations may contain more stringent guidelines, which vary from state to state, so it is recommended that the service company first check with local and state authorities prior to disposal of all pollutants removed from the V2B1®.

Material handling for the V2B1® is accomplished under standard construction practices with no handling of hazardous material. The V2B1® requires no insert installation in the field and the majority of the components can be handled and installed with standard construction site equipment.

1.4 Project Description

This verification project primarily involved the evaluation of a laboratory test report to verify that the Environment 21 V2B1® Stormwater Treatment System satisfies the performance claim made by Environment 21, LLC.

1.5 Key Contacts

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2. Evaluation of the Applicant

2.1 Corporate History

Environment 21, LLC was incorporated in 1999 by Michael Kistner, Board of Director for Kistner Concrete Products, a New York State based Precast manufacturer. Mr. Kistner saw a need for a more cost effective and efficient stormwater treatment solution that was easier to produce to meet his client's needs and demands. Mr. Kistner worked in conjunction with Paul J. Rowe, P.E. to develop a system that would provide maximum treatment using components that were standard across the precast industry. The goal of the design was to provide a solution that would gain maximum removal efficiency while providing ease of access to captured pollutants. This was accomplished by providing all vertical inserts, thereby reducing any obstruction for visual inspection. The unique design also allowed for reduced re-suspension of captured material by utilizing a high flow bypass as provided for by the V2B1® Stormwater Treatment System. Mr. Kistner installed the first V2B1® Stormwater Treatment System in January 2000. Environment 21, LLC has continued over the years to enhance the V2B1® design by continuous testing of the V2B1®, and monitoring of various field applications. Since then Environment 21, LLC has developed an extensive product line to handle a variety of stormwater applications and holds the patents associated with these products.

2.2 Organization and Management

Environment 21, LLC is headquartered in East Pembroke, New York and works with various distributors throughout the United States, Canada, Eastern Europe, and Southern Pacific countries. Environment 21, LLC distributors and manufacturers are held to the highest standards, requiring them to be NPCA certified and preferably State DOT approved. Environment 21 principal management is comprised of: Jeffrey Benty, Director of Sales & Marketing - Jeff has over 5 years experience in Stormwater Treatment and over 15 years in the construction industry and Paul J. Rowe, P.E., Director of Engineering - Paul has over 12 years in the stormwater industry and 25 years experience in engineering and product development.

Environment 21, LLC Board of Directors has over 25 years experience in business management and the construction industry and is well equipped with the background and resources to handle the demand of the stormwater industry.

2.3 Operating Experience with the Proposed Technology

The V2B1® has been installed in over one thousand locations around the world.

2.4 Patents

The V2B1® stormwater treatment system is protected under U.S. Patent #6,120,684 in addition to several other international pending patents.

2.5 Technical Resources, Staff and Capital Equipment

Environment 21, LLC has their corporate headquarters and technical support facilities located in East Pembroke, New York. The staff of engineers consists of a multitude of disciplines including civil engineering, hydraulic engineering, and construction management. All system designs are completed at Environment 21's corporate headquarters ensuring that the systems are properly sized and designed to meet project goals.

A core part of the system design and value added by Environment 21 upon receipt of project requirements and site hydraulics includes site specific system drawings, site layout, backwater analysis, and estimated maintenance interval. After receipt of an order, systems can be delivered to the project site in as little as 1-2 weeks dependent on the model size and site restrictions. The manufacturing and delivery of all internal components are completed by locally approved precast manufacturers familiar with Environment 21 products, ensuring the highest quality standards and that the product has been manufactured to Environment 21 design standards.

Installation of the V2B1® Stormwater Treatment System is handled by the contractor in most cases and installs to the same standards and guidelines for standard stormwater manholes. Environment 21 continues to test in-house in their state-of-the-art laboratory; additionally, Environment 21 works with established Third Party reputable stormwater testing institutes.

3. Treatment System Description

The V2B1® M1 chamber is comprised of a round structure with a sump ranging from 3.5 feet to 7.5 feet to allow for collection of sediment (additional storage depth can be added as required by the project). It is designed with a tangential inlet directing the inlet flow into a circular centrifuge flow pattern. The circular flow pattern allows additional time for sediment to settle out while the water and floatable debris travels out of the M1 structure via the Coriolis Pipe located in the center of the structure. The crest of the top of the Coriolis Pipe is determined by Environment 21 staff based on the site hydraulics (Figure 1 and Appendix A).

The V2B1® M2 chamber is comprised of a rectangular or round structure with a sump depth equivalent to the sump depth of the M1 chamber. Flow enters the M2 chamber via the Coriolis Pipe or the secondary/bypass pipe. Contained within the M2 chamber is a baffle wall made of concrete or other rigid material. Two specially designed and configured triangular shaped openings, with the widest point to the outside, are located in the baffle wall below the Water Surface Elevation (WSE) control and direct the flow through the wall prior to discharge from the system. The baffle wall is designed to contain all floatable debris and hydrocarbons that enter the system. Additional TSS removal is achieved in the M2 chamber due to its quiescent flow.

The secondary or bypass pipe is located between the M1 and M2 chambers; it passes through the baffle wall located in the M2 chamber. The elevation of the secondary pipe is set at the WSE where flows greater than the treatment flow rate are desired to bypass. By passing through the baffle wall it also bypasses the floatables storage area thereby allowing the system to retain the floatables previously retained.

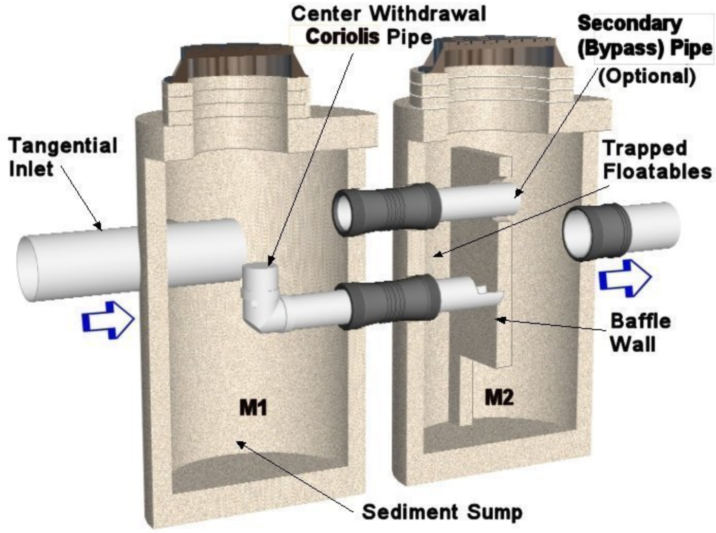


Figure 1 V2B1® Stormwater Treatment System

Operation

The cycle of operation of the V2B1® is described as follows:

M1 Chamber: Flow enters the V2B1® via a tangential inlet causing the flow to move in a circular flow pattern creating a vortex. As the flow travels in a circular pattern, increased residence time allows the TSS additional time to settle out, while floatables travel to the center of the M1 chamber and flow into the Coriolis Pipe passing to the M2 chamber. During storm events greater than the treatment flow rate, the WSE rises in the M2 chamber until it is at the same elevation as the secondary (bypass) pipe. At this point the excess flow leaves the M1 chamber untreated and passes through the M2 chamber to the outlet pipe from the M2 chamber.

M2 Chamber: Flow enters the M2 chamber via the Coriolis Pipe carrying with it floatable debris and hydrocarbons. The flow, along with the floatables, exits the Coriolis Pipe via a coped out end of the pipe directing the floatables to the water surface. This redirection of the flow also diminishes any potential re-suspension of collected sediment and pollutants in the bottom of the M2 chamber. The quiescent flow found in the M2 chamber then passes through the triangular shaped flow openings located in the baffle wall below the WSE leaving the floatables trapped on the upstream side of the baffle wall. The flow then exits the downstream side of the baffle wall via a standard outlet pipe.

