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Port of Portland Pump Station

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1. INTRODUCTION

The Port of Portland operates the Portland International Airport (PDX), as shown in Figure 1. As the expansion of PDX continues, portions of the airport property are in the process of improvements and upgrades. Due to the addition of more impervious surfaces and an aging piping system, there are currently stormwater management issues throughout the property. The Port of Portland separated the PDX property into twelve different drainage basins to better manage the flow of stormwater. Although many of the drainage basins at the airport have stormwater management problems, Drainage Basin 7, as shown in Figure 2, is currently experiencing ponding issues around runways and parking lots that are causing safety concerns. The Port found that only certain areas of Basin 7 were experiencing the worst water ponding and the current drainage system was not able to efficiently discharge the stormwater. The concerns of the Port of Portland are the ponding driven by hydraulic capacity limitations, stormwater discharge quality, and further failure of the stormwater management system. Due to the quantity of the flow and the areas of ponding, the best option to resolve the current stormwater management issue is to pump the stormwater off site. The Port of Portland asked our team to provide a preliminary design of a stormwater pump station at Basin 7 that would best solve their current and future critical stormwater management issues. Our preliminary design will include a water storage unit, treatment unit, pump, and piping system based on the current site conditions and regulatory standards.

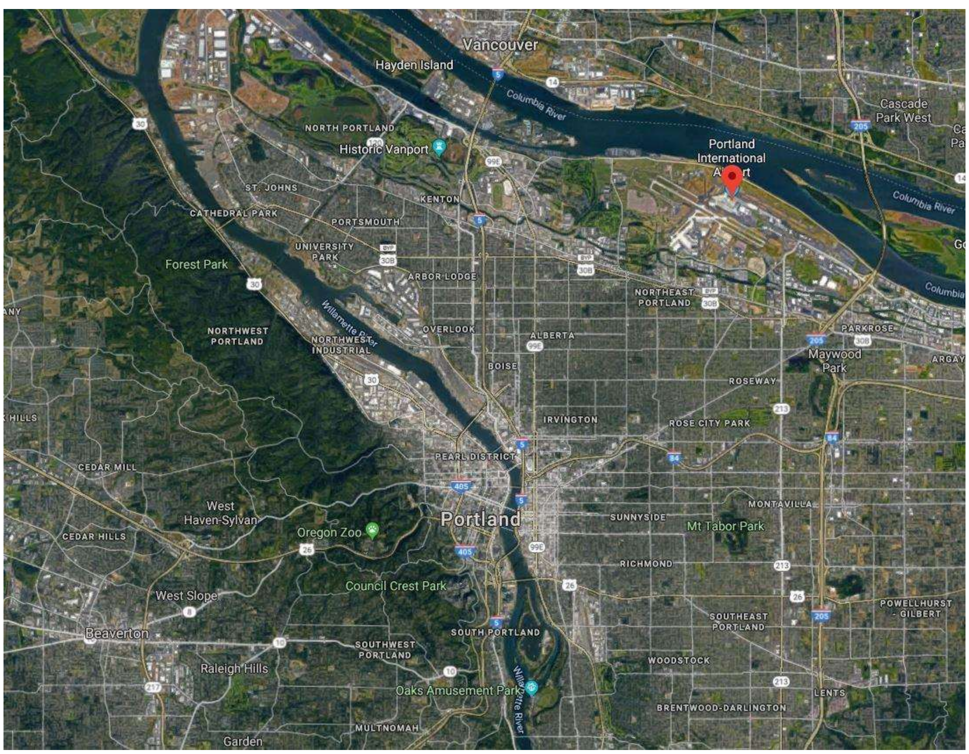

Figure 1. PDX in relation to Portland shown by red dot (Google Maps, 2019).

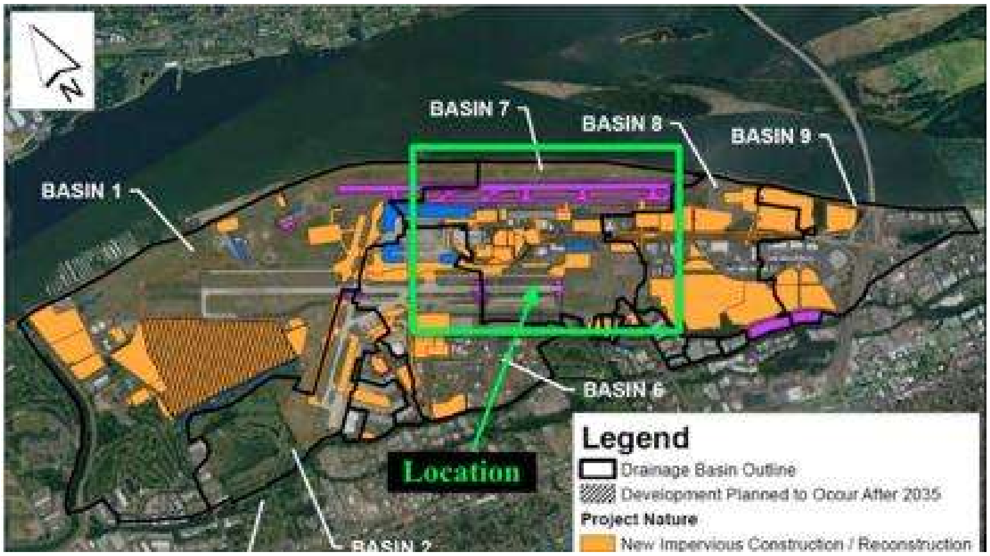

Figure 2. Basin 7 location shown by green box (Port of Portland, 2015).

For our scope of work, we were tasked to provide a 30% preliminary design of the stormwater pump station. The design encompasses internal features of the pump station and consideration for Basin 7 features. The internal components of the pump station that require sizing and specification are the storage unit, treatment unit, and the pump. Inflow and outflow pipes will also be sized to effectively handle the storm flows. A site location and pump station configuration will be proposed so that the stormwater needs are met. Our group will also analyze stakeholders and various aspects that contribute to the needs of the project. In order to complete our design task, we will use reports and current site data provided by the Port of Portland.

The purpose of this report is to explain the history of the project, our design process, and our final recommendations. The background of the project will follow all the design aspects that limited or guided our recommended design. Following the background will be the design approach which consists of the full detailed scope of work, schedule for our design, and several design alternatives. Last, the report will list the design work completed with the standards and methods used to come to our conclusions.

2. BACKGROUND

2.1 History

The Port of Portland has been expanding the PDX property for the last 70 years with the addition of multiple facilities and other various infrastructure. Over this time, critical portions of the drainage infrastructure have remained the same since the original construction. Years of additional drainage infrastructure built on a project by project basis have resulted in system capacity limitations. The Port of Portland has found that the drainage systems are not up to code with the current standards and there is an excess amount of ponding occurring in Drainage Basin 7. Currently, the Port of Portland is planning to further expand PDX for the construction of additional airline terminals. This expansion will add additional impervious surface area that will contribute to more ponding around the drainage basin. Ponding near an airport presents an issue because of airplane safety risks and wildlife attraction. Since PDX runs adjacent to the Columbia River, abundance of wildlife in the area presents a hazardous risk of endangering airplane crews and passengers. Due to the proximity of the river, the environmental concern involves discharging contaminated water into the Columbia. Stormwater at the airport will come in to contact with trash, metals from cars, and deicing fluid from the runway. The Port of Portland Basin 7 pump station project was first proposed to help solve critical issues at PDX including the excess water present on runways and parking lots and the need to meet current and future water quality regulations. The pump station's main goal is to alleviate the current issue of the presence of ponding and to treat the water before discharging into the Columbia River.

Drainage Basin 7 is located at the northern portion of PDX. It is bounded by Taxiway East to the west, the North Runway to the east, the Columbia River to the north, and the McBride Slough to the south, as shown in Figure 3. The current drainage method within Basin 7 is a primary trunk line near Taxiway A3 of the north airway that conveys southeast toward Outfall 7a through a gravity outfall pipe into the McBride Slough. Currently, the McBride Slough is an isolated collection of channels that connects into the Columbia Slough with a single discharge pipe.

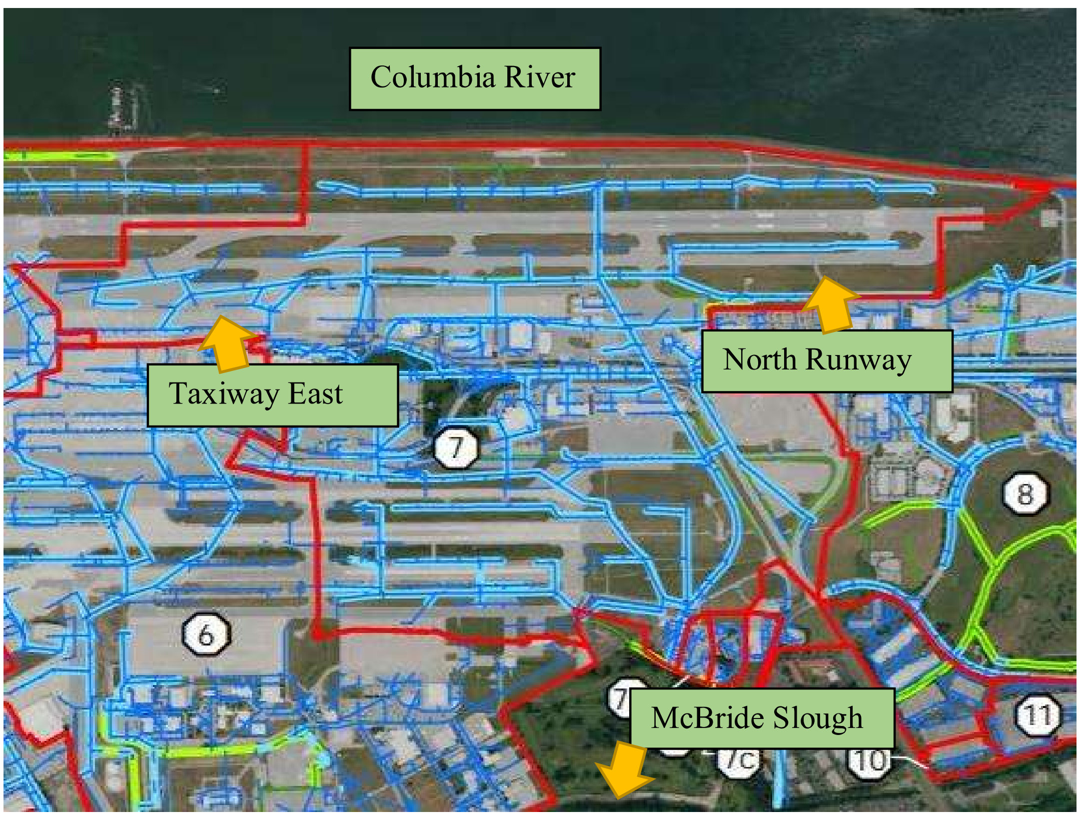

Figure 3. Location features of Basin 7 (Port of Portland, 2015).

Over the last few years, the Port has experienced severe ponding issues around the post office, employee parking lot, GA ramp, and Taxiway A. As shown in Figures 4, 5, 6, and 7, current stormwater conditions were simulated by Gresham Smith and Partners, to show the current ponding extents (Port of Portland, 2015). The models provided show that the sitting water pose a risk around parking lots and airways. After analyzing the existing conditions at Basin 7, the Port of Portland has anticipated a larger volume of runoff and therefore advised our group to reroute of portion of the flow from the McBride Slough discharge trunk line to drain directly into the Columbia River. The solution involves a stormwater pump station that is proposed to discharge into the Columbia River.

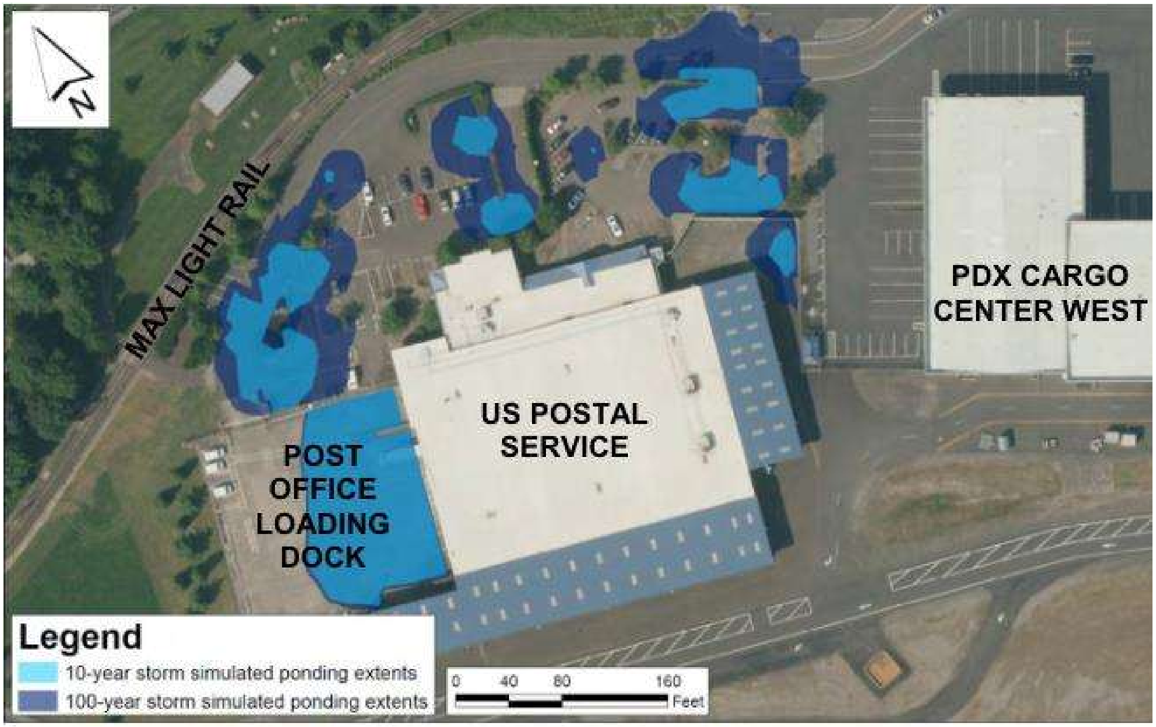

Figure 4. Ponding issues located at the Post Office parking lot and loading dock within Basin 7 (Port of Portland, 2015).

Figure 5. Ponding issues located at the employee parking lot within Basin 7 (Port of Portland, 2015).

Figure 6. Ponding issues located at Hangar K, Hangar L, the North Cargo Facility, NE Airport Way, and the Atlantic Aviation Facility within Basin 7 (Port of Portland, 2015).

Figure 7. Ponding issues located at Taxiway A and K within Basin 7 (Port of Portland, 2015).

2.2 Jurisdiction and Regulation

Due to the project's location and the Port of Portland's unique set of regulations, the jurisdiction of the project is covered by the authority of the City of Portland, the state of Oregon, and the federal government. The various jurisdiction of the project site location required analysis of the varying requirements each jurisdiction had in place. Each body has separate standards that must be met, as well as the Port of Portland's own Design Manual that attempts to incorporate all three jurisdictions and their own best practices. The Port of Portland is required to obtain permits from each level of government and follow all codes and regulations. The Port of Portland and City of Portland each own and operate separate Municipal Separate Storm Sewer Systems (MS4's) but regulate the properties of discharged stormwater with identical standards (Port of Portland, 2015). Although the airport is within the city limits of Portland, the Port of Portland still manages their own MS4 permit because they are technically under the jurisdiction of the state. The City of Portland still has some regulation requirements for PDX because it operates as an industrial establishment. Regarding the airport safety and functionality, the Federal Aviation Administration (FAA) has standards that the airport must follow. These standards highlight the importance for proper maintenance of all stormwater runoff from runways to allow for safe conditions when planes are landing or taking off.

The project must follow many regulations due to the complex jurisdiction of the Port and the airport location. There are two main aspects to the regulatory guidelines that the Port must follow when designing storm water projects. The first set of standards encompass the overall safety and ability to operate properly at the airport. These regulations are put in place by the FAA and are part of section 150/5320-5 (Drainage Design), 150/5300-13 (Airport Design), and 150/5200-33

(Wildlife Hazards) (Port of Portland, 2015). The first two sections (150/5320-5 and 150/5300-13) address the concerns of water on the runway and around major access points. Improper drainage could result in excess water that could affect not only the aircraft, but any emergency vehicles in need of accessing the runway (Federal Aviation Administration [FAA], 2018). These guidelines state that drainage systems should be designed for 5-year and in some areas of the airport 10-year storms. The third section of the FAA regulations address the potential dangers of wildlife migrating to areas of collected stormwater on airport grounds. Due to the hazards of wildlife around aircraft, complete drainage 48 hours after a storm event is required (FAA, 2018). Failure to comply with the FAA codes may result in the loss of the airport's certification. In addition to federal government concerns, water ponding that is currently present impacts local wildlife While the airport safety standards come mostly from the FAA, there are various regulations regarding the discharge of stormwater collected on an industrial site. The MS4 permit issued by the Oregon Department of Environmental Quality's (ODEQ) National Pollutant Discharge Elimination System (NPDES) regulates the stormwater treatment and discharge at the Port of Portland (ODEQ, 2019). This permit is required by all industrial facilities that discharge water from their site.

2.3 Public Health, Safety, and Welfare

One mission of Port of Portland is to provide access to national and international trade and travel. They strive to provide safe passenger air travel and cargo distribution for all customers. Considering the role Port of Portland has in transporting people and goods, it is their responsibility to maintain efficient modes of transportation. The Columbia River connects to the ocean and affects communities surrounding it. This has the potential for a negative global impact on other ecosystems and waters if pollution is not minimized at the Port of Portland. It is also important to keep the runways clear so that airlines can operate at optimum efficiency. If the ponding on the runway were to continue, a large part of PDX would suffer because air traffic control would be forced to direct their planes elsewhere, potentially causing a bottleneck effect. Also, because PDX is a home base for the Oregon Air National Guard, the runways must always be operational in case of aviation emergencies. Due to the location of PDX and the impact of an international airport, the public health and safety affected our pump station design because the Port of Portland's mission is to help continue to provide positive global impacts and meet environmental regulations.

