SAM Stormwater Effectiveness Studies

Quality Assurance Project Plan (QAPP)

Ditch maintenance for improved stormwater management

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Date	February 28, 2023

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1.0 Table of Contents

2.0 Executive Summary

Reconfigured ditches and grass swales have potential to mitigate stormwater quality draining catchments of varying sizes. The standard trapezoidal ditch shape has been shown to erode, requiring constant maintenance, and offering little in terms of water quality treatment. As sediments accumulate within a roadside ditch, a 'clean out' of the ditch is the common maintenance practice where the ditch is restored to its original trapezoidal shape by simply re-grading the system, removing sediments, and reestablishing the original trapezoidal cross-section with a backhoe bucket. While erosion control measures are installed, there can be still releases of sediment downstream if erosion control measures are compromised, or if large storm events occur right after reconstruction. This study aims to evaluate various grass blends to determine plant establishment and growth when planted in a cleaned-out ditch. The study will be conducted at three sites, two in western Washington, and one in eastern Washington.

3.0 Introduction and Background

This Stormwater Action Monitoring (SAM) study addresses the Stormwater Work Group (SWG) 2019 Priority Topic 15 which is: Evaluate effectiveness of ditch enhancement techniques at removing pollutants.

3.1 Introduction

Roadside ditches directly receive road runoff which carries contaminants from the road surface, such as spills, vehicles (oil, fuel, tires, brakes), and atmospheric depositions. Runoff can wash along the roadsides picking up trash, bacteria, sediment, many different types of metals, organic chemicals from deicing and agricultural chemicals, and a set of emerging pollutants yet to be identified (Bannerman et al., 1993; Peter et al. 2018; Maestre and Pitt, 2006; Opher and Friedler, 2010; Herrera, 2008; Tian et al., 2021). In addition, the ditch is a source of potential sediment from bank and bed erosion, particularly after maintenance and re-construction.

Ditches and ditch maintenance represents an opportunity to improve stormwater quality if managed and maintained more effectively. Using plants that can quickly establish after maintenance or reconstruction will limit bank erosion and transport of sediments and associated pollutants. If those plants can also be low-growing, and outcompete invasives for a significant period, less frequent ditch maintenance and mowing will be needed.

After multiple conversations with permittees to develop this project, we found that installing ditches that require the least maintenance over time was their highest priority in terms of ditch management in the Puget Sound region. Reportedly, constant ditch maintenance is a huge expense, and poorly maintained ditches (either neglected or maintained in a manner that promotes erosion) can themselves become pollutant sources.

Ditch maintenance is often triggered by complaints from residents (overgrown with invasive plants) or when the jurisdiction determines the ditch has lost conveyance, due to sediments or vegetation. With hundreds of miles of roadside ditches in western Washington, ditch maintenance methodologies when not implemented properly waste money and could be contributing pollutant loads to waterways. These systems with some simple alternative planting blends, could be more optimally managed as both conveyance with water quality treatment.

This work aims to identify improved plant blends that establish quickly in a ditch system, are low-growing, and outcompete invasives, yielding lower long-term maintenance effort. This research will lay the foundation for improved ditch management techniques across the region.

3.2 Problem Description

With considerable efforts going into maintaining ditches through ditch clean-out, there is a need for a standardized, affordable, and appropriate choice of plants to ensure that the ditch banks are stabilized quickly post-clean-out and survive over a long period.

3.4 Regulatory Requirements

The data collected from this study is intended to provide more information on the performance of plants in a ditch and associated maintenance effort. Ultimately these results will inform Ecology's stormwater guidance, specifically associated with roadside ditch maintenance and biofiltration swales. Ecology considers ditches only to be conveyance, but biofiltration swales can be built as a BMP and can provide conveyance.

4.0 Project Overview

4.1 Study Goal

The goal of this project is to determine the benefits of 8 types of plant blends in ditch systems that were recently cleaned out. The study aims to quantify how well certain plant blends establish, grow, and survive at three ditch systems across the state to minimize maintenance effort. While no swales will be evaluated, plant blends that are suitable for ditches will likely work well in bioinfiltration swales. From this point forward, only ditches will be referenced.

