



**TRI/ENVIRONMENTAL, INC.**  
*A Texas Research International Company*

**Large-Scale Sediment Retention Device Testing  
of  
FLEXSTORM PC / PC+ Inlet Filters  
for  
Total Petroleum Hydrocarbons (TPH) Removal  
at Various Flow Rates**

**November 2009**

Submitted to:

Inlet & Pipe Protection, Inc.  
24137 W. 111<sup>th</sup> St., Unit A  
Naperville, IL 60564

Attn: Mr. Jamie Ringenbach

Submitted by:

TRI/Environmental, Inc.  
9063 Bee Caves Road  
Austin, TX 78733

A handwritten signature in black ink, reading 'C. Joel Sprague'. The signature is written in a cursive, flowing style.

C. Joel Sprague  
Project Manager



November 30, 2009

**Mr. Jamie Ringenbach**

Inlet & Pipe Protection, Inc.  
 24137 W. 111<sup>th</sup> St., Unit A  
 Naperville, IL 60564  
 E-mail: jr@inletfilters.net

**Subject:** Sediment Retention Device Testing of FLEXSTORM PC/PC+ Inlet Filters for Total Petroleum Hydrocarbons (TPH) Removal at Various Flow Rates (Log #2278-01-46)

Dear Mr. Ringenbach:

This letter report presents large-scale sediment retention device tests performed on the FLEXSTORM PC and PC+ sediment bags. The PC version is a 2-ply geotextile with a nonwoven inner liner and woven outer layer; a MyCelx skimmer pouch is used in the PC+ version. Oil retention effectiveness and removal rate based on total petroleum hydrocarbons (TPH) testing of effluent grab samples and captured oil measurements are reported. The data were developed for oil-laden runoff having a concentration of 243 mg/L. Generated results were used to develop the following effectiveness percentages for the tested materials:

| Product Tested | Hydrocarbon Load   | Ave Flow Rate GPM | TPH Removal | Oil Retention Efficiency |
|----------------|--|-------------------|-------------|--------------------------|
| FLEXSTORM PC+  | 243 mg/L using   | 19                | 99.04%      | 97.22%                   |
| FLEXSTORM PC   | 750 mL (1.45 lb) used motor oil + lube oil and Clean Water | 20                | 97.67%      | 91.61%                   |
| FLEXSTORM PC+  |  | 92                | 96.88%      | 99.11%                   |

TRI is pleased to present this final report. Please feel free to call if we can answer any questions or provide any additional information.

Sincerely,

C. Joel Sprague, P.E.  
 Senior Engineer  
 Geosynthetics Services Division

Cc: Sam Allen, Jarrett Nelson - TRI



# LARGE-SCALE SEDIMENT RETENTION DEVICE (SRD) TOTAL PETROLEUM HYDROCARBONS (TPH) TESTING REPORT

## FLEXSTORM PC / PC+ Inlet Filters

### TESTING EQUIPMENT AND PROCEDURES

#### Overview of Test and Apparatus

TRI/Environmental, Inc.'s (TRI's) large-scale sediment retention device (SRD) testing facility is located at the Denver Downs Research Farm in Anderson, SC. Testing oversight is provided by C. Joel Sprague, P.E. The large-scale testing is performed to present oil-laden flow to an area inlet at varying flow rates. Effluent Grab Samples are taken at intervals for total petroleum hydrocarbons (TPH) laboratory analysis. Additionally, the oil collected in the SRD was measured. The results were compared to the calculated amount of oil in the associated upstream flow to quantify the effectiveness of the SRD in retaining the oils and to confirm TPH removal rate.

This test method is full-scale and therefore, appropriate as an indication of product performance, for general comparison of product capabilities, and for assessment of product installation techniques. For this testing, a simulated area inlet comprised of a lined wooden "box" section and 24" diameter inlet opening was used to position the SRD in a representative condition. This facilitates multiple test repetitions during a single day of testing. The test apparatus is shown in Figure 2.

#### Sediment Retention Device (SRD)

The following table describes the tested SRD.

**Table 1. Tested FLEXSTORM PC / PC+ Sediment Bag**

| Fabric Component Description         | Inner Liner | Outer Layer         |
|--------------------------------------|-------------|---------------------|
|                                      | NonWoven    | Woven Polypropylene |
| AOS, sieve                           | 170         | 35                  |
| Water Flow Rate, gpm/ft <sup>2</sup> | 81          | 336                 |
| Tested Bag Capacity, ft <sup>3</sup> | ~ 2.1       |                     |

NOTE: The PC+ Sediment Bag includes a skimmer pouch filled with 20-25 MyCelx impregnated snippets. A photo of the FLEXSTORM PC+ is shown in Figure 1.