2.4 Environmental and Sustainability

EPA Clean Water Act Section 401/404 permitting, the National Marine Fisheries Services (NMFS) consultation, and the City of Portland environmental zones include environmental and sustainability requirements for the pump station design. With the City of Portland, coordination with Port departments are also required to make sure we are in MS4 compliance. The EPA Clean Water Act regulates the water discharged from various locations and limits pollution deposited into waterways to mitigate the potential for environmental damage (EPA, 2017). The NMFS consultation evaluates the effect of minor projects on aquatic species, such as fish, to make sure they are protected against potential environmental threats. For this reason, it is important to consider the impacts on local aquatic species in order to avoid violations or potential risks to various organisms (NOAA Fisheries, 2018). In our design, it was not only necessary to meet the environmental regulation requirements, but also to be conscious of the environmental impacts made on waterways and wildlife. As a result, the final design includes water treatment that will produce cleaner water.

Potential environmental factors to take into consideration for pump and pipe failure are root growth, soil corrosivity, geotechnical stability, chemical degradation from deicer chemicals, surface land use, and seasonal variation in the ground water table. The deicing system used is a highly important environmental aspect to consider at the Port of Portland. To make sure the Port complies with the NPDES permit, they must monitor the total organic carbon (TOC) concentration at specific locations (Port of Portland, 2015). The basin is interconnected; some stormwater runoff is discharged while the rest is collected and routed to the dilute detention basin (DDB) before being pumped into one of the two dilute storage tanks. Even though this diversion takes place, water treatment has been added to previous pump stations at PDX which contains runoff from parts of the airfield where deicing may occur. Another important environmental consideration is spill control. The Port of Portland currently makes sure their spill control systems are in accordance with the Portland Stormwater Pollution Control Plan (PDX SWPCP) and Spill Prevention, Control and Countermeasure (SPCC) Plan; however, there is a potential for new spill control facilities in Basin 7 to improve responsiveness from runoff collection (Port of Portland, 2015).

2.5 Port Stakeholders

Although PDX is owned and operated by the Port of Portland, the land on which it occupies is home to many companies, ranging from rental car facilities to retail stores. Because of this, there are many stakeholders that are affected by decisions to expand and improve systems at the Port. PDX is involved in general, cargo, and commercial aviation as well as hosting the base of operations for the Oregon Air National Guard. A multitude of airlines, private and commercial, transport millions of travelers a year to and from PDX. Outside of these airside facilities, the Port owns land properties. These properties include rental car facilities, hotels, restaurants, business parks, and retail areas such as Cascade Station and Portland International Center (Port of Portland, 2015). These companies are not only valuable to the reputation of PDX, but also make up a large portion of the Port's income. Other stakeholders include various animal rights and environmental groups, the Multnomah People tribe, government agencies, and the general public. Because the project involves the protection of wildlife on airport runways, many animal rights groups have taken an interest to ensure the safety of the affected wildlife species. Species typically found in areas of standing water include gulls, geese, and other types of birds. The Columbia Riverkeeper is an environmental sustainability group focused on protecting Columbia River communities from threats such as fossil fuel export terminals and intensive industrial development (Columbia Riverkeeper, 2018). Portland's emphasis on environmental and wildlife protection makes animal and environmental advocacy groups a valid stakeholder in the project. The Multnomah People are a tribe of Chinookan people who live along the Columbia River (Native American Community in Multnomah County, 2017). Because their tribe is located next to the river, our group, in addition to mitigating the ponding on Basin 7, is striving to minimizing pollutant inputs to the Columbia River from Basin 7. Our group will have to keep in mind the goals of these environmental groups in order to have a well-rounded design.

Due to the location of Basin 7, stakeholders also include the airlines specific to Taxiway E and those which use the North Runway, adjacent hotels, general aviation hangars, and other businesses in the area. The PDX Stormwater Management Program recognizes the collaboration needed with tenants for a successful project for the Port. One way that the Port can satisfy their tenants is the designation of a Tenant Permit Coordinator, who is a member of the Community Advisory Committee (CAC) (Community Advisory Committee, 2018). The PDX management program functions as a supervisor to all stormwater related projects and any decision-making performed in the process of designing and implementing new and redeveloped projects. The program also keeps account of projects relevant to long-term planning, compliance, asset management, operations and maintenance, and engineering functions. The master plan also has a set of standards when coordinating with tenants and stakeholders to fulfill all expectations agreed upon by the two entities. This would include potential closures of facilities, nearby roads, runways, and taxiways. The master plan also considers contingencies which are put in place in case of project delays or mishaps.

2.6 Political and Societal

Discharging contaminated stormwater into the Columbia river poses some political concerns for the project. While the Port plans to treat the collected stormwater, there is still a possibility of river contamination. The Port must follow MS4 and other regulatory requirements, but even with the permits, stormwater can carry nutrients into the river that was not there before. Without careful treatment, the Port of Portland may have liability issues because of potential interference with the Columbia River's natural ecosystem. Some environmental groups and animal rights groups may find that discharging stormwater into the river is problematic and unethical. There are also communities downstream that use the Columbia River as a main water source, so if there are contaminants present the Port may be responsible. Although the Port incorporates treatment methods into their design practices, some of those methods may not be effective enough or sustained long term. In order to alleviate the potential risk of water contamination, it is important to look for more treatment options to protect natural landscapes.

There are also some societal aspects to consider due to the community surrounding the airport. There are several businesses close to the project location as well as homes across the Columbia River in Washington that may be affected by any construction needed for the project. The project location is also right next to Airport Way, a heavily traveled street. During construction of the project, there may be some issues with road blockage, noise, and movement of heavy construction material. The residents across the river specifically have expressed frustration over the lights and noise during construction at the airport. This will have to be considered because construction could last for several months. Not only does the project location impact the local community, there is also concern regarding water quality. The outfall pipe is intended to discharge into the Columbia River, which is an important part of the culture of the local society. If stormwater is not treated properly, the discharged water could affect aquatic habitats and the safety of the water. The river is used for recreational purposes and as a source of water for communities downstream. In order to prevent any degradation of the quality of the river water, treatment for the discharged water must be considered. The societal impacts on the project are important to consider because it is the Port's duty to ensure they are serving the public appropriately.

2.7 Constructability and Economic

The construction of the proposed design may present problems due to the footprint of the intended site. One of the potential difficulties with excavation for the project are the utility lines that are underground in the area. Building around these utility lines will be more cost effective but can prove to be a challenge if they are too large. Due to the nature of the area having large ponding issues, the excavation cost will increase due to the difficulties of excavating ground with high water content. There are also some issues with construction because the proposed site is in a high-density area. As shown in Figure 8, Airport Way, Atlantic Aviation parking lot, and a runway border the potential site. Therefore, the addition of pipe may cause a lot of disruption to these areas. While some construction methods allow for in-situ pipe installation, it is important to know the limitations of those methods for our design.

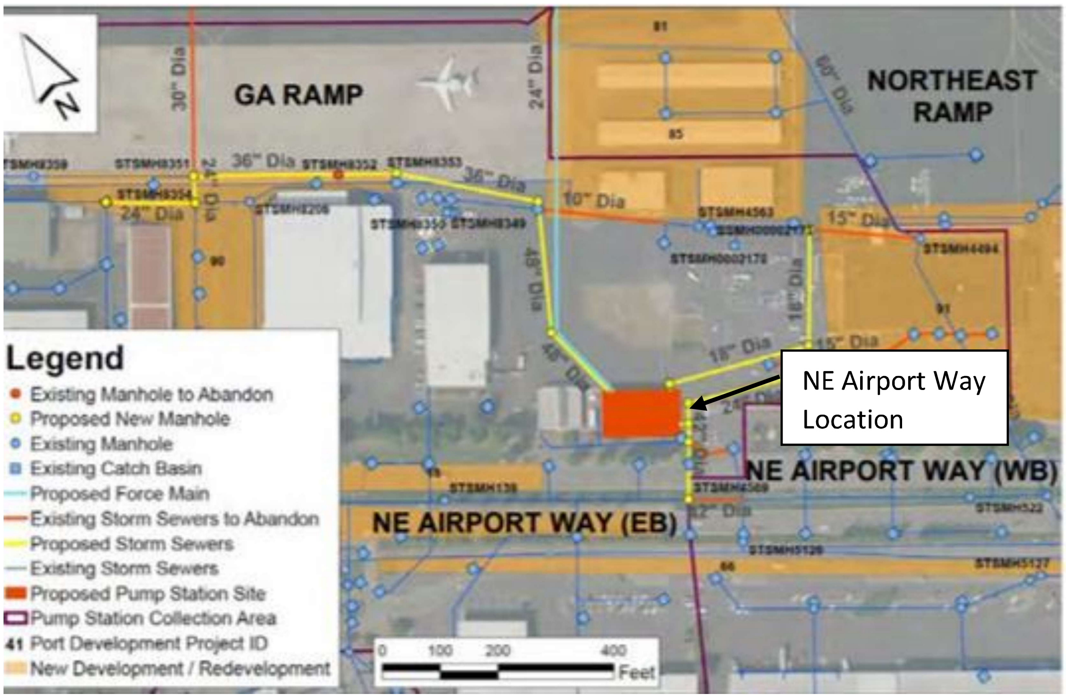

Figure 8. The location of the proposed pump station (Port of Portland, 2015).

Between 2016 and 2017, the Port has raised their operating revenues by almost 16%, decreased their operating expenses by about 3%, and increased its total net position by 8% (Port of Portland, 2018). In the process, the Port has also been able to increase the value of their assets by almost 18% (Port of Portland, 2018). Overall, a positive net cash flow of $163 million not only supports the statement that the Port is in good financial standing, but also shows strong growth and potential. Although the proposed pump station project may be costly, the Port of Portland can support a large-scale stormwater management project.

2.8 Data Collection Method

Throughout the project we have gathered information from several sources to complete our design. Most of the information we collected came from records at the Port of Portland. Our industry adviser, Brian Freeman, provided files and advice during in-person meetings or through email coordination. The main source for the background of the project came from the Portland International Airport Stormwater Master Plan, which included project history and solutions. The manuals used in our design include the Port of Portland's Design Standards Manual and the City of Portland Stormwater Management Manual. Further design recommendations were gathered from our faculty adviser, Dr. Poor. She encouraged us to continue research online, through manufacturers and the City of Portland.

3. DESIGN APPROACH

3.1 Scope of Work

This Scope of Services has been separated into three different tasks. A detailed scope of work for each task is described below, which includes the project management style, stakeholder involvement, and preliminary development design for the pump station at Port of Portland Basin 7.

Task 1- Project Management:

Objective:

Student consultants shall coordinate with academic and industry advisors as needed throughout the project duration. Coordination will occur via telephone communication, written correspondence, e-mail, and meetings.

Activities:

1.1 Invoices/Status Reports

Student consultants will prepare monthly memorandum reports, including the individual hours worked by each group member, tasks accomplished the previous weeks, and goals moving forward for the next weeks. A draft formal written report will conclude the progress of the student consultants for the first half of the project.

1.2 Coordination with Academic Advisor

Student consultants will meet with their academic advisor on a biweekly basis. These meetings will be conducted in person and cover any questions about the project and update our advisor on progress.

1.3 Coordination with Industry Advisor

Student consultants will meet with their industry advisor on a biweekly basis with communication either over phone, email or site visit. There will be at least two in person meetings, one for a site visit to see the project space and a final wrap up to conclude the first half of the project progress.

1.4 Project Coordination Meetings

There will be weekly project meetings within the team to discuss the accomplishments made that week and agendas for the following week. Memorandums will be written at a weekly basis to establish progress within the group. These rough weekly memos will be included in our formal monthly status report memorandums.

Task Deliverables:

1. Student consultants shall deliver monthly progress memorandums to faculty advisor.
2. A final written report will conclude the progress at the end of Fall Semester.

Assumptions

1. 8 monthly memorandum reports will be submitted for the duration of the project.
2. Project coordination meetings are at least one hour each week.

Task 2- Stakeholder Involvement

Objective:

To evaluate stakeholder involvement during the preliminary design.

Activities:

2.1 General Public Involvement Recommendation

Analysis of community factors and recommendations based on public's interests. Students shall keep in mind the best interests of indigenous tribes along the Columbia River, environmental advocacy groups, animal rights group, government officials, and the general public during all aspects of the project.

Task Deliverables:

1. Evaluation provided in written report.

Task 3 – Preliminary Design Development

Objective:

Student consultants shall review design standards, existing drawings for Basin 7, applicable alternative designs, design constraints, sizing of pump station, city regulations, and other relevant information to develop design criteria for the proposed pump station, trunk line, and proposed water quality treatment alternative.

Activities:

3.1 Review Data and Information

Student consultants shall review relevant portions available, including Port of Portland's 2017 Design Standard Manual (DSM), Port of Portland's 2015 Stormwater Master Plan (PDX SWMP), Federal Aviation Administration (FAA), City of Portland's 2016 Stormwater Management Manual (SWMM) and other information provided by the Port of Portland.

3.2 Prepare Alternatives Analysis for Initial Design

Prepare an analysis of location and water quality alternatives that evaluates the pump station in terms of efficiency, regulation requirements, sustainability, constructability, maintenance, cost, and creativity. This analysis will take into consideration storm water discharge location and possible trunk line expansion with recommendations for proceeding with the preferred alternative.

3.3 Develop Design Flow Recommendations

This task includes developing a peak hour flow rate for a 10-year storm event and 100-year storm event for the pump station design flow. For design flow recommendations, the infiltration rates, peak factors and dry weather unit flow factors will be determined with consideration of calculated drainage area.

3.4 Determine Pump Station Sizing and Configuration Recommendations

Preliminary sizing for Basin 7 pump, piping and structure will be completed to serve a projected 20-year life span.

- Pump sizing for installation to meet projected flows.
- Examine pump staging to accommodate specified flow ranges.
- Preliminary layout for discharge piping, flow meter, wet well, spill control chamber, flow junction chamber, water quality (BMP) flow value and valve structures.
- Examine downstream capacity impacts from discharge location

3.5 Water Quality Treatment Design

Evaluate passive and active water quality systems based on site location and treatment levels to improve contaminated storm water, while ensuring Port of Portland regulations. Students will design the chosen treatment system and provide a detailed report describing the design process involved for water quality treatment.

3.6 Prepare Typical Detail Sheet(s)

Submit preliminary site plan layout options for internal structure of the pump; the layout will consider present utility lines, and the footprint of the site. Detailed sheets will include the internal structure of the pump, the site location showing the approximate size of the pump station, and bioretention cell layouts. Students will also prepare plan and profile sheets for the pump station, trunk line, and bioretention cell locations. Cut sections of the trunk line and outfall will also be provided.

3.7 Prepare a Preliminary Design Report

Provide a preliminary design report that describes the history of the project, summarizes design criteria, and the proposed improvements. Construct a written report on the background of the project and the design approach needed to complete a preliminary design. Develop preliminary engineering drawings, including a site plan and pump station prefatory design. All reporting will comply with the Port of Portland Design Standards.

3.8 Provide Material Recommendations and Cost Estimate

Students will provide recommended materials for the trunk line and the structure of the pump station. Students will also give a cost estimate for the listed materials based on quantities found for each component.

Task Deliverables & Date:

1. Written Report, November 30, 2018
2. Final Detail Sheets, April 18, 2019
3. Preliminary Design Report, April 26, 2019

Assignments not covered

- Geotechnical report or soil analysis.
- In-depth structural analysis of the pump station.
- Temporary traffic control
- Construction sequencing
- Re-evaluating groundwater elevations
- Surveying Work
- Coordination with Atlantic Aviation

Assumptions:

1. The level of design completed under this task will be approximately 30% complete.

3.2 Design Schedule

The design schedule our team chose to follow focused on technical research during the fall semester and design focused during the spring semester. While we plan to complete everything included in our scope, our schedule was not always followed. Almost all the project history information was found in the fall, making the spring semester only for design work. However, due to setbacks and time scheduling conflicts, almost everything in our schedule during the spring was pushed back. That did cause some issues for staying on track, but we still used our original schedule to guide us in completing our tasks. Our original schedule, shown in Appendix G, displays the original expected dates for completed tasks.

3.3 Location Alternative Analysis

Basin 7 is a large area within the airport property that includes airplane ramps, parking lots, cargo facilities, and boarders the Columbia River. Due to the highly trafficked area, it is difficult to determine a location that could be easy to access, large enough, and relatively low number of pipe additions. In order to meet the flow needs for the project, we considered two different location alternatives for our pump station design NE Airport Way and North Runway 10L-28R, shown in Figure 9. Both locations have benefits and drawbacks that affect the overall project results. We evaluated the cost, sustainability, efficiency, constructability, airport regulations, maintenance, and creativity of the two alternatives when we implemented our decision matrix.

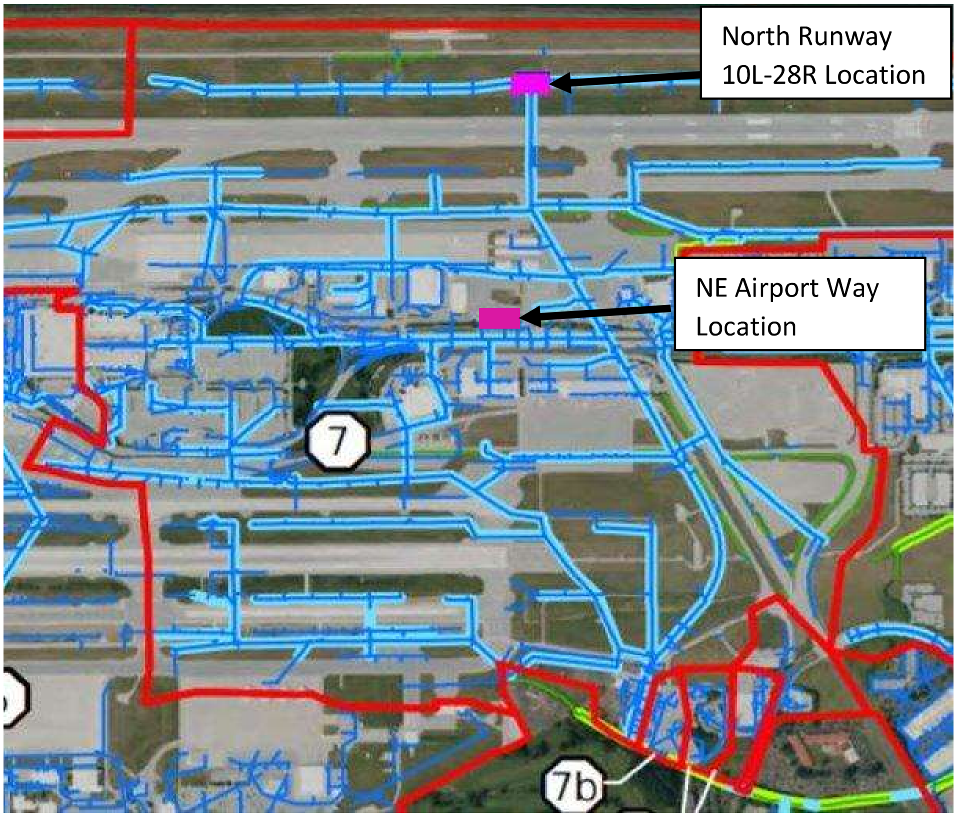

Figure 9. Location alternatives (Port of Portland, 2015).