4.2 Study Description and Objectives:

This study will evaluate plant growth and establishment in three ditches just after the ditches were cleaned out. Seeding blends developed by WSDOT, WSU and the City of Tacoma will be used to make up each blend. Vegetation plots will be 10 ft * 10 ft.

The study objectives are:

1. Quantify percent establishment of plant blends.
2. Quantify quality ratings of plant blends.
3. Quantify survival of plant blends.

4.3 Study Location

The work will be performed three locations.

1. **Fife Ditch:** The Fife Ditch is a flat, low-lying system that drains directly into the Puyallup River. It is dominated by the presence of colonial bentgrass (*Agrostis capillaris*), reed canary grass (*Phalaris arundinacea*), and Seattle's blackberry (*Rubis armeniacus*). This ditch system is located adjacent to many industrial zoned and commercial businesses. The Fife ditch is prone to flooding and has very slow drainage.
2. **78th Ave Ditch:** The 78th Ave Ditch is in a heavy traffic residential area. The slope of the ditch is great enough so that there are no standing water issues. The plants on site are a combination of grasses and forbs that were planted when the ditch was constructed and do not include any aggressive non-native species.
3. **Pullman Farm Ditch:** The ditch at the Grass Breeding and Ecology Farm at WSU Pullman receives the runoff from 5 acres of irrigated agricultural plots before it enters Paradise Creek and ultimately the Palouse River. It is graded at roughly a 3% slope and was originally planted into perennial ryegrass in 2019.