System Configuration

The V2B1® Stormwater Treatment System is available in three configurations: (1) 2 Precast Manhole Configuration, (2) M1-Precast Manhole and M2- Precast Vault and (3) Cast in Place Configuration. Due to the unique design of the V2B1® and the utilization of standard products the system can be designed to use standard precast products or in cases where standard precast is not available in the market area the system can be cast in place. The V2B1® can be sized to treat any size flow because of these options. Standard Model Sizes and associated flow rates are shown in Table 1.

System Sizes: The V2B1® can be sized for almost any flow rate; however based on the market availability of standard precast structures Environment 21 has compiled a list of standard models utilizing standard precast structures available anywhere in the country. Should there be a demand for systems with structures larger than standard available precast structures, Environment 21 can provide a system design incorporating segmental precast or cast in place options.

4. Technical Performance Claim

Claim – The V2B1® Model 4 Stormwater Treatment System, at a treatment flow rate of 0.8 cfs (358 gpm, 9.13 gpm/ft^2), has been shown by mass balance testing to have a 63.8% total suspended solids (TSS) removal efficiency (as per the NJDEP methodology for calculation of treatment efficiency) using NJDEP specified material with an average d_{50} particle size of 60 microns, influent concentrations of 100-320 mg/L and 50% initial sediment loading in laboratory studies using simulated stormwater.

5. Treatment System Performance

In 2007, Environment 21, LLC requested a third party performance evaluation of the V2B1 hydrodynamic separator in a laboratory setting. A standard V2B1 Model 4 was cast from Fiberglass for ease of laboratory installation purposes and transported to the University of Minnesota, St. Anthony Falls Laboratory (SAFL), Minneapolis, Minnesota. The scope of the laboratory testing was to determine the maximum hydraulic rate (MHR), to assess the performance of the device according to the NJDEP requirements, to determine effluent concentrations under high flow conditions, and to determine the general performance of the system.

5.1 Laboratory Studies

The V2B1 Model 4 hydrodynamic separator was tested as an in-line storm water treatment system for the removal of solids and floatables. The system is comprised of two in-line manholes, M1 and M2, connected by a pipe with a 90-degree elbow at its upstream end (Figure 2). The second manhole is divided into two compartments by a baffle wall, with the first compartment for removal of floatables. A bypass pipe has also been provided which connects M1 to the second compartment of M2. The bypass pipe allows a portion of inflowing water to travel directly to the outflow pipe as discharge exceeds the design flow.

As water enters M2 through the elbow pipe, it hits the baffle wall. All of the water under the design rate must travel through the two orifices in the baffle wall before it leaves through the outflow pipe (Figure 3). The two triangular shaped orifices are located approximately 12 inches above the floor of the manhole. The baffle wall is intended to trap floatable material in the upstream chamber of M2 and allow it to be removed during the scheduled cleanout of the device.

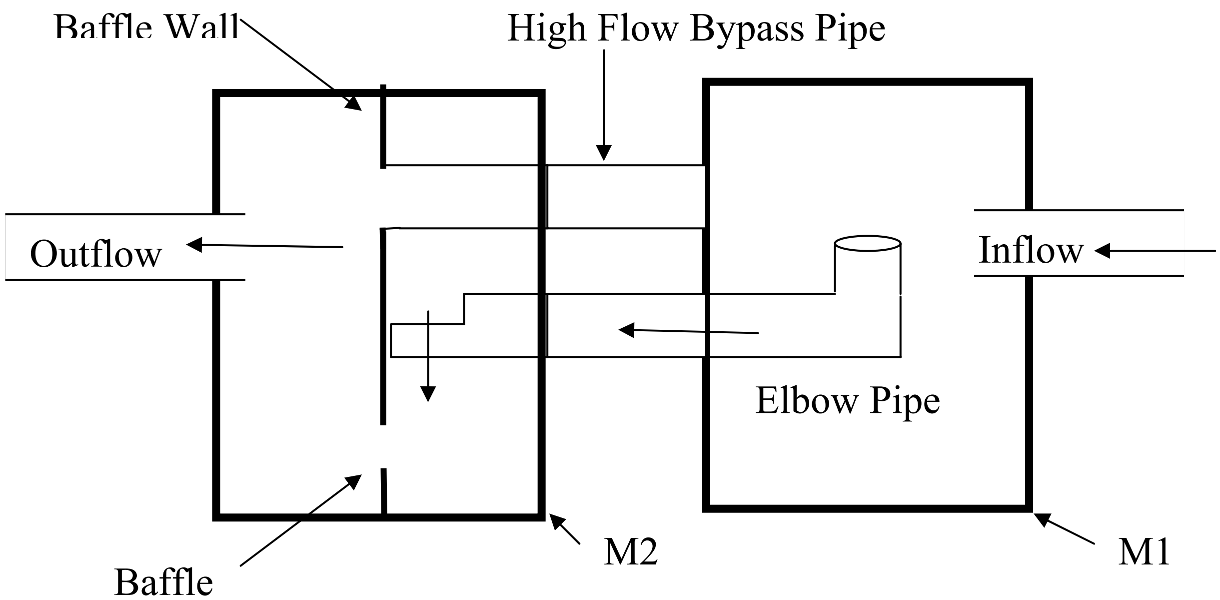


Figure 2 Schematic of V2B1 tested at SAFL

The inflow pipe is mounted tangentially in M1. This creates a swirl flow in M1 as water enters the manhole. Suspended sediment removal primarily occurs within the M1 manhole; however, some sediment removal also occurs in M2.

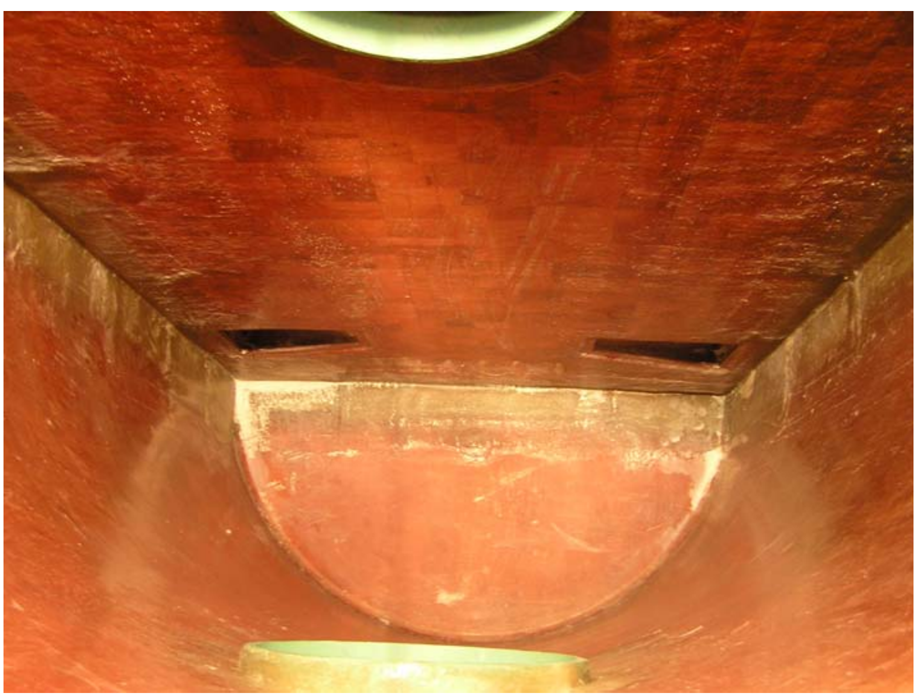


Figure 3 View of the baffle wall from the second compartment of the M2 manhole.

5.1.3 Testing System Description

The test stand was set up on the lowest floor of SAFL. Mississippi River water for the experiment was supplied through a single 12-inch diameter pipe with approximately 45 feet of head which was then expanded into a 20 foot long 15-inch corrugated HDPE pipe. According to the samples taken from the influent pipe, the background concentration varies between 10 to 30 mg/l with mostly organic materials, which cannot be removed by hydrodynamic separators. Nevertheless, a few quasi-mass balance tests were conducted to determine the background concentration. The 20 foot long inflow pipe was set to a slope of 2%. The flow rate for the experiments was controlled using a gate valve on the 12-inch section of the supply pipe.

