PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Bull Run TREATMENT PROJECTS | Filtration

# Technical Memorandum

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| **Subject:** | Stormwater Flow Spreader and Vegetated Slope |
| **PWB Project #s:** | W02229 |
| **Date:** | April 15, 2025 |
| **To:** | David Peters, Program Director<br>Portland Water Bureau |
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# 1. Introduction

The Portland Water Bureau (PWB) is developing the Bull Run Filtration Facility (BRFF) as part of a program to bring their existing, unfiltered drinking water supply system into compliance with the Surface Water Treatment Rule. The construction of the BRFF will include new stormwater management systems as described in the BRFF Stormwater Drainage Report dated April 15, 2025 (BRFF Stormwater Report).

This Technical Memorandum (TM) provides additional detail for two elements of the BRFF stormwater management system: the flow spreader and the vegetated slope in the southwest quadrant of the site shown in Figure 1. These elements convey stormwater to Johnson Creek across a vegetated slope and through land designated as an area of Significant Environmental Concern (SEC) due to its proximity to Johnson Creek. These elements have been designed and will be operated consistently with the project goals for flow control and stormwater quality described in the BRFF Stormwater Report.

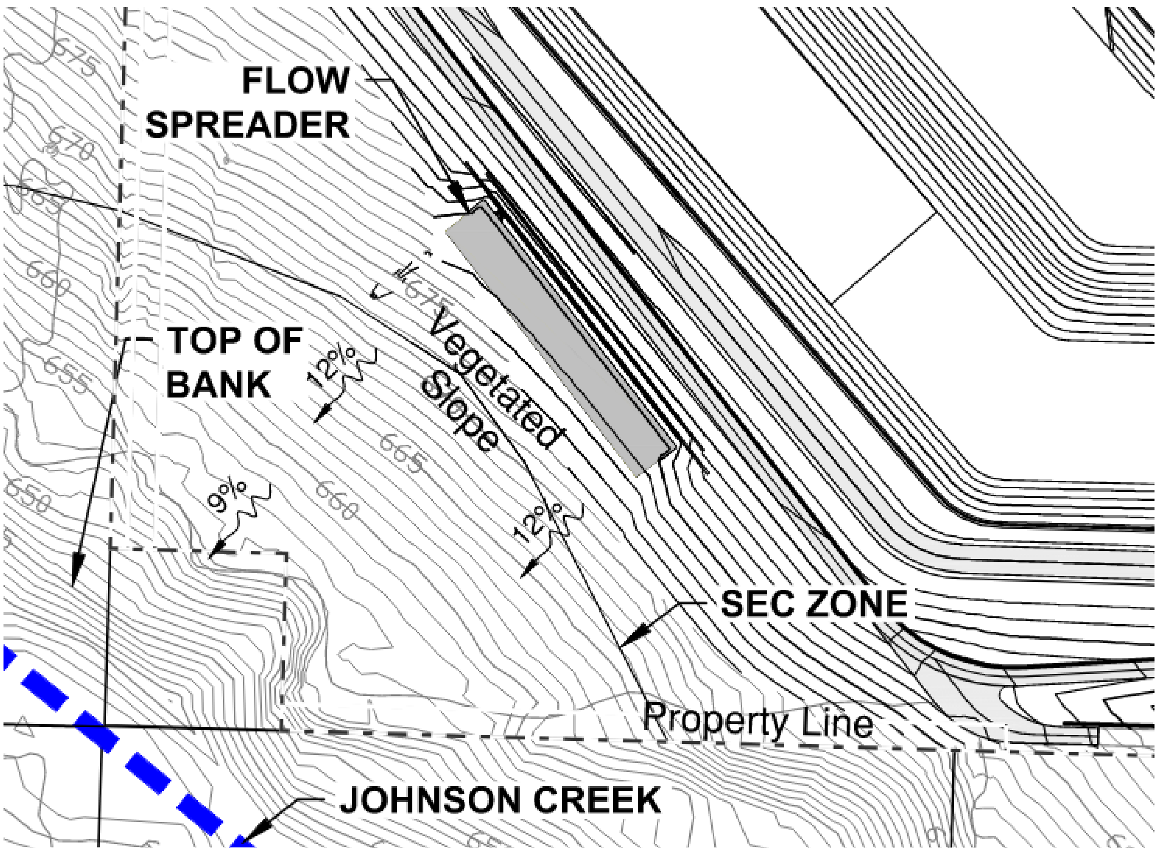


**Figure 1. Flow Spreader and Vegetated Slope**

As further explained in the BRFF Stormwater Report, the Multnomah County Design and Construction Manual (MCDCM), Section 5 – Drainage, provides the relevant requirements of the government with jurisdiction over stormwater management for the Facility site, in part (for water quality only) referring to the City of Portland *2020 Stormwater Management Manual* (SWMM) for additional standards. The MCDCM provides standards for water quantity in Section 5.1.2 (generally, post-developed discharge flow rate does not exceed flow rate before the development, not based on the SWMM) and for water quality in Section 5.1.3 (generally, post-development water quality must be equal to or better than before the project, based on the SWMM). The elements of the stormwater system addressed in this TM – the flow spreader and associated vegetated slope – primarily function to provide water quantity control, as elements of the stormwater system before the flow spreader will have already managed water quality for the water entering the flow spreader. Accordingly, the SWMM is not directly applicable in this TM, but has been reviewed by the project for general guidelines of water quantity control in the region.

