Non-Vegetated Filtration Swale Effectiveness Study

Study Goal and Background

The goal of this study was to evaluate the effectiveness of a non-vegetated filtration swale BMP. Effectiveness was based upon whether the BMP could provide basic treatment (80% reduction of total suspended solids) in accordance with Ecology treatment performance goals.

Constructing a non-vegetated filtration swale is highly desirable for locations with hot and dry summers or in areas where dry periods cause grass to become dormant or where supplemental water is needed to establish vegetation. A non-vegetated BMP will benefit multiple Washington State Permittees by providing a BMP option that does not require irrigation. This fact sheet is a summary of the information found in the Non-Vegetated Filtration Swale Effectiveness Study Technical Evaluation Report.

Figure 1: Test Swale and Sample Locations

Study Description

The study goal was accomplished through controlled tests conducted at a test site in West Richland. Four swale design alternatives (alternatives) were tested in 200-foot-long swales at the site followed by one final swale design alternative (final alternative) as shown in **Figure 1**. The final alternative was selected based on the treatment performance of the four alternatives. A cross-section of the final alternative swale design is shown in **Figure 2**.

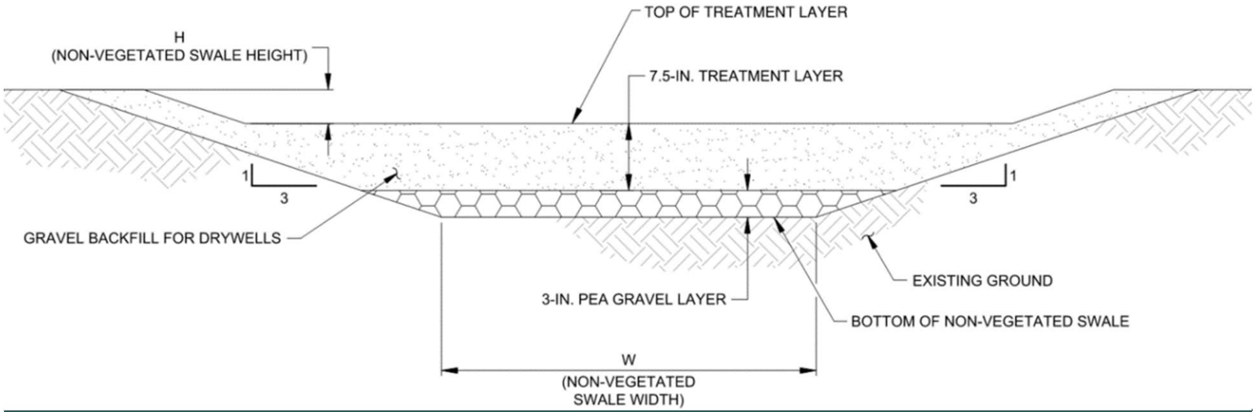

Figure 2: Final Swale Alternative Cross Section

Figure 3: Influent Distribution System at Test Swale

Treatment performance was measured from samples collected from each alternative, which were analyzed for total suspended solids (TSS). An influent distribution system mixed and pumped synthetic stormwater to the swale at the design flow rate to simulate a storm event (as shown in **Figure 3**).

As the synthetic stormwater flowed through the swale, grab samples (shown in **Figure 4**) were collected in eight sample locations that were spaced at 25-foot increments along the swale. After each simulated storm event, an amount of TSS equivalent to one year of loading was distributed to the swale to stress-test the swale and determine when the swale would require maintenance.

Figure 4: Grab Sample from Test Swale

The travel time for stormwater to flow through the swale was recorded at each sample location. The measured travel time was then used to estimate the velocity of flow through the treatment layer. This information was used to inform the velocity limits for the swale design guidance.

Study Location

The test site location was south of the City of West Richland Public Works Building and adjacent to a gravel parking lot (as seen in **Figure 5**). An existing 430-foot-long swale at the test site was retrofitted into the two 200-foot-long test swales. The controlled tests were conducted during the dry season; therefore, no runoff from the gravel parking lot contributed to the test swales.