**FLEXSTORM PC+ INLET FILTER**

**Figure 1. FLEXSTORM PC+**

### **Test Oil**

The test oil used was a combination of 50% used motor oil and 50% lube oil

### **Test Preparation**

**SRD Installation** – The Sediment Retention Device (SRD) installation used a simulated area inlet comprised of a wooden “box” section and inlet opening to position the inlet filter bags in a representative condition.

**Mixing Oil-Laden Runoff** - Oil-laden runoff was created by combining water and oil in the mixing tank and agitating during the test. 6000 lbs of water and 1.45 lbs of oil mix (750 mL) were combined to create the oil-laden runoff at a oil concentration of 243 mg/L. This concentration was determined to be consistent with “pavement runoff” conditions.

**Controlling Flow** - Flow was controlled by opening a valve to release water through an outlet pipe leading to the area inlet. Weight change in water leaving the hopper over time was used to confirm average flow rates. Three tests were performed at low, medium, and high flow rates, respectively. A new bag was used at the start of each test.

## TEST SETUP

As noted, the submitted SRD installation used a simulated area inlet comprised of a wooden “box” section and 24” diameter inlet opening to position the FLEXSTORM PC in a representative field condition. Oil-laden flow was introduced through a pipe from the mixing tank as shown in Figure 2.



HOPPER WITH OUTLET PIPE LEADING  
TO AREA INLET



INSIDE VIEW OF  
HOPPER AGITATOR



AREA INLET SIMULATED  
SHOWING INFLUENT  
DISCHARGE FROM PIPE

**Figure 2. Test set-up, including mixing tank and wooden box with simulated area inlet.**

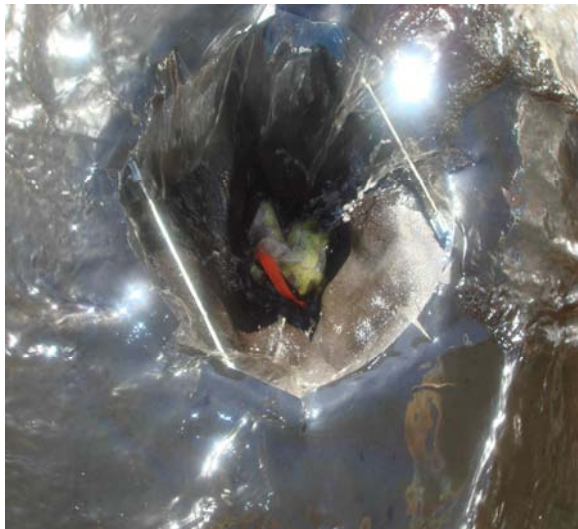
## Test Procedure

Releasing and Collecting Oil-Laden Runoff - The oil-laden water was discharged at average flow rates of 19, 20, and 92 gallons per minute, respectively, in the three tests. Effluent grab samples were collected throughout the tests and the weight of water/oil discharged was recorded. Retention observations and associated times were recorded during the test.



EFFLUENT GRAB SAMPLES  
TAKEN HERE

## GRAB SAMPLE CONTAINERS



OIL LADEN RUNOFF ENTERING PC+ SEDIMENT BAG  
THROUGH 24" DIAMETER OPENING



## TEST RESULTS

Laboratory TPH analysis results of the effluent grab samples are shown in Table 2 below along with the percent removal rates. Total oil and associated runoff measured during the testing are the supporting data used to confirm the performance of the product tested in addition to the measured TPH in the effluent grab samples. The oil captured captured was compared to the calculated oil discharged to quantify the oil retention effectiveness and the removal rate of the SRD.