Flow spreaders (also known as level spreaders) are a well-established Best Management Practice (BMP) for stormwater management, converting concentrated or channelized flow to sheet flow. The SWMM guidelines, for example, explain that the general strategy of upland dispersion – which "spreads stormwater out over an area outside of the riparian zone and higher in elevation than the receiving stream" – is a method that "enables stormwater to be used to support habitat functions while also adding stormwater attenuation benefits through uptake by vegetation, decreased flow velocities, and allowing infiltration." Section B.3.2.4. The SWMM guidelines, however, are focused on the design of a flow spreader and vegetated slope for relatively lower stormwater discharges, using a rock pad or dispersion trench. For the stormwater flow rates anticipated at the BRFF and described in the BRFF Stormwater Report, a higher-performance, engineered system will be provided, as described in this TM. Providing an engineered system, in lieu of a more off-the-shelf design for a smaller system provided by the SWMM, is consistent with the SWMM, which encourages this approach for outfall discharge protection and energy dissipation:

> "The design of an energy dissipation device is unique to the site; both the engineer designing the system and the reviewer of the design should consider that the device may not match the specifications outlined in this manual. However, as long as it can be proven to both dissipate energy and protect against erosion and scour, it can be considered acceptable. Depending on the flow velocity and existing site conditions, a variety of approaches can be used to disperse energy and prevent erosion."*SWMM, page B-B-16.*

Accordingly, in compliance with the SWMM and MCDCS, this memorandum provides a summary of the analysis by which the flow spreader and vegetated slope as proposed can be "proven to dissipate energy and protect against erosion and scour."

# 2. Hydraulic Design

The flow spreader and vegetated slope are an integrated facility which provides energy dissipation and evenly distributes flows from the BRFF stormwater management system across the slope downstream of the flow spreader, conveying that flow to Johnson Creek without creating erosion or scour (evidenced by gullies or rills) or mobilizing sediment. Stormwater sent to the flow spreader has already passed through water quality treatment facilities, so the ability to filter stormwater runoff was not a design objective. The resulting flows from the flow spreader system will mimic the pre-developed flow conditions, in which stormwater flowed across farmland and dirt roads, across the property line, and then to Johnson Creek.