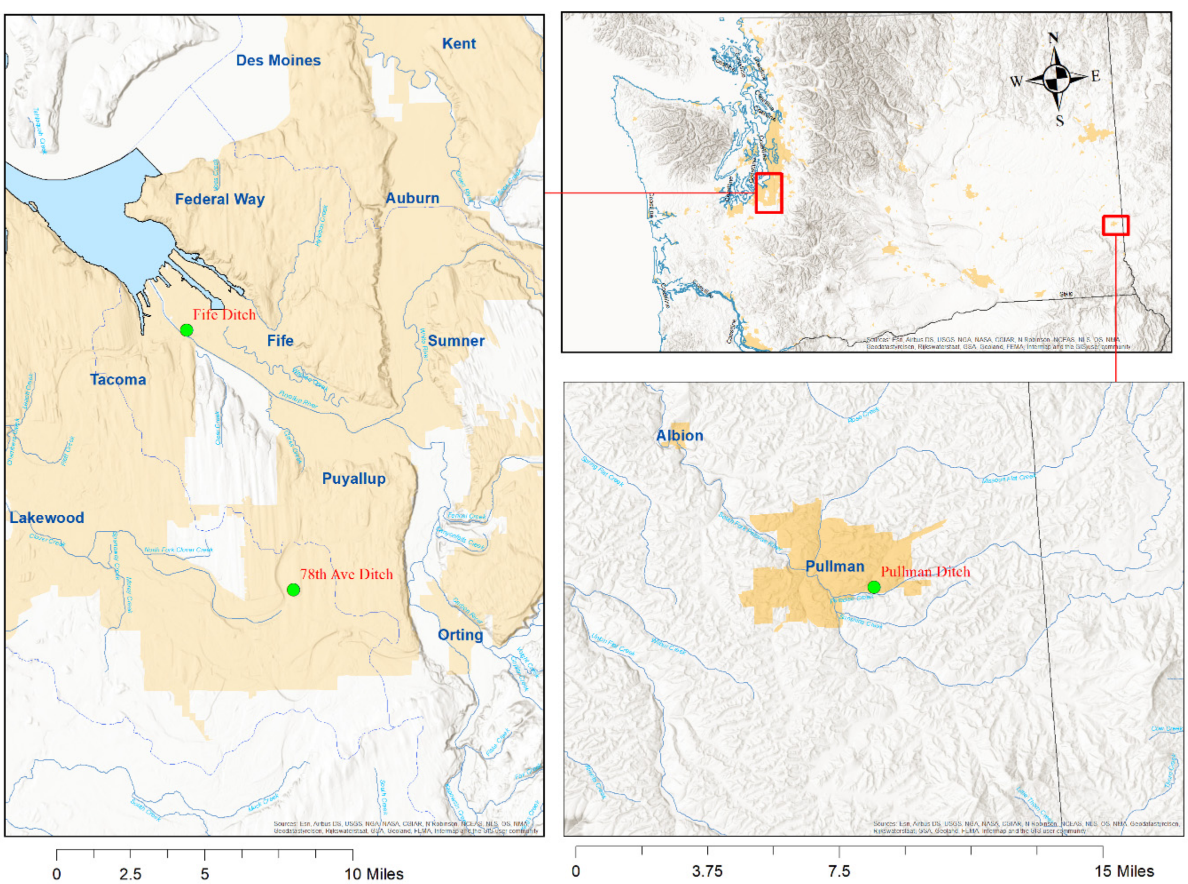

Figure 1: Location of three ditch sites in Washington. Locations are marked with green circles, two are close to Fife and Puyallup, and one located in Pullman.

4.4 Data Needed to Meet Objectives

Data collected in this study will be used to determine: 1) if each blend established under no maintenance conditions and 2) to what extent were the species contained within the blend were able to survive on site beyond the first year.

Initial establishment and later stand monitoring is critical in that:

1. Establishment rates dictate the success of each species in a blend.
2. Poor stand longevity leads to increased maintenance in the form of future retrofits.
3. Too many plants at establishment can lead to problems related to disease, moisture, and nutrient competition later during stand growth.
4. Poor establishment of grasses meant to control water runoff could lead to more contaminants entering water systems while other weedy species attempt to colonize the site from soil seed banks.
5. The economic value of having plantings successfully established should reduce maintenance costs over time.

Data Measurements include:

Temporary grass seed shall be a commercially prepared mix made up of low-growing grass species and that will grow without irrigation at the project location. The application rate shall be 6 lbs/1,000 ft^2, and for one pre-existing blend, at a rate of 1lb/1,000 ft^2.

The following timeframes of measurement are:

1. Establishment percentage (4-6 weeks post-seeding)
2. 6 stand quality ratings (3 ratings per year: spring, summer, and fall on a 1-9 scale; 1, = dead, and 9 = ideal)
3. Winter survival percentage (at each spring stand quality rating date)
4. Percent invasive cover (at establishment and each stand quality rating date)
5. Ground cover percentage (3 ratings per year: spring, summer, and fall)
6. Species dominant (at the conclusion of study).

Successful blends will have a high percent establishment, quality rating >5, low invasive percentage, high winter survival percentage and species dominant as a component of the seed blend. Planting of sites will occur in Fall 2021, and monitoring will continue through to the end of the project in early 2024.

4.5 Tasks Required to Conduct Study

This study is executed via Ecology contract C2200016. The following tasks are briefly described:

Task 1 Project management and administration.

Project administration will be led by WSU staff and students. This includes initiating agreements, subcontracting with project partners, tracking the progress of deliverables, reimbursing partner project work based on detailed reports on deliverables, and semi-annual reports to Ecology SAM program. WSU will provide updates and reporting to Ecology semi-annual or as requested and required by the contract.

Task 2 Quality Assurance and Project Protocol (QAPP) development.

This document, the QAPP, describes the study design, instrumentation, intended type of data, how often data are collected, maintenance protocols for the system, how data will be managed, and lastly, how data will be analyzed. Costs associated with QAPP development are related to the time taken to write and revise this QAPP document.

Task 3 Site instrumentation.

Two ditches in Pierce County and one ditch in Whitman County will be selected for this study. A split arrangement of three alternate vegetation and retrofit experimental setups. One of each experimental setup will be implemented in a ditch – with three ditch sites total.

Task 4 Evaluating alternative plant blends.

Plant blends will be evaluated to determine the efficacy of current roadside blends as well as the potential for new blends to be incorporated for use in western and eastern Washington.

Task 5 Quantifying effects ditch maintenance and retrofit on water quality and quantity.

(This task will no longer be part of this study).

Task 6 Communication of findings

A final report will summarize ditch treatment effects on water quantity and quality for the four ditch treatments tested and design and maintenance recommendations.

4.6 Potential Constraints

This work is dependent on rainfall events to keep the plants alive.

5.0 Organization and Schedule

5.1 Key Project Team Members: Roles and Responsibilities

Table 5.1 Key project people and roles.