Total discharge was measured using a pre-calibrated circular weir and submerged pressure transducer probe located at the end of the outflow pipe. The probe was connected to an ISCO 4120 data logger to record the data. A desktop computer was connected to the ISCO 4120 data logger to download the data and read real time flow measurements from the submerged probe.

Two sediment feeders were used to control sediment supply rates and concentrations. The sediment feeders were located on the inflow pipe upstream of the M1 manhole. Clay particles were fed separately to avoid any coagulation of particles before entering the influent pipe. The feeders were calibrated before testing to meet the target concentrations. However, the average influent concentrations were determined by weighing all the sediments fed into the feeders prior to each test, timing of the feeding period, and the measured flow rate.

A set of manometers was connected to the pressure taps mounted on the walls of the manholes and pipes to keep track of hydraulic conditions of the entire system. The pressure taps gave water surface elevations in M1, both compartments of M2, in the influent pipe one foot upstream of the entrance, in the effluent pipe one foot downstream of the exit, and in the bypass pipe.

5.1.2 Load Cells

To conduct a quasi-mass balance assessment of the system, it was decided, while the sumps are preloaded, to use load cells to keep track of the changes in the weight of the manholes. Total mass of the system was taken using six Tovey Engineering Model FR10-5K load cells. The load cells have a range of 0 – 5000 pounds with a static error band of +/- 0.04% of the rated output, resulting in an accuracy of ±2 lbs. The load cells were calibrated at Tovey Engineering before shipping to SAFL. Each manhole was weighed separately on three load cells. A steel triangular platform was constructed and sheeted with a wooden platform to support the weight of each manhole solely on the load cells. This method was used to ensure an equal weight on each load cell. Each load cell was centered on a plate between three leveling bolts to ensure loading along the axis of the load cell (Figure 4).

To eliminate shear loading at the loading points, two of the three load cells under each tank were mounted on a plate that rode on a ball bearing transfer plate. The ball bearings were loosely constrained to allow small movements due to loading and temperature changes (Figure 5). Data acquisition was conducted using a PC running LabView and a Measurement Computing

Corporation PCI-DAS6052 A/D card. The A/D card used for testing was a 16 bit, 8 differential channel board.

Figure 4 Support system of the M2 manhole

Figure 5 Load cell mounted on a transfer plate

Load cell signals were amplified by six Interface Model SGA Strain Gauge Transducer Amplifiers set to a gain of 2.00 mV/V. This resulted in full scale output of the load cells. Load cell excitation was measured at each load cell using the voltage sense wires of that load cell. To provide the same excitation voltage to each load cell, an independent linear power supply was used to power all of the load cells. This also allowed the excitation voltage to be set to a value within range of the acquisition board. Since accuracy was more important than speed, readings from each load cell signal and the excitation were taken individually to eliminate errors associated with acquisition board settling time between measurements.

5.1.3 Water Surface Elevation Measurements

In a five foot diameter tank, at 68 ^{o}F water temperature, ±0.001 ft error in water level results in ±1.22 lbs error in measuring the weight of the tank. So, for maximum accuracy the water surface elevation difference before and after each test was measured and the weight readings corrected based on the differences.

To accurately measure water surface elevations, initially sonar transducers were employed; however, the sonar transducers were sensitive to humidity and were not repeatable within the above limits. To accurately measure the water surface elevation, Lory type-C point gages in stilling wells were mounted at each tank. These point gages have a precision of 0.001 ft and it was observed that at least four people using the same technique read a water surface elevation with a repeatability of ±0.001 ft. The draining systems were not connected to any other piping therefore they did not adversely affect the weight readings.

5.1.4 Adjusting and Verifying Load Cell System Accuracy

Since using load cells can result in a number of electronic and mechanical problems, during the initial setup of the Load Cell system some adjustments were made as described below.

One of the electronic adjustments made was to establish proper grounding of the excitation voltage in order to minimize the noises picked up by the sensitive load cells. Also, in order to achieve the required accuracy, the samples (measurements) taken from the acquisition board were properly spaced to minimize any settling times within the board. Multiple readings were taken every 20 seconds. The sampling frequency was 10,000 Hz and averaged over one second to reduce any noise.

To improve the repeatability of the system, film rubber which transmits little tension and no compression was used for the connections. Additionally the manholes were disconnected during weighing (i.e., external pipe connections were removed) and the load cells were carefully examined for any eccentric loading. Internal piping between the two manholes was left connected to prevent any sediment loss.

Around the clock measurements were taken during the final testing phase of the system to monitor any drift or step changes in the data that would affect the test runs. The repeatability of the system was checked by incrementally adding 20 lb weights to each manhole and then weighing each manhole. The final results of the repeatability tests on M1 are shown in Figure 6.

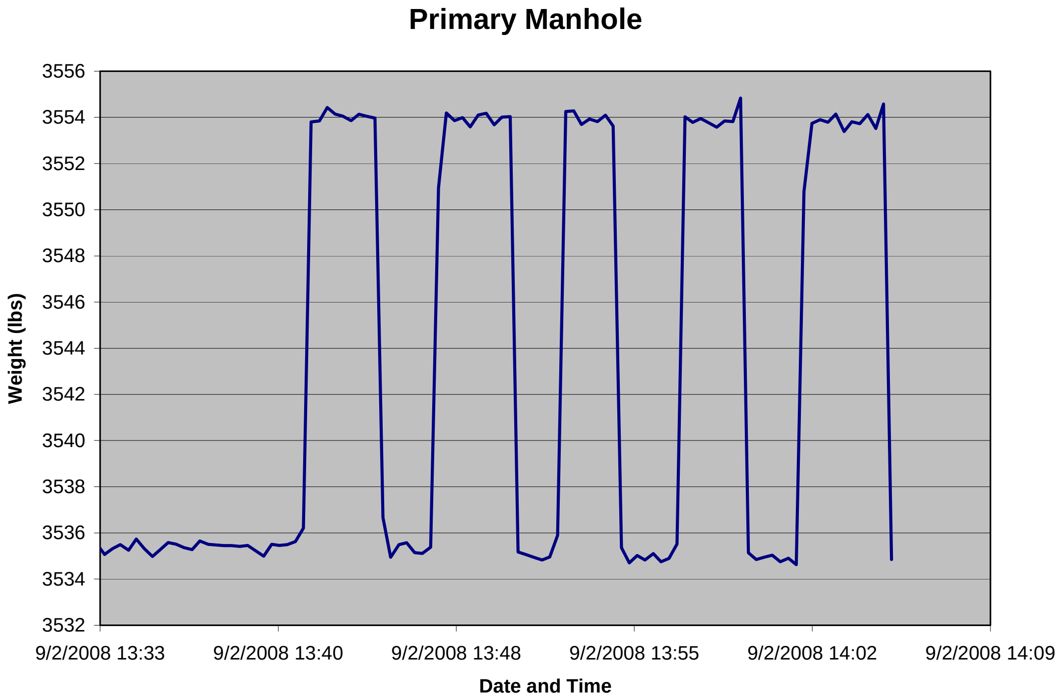


Figure 6 Results of the repeatability tests conducted on the load cells of the primary manhole (M1) by adding and removing 20 lb weights

Because the chambers were connected to each other, the removal efficiencies were based on the total mass change of the two manholes. This eliminates any concern of load transfer from one manhole to the other, or any creep variance associated with the connection, as shown in Figure 7. The net system load measurement accuracy of the two chambers was approximately ±3 lbs.

5.1.5 Performance Tests

To meet the NJDEP requirements for determining the TSS removal efficiency of V2B1 Model 4, it was required to conduct a total of 15 tests, 3 tests each at 125%, 100%, 75%, 50% and 25% of the design flow rate (a.k.a. as the maximum treatment rate) and using three influent concentrations of 100, 200 and 300 mg/l at each flow rate. The design flow rate of the V2B1 Model 4 was set at 0.8 cfs; the bypass was set at 1.14 cfs. Therefore, the tests were conducted at 1, 0.8, 0.6, 0.4 and 0.2 cfs respectively. NJDEP recommends a specific particle size distribution (PSD) with a specific gravity of 2.65. In addition, one of the requirements of the NJDEP laboratory testing protocol is to preload the sump with the recommended materials at 50% of the sump capacity. In the following sections, the PSD used for the tests, the specific gravity of the materials and the testing protocol are presented.