The BRFF flow spreader and vegetated slope receive the detained flows at Point of Discharge #2, as described in the BRFF Stormwater Report, and the discharge from 25-year design storm was used as the basis of design, as it provides the most conservative standard. Specific design objectives are described below and summarized in Table 1.

| Table 1. Flow Spreader and Vegetated Slope Design Criteria | | | | |
|---|---|---|---|---|
| **Performance Objective** | **Criteria** | **Value** | **Source or Rationale** | **Achieved or Calculated Values[a]** |
| Safely convey design storm | Discharge to flow spreader during 25-year Design Storm | 3.7 cfs | MCDCM Section 5.1.2; BRFF Stormwater Calculations | 3.7 cfs |
| Even flow distribution across flow spreader & energy dissipation | Variation in discharge across length of flow spreader due to channel headloss | ± 10% | See discussion in Section 2.1 | ± 1% |
| | Construction tolerance for level spreader elevation | ± 0.25 in. | See discussion in Section 2.1 | N/A |
| Non-erosive flow | Maximum slope | 20 percent | SWMM B.3.1 Upland dispersion | 12 percent |
| | Maximum flow velocity down slope | 3 ft/s | SWMM 3.2.5.5 | Grass: 1.3 ft/s<br>Dense Brush: 0.54 ft/s<br>Trees: 0.22 ft/s |

Notes

a. Calculated values are based on the flow discharged by the flow spreader during the 25-year Design Storm

## 2.1 Even flow distribution across the length of the flow spreader

Even flow distribution across the length of the flow spreader is important to avoid flow concentration on the slope that results in local areas of high flow velocity, leading to erosion or mobilization of sediment. The criteria used in the design of the flow spreader is to limit the difference between the area of lowest discharge and the area of highest discharge to no more than ten percent. This is accomplished by using a wide flow distribution channel behind a concrete broad-crested weir, as shown in Figure 2. Final calculations were reviewed to confirm that a ten percent increase or decrease in flow would still produce results meeting the performance criteria.

Even flow distribution across the length of the flow spreader also depends on the flow spreader weir being level across its entire length. Accordingly, a construction tolerance of ± 0.25 inches will be applied to the flow spreader weir level. Minor local variations in flow across the weir will not significantly impact performance, as the flow falls onto a strip of drain rock.

Fencing around the flow spreader will minimize the debris entering the flow spreader. The fence mesh will end three inches above the ground on the downstream face of the flow spreader to allow small debris from the flow spreader to pass under the fence.