NE Airport Way

After continuous construction in Basin 7, more impervious area has meant a greater need for stormwater removal. In order to design a stormwater pump station correctly, the location of the pump site must be considered. Basin 7 is populated with structures, runways, and roadways which make finding the best location for the pump station difficult. Although Basin 7 has many obstacles, there are still some viable options for pump station placement. The location proposed by the Port of Portland for the pump station is between NE Airport Way and the Atlantic Aviation parking lot. The NE Airport Way location was proposed mostly because of its central location in the basin. Due to the easy accessibility of the site, it makes it ideal for maintenance needs. The central location also means many of the storm lines pass through the area of the proposed pump station. This is cost effective because only minimal storm sewer lines would have to be added around the site. There are some concerns regarding the size of the lot and the proximity to Airport Way. Basin 7 is a large area and in order to ensure no ponding, the pump station must handle heavy storm flows (Port of Portland, 2015). If the pump station cannot accommodate larger flows, then it will not be efficient. The site, which once housed Building #8007, is in a compact area that makes it more difficult to expand if needed (Port of Portland, 2015). Due to the difficulty of expansion, extensive flow analysis is necessary in order to size the pump station correctly making sure it can fit within the site. Utility lines will also need to be updated and added due to the pump station. Construction around Airport Way will be necessary with the constructing of new utility lines. This section on the street is the main access point into the airport terminals and it could be nearly impossible maneuvering during the construction of additional utility pipelines. For these reasons, it is important to consider an alternative location for the pump station.

North Runway 10L-28R

At the north end of Basin 7, there is a long stretch of undeveloped land just north of Runway 10L-28R suitable to house the pump station. This new site could provide a better alternative to the Port of Portland's suggested location. The benefit of moving the pump station to the north side of the basin is the increase of space. The pump station at this location could be even more efficient at removing stormwater because the pump station could be sized appropriately. The site is also large enough to make any necessary expansions to the pump station in the future. The North Runway 10L-28R location is far away from concerning roadways, therefore it will not cause disturbance to traffic patterns or business access during the construction of the pump station. If maintenance is needed, crews could access the pump station either on the runway or from Marine Drive. However, there may still be some issues with the proximity to the runway and the risk of maintenance being so close to aircrafts.

With respect to constructability, there could be less disturbances because the site is further away from public access; however, due to the site's proximity to the runway, there may be some changes to flight schedules or closure of the entire runway during construction. This could result in some issues involving flight regulations. However, the pump station is similar enough to the proposed design that it would still meet construction and stormwater management regulations. In economic costs, the new location would require more gravity lines to be built towards the station. Since the new site is not centrally located in the basin, it may be more difficult to move the stormwater to the pump station. Adding more gravity pipelines so all the areas of the basin can be drained properly will add extra cost. The design of the original pump station and the new location are relatively similar in terms of sustainability because they would both incorporate a water treatment unit.

Recommended Alternative

After researching the strengths and weaknesses of the different locations for the pump station, our team drafted a decision matrix. The decision matrix, shown in Table 1, incorporated seven aspects, each weighted differently from 1-5 based on our client's preferences and our own criteria. Efficiency was weighted 5 because it is essential the pump station meets the need of the Portland of Portland. Regulation requirements was weighted 5 also because the Port of Portland must meet all regulations that are enforced to ensure there are no problems. Sustainability was weighted 4 because the Port's vision is to be environmentally friendly, so our design must keep that in mind. Constructability was weighted 4 because practicality and feasibility are important to consider for the proposed location. Maintenance was weighted 3 because maintenance must be done on the pump station after construction, and our design should incorporate the needs of the maintenance workers. Cost was weighted 3 because we do not want our design to be so expensive that it becomes unrealistic for the Port to construct. Lastly, we weighted creativity 1 because we wanted to consider an alternative that was something the Port of Portland would not have considered. Each alternative was then assigned a score of 1-5 for each section and the score was multiplied by the weight to determine the outcome. Our final decision was then based on the best overall outcome of the matrix.

Table 1. Decision Matrix for Location Alternatives

Decision Matrix for Location Alternative		
Alternatives (Weight factor)	NE Airport Way	North Runway 10L-28R
Efficiency (5)	15	20
Regulation Requirements (5)	20	15
Sustainability (4)	16	20
Constructability (4)	12	8
Maintenance (3)	15	6
Cost (3)	9	6
Creativity (1)	2	3
Total	89	78

The decision matrix process led our group to conclude that the NE Airport Way location was best for the project. Although the site is smaller and in a busy area, it meets all regulations and would still meet ponding removal needs. The North Runway location was a viable option, but because of the proximity of the runway and the many storm sewer additions, it would not work best for the project.

3.4 Water Quality Treatment Alternative Analysis

In order to meet water quality standards, our design will incorporate water treatment methods. Although we are evaluating treatment alternatives as an addition to our design, a standard cartridge filter unit will be included within our pump station to handle various toxins that may be present in the inflow stormwater. The cartridge filter was recommended by the Port of Portland because of the flow capacities in Basin 7. We have included a detailed description of a cartridge filter.

In addition to the cartridge filter, our team wanted to find another treatment method to provide further pollutant removal. We considered three different alternatives for additional water quality treatment in the pump station: a treatment catch basin, pervious pavement, and a bioretention system. All three of these alternatives had a variety of advantages and disadvantages, which were considered in our process of distinguishing the best management practice. We evaluated the cost, sustainability, efficiency, constructability, airport regulations, maintenance and creativity of the three alternatives when we constructed our decision matrix.

Cartridge Filter

Cartridge filters are commonly used as stand-alone treatment units. They are comprised of inflow and outflow openings, and cartridges for filtering. The selection of the cartridge filter media is based on the pollutants wanted for removal. The efficiency of the treatment unit will decrease the longer it is in use because flow through the system will decrease as more particles are trapped in the porous structure of the filter media. Therefore, replacement of filter media is required to assure proper removal of pollutants in the stormwater passing through. A manhole is included in the design to allow for access to the treatment unit. Access to each compartment of the cartridge filter is required to allow visual inspections of the inlet, cartridges, and outlet (Port of Portland, 2017).

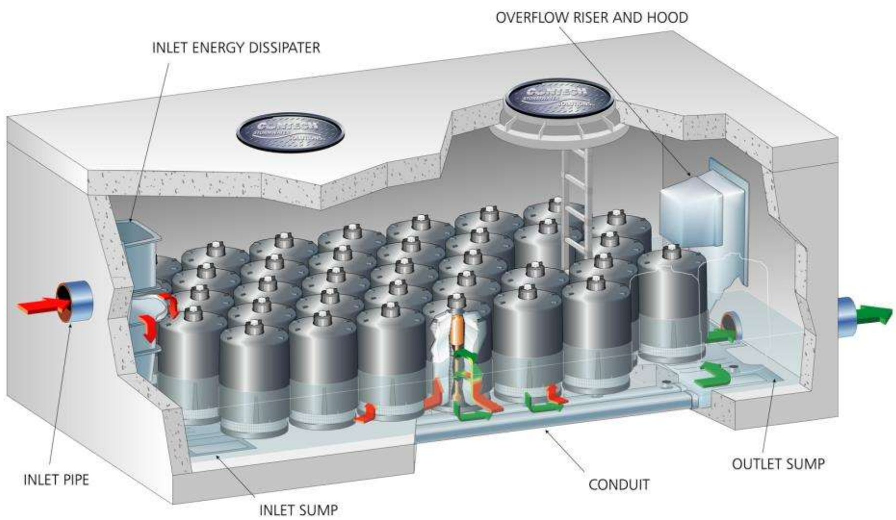

Figure 10. The components and function of a typical stormwater cartridge filter (Rainwater Management, 2019).

The benefit of a cartridge filter is the ability to perform easy maintenance practices. The filter media is specific to the type of pollutants being removed. For example, there are certain filter medias for removing hydrocarbons, total suspended solids, nutrient and metals which are all common pollutants we want to remove from the stormwater at PDX. Although this unit will require regular maintenance, this ensures the treatment will be effective in removing as many pollutants as possible from the stormwater before discharging into the river. Due to excavation, regular maintenance, and the size of the filter, this will be an expensive product. Specific costs vary on the model chosen; however, they are expected to range up to a few thousands of dollars.

Oil/Water Catch Basin

Oil and water separators are commonly used in airport locations and various situations involving the treatment stormwater runoff from streets or runways. The goal of this alternative is to not only pump the stormwater to the McBride Slough efficiently, but also treat the water from possible deicing contaminants, oil and metal contaminants, and any other types pollution. Though the primary concern for this project is to drain the stormwater efficiently and reduce spill controls, it would be beneficial to incorporate a type of filter to purify the stormwater. The flow process of an oil and water separator can be seen in Figure 10. Oil and water separators are efficient for removing various chemicals and oil pollutants; however, this type of system is not made to remove stormwater collection at high volumes because the higher speed will reduce treatment effectiveness. The performance of the separator is dependent on the inflow rate (HydroFlowTech, n.d.). Therefore, it is important to keep in mind the volume of stormwater at any given time and the space available for the catch basin and separator, as this will affect the efficiency of the separator.

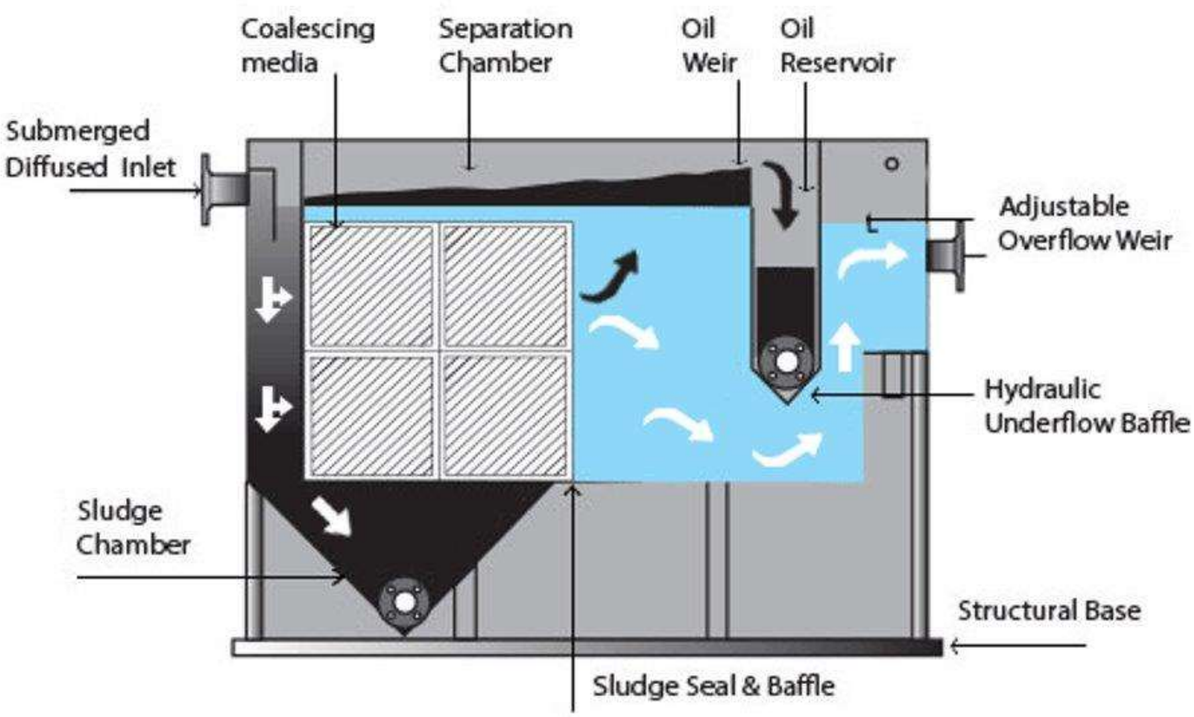

Figure 11. The components and function of a typical Oil/Water Catch Basin (Ellis Wastewater, n.d.).

In order to effectively treat the water, the oil and water separator will need to be regularly serviced, typically every 3 to 6 months. If it is not properly managed, it could pollute the ground water and surface area around it (EPA, 1999). It is also important to keep in mind the amount of dirty water flowing through the separator and knowing how often it should be clean depending on these factors. Due to maintenance regularity, excavation, and the size of this separator, this alternative would be a significant investment. An aviation oil/water separator of 25,000 gallons costs approximately $125,000 not including a possible cost of $200,000 for an installation fee and other factors to consider within the design (Eryou, 2007). This alternative could be in the upwards of a few million dollars when taking account for additional piping and excavation that may not have been needed for the development of this project.

Regarding sustainability, this alternative would be environmentally beneficial to the Port of Portland's impact on the surrounding waterways. If it is maintained properly, it could have a long-life expectancy and be able to service as an efficient device over a long period of time. Not to mention oil collected from the oil and water separator could potentially be recycled for various uses (Michigan Department of Environmental Quality, 2017). In a sense, this alternative would be a creative option when looking at the purpose of this project. Though removing stormwater and increasing spill control is the first and foremost priority, it would be effective to include the treatment of the water considering the pollution entering the waterways. This alternative is creative as part of the design because it will be an option to collect stormwater and purifying it. However, this is also a common use of treatment at various airports regarding the cleansing of contaminated water from airfield chemicals (Forester Media, 2003).

Pervious Surface

Porous pavements provide an efficient way for developers to manage stormwater. Porous pavements allow water to drain through the pavement surface and infiltrate into the soils below. Figure 11 portrays the layers potentially added to a pervious pavement design (Virginia DEQ Stormwater Design Specification, 2011). This is a cost-effective alternative to conventional asphalt that promotes infiltration and improves water quality. Stormwater drains through the porous surface and is temporarily held in a reservoir, then drains slowly into the uncompacted subgrade to restore groundwater supplies. As the water drains, microbial activity decomposes pollutants and contaminants are filtered from the water, improving the water quality (Federal Highway Administration [FHWA], 2015). This option will include high costs and difficult construction due to the need for replacing the pre-existing pavement with new porous pavement. We must also consider that part of the main area that will be affected by the construction process is the parking lots of the buildings that the tenants are renting from the Port of Portland. The excavation will be troublesome to these tenants because they will not have a parking lot available for their customers for a period of months. The adjacent runways would also have to be temporarily out of service, both factoring in an even higher cost deficit.

Figure 12. Visual representation of pervious pavement (Auburn University, 2015).

Although pervious pavement is very efficient in its task of improving water quality and providing stormwater drainage, it will not fully solve the issue of ponding in Basin 7. This is because it is not applicable for use as a pavement for runways, maintenance areas, or taxiways with heavy aircraft usage. Pervious pavement cannot bear the load of consistent usage of heavy aircraft, and the risk of spills in maintenance areas is too high for pervious pavement to be considered (Ballou, 2017). Pervious pavements are sustainable due to their high removal rates of total suspended solids, metals, oil and grease, as well as a moderate removal of phosphorous. The University of New Hampshire Stormwater Center has shown that pervious pavements provide a 75% or greater reduction of deicing salts leading to an effective method for reducing chloride pollution (FHWA, 2015). General maintenance consists of conducting a vacuum sweep in the fall and spring, making structural repairs in the summer, monitoring infiltration rates during the winter, and maintaining vegetation growth year-round. FAA guidelines restrict the usage of pervious pavement for runways with heavy aviation traffic. Other airside uses that are designed for infrequent loading such as taxiway shoulders, aprons, and service roads must follow the FAA rules and regulations for conventional pavement application. Only 7 airports in the US are using pervious pavement for airside applications such as shoulders, overruns and aprons (Ballou, 2017).

Bioretention System

Bioretention cells are a natural filtering process commonly used to help reduce pollutants such as metals and nutrients commonly found in stormwater. The addition of agricultural byproducts as well as plants are important for improving the effectiveness of pollutant removal. Plants also add an aesthetic value to the design. It's important to consider the media of the composed soil, as well as the climate resiliency and habitat of the chosen plants in the system. Typically, selected vegetation should reflect the solar energy of the area to determine the speed in which the plants can maximize evapotranspiration. It is also important to consider the type of plant: whether it is a native plant and will have perennial vegetation. Figure 12 visually represents the general components incorporated in a bioretention cell (Michigan Department of Environmental Quality, 2017). Because soil is a porous media, stormwater can infiltrate into the soil, minimizing the volume of stormwater needed to be discharged in the outflow pipe and help to reduce ponding. On the other hand, it is important to keep in mind that soil requires a slower infiltration rate than various medias which may allow water to pass through at a faster rate.