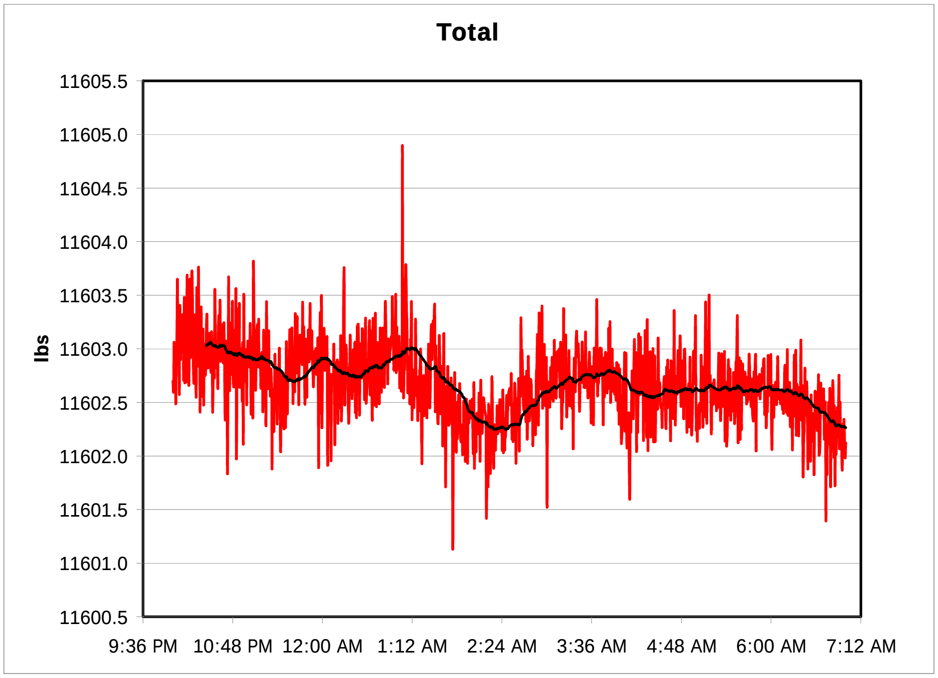


Figure 7 Overnight monitoring of the entire system weight in a static state. The dark line is the moving average of the data showing the drift in all load cells combined.

5.1.6 Particle Size Distribution (PSD)

The sediment mixture recommended by the NJDEP is shown in Table 2. In order to prepare a mix similar to the mixture in Table 2, sediments with five different gradations were mixed Table 3). For very fine materials, it was decide to use kaolin (clay particles), which was 38% of the total mix. To check the mix, three samples were taken from the mix. However, since adding the clay particles to the mix would coagulate the samples and provide unrealistic particle size distribution of the mix, it was decided not to add the kaolin. The samples were sieved, dried and weighed to determine their size distributions.

Figure 8 shows the NJDEP target distribution, the theoretical mix, and the three analyzed samples. The theoretical mix in Figure 8 includes the clay particles which were added numerically. The d_{50} of the tested PSD was about 60 microns. These results show that the designed and tested mix had a PSD equivalent to the NJDEP target PSD.

In addition, in order to determine the particle specific gravity (SG) of the mix, and the bulk specific gravity of the mix, a total of nine samples were collected from which two samples were used for measuring the SG of the mix with no clay, two samples for the SG of the clay particles, and five samples for the bulk SG of the mix. The ASTM D 854 standard test was used to determine the SG of the particles. The particle SG of the mix without the clay particles was measured to be 2.49, and the SG of the kaolin was measured to be 2.59. The bulk SG of the total mix was measured to be 1.60 with a standard deviation of 0.01.

Table 2 NJDEP Recommended Mixture

Particle Size (microns)	Sandy loam (percent by mass)
500-1000 (coarse sand)	5.0
250-500 (medium sand)	5.0
100-250 (fine sand)	30.0
50-100 (very fine sand)	15.0
2-50 (silt)	(8-50 um, 25%) (2-8 um, 15%)
1-2 (clay)	5.0

Table 3 Five Sediment Fractions

Portions of Proposed Mix	**0.02**	**0.04**	**0.34**	**0.22**	**0.38**	**Proposed Percent Finer**
Particle Size (microns)	**AGSCO 20-40**	**AGSCO 35 - 50**	**F - 95**	**SCS106**	**Kaolin**	
850	100	100	100	100	100	100
500	26	79	100	100	100	98
250	0	1	96	100	100	92
106		0	20	99	100	66
45			0	12	100	40
8				0	50	19

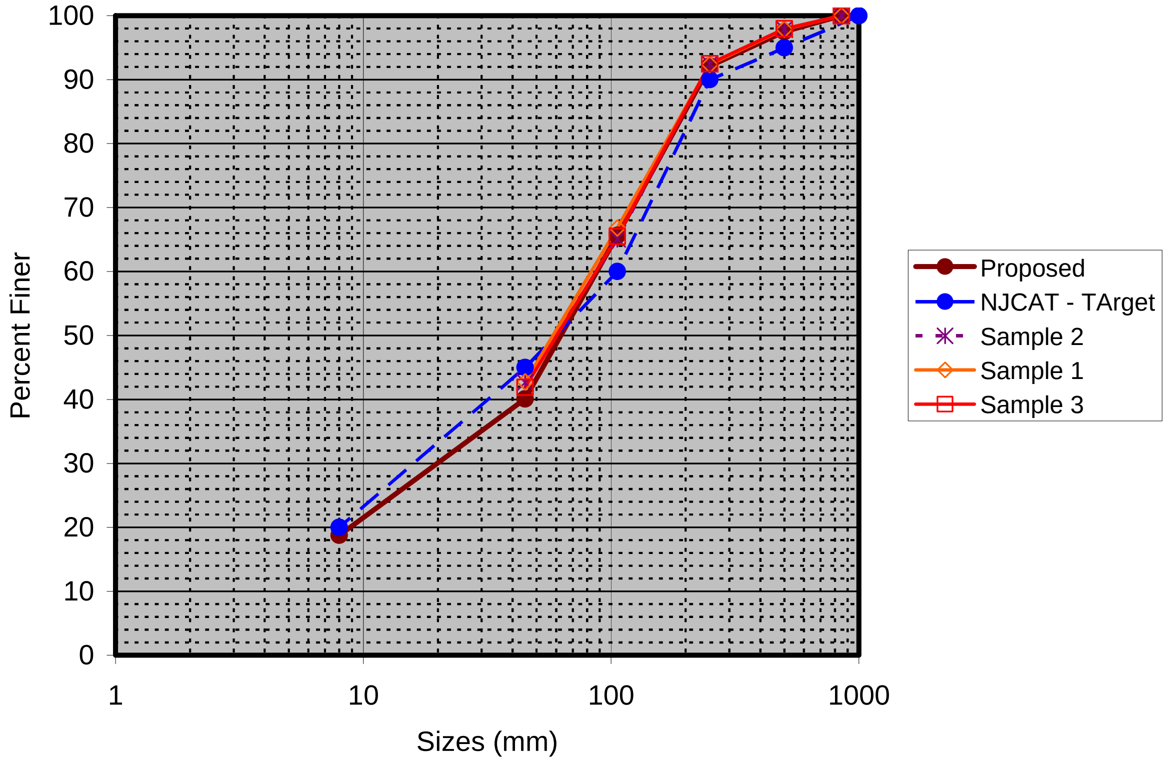


Figure 8 The target particle size distribution (PSD), the proposed (theoretical) PSD, and the PSD of three samples from the mix.