Key Team Members	Role	Responsibility
Ani Jayakaran, PhD PE Washington State University 253-445-4523 anand.jayakaran@wsu.edu	Lead Entity, proposal co-author and Quality Assurance Coordinator	Overall project management and ensuring that water quality and quantity objectives are met. Also responsible for deliverables.
Brandi Lubliner, PE WA Dept. of Ecology 360-407-7140 brwa461@ecy.wa.gov	SAM Project Manager	Reviews the project scope and budget, tracks progress, reviews and approves contract deliverables. Serves as the contact person for all communications, notifications, and billings questions
Michael Neff, PhD Washington State University mmneff@wsu.edu	Key Team Member, Proposal coauthor, and project collaborator	Responsible for evaluating plant related metrics.
Jonathan Schnore Washington State University jschnore@wsu.edu	Graduate student	Responsible for evaluating weeding and plant related metrics.
Carly Thompson Washington State University carly.thompson@wsu.edu	Project Technician	Responsible for logistics associated with sampling sites.

5.2 Project Budget

Table 5.2: Budget

Deliverable by Task	Target Deliverable Cost
Task 1.0 Project Management	
D1.1 Semi-annual Progress Report	$1,910
D1.2 Semi-annual Progress Report	$1,910
D1.3 Semi-annual Progress Report	$1,910
D1.4 Semi-annual Progress Report	$1,910
D1.5 Semi-annual Progress Report	$1,910
Task 2.0 Planning and QAPP	
D2.1 Draft QAPP	$16,539
D2.2 Final QAPP	$5,513
Task 3.0 Site Instrumentation	
D3.1 Installation Memo	$144,581
Task 4.0 Evaluating Plants	
D4.1 Draft Plant Report	$62,177
D4.2 Final Plant Report	$62,177
Task 6.0 Communication	
D6.1 Whole Study Draft Report	$5,228
D6.2 Whole Study Final Report	$5,228
D6.3 Two Presentations	$5,228
D6.4 Draft Fact Sheet	$5,228
Total	$321,449

6.0 Quality Objectives

The data quality objectives for this project are to ensure that the measured data adequately represent plant success at the three sites. To do this, field data will be collected to characterize plant establishment, growth, and survival. Data will be generated according to procedures outlined in Section 8.0. Data will be deemed acceptable in terms of data quality as outlined this section and only those data that meet and exceed our data quality requirements will be used for analyses. This data is expected to be scientifically accurate, useful for the intended analysis, and legally defensible. To achieve that goal, the collected data will be evaluated relative to the following indicators of quality assurance (QA).

Precision: A measure of the variability in the results of replicate measurements due to random error

Bias: The systematic or persistent distortion of a measurement process that causes errors in one direction (i.e., the measured mean is different from the true value)

Representativeness: The degree to which the data accurately describe the conditions being evaluated based on the selected sampling locations, sampling frequency and duration, and sampling methods

Completeness: The amount of data obtained from the measurement system

Comparability: The ability to compare data from the current study to data from other similar studies, regulatory requirements, and historical data

Measurement quality objectives (MQOs) are performance or acceptance criteria that are established for each of these QA indicators. The MQOs are described below in separate subsections for hydrologic and laboratory data.

6.1 MQOs for plant data

Plant growth monitoring will involve measurement of visual ratings for establishment and stand quality over time as well as species composition estimates of each plot at the conclusion of the study. Visual rating can be problematic when the individual rating the plants is either unfamiliar with the species being rated or confuses weed species for crop species. Plot layout and boundary markings can also have a negative impact on visual ratings due to the evaluator not being able to determine where one plot starts and another ends. Environmental variation across the site can also have a negative impact on the ability to visually determine proper growth and development of plants due to the presence or absence of important nutrients or environmental toxins across the site.

The data quality indicators for these measurements are expressed in terms of precision, bias, representativeness, completeness, and comparability. Assessments of precision and bias will be conducted in the field. The MQOs for field data are defined below.

Precision

Plant visual rating precision will be a factor of the experience of the rater. The ratings will be taken by an individual with over 10 years' experience rating turf professionally for private and public entities such as the National Turfgrass Evaluation Program (NTEP). Each plant blend is replicated 3 times in a standard random complete block design across the site.