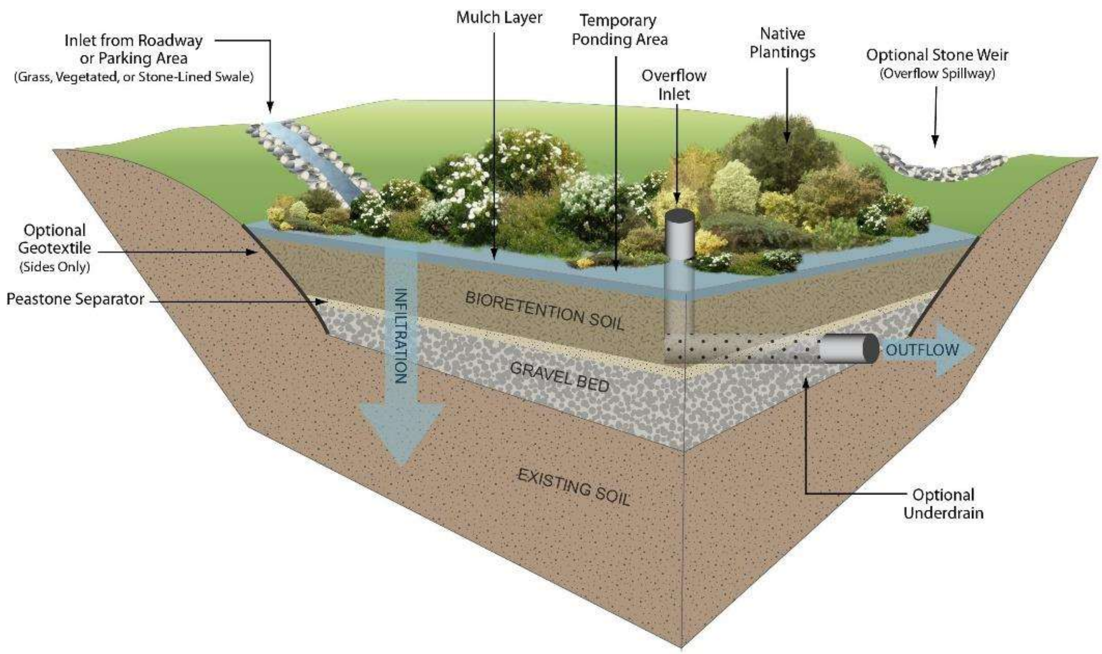

Figure 13. General components and function of a Bioretention Cell (Massachusetts Department of Environmental Protection, n.d.).

A major benefit of this alternative is the lower cost for implementation. Because the majority of this system is soil and plants, it would not be as expensive as other alternatives; however, excavation and additional piping may be needed depending on the cell location. This natural process is self-regulating which also allows for minimal maintenance and sustainable life of the system. The main downfall to this system is that it could attract wildlife because it is a natural habitat for various animal species, even though the surrounding Port of Portland area is not. Based on our proposed site locations for these bioretention cells, an additional trunk line may be a needed, which add more work in terms of cost and constructability of the design. We would use the bioretention cells to replace the Atlantic Aviation parking lot planters as well as the landscape around the pump station. These locations are ideal for bioretention cells because the close proximity to high volume roads and the pump station location. A bioretention system efficiently removes metal from stormwater; these metal concentrations are very high due to the high-volume traffic in the surrounding roads and parking lots. Overall, as a leading environmental conscious company, this bioretention alternative aligns with the goals and mission of the Port of Portland because it is an environmentally friendly alternative incorporating a natural system process to remove common metals including copper and zinc that are found in stormwater.

Recommended Alternative

The decision matrix, shown in Table 2, incorporated seven aspects, each weighted differently based on our client's preferences and our own criteria. Efficiency was weighted 5 because the water quality treatment added to the design should be a solution which increases the overall efficiency of the system. Regulation requirements was weighted 5 also because the Port of Portland must meet all water quality regulations in order to discharge into the Columbia River. Sustainability was weighted 5 because the chosen water quality treatment should align with the Port's vision of an environmentally friendly design. Constructability was weighted 4 because practicality and feasibility are important to consider for the proposed treatment alternative. Maintenance was weighted 3 because maintenance must be conducted on the treatment alternative. Cost was weighted 3 because we do not want our design to be so expensive that it becomes unrealistic for the Port to construct. Lastly, we ranked creativity 1 because we wanted to consider a water quality system that added our own flare to the overall project. Each alternative was then assigned a score out of 5 for each section and multiplied by the weight of the section. Our final decision was then based on the best score of the matrix.

Table 2. Decision Matrix for Water Quality Treatment Alternatives

Decision Matrix for Water Quality Treatment Alternative			
Alternatives (Weight factor)	Oil/Water Separator	Pervious Pavement	Bioretention
Efficiency (5)	15	15	10
Regulation Requirements (5)	25	15	25
Sustainability (5)	10	10	25
Constructability (4)	4	4	16
Maintenance (3)	6	9	9
Cost (3)	12	15	12
Creativity (1)	3	4	3
Total	75	72	99

The decision matrix process led our group to conclude that the bioretention water quality alternative was best for the project. Although the bioretention lacked efficiency, it had the highest scores for most of the other criteria. The oil/water separator is still a viable option due to it meeting most of the requirements; however, its scores lacked in the sustainability, constructability, and maintenance criteria. The pervious pavement was less viable, giving it a low rank due to its low constructability, little regulation requirements, and poor sustainability.

4. DESIGN

4.1 Pump Station Design

The components of the pump station include the pump, wet well, water treatment units, piping network, and junction box. The overall station fits within a 100' x 50' footprint located along NE Airport Way, shown in Figure 13. Within the pump station, water will enter the water treatment unit, then into the wet well, and then pumped out to the Columbia River. In the case of large rain events, the junction box will divert flow from the treatment unit into the wet well. There is also an added element of bioretention that allows for natural stormwater treatment.

Figure 14. Aerial photo of the pump station site (Google Maps, 2019).

The design criteria that was considered in our design was efficiency, regulatory requirements, sustainability, constructability, maintenance, and cost. While keeping these in mind, we analyzed our proposed internal components to better maintain stormwater within Basin 7. The final preliminary design of the pump station uses the criteria mentioned above, standard practices, and the preferences of the Port of Portland.

4.1.1 Pump

The pump was the first component our team sized during design. In order to properly size the pump, our group needed the peak flows for a 10-year and 100-year storm. Our pump will not mitigate all the ponding that is currently in Basin 7, but it is intended to collect stormwater from the area shown in Figure 14. Using the Storm and Sanitary Analysis file provided by the Port, we were able to simulate 10 and 100-year 24-hour storms that provided flows within Basin 7. The flows within the relevant subbasins in Basin 7 were summed to determine each flow. The 10-year peak flow was found to be 32.5 cfs and the 100-year peak flow was found to be 45 cfs.

Figure 15. Area of Basin 7 to be directed to the pump station (Gresham Smith, 2014).

After the peak flow was determined, the total head loss was needed to create a system curve. Using the Hazen-Williams equation, we determined the total head loss in the force main pipe. Once our system curve was completed, we were able to select a pump (Engineered Software, Inc., 2019). Based on our industry adviser's preferences, we only compared pumps manufactured by Flygt. The Port also specified to design for pumps in parallel, to maximize the efficiency, and for vertical turbine pumps, because that is what the Port mostly uses. We specified our pumps to handle a 10-year flow, a static head of 10 ft, and a total head loss of 15 ft. The resulting pump curve, shown in Figure 15, shows the operating flow with two pumps is 32.5 cfs.

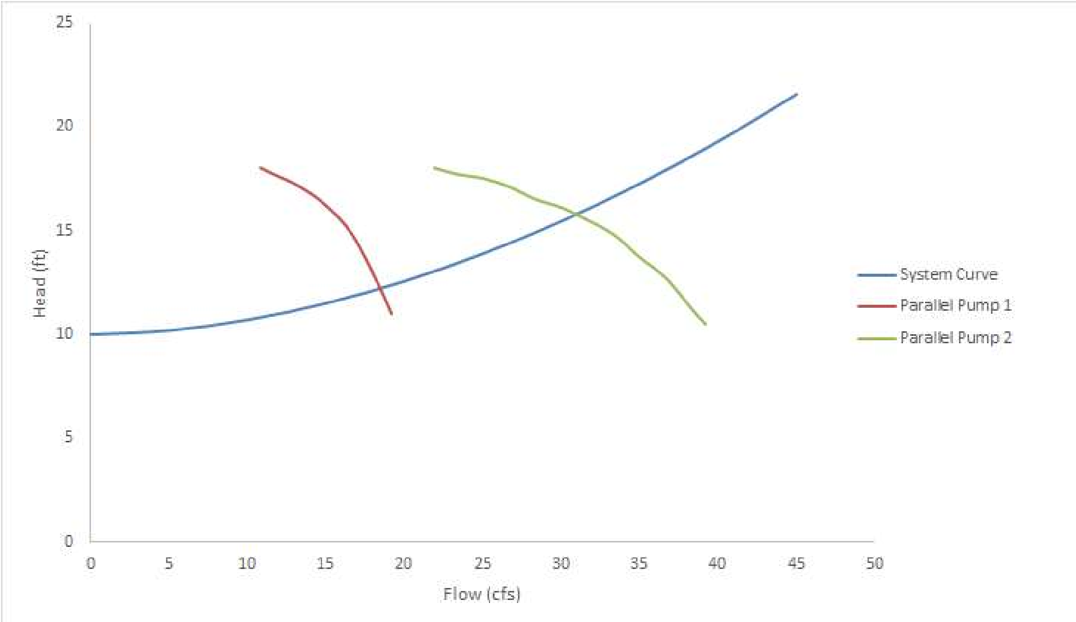

Figure 16. Pump curves for two parallel pumps.

Based on the pump curve and specified preference, out team found that two 30GHXC lineshaft Flygt pumps. The 30GHXC model, shown in Appendix D, has a 30-inch bowl diameter and a synch speed of 428 rpm. While the two pumps in parallel will handle the flow of a 10-year storm, it is also important to have a third pump for redundancy. The third pump is not planned to remain operational, but instead kept as a back-up in case one pump fails in a large storm event. These pumps will be housed within the pump station building. The pumps will move water that is being stored within the wet well out into a force main pipe. The force main will then outfall into the Columbia River. The recommended pump model should effectively prevent ponding within Basin 7.

4.1.2 Wet Well

The wet well design shown in Appendix D follows the design standards given in the City of Portland Pump Station Design manual and the City of Portland Stormwater Management Manual provided by the Bureau of Environmental Services, as well as the Port of Portland's Design Standards Manual. The wet well is designed using a flow of 32.5 cfs, the design flow for a 10-yr storm event and placed 6 feet below ground surface level. The dimension of the wet well is a 50 ft x 50 ft area that is 20 feet deep; the total volume of the wet well is 50,000 $ft\text{-}^{3}$. Sensors will be placed at the 4 ft, 8 ft, and 12 ft water elevation markings to determine when the pumps will turn on or off. The sensor at 4 ft elevation will determine when both pumps will be turned off, allowing a 4 ft dead space that will be continuously filled with water at the base of the wet well to accommodate the 3 ft diameter outflow pipe. The first pump will be turned on at the 8 ft water elevation mark and run at 16.25 cfs. The second pump will be turned on at the 12 ft elevation mark, for a combined 32.5 cfs. This allows for a 10.25-minute cycle time for both pumps when in operation. There is a 3 ft excess storage space, for a total of 7500 ft^3 of extra stormwater in the event of a storm with a larger intensity than the 10-yr design storm, or for future expansion of larger pumps to accommodate a higher intensity storm in the future. The wet well is designed for three inflow pipes, a 4 ft diameter pipe from the junction box, a 4 ft diameter pipe from the treatment unit, and a 6 in diameter pipe from the bioretention unit.

The wet well is designed to effectively handle a 10-yr storm event. If a larger intensity storm occurs, Basin 7 will still experience ponding for the duration of the storm. The exceedance probability of a 10-yr storm event is 10 percent. This shows that Basin 7 should experience ponding during 10 percent of all storms in a year. Designing for a higher intensity storm is not feasible for a wet well design. This would require the design of a detention basin, much too large for the area of our project.

4.1.3 Water Treatment

Due to the nature of the stormwater runoff in Basin 7, water treatment is necessary for discharging into the Columbia River. The preferred method of water treatment from the Port is a cartridge water filter. The guidance from our industry adviser and past internship experience led us to use a filter model from Contech Engineered Solutions. The Contech StormFilter cartridge filter is widely used in the state of Oregon. Based on the peak flow rates, we were able to determine a 44-cartridge unit would handle the amount of toxins that may be present in the stormwater. The peak diversion StormFilter model SFPD0824, shown in Appendix D, is an 8' x 24'precast concrete unit that will be 8 ft deep. The structure will house 44 cartridges that contain media that removes total suspended solids, hydrocarbons, nutrients, metals, and other common pollutants (Contech, 2019). During storm events, water passes through the filter media within the cartridge and buoyant forces pushes the filtered water free. The StormFilter is designed so stormwater comes into contact with all layers of the media, which guarantees longevity of the media and cleanliness of the water (Contech, 2019).

As an addition to the pump station design, a bioretention system is included as a part of the water treatment for the preliminary design layout. Bioretention cells are a natural filtering process commonly used to help reduce pollutants such as metals and nutrients commonly found in stormwater. Based on previous research the addition of agricultural byproducts, as well as plants, is important for improving the effectiveness of pollutant removal. Plants also add an aesthetic value to the design, as this will be located next to Atlantic Aviation parking lot and alongside NE Airport Way leading up. It is important to consider the media of the composed soil, as well as the climate resiliency and habitat of the chosen plants in the system. Typically, when considering the selected vegetation, it is important to evaluate the type of plant: whether it is a native plant and will have perennial vegetation. Because soil is a porous media, stormwater can infiltrate into the soil, minimizing the volume of stormwater needed to be treated before discharging in the outflow pipe and it will help to reduce ponding in the parking lot area.

The bioretention system will be located around the pump station housing and above the wet well to fill in the area of the site that would otherwise be comprised of dirt. Within the bioretention, there will be a 48" diameter manhole for maintenance access to wet well because it is buried underneath the bioretention system. Due to the large top width sizing, it can be considered a bioretention rain garden per the Stormwater Management Manual. The top area of the bioretention is 3200 square feet. In order to allow gravity to activate the flow of the stormwater into the wet well, the sides of the bioretention are sloped at 2.5% to allow water to drain into an inlet pipe that will then discharge the collected stormwater into the wet well. Using the rational method, calculations for approximate flow into the bioretention rain garden were used to size the pipe going into the wet well. Below the gravel the pipe will be 6 inches in diameter due to a smaller predicted flow; the pipe will be a perforated HDPE material as allowed in the Port of Portland design standard manual (Port of Portland, 2017). The bioretention depth contains 3.5 feet of soil media to allow for maximum infiltration, .75 feet of pea gravel to separate the last layer of 1.75 feet of ¾" to 1 ½" gravel (Stormwater Management Manual, 2016). The soil media for the system is comprised of 2/3 sand and 1/3 compost, known as City of Portland bioretention soil mix (BSM); this ratio allows for good infiltration and water retention (S&H Landscape Supplies & Recycling, 2019). Native plants to the Pacific Northwest are included in the system design. Bureau of Planning and Sustainability contains a list of proper plants to include in the bioretention system to perform best management practices (Portland Plant List, 2016). Based on the area of the bioretention rain garden, for every 100 square feet, 80 herbaceous plants can be included or 72 herbaceous plants and 4 shrubs (City of Portland, 2016).

A major benefit of this alternative is the lower cost for implementation. Because most of this system is soil and plants, it would not be as expensive as other alternatives; however, additional piping will be needed to discharge the stormwater into the wet well. Due to the need for excavation of the site for the pump station, that will not be an added cost to the overall design. This natural process is self-regulating which additionally allows for minimal maintenance and sustainable life of the system, as well as an aesthetic appeal. Though the design only includes a bioretention location on the pump station site, it is recommended to include more bioretention systems within the parking lot to improve infiltration rates and lessen runoff. It is recommended to use the bioretention cells to replace the Atlantic Aviation parking lot planters. This location would be ideal for bioretention cells because of the close proximity to high volume roads and the pump station location as well as the system's ability to separate metals shed by vehicles from the stormwater runoff. Overall, as a leading environmental conscious company, this bioretention alternative aligns with the goals and mission of the Port of Portland because it is an environmentally friendly alternative incorporating a natural system process to remove common metals including copper and zinc that are found in stormwater.

4.1.4 Piping Network

The piping network for the pump station design is a high-density polyethylene (HDPE) material. According to the Port design manual, HDPE meets the required standards for the pump station design. The benefits of this material are its rugged, flexible and durable properties that can resist chemical and environmental stress. HDPE has a sustainable footprint, which is a highly important component in regard to the project goal of discharging clean stormwater into the Columbia river, but in addition it is light weight, it offers a zero-leak rate due to the seamless nature of the pipe system (HDPE Pipe and Fittings, 2016).

To determine the piping diameters, uniform pipe flow was assumed using the Manning's equation. The inflow pipe leading into the pump station is sized based on a 100-year storm, resulting in a diameter size of 48 inches. The force main pipe leading into the Columbia rivers is sized based on a 10-year design storm, resulting in a diameter size of 36 inches. Due to the large diameter size needed for both the inlet and outlet pipe, a smooth, non-corrugated inside lining for HDPE pipe is ideal to diminish the amount of wear on the structure; not to mention, the smoother texture will lower the roughness coefficient of the material, leading to a smaller pipe diameter, overall cutting down both cost and space.

4.1.5 Junction Box

The junction box is used for a diversion pipe to connect directly to the wet well in an event when the treatment unit may be at capacity. During larger flow events, the remaining stormwater that is not being treated will divert into the wet well. The shape of the junction box is circular to allow for the diversion pipe connection to be next to the treatment pipe and slope downward. To accommodate for diameter pipe of 3 feet, the diameter chosen for the junction box is 8 feet and the depth of the junction box is 8 feet deep. The junction box configuration, shown in Appendix D, shows the orientation of the inlet and outlet pipes. The junction box will work to guide flows and prevent the water quality treatment unit from reaching overflow.

4.2 Envision

Envision is a rating system and best practice resource created by the American Society of Civil Engineers (ASCE) intended to help engineers make their projects more sustainable. Once our design was complete, the final checklist to go through was the envision tool to rate our project. Shown in Appendix G, there were some difficulties with each section of envision because many of the different questions were not applicable to the stormwater pump station project. When the envision checklist was complete, some portions were not completely accurate. Although there are some discrepancies due to the non-applicable questions, it is still clear that our project improves and enhances sustainability overall. Our project will successfully deploy sustainable solutions and may open new opportunities to add on or further improve the project after it has been implemented. While the envision tool is not always applicable for every project, it is still important to use these types to checks to ensure engineers are making best practice decisions.