**Table 2. Measures of Effectiveness**

| Run:                                   | E  |           |      |           | F             |           |      |           | G             |           |      |           |
|--|--|-----------|------|-----------|---------------|-----------|------|-----------|---------------|-----------|------|-----------|
| Oil Load:                              | 750 mL (1.45 lb) used motor oil + 6000 lbs water |           |      |           |               |           |      |           |               |           |      |           |
| Calculated Oil Concentration (mg/L):   | 243  |           |      |           |               |           |      |           |               |           |      |           |
| Flow Rate (lb/min):                    | 160  |           |      |           | 168           |           |      |           | 767           |           |      |           |
| Flow Rate (gal/min):                   | 19   |           |      |           | 20            |           |      |           | 92            |           |      |           |
| Product Tested:                        | FlexStorm PC+                                    |           |      |           | FlexStorm PC  |           |      |           | FlexStorm PC+ |           |      |           |
|  | No.  | Time, min | mg/L | % Removal | No.           | Time, min | mg/L | % Removal | No.           | Time, min | mg/L | % Removal |
| Samples (downstream):                  | E1E  | 1         | 1.4  | 99.42%    | F1E           | 1         | 5.6  | 97.70%    | G1E           | 1         | 8.5  | 96.50%    |
|  | E2E  | 2         | 1.9  | 99.22%    | F2E           | 2         | 5.5  | 97.74%    | G2E           | 2         | 8.1  | 96.67%    |
|  | E3E  | 3         | 3.2  | 98.68%    | F3E           | 3         | 5.3  | 97.82%    | G3E           | 3         | 7    | 97.12%    |
|  | E4E  | 4         | 2.8  | 98.85%    | F4E           | 4         | 6.2  | 97.45%    | G4E           | 4         | 7.9  | 96.75%    |
|  |  | 5         |      |           |               | 5         |      |           | G5E           | 5         | 6.4  | 97.37%    |
|  |  |           |      |           |               |           |      |           |               | 5.5       |      |           |
| <b>*Ave TPH Removal Rate (%):</b>      | <b>99.04%</b>                                    |           |      |           | <b>97.67%</b> |           |      |           | <b>96.88%</b> |           |      |           |
| Calculated Water In (lbs):             | 800.0  |           |      |           | 840.0         |           |      |           | 4218.5        |           |      |           |
| Calculated Oil In (lbs):               | 0.19   |           |      |           | 0.20          |           |      |           | 1.03          |           |      |           |
| Oil Captured + Bag (lbs):              | 1.129  |           |      |           | 1.127         |           |      |           | 2.676         |           |      |           |
| Estimated Bag Wt. (lbs):               | 0.94   |           |      |           | 0.94          |           |      |           | 1.66          |           |      |           |
| Net Oil Captured (lbs):                | 0.189  |           |      |           | 0.187         |           |      |           | 1.016         |           |      |           |
| Oil Retention Effectiveness            | 97.22%   |           |      |           | 91.61%        |           |      |           | 99.11%        |           |      |           |
| Total Calculated Oil In (lbs):         | 1.424  |           |      |           |               |           |      |           |               |           |      |           |
| Total Oil Captured (lbs):              | 1.392  |           |      |           |               |           |      |           |               |           |      |           |
| Total Oil Retention Effectiveness (%): | 97.78%   |           |      |           |               |           |      |           |               |           |      |           |

\*Oil and Grease TPH was measured in accordance with EPA 1664A



## **APPENDIX A – LABORATORY QUALIFICATIONS**





## Testing Expertise

TRI/Environmental (TRI) is a leading, accredited geosynthetic, plastic pipe, and erosion and sediment control product testing laboratory. TRI's large-scale erosion and sediment control testing facility in the upstate of South Carolina at the Denver Downs Research Farm (DDRF) is focused on full-scale erosion and sediment control performance tests.

## Technical Oversight

Joel Sprague, P.E., TRI's Senior Engineer provides technical oversight of all of TRI's erosion and sediment control testing and can be contacted at:

Mr. C. Joel Sprague, Senior Engineer  
PO Box 9192, Greenville, SC 29604  
Ph: 864/242-2220; Fax 864/242-3107; [jsprague@tri-env.com](mailto:jsprague@tri-env.com)

Mr. Sprague has been involved with the design of erosion and sediment control systems and the research, development, and application of erosion and sediment control products/materials for many years. He was the lead consultant in the development of bench-scale testing procedures for the Erosion Control Technology Council. Mr. Sprague has authored numerous technical papers on his research and is readily available to assist clients with their research and testing needs.

## Operations Management

Sam Allen, TRI's Division Vice President provides operational management of all TRI laboratories and can be contacted at:

Mr. Sam Allen, Vice President & Program Manager  
9063 Bee Caves Road  
Austin, TX 78733  
Ph: 512/263-2101; Fax: 512/263-2558; [sallen@tri-env.com](mailto:sallen@tri-env.com)

Mr. Allen pioneered the laboratory index testing of rolled erosion control products (RECPs) and has been actively involved in the development and standardization of testing protocol and apparatus for more than 10 years. He set up and oversees TRI's erosion and sediment control testing laboratories. His oversight responsibilities include test coordination, reporting, and failure resolution associated with the National Transportation Product Evaluation Program (NTPEP) for RECPs.

## Subcontract Laboratory Sample Testing

TRI/Environmental (TRI) subcontracts with leading, accredited analytical laboratories for some sample testing. Total Suspended Solids (TSS) testing and Oil and Grease (TPH/HEM) testing are performed by:

Shealy Environmental Services, Inc.  
106 Vantage Point Drive  
West Columbia, SC 29172  
Ph: 803/791-9700; Fax: 803/791-9111