Bias

Bias associated with planting blends is dealt with by each entry having a coded number rather than a blend name. Familiarity with each plot is then developed by plot performance and not by blend performance expectations. The ratings are done blind so that the rater does not impart their performance expectations to the rating. The only exception is when weed growth and plant competition force the rater to identify the blend so that the plot can be properly identified to prevent data loss or confusion.

Representativeness

The representativeness of the visual ratings will be ensured by using the well-established NTEP visual rating protocols with % establishment (0-100), % weed species (0-100), quality (1-9 where 1=dead, 9= ideal turf) and plot species composition estimates.

Completeness

Completeness of the plant blend evaluation will be assessed based on the successful collection of the initial establishment rating, three subsequent quality and % cover ratings as well as the final species composition estimate.

Comparability

By using a standard method of visually rating the plant blends such as the NTEP rating system, the results should be useful and comparable to similar plantings and experiments that can be easily disseminated to multiple groups familiar with this system.

7.0 Experimental Design

7.1 Study Design Overview

The study will be conducted at three sites, two in Puyallup, WA, and one in Pullman, WA. The study comprises three basic physical components to the experimental design:

1. **Ditch systems** (**3**), three ditches at three locations across the state.
2. **Plant blends (8)** – 8 plant blends testing different seed mixes.
3. **Plant plots (59)** – 10ft * 10ft plots – we fit 59 plots in total across all three sites.

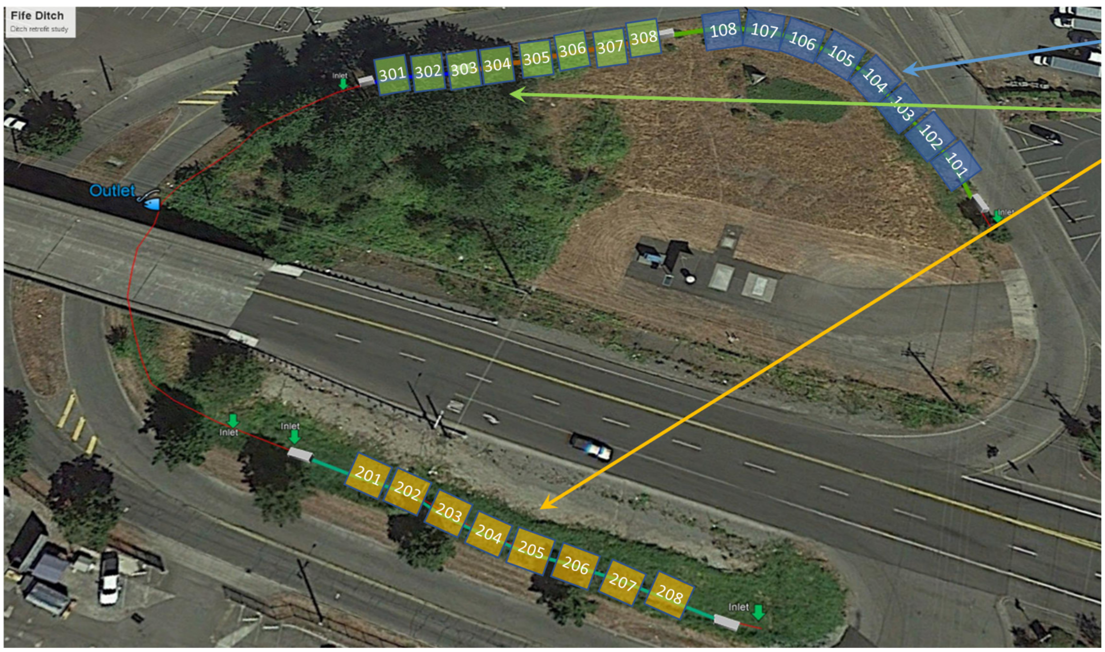

Figure 2: Image showing 24 plant plots laid out at the Fife Ditch site.