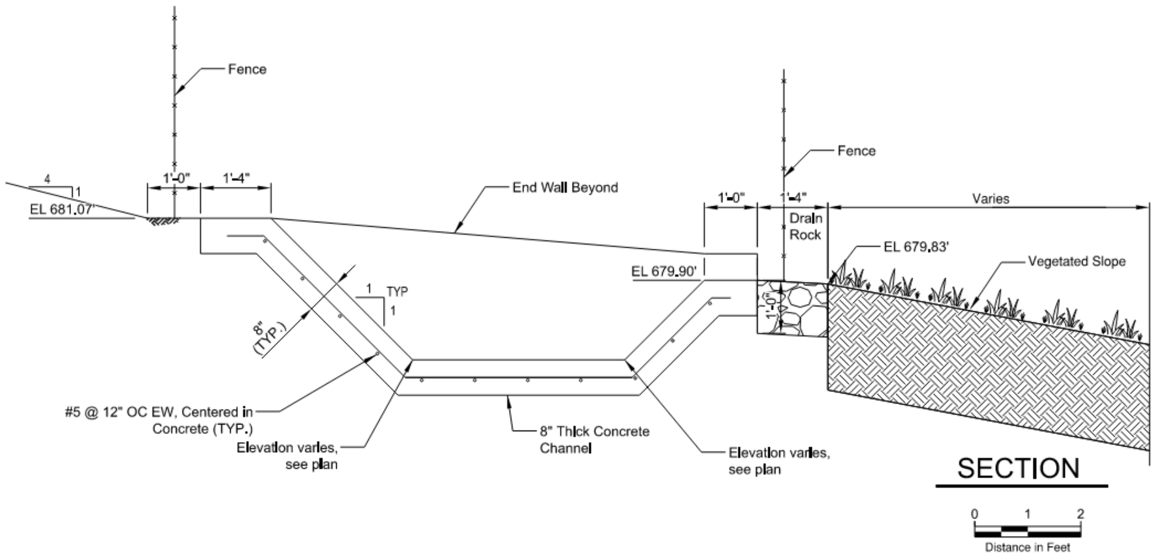


**Figure 2. Cross Section of Flow Spreader**

## 2.2 Non-erosive flow down vegetated slope

The vegetated slope below the flow spreader will function analogously to a grassy swale, a type of stormwater facility often paired with a flow spreader. *See* SWMM, p. 3-92. The SWMM includes design criteria for grassy swales (Section 3.2.5.5), which must be sized to safely convey the 25-year storm event while maintaining a maximum velocity of 3 ft/s.[1] Maintaining flow velocity below 3 ft/s will prevent erosion, mobilization of sediment, and damage to the vegetation. The SWMM further limits discharge from level spreading to slopes with a gradient of 20 percent or less (Section B.3.1).

As shown in Table 1, the design meets these criteria. The existing slope below the proposed flow spreader is approximately 12 percent, and that slope will be maintained in the final grading. The slope downstream of the flow spreader will be densely planted (the Riparian Buffer Area described below). Accordingly, flow velocity and depth for the BRFF vegetated slope below the flow spreader were calculated based on a Manning's roughness coefficient (Manning's n) of 0.070, per the Oregon Department of Transportation (ODOT) Hydraulics Manual table for "Medium to dense brush, in winter". The calculated flow velocity of 0.54 ft/s during the 25-year storm event is well below the design criteria of 3 ft/s, providing a safety factor (the ratio of desired performance to calculated performance) of 5.5 to account for potential flow concentration as stormwater flows down the slope. Any safety factor above 2.0 is appropriate for this application.

Calculated flow velocities and depths for two other types of plantings are also provided in Table 1. Flow through grass is provided to compare the performance of the proposed system against the grassy swale described in the SWMM. Flow through the Riparian Buffer Area described below was evaluated as "Dense willows, summer, straight" with a Manning's n of 0.150 per the ODOT Hydraulics Manual. The design criteria (3 ft/s) is met in both of these additional cases, with the denser plantings, as expected, showing lower flow velocities and greater protection against erosion and mobilization of sediment.

[1] Velocity criteria in the SWMM for achieving treatment are lower, to allow effective sediment removal and contact time with vegetation, but for the BRFF system, the flow spreader and vegetated slope are not needed to provide treatment, as all treatment requirements are met prior to the flow spreader.

# 3. Vegetated Slope Design

Stormwater leaving the Filtration Facility at Discharge Point #2 will be evenly dispersed using the flow spreader. The area immediately below the flow spreader will have approximately one foot of drain rock to accept water dropping off the flow spreader weir and then approximately twenty feet of native shrubs and grasses (the "Grass/Brush Area"). The planting plan for the Grass/Brush Area is provided in Table 2 below. This Grass/Brush Area below the flow spreader will allow for maintenance of the flow spreader and provides a buffer between the concrete flow spreader and tree roots lower on the slope.

| Table 2. Grass/Brush Area Planting | | |
|---|---|---|
| **Grass/Brush Area - Containerized Planting** | | |
| **Botanical Name** | **Common Name** | **Plants/Acre** |
| *Cornus sericea* | Red-Osier Dogwood | 1 Gallon - 1 Row @ 6' O.C. |
| *Spiraea douglasii* | Douglas Spirea | 1 Gallon - 2 Rows @ 6' O.C. |
| *Carex obnupta* | Slough Sedge | 1 Gallon @ 36" O.C. |
| *Deschampsia cespitosa* | Tufted Hairgrass | 1 Gallon @ 18" O.C. |
| *Cornus and Spiraea are to be arranged in rows directly below the flow spreader drain rock on 6' centers. Carex is to be interplanted throughout the 20' zone on 3' centers around the Cornus and Spiraea. Deschampsia is to be planted below the rows of Cornus and Spiraea. It is to be interplanted between the Carex on 18" centers.* | | |
| **Grass/Brush Area - Stormwater Seed Mix** | | |
| **Botanical Name** | **Common Name** | **Plants/Acre** |
| **Grasses** | | |
| *Danthornia californica* | California Oatgrass | 5 |
| *Deschampsia cespitosa* | Tufted Hairgrass | 3 |
| *Deschampsia elongata* | Slender Hairgrass | 3 |
| *Hordeum brachyantherum* | Meadow Barley | 1 |
| **Flowering Plants** | | |
| *Achillea millefolium* | Yarrow | 0.5 |
| *Asclepias speciosa* | Milkweed | 0.5 |
| *Carex densa* | Dense Sedge | 1 |
| *Carex unilateralis* | Lateral Sedge | 1 |
| *Juncus patens* | Slender Rush | 1 |
| *Juncus tenuis* | Spreading Rush | 1 |
| *Lupinus latifolius* | Broadleaf Lupine | 0.1 |
| *Potentilla gracilis* | Slender Cinquefoil | 0.5 |