5.2 Test Procedures

5.2.1 Influent Concentration

The influent sediment concentration was controlled by the feed rate of a Schenke Accurate and a Tecweigh sediment feeder. Since kaolin (clay particles) could easily coagulate under very low moisture conditions and artificially increase the removal efficiency of the unit, it was decided to feed kaolin separately into the system. The solids were fed into the system at the downstream end of the 15-inch PVC pipe attached into the manhole supplied by the fiberglass manufacturer. Water was fed by a hose with the influent sediment to create a slurry mixture through a funnel into the inflow pipe. The feed rate of the feeder was determined beforehand by the following formula,

$$f = \frac{28.32QC}{1000}$$

where f is the feed rate in grams per second, Q is the target flow rate in cfs, C is the desired concentration in milligrams per liter and 28.32 is a conversion factor.

The speed of the feeder was set to match the desired feed rate by weighing a sample of the desired sediment metered out over a recorded period of time. To verify the average feed rate, before an experiment started, a known mass of sediment was weighed and placed in the hopper of the feeder. Then any sediment remaining in the hopper after the feeder was turned off was weighed. The difference between the two masses gave the total mass that was fed into the system. The period that the feeder operated was also recorded. The ratio of the mass to the recorded period gives the average feed rate, *f*. Rearranging the above equation, results in the following equation which determines the average influent concentration.

$$C = \frac{1000 f}{28.32 Q}$$

5.2.2 Sediment Removal

The mass balance testing procedure was developed after a series of conference calls with NJCAT. The testing procedure was based on a preloaded sump. It was decided to preload the sump by feeding sediment while there was a flow through the sump. Below is the description of the step by step testing procedure.

- The background concentration was determined by flowing Mississippi water through the device at 0.1 cfs for a period of one hour. The particles removed from the sumps were collected using a shop vac, dried and weighed. This test was repeated four times. The average weight of the materials was less than 0.037 lbs (17 grams). The background concentration impacting the results of the tests was calculated to vary from 1.1 to 1.7 mg/l.[1]

- About 1000 lbs of the test sediment was prepared and mixed using a mixer. The clay particles were fed separately to avoid coagulation among particles.

- The valve was opened and the manholes were filled with water until some discharge was observed through the effluent pipe. Then the valve was closed and the system was drained to a target elevation (about 3 ft above the sump floor). The weight of each manhole was recorded using the load cells. Water levels in the manholes were different.

- The system was then fed at a concentration of about 3 g/l of the proposed gradation for a period of about 4 hours. The goal was to feed the system until the weight of the system increased by about 490 lbs, which is equivalent to 50% sediment capacity. The loading cycle was 70 minutes at 25% of the design rate (MTR), 42 minutes at 50% MTR, 33 minutes at 75% MTR, 28 minutes at 100% MTR, and 24 minutes at 125% MTR. Since the previous tests had shown that below 125% and 100% MTR, less than 1% of clay materials can be removed by the device, the clay materials were not fed under those two flow conditions. The final weight of the system was recorded by the load cells to increase

[1] Originally, it was intended to use the load cells to measure the background concentration. However, the background concentration of inorganic materials was too small to be detected by the load cells. Therefore, the background concentration was measured as explained above.

by 464 lbs (Table 4). However, this increase in the weight was not equivalent to the weight of the sediment, because a volume of water equal to the volume of sediments was removed from the device (Archimedes Principle). Assuming a SG of 2.49 for the sediments, during the preloading 775 lbs of sediment were captured by the device to an average thickness of 4.7" covering the entire bottom.

- A total of 15 tests were conducted under five flow conditions at 125%, 100%, 75%, 50% and 25% MTR and influent concentrations of 100, 200 and 300 mg/l. The water flow rates were set initially at the desired rate and were verified after a minimum of two residence times and then maintained throughout each individual test.

- Each test took more than one hour. To ensure the results are meaningful, an error calculation was conducted prior to each test to provide an estimate of the test duration. During each test, sediment was fed using a pre-calibrated feeder as explained above. In addition, the total amount of sediment fed into the feeder was weighed prior to the test to determine the actual average concentration throughout each test. At the end of each test, the valve was closed and the manholes were drained to the target elevation and weighed. The difference in water elevations were measured using the point gages and the additional weight of water was incorporated to determine the added weight of the system.

- During each test the following parameters were measured:

  - Discharge was measured continuously using a pressure transducer upstream of the pre-calibrated circular weir.

  - Temperature was measured inside the sump at the beginning and the end of each test.

  - Water surface elevations were recorded upstream of the inlet inside the influent pipe, inside both sumps, and downstream of the exit inside the effluent pipe.

  - The starting and ending time of the test as well as the beginning and ending times of the constant discharge were recorded to determine the duration of each test.

- The removal efficiency (η) was calculated as follows:

$$\eta = \frac{\left(W_f - W_i\right) SG}{W_{fed}\left(SG - 1\right)}$$

Where W_f and W_i are the final and initial weights of the system after the correction for the difference in water surface elevations, W_{fed} is the weight of the dry sediment fed into the system, and SG is the specific weight of the sediment.

Table 4 The preloading of the sump over a 3.25 hour period

General test Information						Water Elevations (feet above M1 floor)					Sediment				Weight			
Run	Test Type	Water Temp (F)	Duration of test inputting sediment (sec)	Average Height Above Weir (ft)	Flow Rate (CFS)	Inflow (ft)	M1 (ft)	M2a (ft)	M2b (ft)	Outflow (ft)	NJCAT (no clay) Mix Feed (g/sec)	Clay Feed (g/sec)	Average Sediment Concentration (g/L)	Target Sediment Concentration (g/L)	Primary Manhole Start and End Weight (lbs)	Secondary Manhole Start and End Weight (lbs)	Primary Manhole Weight Gained (lbs)	Secondary Manhole Weight Gained (lbs)
1	125% MTR	65.8	1440	0.505	1.06	6.43	6.42	6.03	6.02	5.76	61.3	0.0	2.041	2.17	2628	2558		
2	25% MTR	66.1	4200	0.218	0.198	6.305	6.34	5.68	5.68	5.575	12.5	7.5	3.567	3.5				
3	50% MTR	65.9	2520	0.311	0.404	6.34	6.375	5.785	5.78	5.64	24.9	15.0	3.488	3.5				
4	100% MTR	65.7	1680	0.443	0.815	6.39	6.4	5.94	5.93	5.705	50.0	0.0	2.167	2.17				
5	75% MTR	65.7	1980	0.375	0.585	6.355	6.38	5.86	5.85	5.675	34.6	20.0	3.296	3.5	3054	2596	426	38

5.3 Verification Procedures

All the data provided to NJCAT were reviewed to fully understand the capabilities of the V2B1® Stormwater Treatment System. To verify Environment 21's claim, the SAFL laboratory procedures and data were reviewed and compared to the NJDEP TSS laboratory testing procedure.

5.3.1 Laboratory Testing Results

The results of the tests are shown in Table 5. The result of one of the tests (test # 7) seemed to be an outlier and it was repeated to ensure accuracy; therefore, a total of 16 tests were conducted as shown in Table 4.

The duration of the tests was increased to minimize the errors associated with the load cells. The duration of the tests varied from approximately 3 hours to 12 hours. The results of the tests show more consistency in the tests at higher flow rates, i.e. the removal efficiency under different concentrations do not vary at 125% MTR or 100% MTR. This discrepancy can be due to change in temperature as well as the smaller amount of material fed at lower flow conditions. The settling velocity of particles drops significantly as water temperature drops; therefore, it is more likely that removal efficiency of the device drops as water temperature drops. At 125% MTR tests, water temperature varied by less than 1.5 ^{o}F and it was only about 2 or 3 ^{o}F cooler than the air temperature. At 25% MTR, however, water temperature varied by more than 3 ^{o}F and it was about 20 ^{o}F cooler. At 125% MTR and with a concentration of 300 mg/l, the amount of sediment fed and removed were 179.8 lbs and 86.1 lbs (Run 3), respectively. At 25% MTR and with a concentration of 100 mg/l, the amount of sediment fed and removed were 53.9 lbs and 34.1 lbs (Run 15), respectively.