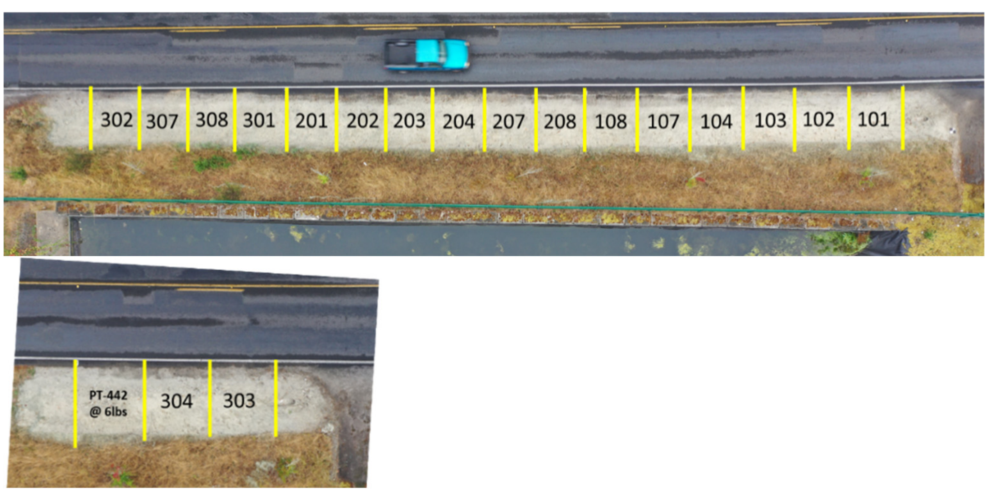

Figure 3: Image showing 19 plant plots laid out at the 78thAve Ditch site.

					Edge of Terrace											
PT-442 @ 6lbs	303	308	302	301	304	201	202	203	204	208	108	104	103	102	101	End of Eas
					Farm plots											

Figure4: Layout of 16 plots at the Pullman Farm Ditch site.

7.2 Site Design and Plant Blends

The study will consist of two sites on the Western side of the Cascades and 1 site at the Grass Breeding and Ecology Farm at WSU Pullman. Each study site will have a standardized plot based on the site's ability to accommodate 3 replications of each blend on the site.

Ditch systems

Three ditch sites were selected (see Figures 2, 3, & 4).

1. Fife Ditch (24 plots, 8 blends, each blend replicated 3 times)
2. 78th Ave Ditch (19 plots, 6 blends, each blend replicated 3 times + 1 PT442@6lbs/1000ft^2)
3. Pullman Farm Ditch (16 plots, 5 blends, each blend replicated 3 times + 1 PT442@6lbs/1000ft^2)

Plant blend blends

Plant blends are to be derived from turfgrass species, native plant species and forage legume species. All seed blends other than PT442 are custom blends created for the purpose of this study and are composed from seed that is readily available on the open market. No proprietary blends, species or blend combinations are to be used in developing these blends. Any seed company/distributor should be able to replicate the blends used without undue difficulty, expense or licensing. Eight plant blends were selected for further testing. The 8 blends and identifying plot codes are listed in Table 7.1

Table 7.1: Listing of 8 plant blend blends with codes used to identify a plot based on the blend. All plots use a replicate identifier of 100, 200 or 300. Blend identifiers ranges from 1to 8. So, plot 302 is replicate 3 with blend 2.

Plant blend	**Plot Codes**	
	PT442 Blend: City of Tacoma & BES Grassy Swale Native Mix	
1	101,201,301,401	25% Meadow Barley, 15% California Oatgrass, 10% Blue Wildrye, 10% California Brome, 10% Roemer's Fescue, 10% Tufted Hairgrass, 10% Spike Bentgrass, 5% Water Foxtail, 5% Slender Hairgrass
	WSDOT blend per online specs - http://www.directseedsales.com/erosion.html	
2	102,202,302,402	50% Perennial Ryegrass, 40% Creeping Red Fescue, 10% White Clover
	WSU Blends	
3	103,203,303,403	50% Creeping Red Fescue, 40% Chewings Fescue, 10% Highland Bent
4	104,204,304,404	50% Hard/Sheep Fescue, 35% Strawberry Clover, 15% Yarrow
5	105,205,305,405	35% Idaho Fescue, 35% Tufted Hairgrass, 30% Strawberry Clover
6	106,206,306,406	70% Creeping Red Fescue, 15% Yarrow, 15% Meadow Foxtail
7	107,207,307,407	50% Redtop, 50% Highland Bent
8	108,208,308,408	50% Slender Creeping Red Fescue, 40% Chewings Fescue, 10% Redtop