4.3 Cost Analysis

The cost analysis was conducted using outside resources as well as the Port of Portland Stormwater Master Plan. A large part of the overall labor and material cost was in part of the specific units recommended for project efficiency. At $135 and $180 per linear foot (LF) of 36" and 48" HDPE pipe, respectively, the total piping capital cost totaled just over $320,000. With labor estimates from RSMeans, the total cost for material and installation of the piping network totaled $364,650. The Port of Portland Stormwater Master Plan estimated that the recommended water treatment unit used in the design would total $1,000,000 with capital cost and installation included (Port of Portland, 2015). Three lineshaft pumps from Flygt totaled $15,000 which also concurred with a similar estimation found in the Stormwater Master Plan (VIT Lineshaft Turbine Pumps, 2019). The material proposed for construction of the wet well and junction box was unreinforced concrete. At a total surface area of 1151 LF for both units and a price of $22.61 of capital cost and labor, the amount totaled $210,000. A study conducted by Pennsylvania State broke down the estimated costs of a bioretention cell. They concluded that a bioretention unit would be around $3 per square foot of bioretention cell area and $15 per square foot of permeable soils (Jarrett, 2019). Therefore, the total cost of the bioretention cell was estimated to be $360,000. In total, the cost was $1,934,650. In an effort to leave room for discrepancy, the total was rounded to an even $2 million for labor and material cost.

A breakdown of the project cost included the mobilization and de-mobilization costs, estimated to be 10% of the labor and material cost. Bonds and insurance costs at 2.25% of labor and material costs. Construction management costs at 10% of labor and material costs. Pre-design and design costs to be 4% and 10% of labor and material costs, respectfully. A contingency was also factored into the overall total in case of emergencies during the life of the project. The contingency was estimated to be 15% of the subtotal, bringing the total cost of the project to $3133750.

Table 3. Breakdown of Total Estimated Cost for Pump Station Design and Implementation

Particulars	Amount ($)
Labor and Material Cost	2,000,000
Mobilization and De-Mobilization	200,000
Bonds and Insurance	45,000
Construction Management	200,000
Pre-Design	80,000
Design	200,000
Subtotal	2,725,000
Contingency	408,750
Total Cost	3,133,750

4.4 Conclusion

Our main objective for the stormwater pump station was to create the most efficient and sustainable solution to solve the ponding issues at Basin 7. By evaluating the design presented to us in the Portland International Airport Stormwater Master Plan, we wanted to apply some creative differences in our own design. While maintaining good communication with the Port, we were able to incorporate a more sustainable water treatment system with the inclusion of a bioretention rain garden. Other components within the pump station had basic sizing practices, but we still tried to come to our own conclusions rather than following what the Port had already done. By further research and discussion with our faculty adviser, we were able to conclude on the final configuration of the pump station in Basin 7. While this configuration will provide adequate storm management solutions for a 10-year flow, the desired 100-year flow for the wet well was too large for the site. Our industry adviser originally asked for us to size the wet well for a 100-year flow, but because of the storage volume requirements, that was not a feasible size for the site. Therefore, our design incorporates a 10-year volume for the wet well. The smaller wet well may mean there will still be ponding in portions of the basin, but the pumps should still be able to mitigate some of the flow.

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APPENDIX A: TEAMWORK AND PROFESSIONALISM

Team Dynamics

During the semester, our group met on a weekly basis. Depending on the importance of the information that needed to be discussed, sometimes the group would meet more than one time a week. These meetings typically consisted of touching base with each other to relay information on what each group member had accomplished during the week, as well as to divide workloads for the upcoming week. Meetings were also planned to record billable working hours for each member and track progress as the project proceeded, as well as strategize an agenda for the upcoming faculty or industry advisor meeting. The group held meetings with our faculty and industrial advisers on a bi-weekly schedule. These meetings acted as an update for both our faculty and industry advisor to keep them up to date with the progress of our project. Meetings with our faculty advisor, Dr. Poor, were always held in her office in Shiley Hall. These meetings consisted of updating Dr. Poor with our progress, clarifying any questions we came across during our research and design process, as well as bouncing ideas for design options. Meetings with our industry advisor, Brian Freeman, were similar to meetings with Dr. Poor but were typically email interaction or conference call. There were two meetings with Brian that were conducted in person. One meeting on 1/19/2019 was held at the Port of Portland and several documents were exchanged to begin the design phase of the project. The other meeting on 2/17/2018 was held on the University of Portland campus and included an explanation for the SSA file given to the team earlier.

The leadership role within the group was taken on by Madeline Tuff with help from Camille Morgan. As a leader, Madeline conducted each meeting that was facilitated between the group, as well as the meetings between the group and our advisors. She was the main communication link via email to both Brian and Dr. Poor. Communication between the group was typically face to face communication in and outside of the classroom, and the use of group messaging with text. The leadership role also incorporated the role of an overseer, supervising the groups work and making sure everyone was kept on task.

Generally, project decisions were made with a compromising approach. This way, everyone's voice was heard, and the group could make conclusions which everyone agreed on. The group agreed that if a compromise could not be met, then the decision would be put to a vote.

Modern Engineering Tools

Our project required certain programs and applications to help us complete our design. Shown in Table 3, these tools helped us communicate, design, and schedule our project. Certain programs, like Excel and PowerPoint were tools we already knew and were comfortable with using. Microsoft Project and AutoCAD were tools we all had some understanding of, but we learned other aspects of the programs. In order to stick to our project goals, we used Microsoft Project to schedule our design and project timeline. AutoCAD was used to draft our drawings and provide a better understanding of our pump station layout. Storm and Sewer Analysis and Pump-Flo were both programs we had never used before. Storm and Sewer Analysis (SSA) is an Autodesk software that displays the pipe network within an area and can simulate storms. SSA allowed us to find our peak flows and size certain pipes for our pump station design. Pump-Flo is an online tool that helps match your water needs with a pump model and manufacturer. This allowed us to choose a pump that best fit our requirements.

Table 3. Engineering tools used throughout the project.

Modern Engineering tools	Description of Use
AutoCAD	Used for design process: Plan and Profile view of pump station, detail sheets provided.
Microsoft Project	Used to create a detailed schedule for planning deadlines and scheduling due dates.
Microsoft Excel	Used to create tables, calculations and table formations
Microsoft PowerPoint	Used as an aid for our presentation as well as the base formatting software for our presentation board.
Storm and Sewer Analysis (SSA)	This software will be used to properly model hydraulic flow throughout the basin. SSA will also be used to simulate the existing conditions at Basin 7 and the conditions after our design is implemented.
Pump-Flo	The online software compared different pumps based on given flow and headloss in a system.

Engineering Codes

The codes our team used were found from the Design Standards Manuel from the Port of Portland. The manual outlines which standards the Port must follow in order for their designs to meet several requirements.

Table 4. Codes and Regulations followed throughout the project.

List of Codes Used	Description
FAA Hazardous Wildlife Attractant Criteria (FAA 150/5200-33)	Ponding events create a potential to pose hazardous wildlife attractant which is a risk to accompanying aircraft
FAA Airport Drainage Design Criteria (FAA AC 150/5300-13)	Failure of the basin & trunk line will create extensive ponding within the runway safety area (RSA). Therefore, the RSA must be drained by grading or storm sewers to prevent water accumulation.
FAA Airport Drainage Design Criteria (FAA AC 150/5320-5)	Airport drainage systems should provide for safe operation of the facility and convey design flows without surcharging inlets or otherwise causing surface flooding for Runways, taxiways and aircraft aprons during

	the 5-year FAA drainage design storm and 50% must remain free from ponding during the 10-year storm.
Clean Water Act 401	Applicant that discharges must comply with Clean Water Act and state regulations and be permitted accordingly
Clean Water Act 404	No discharge of dredged or fill material may be permitted if water would be degraded and/or a practical alternative exist

Engineering Knowledge

When we were first introduced to the project, we were surprised by the amount of permitting and regulations that were associated with the construction of a pump station. Because the Port follows the regulations of the City of Portland, the State of Oregon, and the Federal Government, we needed to learn how each level was operated and the goal of each permit or regulation. Our research led to many hours spent sifting through the FAA website and the Stormwater Master Plan. We also needed to learn a lot about the Port of Portland's vision and what was most important to them in projects on PDX grounds. We were able to distinguish a project design criterion for the pump station based on many discussions with our industry advisor, Brian Freeman. We also conducted in depth research about bioretention systems, pervious pavement projects, and oil/water catch basins. Research included evaluating existing sites with these systems in place via engineering journals. We also needed to learn about the economics of an engineering project. Because we have not talked about the business side of engineering in any of our classes, we needed to find out how cost played a role in our project. We read through the Port's financial history and the Stormwater Master Plan to understand costs included in this project and the role it had for our design. Overall understanding a project life cycle and the expectations of the industry was a large learning curve. After working on this project, we better understand the process as a whole and know how to improve our work ethic to be more efficient and proactive.

Separation of Work

The group separated work into the Fall and the Spring semester. The Fall semester consisted of conducting background research for the project, the design approach, and drafting our alternatives analysis. The background research consisted of the history of the problem and why the project is necessary in the first place, the constructability, economic, environmental, jurisdictional, political, regulatory, societal, and global aspects of the project. The design approach consisted of drafting and finalizing our scope of work as well as well as concluding that the extent is a 30% design. The spring semester incorporated the finalization of our alternative's analysis and more of the actual design work involved in finalizing our design of the pump station.

Contributions

Aaron: Researched and wrote the history of the problem and the original conditions of the problem and the site. Created and formulated appendix A. Provided design of wet well and helped with overall final design. Helped edit and revise entirety of the paper.

Bradley: Researched and wrote about stakeholders, design work and conclusion. Wrote up and determined the tentative schedule, and greatly contributed to edits and helping write various parts of the paper. Also helped provide all the necessary drawings needed for the project and helped with overall final design.

Camille: Researched and wrote about global, sustainable, and environmental aspects, as well as the oil/water separator alternative, discussion and some contribution to the conclusion. Also helped provide bioretention analysis and data for the project and overall final design. Helped organize the table of contents, as well as edit and revise various parts of the paper.

Dylan: Researched and wrote the introduction, constructability and economical aspects, and data collection method. Created the tentative weekly schedule and organized Appendix B and E. Provided the envision analysis as well as the cost analysis and helped with overall final design. Helped edit and revise parts of design report.

Madeline: Researched and wrote the jurisdictional and regulatory aspects and political and societal aspects of the paper. Summarized the scope of work and outlined tasks that will be completed. Organized the location alternative for the alternative analysis. Provided water treatment analysis as well as created pump curve and helped with overall final design. Helped edit and revise parts of the paper.

Table 5. Weekly billable hours

	Billable Hours				
Week of (Monday Start)	Madeline Tuff	Aaron Madden	Camille Morgan	Dylan Tran	Bradley Hayashi
1/14/2019	3	3	3	3	3
1/21/2019	2	2	2	2	2
1/28/2019	3	2	3	2	2
2/4/2019	3	3	3	3	3
2/11/2019	4	4	4	4	4
2/18/2019	4	3	4	3	3

2/25/2019	4	3	4	4	3
3/4/2019	1	0	1	0	0
3/11/2019	4	3	3	3	3
3/18/2019	6	5	6	5	5
3/25/2019	6	6	5	5	5
4/1/2019	8	9	8	6	7
4/8/2019	10	9	11	7	9
4/15/2019	12	10	13	10	12
Total Hours (Thus Far)	70	62	70	57	61

APPENDIX B: MEETING MINUTES & MEETING AGENDAS

On a weekly basis, our team met and discussed the progression of the report as well as what work needs to be done throughout the semester. Most of these meetings lasted on average 30 minutes to an hour. Our meeting minutes and agenda with our industry and faculty adviser are shown in Table 6 below. We met with Dr. Poor every other week, while we met with our industry adviser sporadically throughout the semester.

Table 6. Describes the meetings with the Industry and Faculty advisors

Meeting Date	Meeting Time	Meeting Agenda
1/17/2019	1 hour	Discuss project with industry advisor
1/22/2019	30 minutes	Discuss project plans for second semester with academic advisor
1/29/2019	45 minutes	Discuss project and design expectations with industry advisor
1/31/2019	2 hours	Met with MCDD engineer Bill Owen and toured a few of their pump stations
2/5/2019	30 minutes	Discuss project details and next steps with academic advisor
2/14/2019	1 hour	Discuss project and asked questions with industry advisor.
2/19/2019	30 minutes	Discuss specific project details with academic advisor and gather more information
2/27/2019	15 minutes	Called industry advisor to ask questions regarding SSA program.
3/14/2019	30 minutes	Discussed ethics panel discussion and questions regarding project setbacks with academic advisor
3/28/2019	30 minutes	Discuss project calculations and pump curve design with academic advisor
4/09/2019	35 minutes	Discuss questions on design with academic advisor
4/11/2019	30 minutes	Discuss progress on design report with academic advisor
4/15/2019	30 minutes	Discuss progress on design report with industry advisor

APPENDIX C: CALCULATIONS

Excel sheets are included in the following pages to show numerical results for determining the pump station design. Equations for the results are as follows:

Q = CiA, for determining the flow of stormwater through the pump and pipes

C = coefficient
i = the intensity coefficient for 10-year and 100-year storm, and t_c (time of concentration)
A = the area of where the water is being collected

The time of concentration will be determined by knowing the time it takes for the farthest amount of stormwater collected to make its way to the pump station. We also used the SSA model to more accurately simulate the predicted 10 and 100-year storm events.

Using the flow (Q) we can then determine the pipe and pump sizing for the design. The Mannings equation was used to determine the pipe diameter and from there we determined the headloss and pump curve with Hazen-William's Equation.

D= [Q*n/(S^(1/2) *.31169)]^3/8

D = diameter
N= roughness coefficient; for HDPE n = 0.009
S = slope

Head loss = (4.73*L*Q^1.852)/(D^(4.87)*C^(1.852)

L = length
C = Hazen-Williams coefficient
Q = flow
D = diameter

Using the head loss equation, we calculated a system curve using various flows. From this we were able to find the operating point for our pump station by comparing the system curve and the pump curve.

For the wet well sizing, we designed it for the 10-year storm, because sizing for the 100-year flow resulted in an unrealistic sizing for the wet well. THe following equation was used to size the wet well:

Tc = Vmin/Qout

Tc = the chosen time it takes for the water to leave the wet well
Vmin = the smallest volume for the wet well
Qout = the flow for the wet well; the 10-year storm was used for this

CALCULATIONS

Diameters

n (RCP) =	0.009	HDPE smooth inner lining
Slope to pump station=	0.003	
Slope to Columbia=	0.003	
Flow max, cfs (100yr) =	45	SSA model
Flow max, cfs(10yr) =	32.5	SSA model
n (force main)	0.009	HDPE smooth inner lining

Pipe Diameters mannings EQN

D = (Q*n/(0.464S^(1/2))^(3/8)

Length from Pump Station to Columbia

3170 feet

Area 90.5 acres

Slope 0.00347003 ft/ft

Flow - Rational Method - For comparison

Q = 65 cfs

Determine for 100 yr storm

D = 3.27862445 feet

39.3434935 converstion to inches

48 inches

Determine for 10 yr storm

D = 2.90197216 feet

34.8236659 conversion to inches

36 inches

Wet Well Volume

Vmin = Tc*Qout Q = 32.5 cfs

Tc = 10 minutes - assumption chosen

Volume = 19500 ft^3 minum volume required to house a 10-year storm

additional height for

Headloss

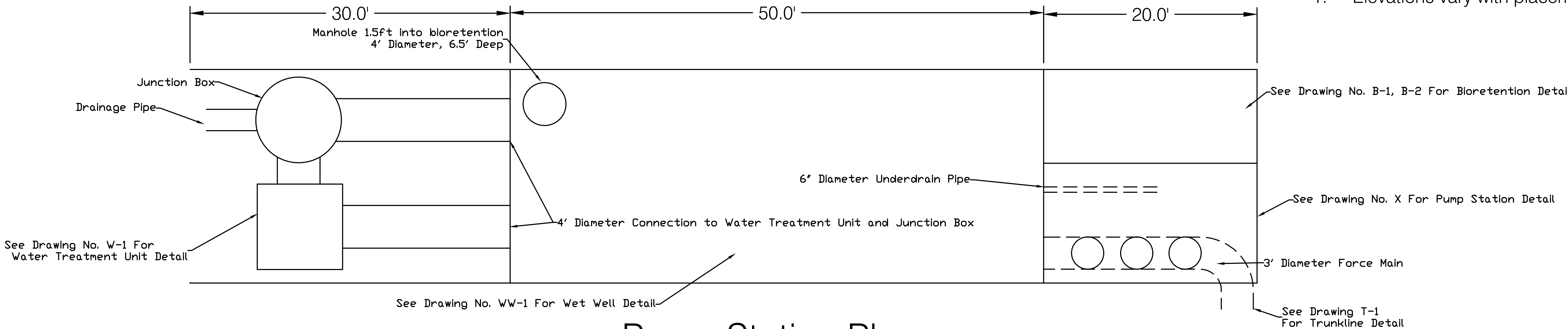
Circular Pipe Head Loss *results shown in table and graph following page

hf = (4.73L*Q^(1.852))/(C^(1.85)*D^(4.87)