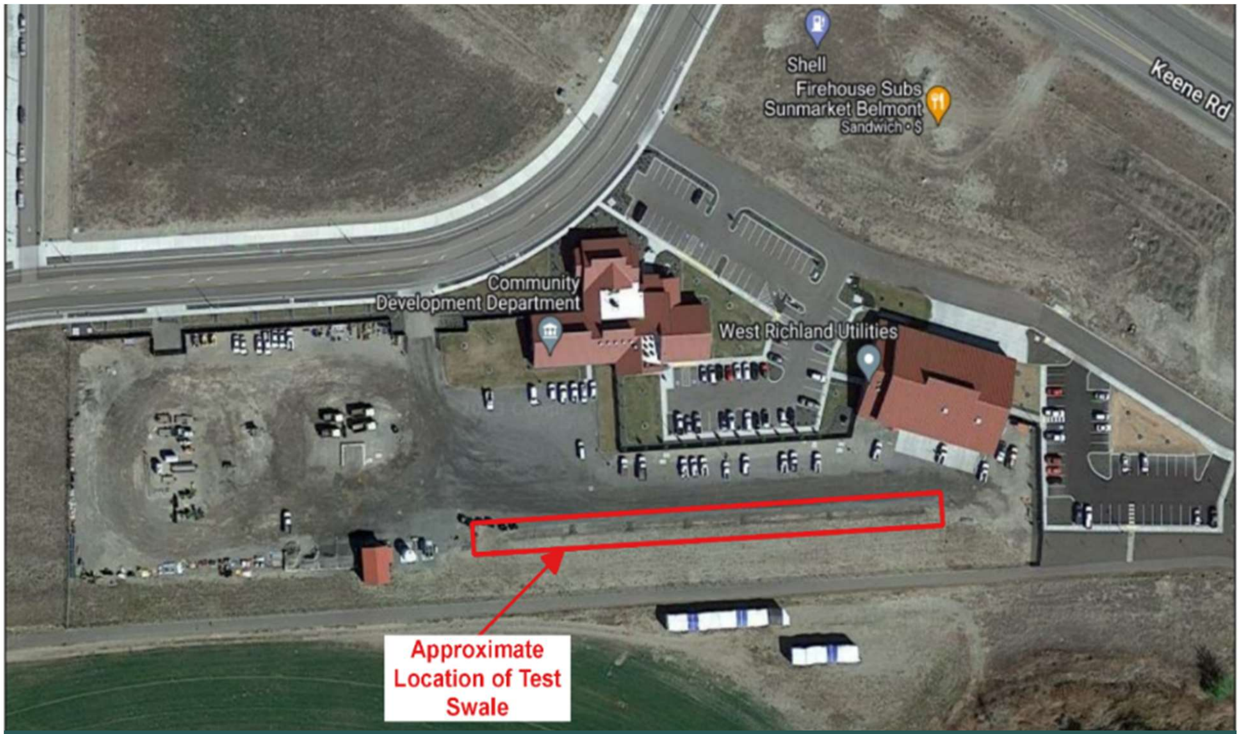

Figure 5: Test Swale Location

Results

Treatment Performance

The initial percent removals for the final alternative indicated that 84.5–87.8% removal of TSS was achieved for the first simulated year, at the sample location at 200 feet from the start of the swale. However, percent removal decreased for the following two simulated years, which was likely due to modifications to the swale needed near the last sample port, due to observed erosion from a grade break immediately downstream of the swale. As a result, the samples collected at the last sample port (200 feet) were discarded and statistical trendline analysis was used to determine how the swale would have performed if the swale modifications had not occurred. This analysis is shown in **Table 1** and indicates that the swale met performance goals for the first two years. Since the treatment performance dropped below 80% for the third year, it is likely that maintenance would need to be performed sometime around the third year to restore treatment performance. Further testing needs to be done to confirm the maintenance procedures and schedule.

Table 1: Final Alternative Water Quality Results from Trendline Analysis[1]

Location in Swale	Year 1	Year 2	Year 3
25 FEET	58.5%	-13.2%	11.9%
50 FEET	62.8%	1.00%	21.4%
75 FEET	67.0%	15.3%	30.9%
100 FEET	71.3%	29.5%	40.4%
125 FEET	75.5%	43.8%	49.9%
150 FEET	79.8%	58.0%	59.4%
175 FEET	84.0%	72.3%	68.9%
200 FEET	88.3%	86.5%	78.4%

1. Results shown are concentrations developed using trendlines.

The percent removal results in **Table 1** were compared to the TAPE treatment performance goals for TSS using the bootstrap statistical analysis to predict the treatment performance of the swale. Years 1 and 2 represent the performance of the swale before maintenance is needed. However, only two data points were available, causing the result of the bootstrap analysis to be equivalent to the lower of the two removal efficiencies. The evaluation of removal efficiencies calculated for years 1–3 added one data point and indicated the swale would meet the TAPE treatment performance goal for all three simulated years.

Design Velocity and Residence Time

The measured travel time for flow to travel through the swale was 50 minutes, from which a design velocity of 0.066 ft/sec was calculated. It is anticipated that treatment will be provided by a swale 200 feet long if the velocity and residence time are less than or equal to the values measured during the study.

Future Action Recommendations

- Submit the swale for Conditional Level Use Designation, so the performance of the swale can be further evaluated in the field for actual storm events.
- Perform additional field testing to understand effective maintenance activities to restore the swale treatment performance every two to three years and the frequency at which more minor action items such as removal of sediment and debris from inlets, weed control, etc., should be performed.
- Perform additional field testing to understand the impact that a catch basin or forebay at the inlet would have on treatment performance and maintenance cycle of the swale.

Lead Entity:
City of West Richland

Contributing Entity:
City of Richland
City of Kennewick
City of Pasco
City of Walla Walla
Walla Walla County
City of Moses Lake
City of Pullman
Idaho Dept. of Environmental Quality
Washington Dept. of Ecology

This study was conducted to support the lead and participating entities in meeting NPDES MS4 Phase II Permit Requirements for S8 Monitoring and Assessment.