Restoration of the area between the Grass/Brush Area and Johnson Creek (the "Riparian Buffer Area") has been underway since 2023 with the goal of establishing a functioning riparian forest. A functioning riparian area will provide a resilient plant cover, be resistant to surface erosion, shade runoff, and protect aquatic resources in the creek. The planting plan for the Riparian Buffer Area is summarized in Table 3 and includes native shrubs and trees well suited to post-development conditions in this area and designed to augment existing woody native cover along Johnson Creek. Willow bundles will be incorporated in the plan for the purpose of quickly creating a means to slow and redisperse surface flow and stabilize soil in the Riparian Buffer Area.

| Table 3. Riparian Buffer Area Planting | | |
|---|---|---|
| **Botanical Name** | **Common Name** | **Composition** |
| **Trees** | | |
| *Malus fusca* | Western Crabapple | 6/10,000 s.f. |
| *Pseudotsuga menziesii* | Douglas Fir | 3/10,000 s.f. |
| *Rhamnus purshiana* | Cascara | 20/10,000 s.f. |
| *Salix scouleriana* | Scouler's Willow | 7/10,000 s.f. |
| *Thuja plicata* | Western Red Cedar | 3/10,000 s.f. |
| **Shrubs** | | |
| *Cornus sericea* | Redosier Dogwood | 80/10,000 s.f. |
| *Lonicera involucrata* | Twinberry | 80/10,000 s.f. |
| *Physocapus capitatus* | Ninebark | 80/10,000 s.f. |
| *Rosa pisocarpa* | Swamp Rose | 80/10,000 s.f. |
| *Spiraea douglasii* | Douglas Spirea | 80/10,000 s.f. |

PWB will take an adaptive management approach in response to challenges with establishing planned vegetation in both the Grass/Brush Area and the Riparian Buffer Area by adjusting the plant palette to those that are appropriate for post-development conditions. Plans are in place to irrigate plants as needed during drier months to ensure effective establishment and survival of the proposed vegetation. Appropriate measures to address challenges related to planting will be taken to ensure successful establishment and survival of vegetation between the flow spreader and Johnson Creek.

As part of the BRFF operations plan, the flow spreader and vegetation between the flow spreader and Johnson Creek will be inspected at least monthly. For the first two years of operation, the flow spreader and vegetated slope will also be inspected following significant rainfall events (greater than 0.5”). Any debris found in the flow spreader will be removed and any plant damage or soil erosion will be repaired.

# 4. Conclusions

The proposed flow spreader and vegetated slope are conservatively designed, exceeding design criteria in the SWMM for similar facilities. The design achieves even flow distribution across the vegetated slope and limits maximum flow velocity to a maximum of 1.3 ft/s (less than half the SWMM criteria), providing energy dissipation and preventing erosion problems and sediment transport off the BRFF site or into Johnson Creek.

# References

Portland Water Bureau. Bull Run Treatment Projects. *Stormwater Drainage Report.* April 2025

City of Portland, Oregon. *Stormwater Management Manual*. 2020

Multnomah County, Oregon. Design and Construction Manual. 2020

Oregon Department of Transportation. *Hydraulics Manual*. Chapter 8 - Appendix A, 2014