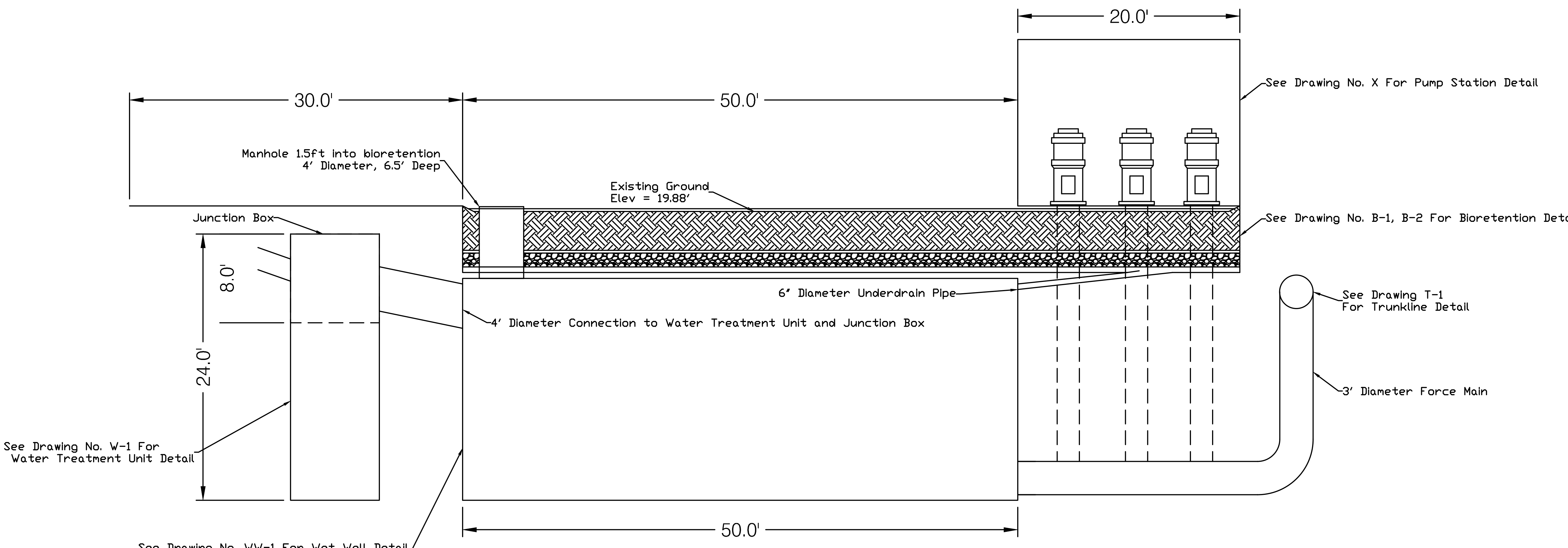
APPENDIX D: DRAWINGS

General Notes

1. Elevations vary with placement of other units

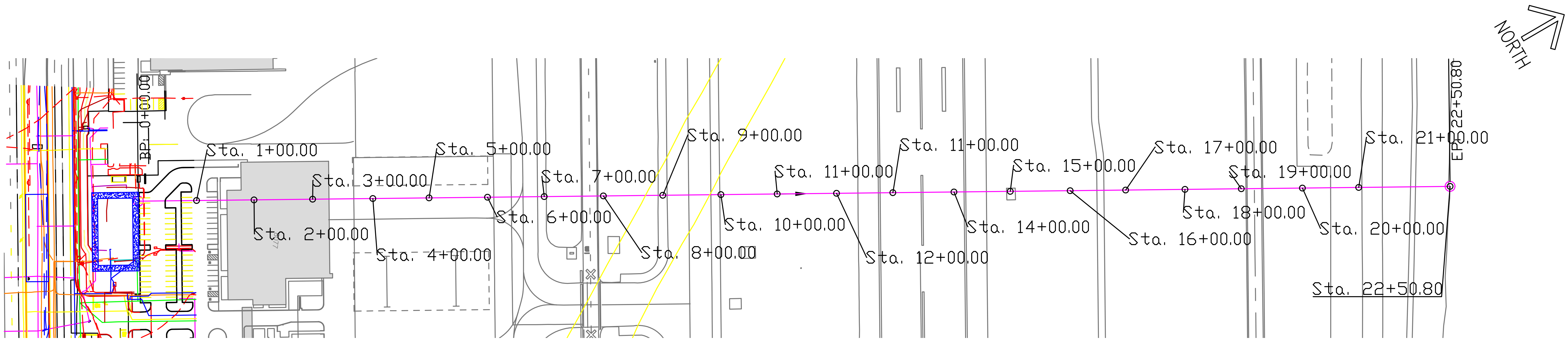


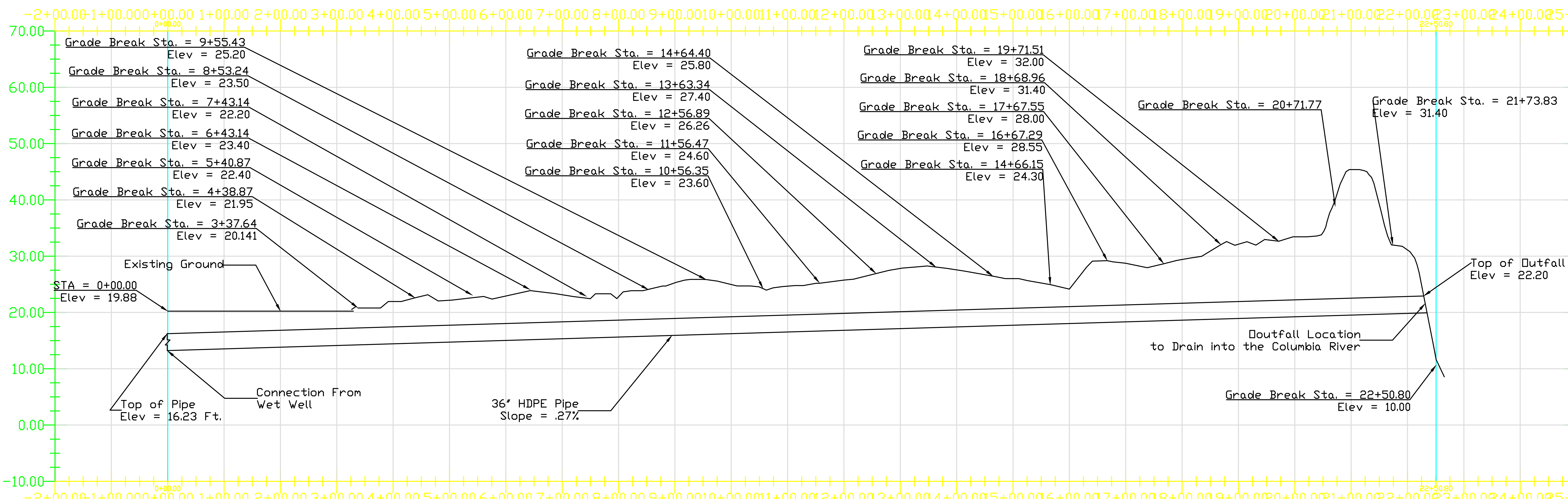
Pump Station Plan



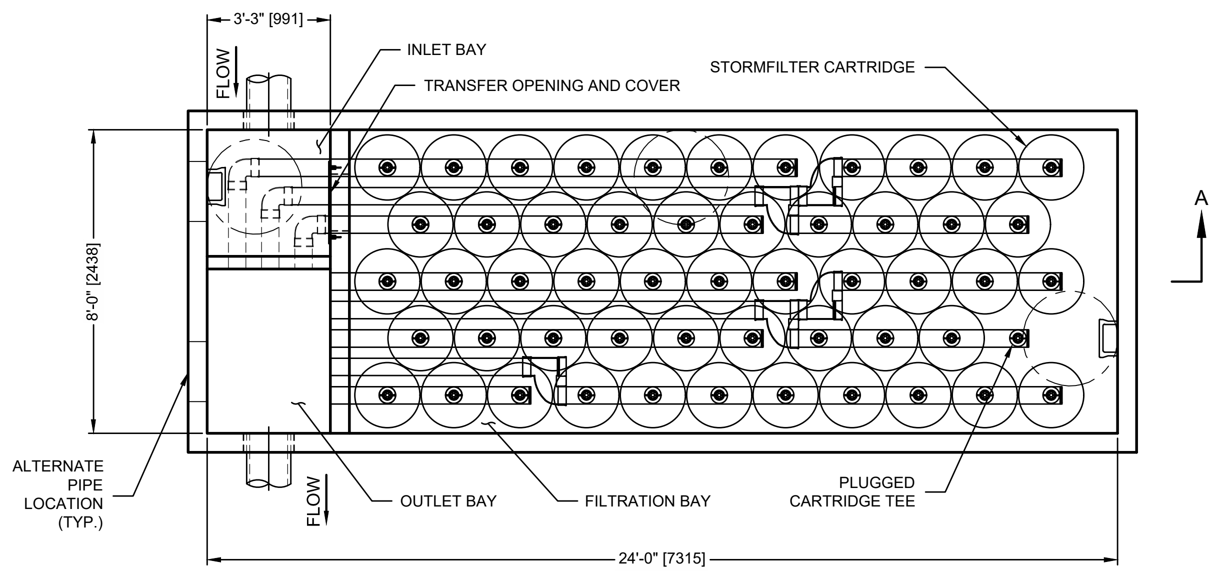
Pump Station Profile

4/18/2019	0	Pump Station Design Team	Port of Portland Basin 7 Pump Station Design	Pump Station Plan and Profile	Sheet No. 1 Dwg No. P-1
Date	Revision				

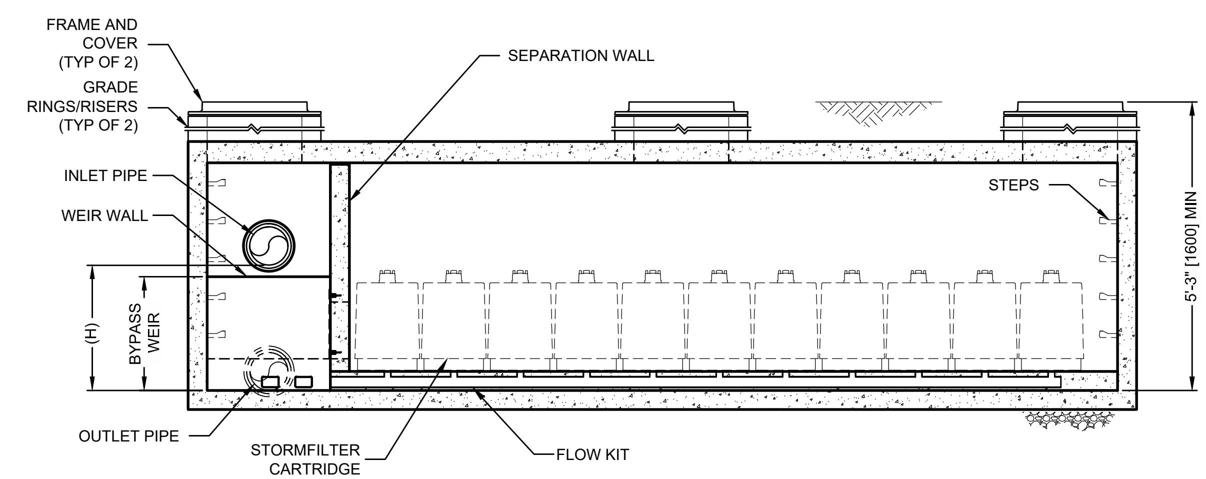




4/18/2019	0	Pump Station Design Team	Port of Portland Basin 7 Pump Station Design	Trunkline Plan and Profile Sta. 0+00.00 to 22+50.80 at EL 0.00	Sheet No. 2 Dwg No. T-1
Date	Revision				



PLAN VIEW
(TOP SLAB NOT SHOWN)



ELEVATION SECTION A-A

STORMFILTER DESIGN NOTES

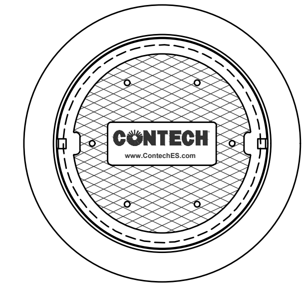
· STORMFILTER TREATMENT CAPACITY VARIES BY CARTRIDGE COUNT AND LOCALLY APPROVED SURFACE AREA SPECIFIC FLOW RATE. PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD
· AN 8' x 24' [2438 x 7315] PEAK DIVERSION STYLE STORMFILTER IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (52) AND IS AVAILABLE IN A LEFT INLET (AS SHOWN) OR A RIGHT INLET CONFIGURATION
· ALL PARTS AND INTERNAL ASSEMBLY PROVIDED BY CONTECH UNLESS NOTED OTHERWISE

CARTRIDGE SIZE (in. [mm])	27 [686]			18 [457]			LOW DROP		
RECOMMENDED HYDRAULIC DROP (H) (ft. [mm])	3.05 [930]			2.3 [701]			1.8 [549]		
SPECIFIC FLOW RATE (gpm/sf [L/s/m2])	2 [1.36]	1.67* [1.13]*	1 [0.68]	2 [1.36]	1.67* [1.13]*	1 [0.68]	2 [1.36]	1.67* [1.13]*	1 [0.68]
CARTRIDGE FLOW RATE (gpm [L/s])	22.5 [1.42]	18.79 [1.19]	11.25 [0.71]	15 [0.95]	12.53 [0.79]	7.5 [0.47]	10 [0.63]	8.35 [0.53]	5 [0.32]

* 1.67 gpm/sf [1.13 L/s/m2] SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (cfs [L/s])			
PEAK FLOW RATE (cfs [L/s])			
RETURN PERIOD OF PEAK FLOW (yrs)			
CARTRIDGE FLOW RATE			
CARTRIDGE SIZE (27, 18, LOW DROP (LD))			
MEDIA TYPE (PERLITE, ZPG, PSORB)			
NUMBER OF CARTRIDGES REQUIRED			
FILTER BAY RIM ELEVATION			
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
NOTES/SPECIAL REQUIREMENTS:			



FRAME AND COVER
(DIAMETER VARIES)
NOT TO SCALE

PERFORMANCE SPECIFICATION
FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS. SPECIFIC FLOW RATE SHALL BE 2 GPM/SF (MAXIMUM). SPECIFIC FLOW RATE IS THE MEASURE OF THE FLOW (GPM) DIVIDED BY THE MEDIA SURFACE CONTACT AREA (SF). MEDIA VOLUMETRIC FLOW RATE SHALL BE 6 **GPM/CF OF MEDIA (MAXIMUM).**

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. ALTERNATE DIMENSIONS ARE IN MILLIMETERS [mm] UNLESS NOTED OTHERWISE.
4. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.contechES.com
5. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
6. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' [1524] AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.
F. CONTRACTOR TO REMOVE THE TRANSFER OPENING COVER WHEN THE SYSTEM IS BROUGHT ONLINE.

The Stormwater Management StormFilter®

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 FAX 513-645-7000

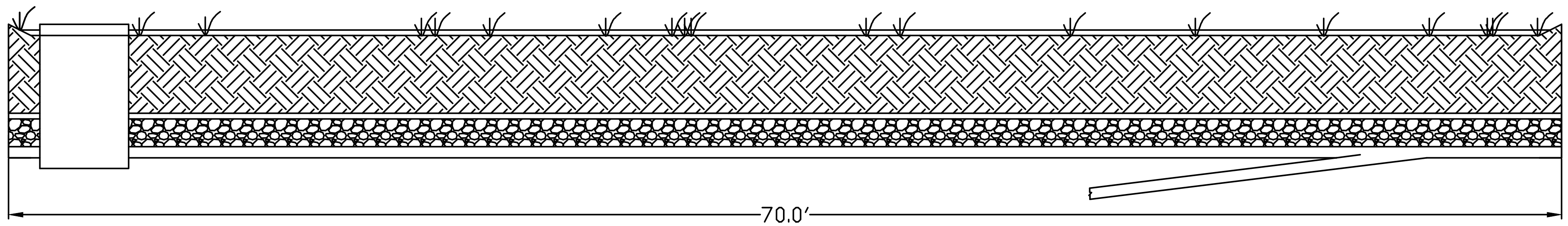
SFPD0824 (8' x 24')
PEAK DIVERSION STORMFILTER
STANDARD DETAIL

\\AD.CONTECH-CPI.COM\ROOT\COMMON\CAD\TREATMENT\10 STORMFILTER\40 STANDARD DRAWINGS\SFPD\DWG\IN PROCESS\SFPD0824-DTL.DWG 3/4/2019 4:29 PM

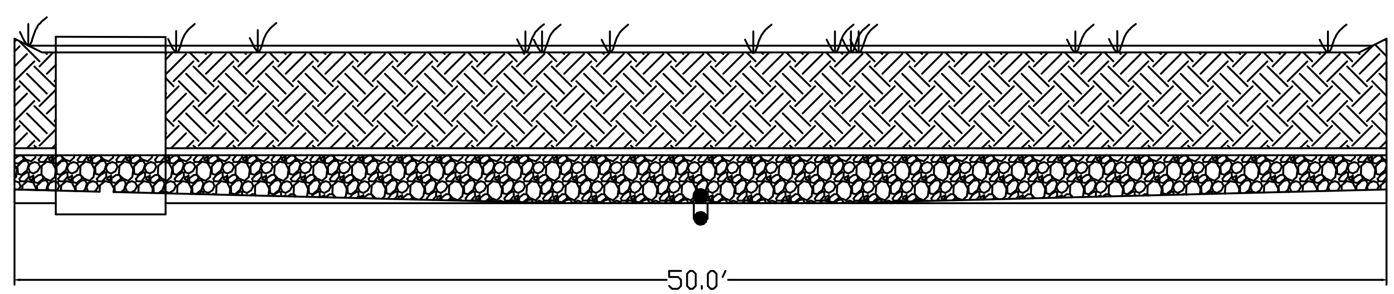
General Notes

1. Use SFPD0824 (8'x24') Unit or Equivalent

4/18/2019	0	Pump Station Design Team	Port of Portland Basin 7 Pump Station Design	Water Treatment Unit Standard Detail	Sheet No. 3 Dwg No. W-1
Date	Revision				