Plant plots

Every plot was 10 ft * 10 ft in dimension, and hydroseeded at the rate of 6 lbs/1,000 ft^2. This seeding rate was applied at all plots except those plots that contained the PT442 blend used by the City of Tacoma. The specified seeding rate for that blend is 1 lb/1,000 ft^2. Plots with PT442 are labeled 101, 201, 301, or 401 (see Table 7.1). However, after the first year of planting, PT442 plots at the Fife ditch seeded at 1lb/1000 ft^2 looked under-established. Therefore, one plot at the two other sites (78^{th} Ave site, and the Pullman Farm site) were seeded with PT442 at a rate of 6 lbs/1,000 ft^2 (Figure 5 & 6). This high seeding rate was an attempt to even the establishment race between this blend and the others who have a higher seeding rate.

7.3 Types of Data Being Collected

Table 7.3: Type and frequency of data collected for targeted parameters.

Parameter	Data type	Frequency of collection
Establishment	%	1@ 4 weeks post planting
% Crop	%	3
% Weeds	%	3
Quality	1-9 (1=dead, 9= ideal)	3
Species Inventory	ID	1 @ study conclusion

7.4 Plant Success

Planting blends will be deemed successful if they are able to establish and persist at the site in numbers that would produce acceptable turf quality for the duration of the study (no lower than a 4 average quality rating and no less than 50% establishment with some of the species planted still present at the conclusion of the study). Blends performing below this standard at all 3 locations will be deemed unsuccessful.

8.0 Sampling Procedures

8.1 Standard Operating Procedures

Establishment and Plant Success Measurement

Performed 4 weeks post planting, then once in March, once in August and once in November of the year after establishment, with data recorded on field data sheets and data entered into a digital database quarterly.

8.2 Field Log Requirements

During site visit to a ditch site, the following information will be recorded on a waterproof standardized field form.

- Site name
- Date/time of visit
- Name(s) of field personnel present
- Sampling errors? (if encountered)
- Unusual conditions (e.g., oily sheen, odor, color, turbidity, discharges or spills, and land disturbances)
- Modifications of sampling procedures

Field notes will be included as an appendix in the final report produced for this project.

9.0 Measurement Procedures

10.0 Quality Control

Quality control (QC) procedures are identified in separate subsections below for field activities. The overall objective of these procedures is to ensure that data collected for this project are of known and acceptable quality.

10.1 Field QC Required

Quality control procedures that will be implemented for field activities are described below.

Field Notes

Four weeks after planting, an initial establishment rating will be taken. The following year there will be a species inventory at the conclusion of the study as well as 2 ratings for quality and % crop, weeds, and bare ground. In addition, any anecdotal notes about plot conditions will also be noted.

10.2 Corrective Action

Human activities on the sites could interfere with plot boundary identification. To prevent plot boundary loss and reduce the potential to be rating off plot species, the following will occur on site before ratings commence:

1. Re-establishment of plot boundaries if missing
2. Identification of plots that have been damaged due to non-plant interactions and make appropriate notes regarding those plots. When plots have been damaged, rely more on intact plots at other locations to identify true performance characteristics.

11.0 Data Management Plan Procedures

11.1 Data Recording & Reporting Requirements

Data from all measurements will be recorded into a digital database after fieldwork. The database also will be used to produce summary statistics for each applicable station. These summary statistics will ultimately be stored in a Microsoft Excel database with other data collected through the project (see description below).

11.2 Procedures for Missing Data

1. Missing data will be filled in when appropriate through interpolation techniques such linear or spline fitting to fill in the gaps. However, data missing over a 6-month period is unlikely to be suitable for this type of gap filling. When appropriate, missing climatic data can be filled in using data from other proximal weather stations.
2. All missing data will be coded appropriately to show that the data are "filled" through interpolation or matching from local sensors.
3. Missing data will be reported with results.

11.3 Data Storage

The final data package will be sent to Ecology's SAM Project Manager and retained by WSU per retention requirements.

12.0 Audits

Audits will be performed to detect potential deficiencies in the data collected for this project. This audit will specifically include an examination of the data record for gaps, anomalies, or inconsistencies between measurements from previous monitoring events. Any data generated from calibration checks that were performed at a particular monitoring station will also be entered into control charts and reviewed to detect drift or other operational problems. In addition, data will be reviewed to assess whether MQOs have been met.