In order to determine the removal efficiency of the V2B1 Model 4 under the recommended NJDEP weight factors while also incorporating the potential errors in using load cells, it was decided to assume ±3 lbs of cumulative error from both manholes (see section 5.1) and calculate the removal efficiencies three ways, tabulating the minimum, maximum and average removal efficiency at each flow condition. The maximum and minimum removal efficiencies were calculated from the worst and best test results at each flow rate in Table 5. The average removal efficiencies were obtained from Table 5 by averaging the three measured removal efficiencies at each flow rate. The results are summarized in Table 6. It is evident that under the worst case performances, V2B1 Model 4 with a design rate of 0.8 cfs (MTR) under the recommended NJDEP flow weighting factors can remove 56% of the sediments with the PSD given in Table 2. The average removal efficiency of the V2B1 Model 4 is 63.8% (Table 6). The removal efficiency vs. flow rate for the 15 runs is shown in Figure 9. The removal efficiency data at 25% MTR appear to be low, possibly a reflection of the cooler water temperature during these runs. Utilizing the equation shown with the NJDEP weighting factors also yields 63.8% removal efficiency.

Table 5 Summary of the test results

General test Information										Water Elevations (feet above M1 floor)					Sediment										Weight									
Run	Test Type		Water Temp (F)	Air Temp (F)	Duration of test inputting sediment (sec)	Average Height Above Weir (ft)	Average Flow Rate (CFS)	Target Flow Rate (CFS)	MTR of System (CFS)	Inflow (ft)	M1 (ft)	M2a (ft)	M2b (ft)	Outflow (ft)	Target Sediment Concentration (g/L)	Target SCS Feed (g/sec)	Target Clay Feed (g/sec)	Target Duration (min)	Total SCS Mix Needed (g)	Total Clay Mix Needed (g)	Actual SCS Mix Feed Duration (min)	Actual Clay Feed Duration (min)	Actual SCS Mix Fed (g/sec)	Actual Clay Fed (g/sec)	Primary Manhole Start Weight (lbs)	Secondary Manhole Start Weight (lbs)	Primary Manhole End Weight (lbs)	Secondary Manhole End Weight (lbs)	Primary Manhole Weight Gained (lbs)	Secondary Manhole Weight Gained (lbs)	Manholes Sum (lbs)	Sediment Removed (lbs)	Sediment Fed (lbs)	Removal Efficiency
1	125%	Start	63.4	65.6	18600	0.518		1.000	0.8	6.440	6.410	6.070	6.050	5.720	0.1	1.76	1.08	360	37921.9	23242.5	310	300	2.039	1.291	6140.3	5646.8	6158.6	5667.4	18.3	20.6	38.9	65.0	134.8	48.23%
		End	62.9	64.2		0.517				6.450	6.420	6.070	6.050	5.720																				
2	125%	Start	62.1	61.1	13080	0.518		1.000	0.8	6.450	6.430	6.060	6.050	5.710	0.2	3.51	2.15	240	50562.6	30990.0	200	218	4.214	2.369	6000.8	5612.8	6024.9	5633.9	24.1	21.1	45.2	75.5	179.8	42.01%
		Middle	62.1	61.9		0.52				6.460	6.440	6.070	6.060	5.710																				
		End	61.9	61.5																														
3	125%	Start	63.1	61.8	9600	0.513		1.000	0.8	6.440	6.430	6.065	6.050	5.720	0.3	5.27	3.23	160	50562.6	30990.0	150	184	5.618	2.807	6119.7	5664.1	6147.1	5688.3	27.3	24.2	51.6	86.1	179.8	47.92%
		Middle	63.1	59.5		0.518																												
		End	62.9	59.8		0.522				6.455	6.430	6.070	6.055	5.720																				
4	100%	Start	61.0	64.1	10200	0.444	0.82	0.800	0.8	6.400	6.380	5.955	5.950		0.3	4.21	2.58	180	44995.0	27578.0	170	165	4.411	2.786	6024.7	5662.9	6074.9	5667.9	50.2	5.1	55.2	92.3	160.0	57.66%
		Middle	61.1	64.3						6.395	6.380	5.955	5.950																					
		End																																
5	100%	Start	61.1	62.6	16320	0.442	0.812	0.800	0.8	6.395	6.380	5.950	5.945	5.705	0.2	2.81	1.72	270	45506.3	27891.0	255	272	2.974	1.709	6070.2	5672.2	6116.3	5682.7	46.1	10.5	56.7	94.7	161.8	58.52%
		Middle	61.0	63.1						6.395	6.380	5.955	5.950	5.715																				
		End	60.5	62.8						6.395	6.380	5.950	5.945	5.715																				
6	100%	Start	60.6	64.1	24840	0.444	0.82	0.800	0.8	6.395	6.380	5.955	5.950	5.715	0.1	1.40	0.86	405	34129.7	20918.2	376	414	1.513	0.842	6123.7	5690.8	6155.0	5698.8	31.3	8.0	39.3	65.7	121.4	54.10%
		Middle	58.6	62.3						6.395	6.380	5.950	5.945	5.720																				
		End	58.7	64.4						6.395	6.380	5.955	5.950	5.715																				
7	75%	Start	60.2	58.0	12540	0.392	0.64	0.600	0.8	6.370	6.355	5.895	5.892	5.700	0.3	3.16	1.94	208	39438.8	24172.2	209	196	3.145	2.055	6143.9	5716.2	6187.7	5735.7	43.8	19.4	63.2	105.7	140.2	75.34%
		Middle	59.4	52.6																														
		End	59.6	54.0						6.370	6.355	5.895	5.892	5.700																				
8	75%	Start	57.2	55.4	18840	0.392	0.64	0.600	0.8	6.370	6.350	5.889	5.880	5.700	0.2	2.11	1.29	312	39438.8	24172.2	292	314	2.251	1.283	6189.4	5720.9	6235.1	5726.9	45.7	6.0	51.7	86.3	140.2	61.56%
		Middle	56.2	54.1						6.370	6.350	5.885	5.880	5.700																				
		End	56.2	54.2						6.370	6.350	5.900	5.880	5.700																				
9	75%	Start	53.8	55.3	26280	0.39	0.634	0.600	0.8	6.380	6.350	5.885	5.880	5.700	0.1	1.05	0.65	468	28899.1	18129.1	438	420	1.100	0.719	6216.3	5725.7	6245.1	5732.0	28.9	6.4	35.2	58.9	103.7	56.77%
		Middle																																
		End	53.9	49.7						6.380	6.350	5.883	5.880	5.695																				
10	50%	Start	53.2	54.8	16500	0.315	0.414	0.400	0.8	6.350	6.330	5.804	5.801	5.655	0.3	2.11	1.29	270	34129.7	20918.2	252	275	2.257	1.268	6242.6	5728.1	6285.0	5733.7	42.4	5.6	48.0	80.2	121.4	66.11%
		Middle	53.3	54.2						6.350	6.330	5.802	5.800	5.655																				
		End	53.3	54.6						6.350	6.330	5.802	5.800	5.655																				
11	50%	Start	54.4	72.8	24720	0.314	0.410	0.400	0.8	6.355	6.335	5.815	5.812	5.655	0.2	1.40	0.86	400	33708.4	20660.0	382	412	1.471	0.836	6336.8	5750.1	6382.1	5758.0	45.3	7.9	53.2	88.9	119.9	74.13%
		Middle																																
		End	52.8	73.9						6.352	6.331	5.807	5.805	5.625																				
12	50%	Start	52.2	72.8	37440	0.312	0.405	0.400	0.8	6.353	6.331	5.809	5.807	5.651	0.1	0.70	0.43	600	25281.3	15495.0	597	624	0.706	0.414	6354.6	5755.2	6385.5	5761.6	31.0	6.5	37.4	62.5	89.9	69.56%
		Middle	51.8	71.8						6.350	6.330	5.802	5.800	5.651																				
		End	52.2	69.9						6.350	6.330	5.801	5.800	5.650																				
13	25%	Start	50.3	69.3	26220	0.218	0.199	0.200	0.8	6.325	6.298	5.702	5.701	5.950	0.3	1.05	0.65	440	27809.4	17044.5	452	437	1.025	0.650	6379.8	5759.8	6420.2	5763.7	40.5	3.8	44.3	74.1	98.9	74.90%
		Middle																																
		End	48.8	68.0						6.321	6.298	5.700	5.700	5.950																				
14	25%	Start	49.2	65.7	40980	0.219	0.2	0.200	0.8	6.320	6.298	5.702	5.702	5.950	0.2	0.70	0.43	660	27809.4	17044.5	663	683	0.699	0.416	6425.0	5766.0	6462.4	5769.2	37.4	3.3	40.6	67.9	98.9	68.69%
		Middle	47.2	65.1						6.321	6.298	5.702	5.702	5.950																				
		End	47.8	65.6						6.320	6.283	5.702	5.702	5.950																				
15	25%	Start	47.5	64.8	44280	0.218	0.199	0.200	0.8	6.322	6.282	5.702	5.702	5.590	0.1	0.35	0.22	720	15168.8	9297.0	738.00	701.00	0.343	0.221	6452.1	5761.2	6471.7	5762.0	19.5	0.8	20.4	34.1	53.9	63.15%
		Middle	47.1	66.7						6.325	6.280	5.705	5.705	5.595																				
		End	47.9	64.4						6.323	6.280	5.701	5.701	5.590																				
Repeat of Run 7	75%	Start	55.6	72.1	12660	0.385	0.618	0.600	0.8	6.380	6.355	5.895	5.890	5.698	0.3	3.16	1.94	208	39438.8	24172.2	211	206	3.115	1.956	6284.5	5736.6	6335.4	5743.6	50.9	7.0	57.9	96.8	140.2	68.99%
		Middle																																
		End	54.2	71.2						6.380	6.355	5.891	5.888	5.696																				