Bioretention Unit Profile

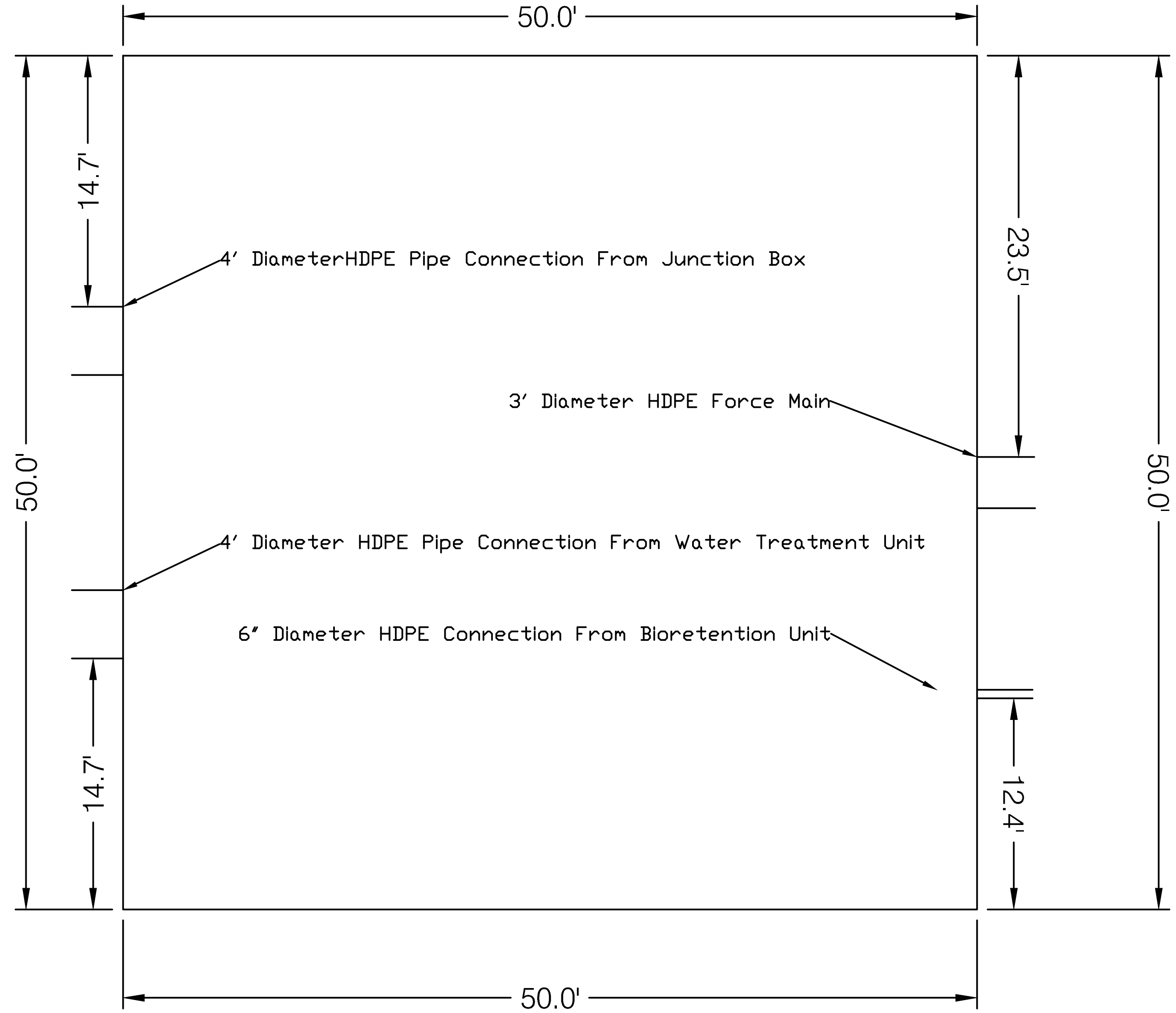


Bioretention Unit Profile SW Wall

General Notes

1. Elevations vary with amounts of fill (Soil Medium, Pea Gravel, Gravel)

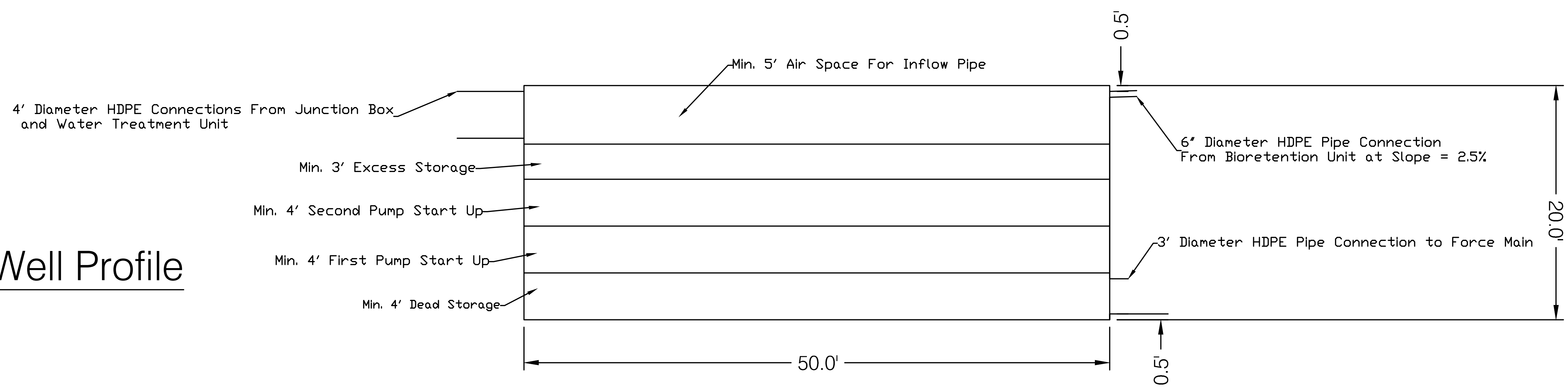
4/18/2019	0	Pump Station Design Team	Port of Portland Basin 7 Pump Station Design	Bioretention Unit Standard Detail	Sheet No. 4 Dwg No. B-1
Date	Revision				



General Notes

1. Elevations of pipes vary with placement of other units
2. "Start Up" refers to elevation when pumps will turn on

Wet Well Plan

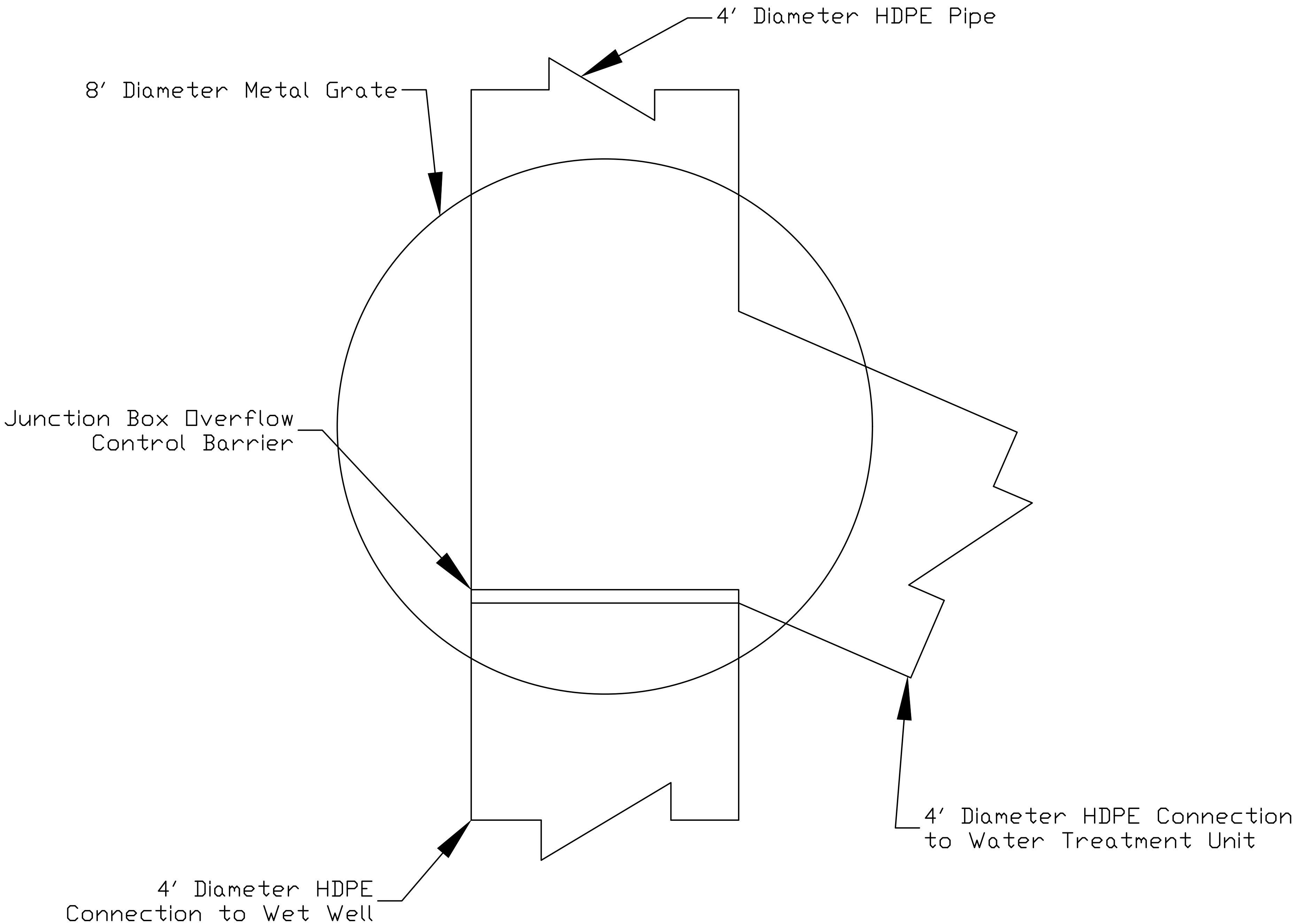


Wet Well Profile

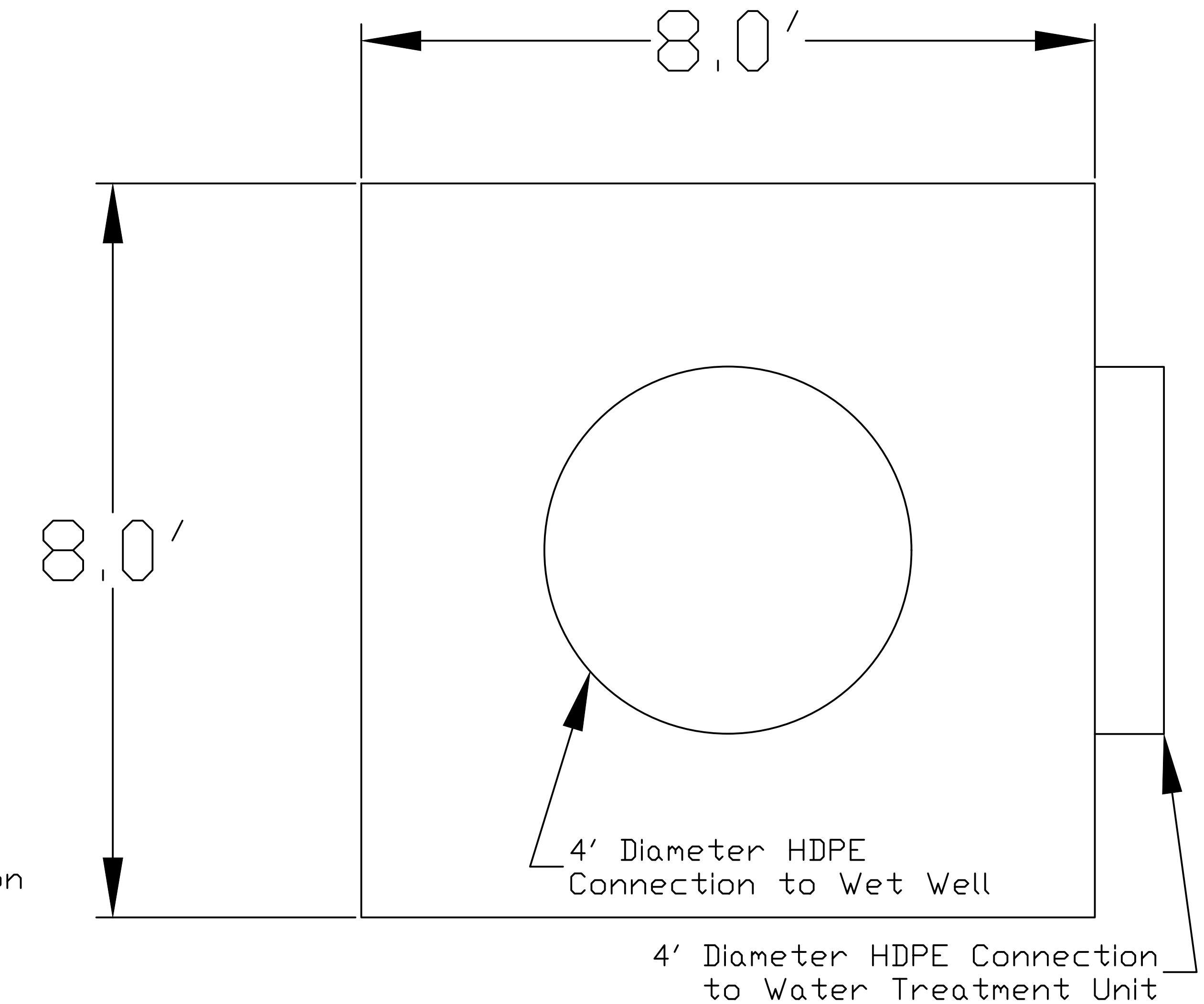
4/18/2019	0	Pump Station Design Team	Port of Portland Basin 7 Pump Station Design	Wet Well Plan and Profile	Sheet No. 6 Dwg No. WW-1
Date	Revision				

General Notes

1. Elevations of pipes vary with placement of other units



Junction Box Plan



Junction Box Profile

4/18/2019	0	Pump Station Design Team	Port of Portland Basin 7 Pump Station Design	Junction Box Plan and Profile	Sheet No. 6
Date	Revision				Dwg No. WW-1

APPENDIX E: PROGRESS MEMORANDUMS

CE 483 PROGRESS MEMORANDUM #1 Fall 2018

Group# 2 **Project Name:** Port of Portland Basin #7
Academic Advisor's Name: Dr. Poor
Industrial Advisor's Name: Brian Freeman
Due Date: 9/21/2018

Our Capstone group so far has done a couple of conference calls with our industrial advisor, Brian Freeman. We have completed a team charter summary report for Dr. Poor during the first week of school while at the same time we outlined our group expectations and roles for the project. On September 10th, we scheduled a site visit with Brian Freeman at Port of Portland headquarters to acquire more information for our project. And on September 14th, we had our Group Work Lab meeting with Kaity Sullivan.

So far, we have learned the basic scope of work for our project. We learned about the information sources that are open to us about the project from Brian Freeman. We learned about the history of our project as well as the purpose for it. We know what the expectations both Dr. Poor and Brian Freeman expect from us. We also have a better understanding about our team's availability during the week for meetings and group work sessions.

The only people we have contacted so far are Dr. Poor and Brian Freeman. We have used the Port of Portland website as well as the Group Work Lab as resources for our project. The challenges we face so far for this project are scheduling meeting times for our team, having an unclear path to achieve our goals, and gathering more information from Brian Freeman. As of now, we have concluded the expectations we have of each other as teammates as well as the basic understanding of our project.

Our team currently has no individual tasks that need to be completed. As a team, we are gathering more information for our project. Together we are creating a schedule for our group work sessions for the future with the basic scope of work. The final task to be done before our next meeting is to establish all milestones for the project.

	Maddy T.	Camille M.	Dylan T.	Brad H.	Aaron M.
Project MGMT	5	5	5	5	5
Total	5	5	5	5	5

Name: Dylan Tran

CE 483 PROGRESS MEMORANDUM FORMAT Fall 2018

Group# 2 **Project Name:** Port of Portland Basin #7
Academic Advisor's Name: Dr. Cara Poor
Industrial Advisor's Name: Brian Freeman
Due Date: 10/12/2018

(4%) 1. ACCOMPLISHMENTS SINCE PREVIOUS MEMORANDUM:

a) What have you done?

Over the past three weeks, our team has been working diligently and cooperatively to create a rough schedule, a draft of our scope of work, conduct detailed research on the background information of our project, and many more individualized tasks.

During the week of September 24, we were able to develop a tentative schedule of the upcoming tasks, both personal and as a team, which must be accomplished within the next month in order to meet deadlines set forth in the CE483 course. Some of these tasks include cleaning up our research, coordinating with Brian Freeman on further direction for the scope of work, finding time to meet with Brian Freeman in person, and finalizing our scope of work. Also during that week, we focused on reading the Port of Portland Stormwater Master Plan and highlighting specific data that would be useful in writing our final report. The highlighted data included topics such as: Jurisdiction, Regulations, History, Stakeholder Involvement, Environmental Aspects, Design Constraints, Financial status of the Port. We then created a four-page, single spaced document based on our findings which will be used as a base for our final report due at the end of the semester.

During the weeks of Oct. 1st and Oct. 8th, we directed our attention to drafting a scope of work in which we could edit based off of comments submitted by our industry and academic advisors. On October 5th we had a conference call with Brian Freeman to discuss our SOW draft and any thoughts he had on how it could be improved. On September 28th and October 11th we had meetings with our academic advisor to discuss the tasks we accomplished, review our drafted scope of work, and to dictate further action for the upcoming weeks.

b) What have you learned?

Our research has concluded many things about the Port of Portland which we did not know previously. Information such as specific permitting, discharge locations, Port regulations and sanctions, water quality standards, the history and future of the Port of Portland, current financial status of the Port, stakeholder and public involvement, and any environmental impacts the project will have, were all discovered and shared during our team meetings. Listed below are the notes taken on major points of action according to our background research conducted over the past three weeks:

- City of Portland and POP own and operate separate permitting

    - because the discharge location is into the Columbia Slough, the Port has a specialized permit, the1200-COLS, which has stricter regulations for the quality of water that can be discharged at and around the airport.
- Permit MS4 is through the state but both use it in environmental impact
- Ponding is the reason for new basin which affects FAA (federal aviation administration)
    - Affects air traffic, wildlife, emergency vehicles, overall safety
- Design for 10 year storm
- 44 cartridge filter used to filter chemicals from deicing runoff
- Maintenance depends on the pumping product
- Over last 70 years pdx has been expanding but critical portions of drainage structure haven't been changed
- Each drainage structure built from project to project instead of a whole
- Not up to code with current standards
- Pump station helps POP meet current water quality standards
- Established boundaries of Basin 7

c) What persons have you contacted?

We have been in contact with Brian Freeman (conference call) and Dr. Cara Poor (two in-person meetings)

c) What resources have you used?

Below are the manuals and sites we have used when conducting our research:

- Port of Portland stormwater master plan
- National Environmental Policy Act
- Bureau of Environmental Services (City of Portland)
- Department of Environmental Quality
- Portland Water Bureau
- Port of Portland Finance and Statistics report

e) What challenges have you faced?