In the event that QA issues are identified based on these audits, measures will be taken to troubleshoot the problem(s) and to implement corrective actions if possible. Response actions in this case might include the collection of additional samples.

12.1 Technical System Audits

Audits of the technical system include:

1. Verifying that field staff are following the SOPs for field measurements (plant metrics)
2. Verify the data management procedures are followed including field data recording.

13.0 Data Verification and Usability Assessment

Data verification will be performed by WSU to determine the quality of the compiled data. This process involves a detailed examination of the associated quality control results to determine if the MQOs specified in the Quality Assurance section have been met. The specific procedures that will be used to verify and validate hydrologic and chemistry data are described in the following sections.

13.1 Field Data Verification

The verification process for plant data will involve the following steps:

1. Metrics of plant growth will be reviewed to identify significant changes over short periods to ascertain if those metrics reflect real world conditions or if they are errors in measurement.
2. If minor quality assurance issues are identified in any portion of the plant metrics record, the data from that station and event will be considered as an estimate and assigned a (j) qualifier. If major quality assurance issues are identified in any portion of the data from a particular station the data from that station and event will be rejected and assigned an (r) qualifier. Estimated values will be used for evaluation purposes while rejected values will not.

13.3 Data Usability Assessment

Based on the results from the processes described in the Data Verification section, the Quality Assurance Coordinator will prepare annual Data Quality Assurance Memoranda to summarize quality control results, identify when data quality objectives were not met, and discuss the resulting limitations, if any, on the use or interpretation of the data. Specific QA information that will be noted in each data validation memorandum is as follows:

- Changes in the monitoring and quality assurance plan
- Results of performance and/or system audits
- Significant quality assurance problems and recommended solutions
- Data quality assessment results in terms of precision, bias, representativeness, completeness, comparability, and reporting limits
- Discussion of whether the quality assurance objectives were met, and the resulting impact (if any) on decision-making.
- Limitations on use of the measurement data

These Data Quality Assurance Memoranda will establish the usability of data and will be included as an appendix to data reports (see Audits and Reports section) that are prepared for each water year.

14.0 Data Analysis Methods

The sections below present data analysis procedures that will be used to compare the growth of plants that will be evaluated through this study (see *Project Description* section).

14.1 Data Analysis Methods

All data analyses will be performed using open-source software (R Core Team 2023)

Effects of blend choices and location on planting success

The null hypothesis that will be tested is that there are no differences in plant blend performance in establishment, quality, or species inventory. Testing for statistical significance will be effected using the non-parametric Mann-Whitney-Wilcoxon test, with metrics of establishment, quality, % plants from original blend, % weeds, % bare ground as a dependent variables, and blend as an independent variable. All statistical testing will be evaluated at the α = 0.05 level of significance.

14.2 Data Presentation

Plant data for ditch maintenance effectiveness will be presented in a combination of tables, charts, and graphs in the final reports to illustrate trends, relationships, and anomalies with the data.

15.0 Reporting

Study findings will be sent to the SAM project manager in the form of a draft fact sheet and final report, which will explain the results for stormwater managers, NPDES permit coordinators, and others involved in stormwater management. In addition, two presentations will be created to share findings of the project with stormwater managers, including a presentation to the Stormwater Workgroup and one regional stormwater conference/workshop.

15.1 Final Reporting

A draft report will be submitted to the SAM Project Manager and to the Technical Advisory committee for review. A final report will be compiled based on feedback of the draft report, presenting all data collected, analysis results, and major study conclusions. The report shall include all monitoring data collected during study period. The reports will be submitted in both paper and electronic form (PDF) and include the following specific information:

- Graphical and tabular summaries for the collected data
- Results from any statistical analyses that are performed on the data.
- Major conclusions from monitoring performed over the water year.
- Appendices with tabular compilations of all raw monitoring data, field data sheets, and the Data Quality Assurance Memorandum (see Data Quality Assessment section)

15.2 Dissemination of Project Documents

All project documents including this QAPP will be hosted electronically on the SAM website [https://ecology.wa.gov/Regulations-Permits/Reporting-requirements/Stormwater-monitoring/Stormwater-Action-Monitoring] and the Washington Stormwater Center's website [https://www.wastormwatercenter.org/].

16.0 References

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