Table 6 Minimum, maximum and average removal efficiencies of V2B1 Model 4 using the NJDEP weight factors.

%MTR	Min	Max	Ave	Factors	Min	Max	Ave
125%	**40.3%**	**50.4%**	**46.1%**	**0.1**	**4.0%**	**5.0%**	**4.6%**
100%	**51.6%**	**60.4%**	**56.8%**	**0.15**	**7.7%**	**9.1%**	**8.5%**
75%	**53.9%**	**71.2%**	**62.4%**	**0.2**	**10.8%**	**14.2%**	**12.5%**
50%	**63.6%**	**76.6%**	**69.9%**	**0.3**	**19.1%**	**23.0%**	**21.0%**
25%	**57.7%**	**78.0%**	**68.9%**	**0.25**	**14.4%**	**19.5%**	**17.2%**
Total Removal Efficiency					**56.0%**	**70.8%**	**63.8%**

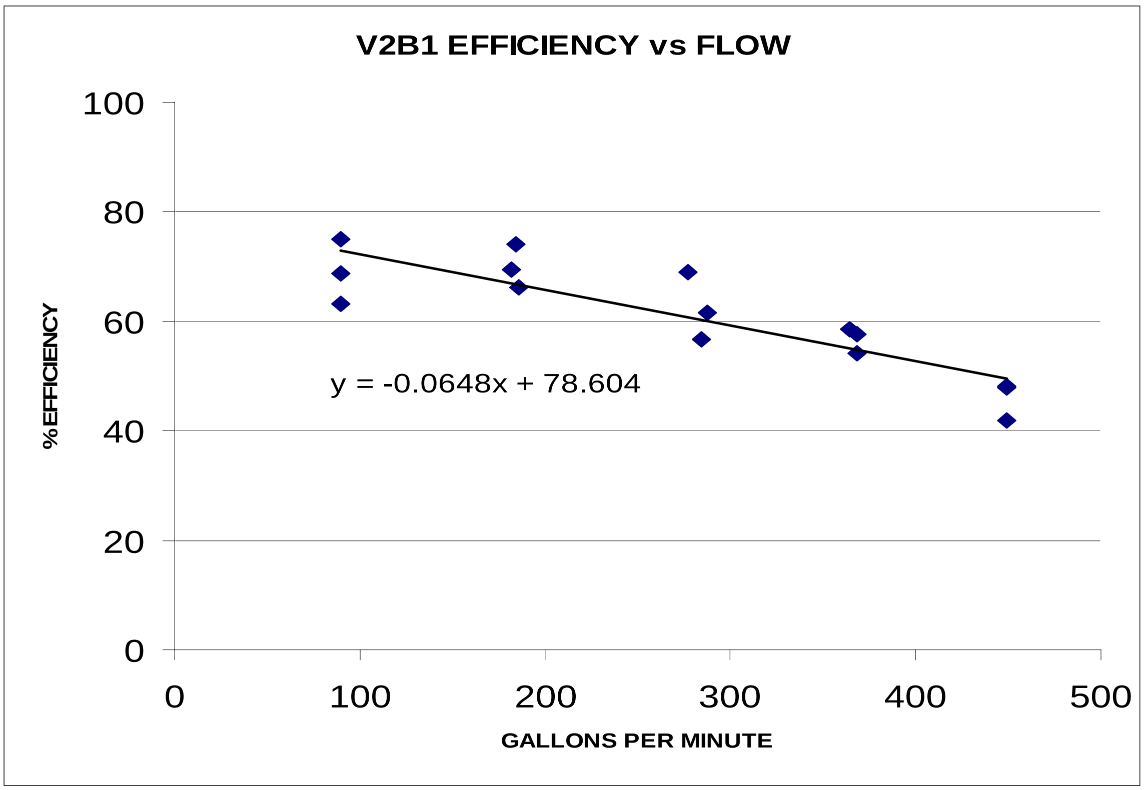


Figure 9 V2B1 removal efficiency versus flow rate

5.4 Maintenance

Maintenance activities include inspection, vegetation and debris removal, oil removal, and water and sediment removal. The unique design of the V2B1® utilizing vertical inserts allows for clear visual inspection and maintenance. Due to limited obstructions within the system almost all areas of the chamber floors in the M1 and M2 chambers can be reached from the surface of the structure requiring no confined space access. As mentioned earlier, a minimum of two 24" diameter access covers or one 30" diameter man access cover is provided on both the M1 and M2 chambers. A vactor truck is required for removal of oils, water and sediment.

Maintenance intervals are determined from monitoring the V2B1® during its first year of operation. After completion of the first year of operation, the established inspection and maintenance intervals will keep pollutant loadings within their respective limits. Establishing and adhering to a regular maintenance schedule ensures optimal performance of the system. Depending on the site, some maintenance activities may have to be performed on a more frequent basis than others. All inspection and maintenance activities should be recorded in an Inspection and Maintenance Log.

Sediment, vegetation, and gross debris can generally be disposed of at the local landfill in accordance with local regulations. The toxicity of the residues produced will depend on the activities in the contributing drainage area and testing of the residues may be required if they are considered potentially hazardous. Settling chamber water can generally be disposed of at a licensed water treatment facility but the local sewer authority should be contacted for permission prior to discharging the liquid. Significant accumulations of oil removed separately from the V2B1® should be transported to a licensed hazardous waste treatment facility for treatment or disposal. In all cases, local regulators should be contacted about disposal requirements.

6. Technical Evaluation Analysis

6.1 Verification of Performance Claim

Based on the evaluation of the results from laboratory studies, sufficient data is available to support Environment 21's claim.

Claim – The V2B1® Model 4 Stormwater Treatment System, at a treatment flow rate of 0.8 cfs (358 gpm, (9.13 gpm/ft^2), has been shown by mass balance testing to have a 63.8% total suspended solids (TSS) removal efficiency (as per the NJDEP methodology for calculation of treatment efficiency) using NJDEP specified material with an average d_{50} particle size of 60 microns, influent concentrations of 100-320 mg/L and 50% initial sediment loading in laboratory studies using simulated stormwater.

6.2 Limitations

As with any stormwater quality treatment practice, lack of inspections and maintenance will lead to reduced performance.

6.2.1 Factors Causing Under-Performance

The V2B1® is designed by Environment 21 staff and if installed in accordance with the system design it will have a minimal chance of performance failure. Some contributing factors that could affect the performance of the V2B1® are lack of maintenance or incorrect maintenance and inspection. The V2B1® should be inspected quarterly to ensure it has not reached capacity as defined in the site specific design report. If the V2B1® has reached maximum storage capacity of floatables or sediment and has not been serviced, one would expect to see an increase in resuspension of captured pollutants or sediment. Maintenance of the V2B1® should be performed by Environment 21 personnel or properly trained and certified personnel utilizing all required OSHA requirements. The actual maintenance interval is driven by the site pollutant loading characteristics and is estimated in the system design report. Quarterly field inspections will minimize the potential for a failure.

Another potential failure mechanism would be a failure of the internal components due to improper upkeep and service of the product by someone not trained in the proper inspection process of the V2B1®. Inspection should be done to determine when the unit needs to be cleaned and after the system has been cleaned the internal components should be inspected for obstruction, wear, or damage. Anyone who will perform maintenance on the V2B1 should refer to the Environment 21 web site www.env21.com for a download copy of the V2B1 specifications and maintenance procedure. These documents will help them become familiar with the V2B1 before commencing maintenance on it.

Upon completion of the construction project the system should be cleaned and cleared of any debris or sediment prior to release to the owner. This process will prevent a need for early cleanout or the potential for under performance.

6.2.2 Pollutant Transformation and Release

The V2B1® will not create additional pollutants in the downstream environment; however if the system is not inspected and serviced on a regular maintenance cycle due to the constant water pool in both chambers there may be a transformation that could occur inside the system from the trapped pollutants. Organic matter is one example where studies have shown that the decomposition of the collected matter has produced nitrogen or nitrates. Sediment collected in the system will not be lost during normal operating conditions with the use of a regular maintenance program as dictated during inspections.

6.2.3 Sensitivity to Heavy Sediment Loading

Heavy sediment loads, depending on the current stored material loading in the V2B1®, may require a shorter maintenance interval or potentially cause the system to re-suspend captured pollutants. If unforeseen excessive pollutants are collected from the site and washed into the system (e.g. due to construction activities on or around the site, excessive or other than normal site traffic, construction activity in the path of traffic entering the treatment area) when the system is near full capacity, resuspension of sediment may result. Regular inspection or increased inspection during these times of potential increased sediment loading is recommended to minimize any failure in V2B1® performance.

6.2.4 Mosquitoes

The V2B1® Stormwater Treatment System is a wet vault system in that both structures have a sump that will contain water collected during normal operation and retained after events. The volume of water contained may decrease during long dry spells due to evaporation; however there is the possibility for this to be an area of concern for the breeding of mosquitoes. To prevent the possibility of mosquito breeding, Environment 21 recommends either solid manhole covers or bolted covers with gaskets.

7. Net Environmental Benefit (NEB)

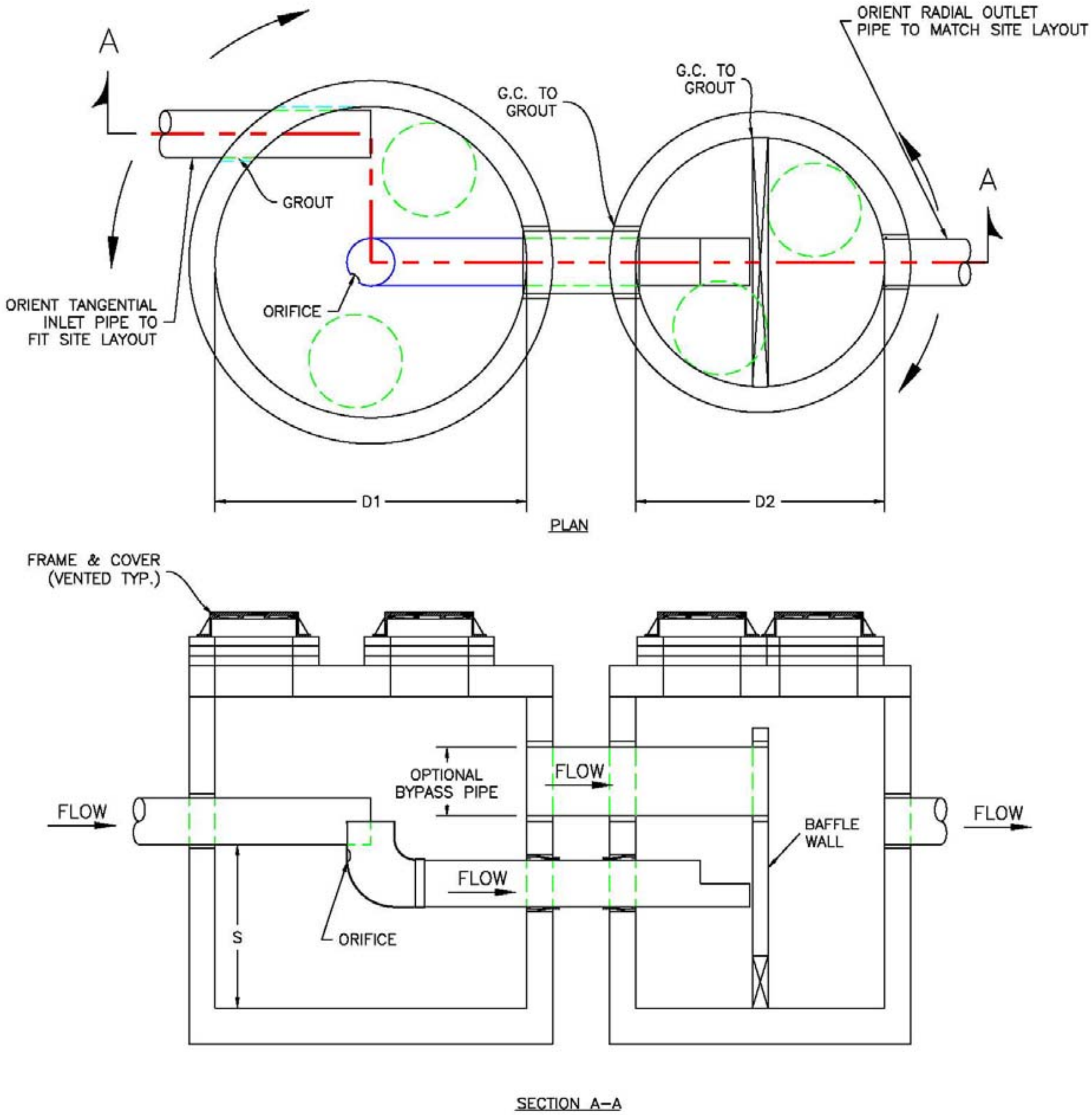
Once the V2B1® Stormwater Treatment System has been granted interim certification by the NJDEP, Environment 21, LLC will proceed to install and monitor a system in the field for the purpose of achieving goals set by the Tier II Protocol and final certification. At that time a net environmental benefit evaluation will be completed. However, it should be noted the V2B1® Stormwater Treatment System has no moving parts, and therefore, uses no water or energy.

8. References

Fyten, A., Lueker, M., and Mohseni, O. (2008). Performance Assessment of the Environment 21 V2B1 Model 4 for Removing Suspended Sediments from Stormwater. Prepared for Environment 21, East Pembroke, NY. November, 2008.

Appendix A

Schematic of V2B1 Online System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A
ORIENT RADIAL OUTLET PIPE TO MATCH SITE LAYOUT
G.C. TO GROUT
G.C. TO GROUT
GROUT
ORIFICE
ORIENT TANGENTIAL INLET PIPE TO FIT SITE LAYOUT
D1
D2
PLAN
FRAME & COVER (VENTED TYP.)
OPTIONAL BYPASS PIPE
FLOW
FLOW
FLOW
FLOW
BAFFLE WALL
S
ORIFICE
SECTION A–A