Over the past few weeks, we have had trouble finding a clear direction in which this project is headed. We all feel like we had a lot to get done but we aren't sure which tasks we should complete in succession of one another. We have successfully grown out of the "research and development" phase and have proceeded to the evaluation of the actual project design. The problem is, we want to be able to plan months in advance instead of just weeks, and the only way that can be accomplished is if we know exactly what we should be doing and when the task should be completed. I think that the scheduling task will be a big help to us because it will force us to truly look at our work ethic and create a realistic and feasible plan for the upcoming year.

f) What have you concluded?

We have come to realize that the project is very extensive and that in order to produce a quality report and viable conclusions, we need to work in harmony with each other as well as our advisors. We have also concluded that although the Stormwater Master Plan is a very reliable resource, we should utilize the TRC which was provided to us at the Port of Portland office. We were also recommended by Dr. Poor to put in more hours so that we can develop further understanding of the project and build a solid foundation of information and background research on which we can build off of.

(2%) 2. TASKS TO BE COMPLETED BY INDIVIDUAL MEMBERS DURING THE NEXT PERIOD (*To be specified for each member*)

Aaron: Look up economical aspects of the design process & what should our range of cost analysis budget be

Bradley: Finish up any loose ends for stakeholder aspects & history portion of the report background

Camille: Continue with environmental background regulations/info on deicing specifically

Dylan: Look into constructability aspects; review construction processes from start to finish

Madeline: Finish up political jurisdictional and regulatory aspects

Team: Continue to work on scope of work according to comments received by Dr. Poor and Brian.

(2%) 3. TABLE OF BILLABLE HOURS SPENT BY EACH GROUP MEMBER PER WEEK SINCE THE PREVIOUS PROGRESS MEMORANDUM

Basin #7 Team	Madeline Tuff	Aaron Madden	Camille Morgan	Dylan Tran	Bradley Hayashi
Project Kick Off	1	1	1	1	1
Industry/Academic Advisor Meetings	3	3	3	3	3
Team Meetings	5	5	5	5	5
Scheduling Draft	1.25	1.5	1.75	1.5	1.75
Background Research	4.5	4	4	4	4
Scope of Work Draft	3	3.25	3	3.25	3
Scope of Work (post-comments)	1.5	1.5	1.75	1.5	1.25
Progress Memorandum Write-ups	1	1	1	3	3
Total Hours	20.25	20.25	20.5	22.25	22

(1%) 4. SITE VISIT COMPLETED

Yes, completed on 9/10/2018

(1%) 5. NAME OF THE PRIMARY AUTHOR OF THE MEMORANDUM

Name: Bradley Hayashi

CE 483 PROGRESS MEMORANDUM FORMAT Fall 2018

Group# 2 **Project Name:** Port of Portland Basin #7

Academic Advisor's Name: Dr. Cara Poor

Industrial Advisor's Name: Brian Freeman

Due Date: 11/2/2018

(4%)1. ACCOMPLISHMENTS SINCE PREVIOUS MEMORANDUM:

a) What have you done?

Over the past two weeks, we have worked to finalize our scope of work and work toward a solid plan for project completion. On October 26, we had an in-depth meeting with Brian Freeman on the University of Portland campus to look over our scope of work and plan our next steps for the project.

During several group meetings we discussed a rough draft of our schedule and what needs to be completed. We designed a plan for starting our design calculations, determining what we need in order to make the appropriate decisions for our design and any alternatives.

b) What have you learned?

We have learned more about the research behind the project, as we are finishing up the background for our written report. After our meeting with Brian, we were provided more access to resources for the project as well as more information involving the plan for the pump station to clarify our previous questions. We also have a better understanding for the steps needed for our design and the outside information we need to retrieve.

c) What persons have you contacted?

We have been in contact with Brian Freeman (one in-person meeting) and Dr. Cara Poor (one in-person meeting).

c) What resources have you used?

We have been using manuals including the Port of Portland stormwater master plan, Port of Portland Finance and Statistics report as well as design drawings sent to us by Brian.

We have also been using tools such as Microsoft Office and AutoCAD in order to develop our schedule and determine our steps for calculation and design.

e) What challenges have you faced?

Currently, our biggest challenge is to determine our schedule for completing the steps necessary to evaluate the project. Our group was unsure what the steps for our project were going to be and what deadlines we should give ourselves. Due to fall break, we also lost some momentum from not having deadlines during the break and the fact that we were not on the University of Portland campus.

Another challenge was opening up a few of the files sent to us by Brian. That set us back a little bit in terms of having all the resources needed to get the job done. However, after our last in person meeting with him, we were able to clarify this issue.

f) What have you concluded?

After the past two weeks, we have come to an understanding for our expectations of each other and what we need to accomplish by the end of the semester. We have also finalized our tasks in the scope of work so we have a better understanding our timeline and what needs to be accomplished at the end of our project. Now, we have a tentative plan to completing our next steps for calculations and evaluating alternatives and designs.

(2%)2. TASKS TO BE COMPLETED BY INDIVIDUAL MEMBERS DURING THE NEXT PERIOD (*To be specified for each member*)

Aaron: Analyze design approach for project and any alternatives that may be available for written report.

Dylan: Conclude background and introduction in written report and start alternative analysis.

Bradley: Complete Microsoft Project schedule and lay out the weekly schedule for the written report.

Camille: Finalize last minute research and begin preliminary calculations for design flow based on information provided by Port of Portland.

Madeline: Determine necessary information to begin preliminary design calculations and confirm weekly schedule on Microsoft Project.

Team: Finish writing the written report and complete schedule plan for this semester and next semester

(2%)3. TABLE OF BILLABLE HOURS SPENT BY EACH GROUP MEMBER PER WEEK SINCE THE PREVIOUS PROGRESS MEMORANDUM

Basin #7 Team	Madeline Tuff	Aaron Madden	Camille Morgan	Dylan Tran	Bradley Hayashi
Industry/Academic Advisor Meetings	3	0	3	3	3
Team Meetings	5	2.5	5	5	5
Draft Schedule	1.25	1.5	1.25	1.75	3
Background Research	2	6	2	4	3
Scope of Work (Finalized)	3.25	1.5	3.0	1.5	1.25
Progress Memorandum Write-ups	3	1	3	1	1
Total Hours	17.5	12.5	17.0	16.25	16.25

(1%)4. SITE VISIT COMPLETED

Yes, completed on 9/10/2018.

(1%)5. NAME OF THE PRIMARY AUTHOR OF THE MEMORANDUM

Name: Camille Morgan and Madeline Tuff

CE 483 LAST (#4) PROGRESS MEMORANDUM FORMAT Fall 2018

Group# 2 **Project Name:** Port of Portland Basin #7
Academic Advisor's Name: Dr. Cara Poor
Industrial Advisor's Name: Brian Freeman
Due Date: 11/16/2018

(3%) 1. ACCOMPLISHMENTS SINCE PREVIOUS MEMORANDUM:

a) What have you done?

Over the past two weeks, our group has been working on finalizing the rough draft of our report and building an alternatives analysis. We have been conducting research on our alternatives and deciding as a group which idea we will recommend. We have also completed our tentative schedule in Microsoft Project for next semester including detailed project tasks and deadlines.

We have conducted several group meetings to discuss what we as individuals have accomplished and what yet needs to be done. We held a meeting with Dr. Poor on November 9th to brainstorm and get approval of our alternatives before we started the analysis.

b) What have you learned?

We have learned a lot of information about our alternatives that will help us analyze them based on numerous factors such as cost, environmental impact, constructability, safety, maintenance, and sustainability. We also have a better understanding of the steps we must take to finalize our written report.

c) What persons have you contacted?

We have been in contact with Brian Freeman (via email) and Dr. Cara Poor (via email and one in-person meeting).

d) What resources have you used?

We have been using different manuals such as the Port of Portland stormwater master plan, the Port of Portland Finance and Statistics report, the City of Portland Stormwater Management Manual, and information and design drawings provided by Brian Freeman. We have also used Dr. Cara Poor as a resource to help brainstorm ideas for feasible design alternatives.

Engineering tools that we have used are AutoCAD, Microsoft Excel, and Microsoft Project to work towards finishing up our design report.

e) What challenges have you faced?

As of now, the main challenge we face is to accumulate all the information we have individually gathered and assemble it into a finalized presentable report before the due date on November 19th. Another challenge we face is picking out the information from our report that we value the greatest and using it as the basis for our poster board presentations at the end of the fall semester.

Come the end of the fall semester, we will have a loss of momentum during winter break. As most of the team is going away for a lengthy period, we are worried about losing sight of the tasks at hand and trying to recover our lost momentum when the spring semester starts in January.

f) What have you concluded?

After the past two weeks, we have embraced the aspects of the report that are lacking, or incomplete and concluded ways to enhance or add the missing elements into our design report. We have also concluded our 3 alternatives of Location, the addition of pervious pavement, and the addition of an oil and water separator catch basin. We have also incorporated a plan to produce a finalized report by November 19th.

(2%) 2. TASKS TO BE COMPLETED BY INDIVIDUAL MEMBERS DURING THE NEXT PERIOD (*To be specified for each member*)

Aaron: Conclude research and analysis on pervious pavement alternative
Bradley: Help other group members to conclude analysis of alternatives
Camille: Conclude research and analysis on bioretention system alternative
Dylan: Help other group members to conclude analysis of alternatives
Madeline: Conclude research and analysis on location alternative.
All members: Revise and edit final report document, think about ideas to present during our poster board presentation.

(2%) 3. TABLE OF BILLABLE HOURS SPENT BY EACH GROUP MEMBER PER WEEK SINCE THE PREVIOUS PROGRESS MEMORANDUM

Basin #7 Team	Madeline Tuff	Aaron Madden	Camille Morgan	Dylan Tran	Bradley Hayashi
Industry/Academic Advisor Meetings	1	1.5	1.5	1.5	1.5
Team Meetings	2	2	2	2	2
Scheduling	1.5	0	2	1	4
Alternatives Research	1	1.5	1.5	1	1
Alternatives Analysis	4	4	4	4	2
Background Research (Finalized)	3	1	1.5	3	1
Finalizing Report	2	2	2	2	3
Progress Memorandum Write-ups	1	3	1	1	1
Total Hours	15.5	15	15.5	15.5	15.5

(1%) 4. SITE VISIT COMPLETED

Yes, completed on September 10, 2018

(1%) 5. GLOBAL ISSUES ADDRESSED

The Port of Portland strives to provide availability of national and international access through trade and travel. They offer a quality of life through passenger air travel and contribute efficient cargo through their trade routes. Since the Port's main trade route is by waterway, it is important to keep the surrounding water ways such as the Columbia River as clean as possible. The Columbia River directly connects to the Pacific Ocean, therefore, pollutants in the Columbia have a negative global impact on the world's oceans. Pollution of the world's oceans is of high concern for environmentalists today, therefore the Port wants to contribute to keeping all waterways as clean as possible. The goal of the Basin 7 pump station project is to help continue to provide positive global aspects for the company and to meet the environmental regulations required of the Port of Portland.

(1%) 6. NAME OF THE PRIMARY AUTHOR OF THE MEMORANDUM

Name: Aaron Madden

CE 484 PROGRESS MEMORANDUM FORMAT Spring 2019

Group# 2 **Project Name:** Pump Station for the Port
Academic Advisor's Name: Dr. Poor
Industrial Advisor's Name: Brian Freeman
Due Date: 2/1/2019

(3%) 1. ACCOMPLISHMENTS SINCE THE LAST MEMORANDUM & PROBLEMS ENCOUNTERED

a) What have you accomplished?

We have had a meeting with both our academic and industry advisors in person. We have had meetings as a team to go over our schedule for the semester and the work we need to get done. We have also scheduled for a tour of current pump stations that the Multnomah County Drainage District (MCDD) owns so that we may have an idea of what they look like.

b) What have you learned & what challenges have you faced?

We have learned more details about the project from our industry advisor and another alternative that the Port is trying to implement that is similar to bioretention which is what we are doing. We have learned what goes into a pump station design thanks to the tour we took. The only challenge we are facing is understanding all the information that has been given to use from our industry advisor.

c) What persons have you contacted?

We have contacted Brian Freeman, Dr. Poor, and Bill Owen who is the engineer that gave us a tour of the Multnomah County Drainage District's pump stations.

d) What resources have you used?

We have used the Port's stormwater master plan, design standards manual, the City of Portland's stormwater management manual, and SSA.

e) What have you concluded?

After the past couple of weeks, we have concluded that finding the peak hour flow is the biggest priority for our design. Once found, we will be able to begin the rest of the calculations needed for the design of our pump station. A lot of time will be needed to complete each task we have set for the semester, so time management will be very important.

January 16, 2019

(2%) 2. COMPARE YOUR PROGRESS WITH YOUR GANTT CHART PREPARED IN CE 483 FALL 2017

As of now we are a week behind of our schedule due to the hydraulic calculations. Fortunately, when making our schedule, we accounted for setbacks so it should not affect our project completion as a whole.

(2%) 3. TASKS TO BE COMPLETED BY INDIVIDUAL MEMBERS DURING THE NEXT PERIOD (TO BE SPECIFIED FOR EACH MEMBER)

Madeline Tuff: Determine peak hour flow
Camille Morgan: Determine peak hour flow
Brad Hayashi: Re-work scheduling for the semester
Dylan Tran: Research surface wetland alternative
Aaron Madden: Research stormwater model user guide

(2%) 4. SUMMARY OF THE TIME SPENT BY INDIVIDUAL MEMBERS SINCE PREVIOUS MEMORANDUM (TABLE OF BILLABLE HOURS)

Basin #7 Team	Madeline Tuff	Camille Morgan	Bradley Hayashi	Dylan Tran	Aaron Madden
Industry/Academic Advisor meeting	2	2	1.5	2	2
Team Meeting	2	2	2	2	2
MCDD Tour	2	2	2	1.5	0
Total Hours	6	6	5.5	5.5	4

(1%) 5. NAME OF THE PRIMARY AUTHOR OF MEMORANDUM

Name: Dylan Tran

January 16, 2019

U:admin/jamies/Mehmet/CE/484(was482)/BiWeeklyProgressMemorandum_Master

CE 484 PROGRESS MEMORANDUM FORMAT **Spring 2019**

Group# 2 **Project Name:** Pump Station for the Port

Academic Advisor's Name: Dr. Poor

Industrial Advisor's Name: Brian Freeman

Due Date: 2/15/2019

(3%)1. ACCOMPLISHMENTS SINCE THE LAST MEMORANDUM & PROBLEMS ENCOUNTERED

a) What have you accomplished?

Since our last memo, our group was able to produce a data report from the Storm and Sanitary Analysis (SSA) model for Basin 7, format appropriate hydraulic calculations for the stormwater runoff based on that report and coordinate next steps as a group. We also had the opportunity to tour multiple pump stations thanks to Bill Owen and Josh McNamee from the Multnomah County Drainage District (MCDD). In addition, we were able to meet with both our academic and industry advisors to clear up any questions we had during our work weeks. Brian Freeman, our industry advisor, also introduced us to Keri Gesner, another professional at the Port of Portland who can help us with any specific stormwater modeling questions we may have during the life of the project.

b) What have you learned & what challenges have you faced?

The tour was very beneficial to our overall understanding pump stations and gave us insight to the practical functions of various types of pumps. Bill and Josh also shared their personal experiences with stormwater and gave us helpful engineering tips for designing pump stations. They also provided us with a couple of sheets which will prove to be useful when we start to ramp up our work in AutoCAD design.

The biggest challenge for us thus far is our group's time management. Our schedules do not align very well so it has been difficult for us to set up a consistent time for us to meet and accomplish work. Although it is still early in the project, we would like to establish a suitable time for us to meet weekly, which accommodates all our schedules. We also had some frustration with the SSA model throughout the week, but the issue was recently resolved.

c) What persons have you contacted?

We have contacted our industry contacts Brian Freeman and Keri Gesner, our academic advisor Dr. Poor, and our tour guides from the MCDD, Bill Owen and Josh McNamee.

d) What resources have you used?

We have used the Port's stormwater master plan, design standards manual, the City of Portland's stormwater management manual, and SSA.

e) What have you concluded?

In order to get back on track, we focused our efforts on the SSA modeling and the determination of the peak flow rate for the site. Because we are starting other important calculations in the upcoming weeks, we have concluded that our priority is producing quality work in a time efficient manner. We have also decided to split up the work in order to cover more of the project in a shorter amount of time. We will reconvene weekly to check each other's progress and quality of work.

January 16, 2019

(2%)2. COMPARE YOUR PROGRESS WITH YOUR GANTT CHART PREPARED IN CE 483 FALL 2017

We are currently two weeks behind our projected schedule. We should have completed our Pump Sizing and Configuration Assessment and becompleting out Water Quality Analysis. Unfortunately, setbacks in the SSA modeling and other areas of the project have pushed us behind schedule.

Please see attached gantt chart for what we plan to accomplish in the upcoming weeks

(2%)3. TASKS TO BE COMPLETED BY INDIVIDUAL MEMBERS DURING THE NEXT PERIOD (TO BE SPECIFIED FOR EACH MEMBER)

Madeline Tuff: Create Pump Curve

Camille Morgan: Create design matrix for passive and active systems

Brad Hayashi: Develop trunkline alignment and size

Dylan Tran: Review Permitting for basin 7

Aaron Madden: Determine pump location and sizing

(2%)4. SUMMARY OF THE TIME SPENT BY INDIVIDUAL MEMBERS SINCE PREVIOUS MEMORANDUM (TABLE OF BILLABLE HOURS)

Basin #7 Team	Madeline Tuff	Camille Morgan	Bradley Hayashi	Dylan Tran	Aaron Madden
Industry/Academic Advisor meeting	2	2	2	2	2
Team Meeting	2.5	2.5	2.5	2.5	2.5
MCDD Tour	2	2	2	1.5	0
Total Hours	6.5	6.5	6.5	6	4.5

(1%)5. NAME OF THE PRIMARY AUTHOR OF MEMORANDUM

Name: Bradley Hayashi

January 16, 2019

U:admin/jamies/Mehmet/CE/484(was482)/BiWeeklyProgressMemorandum_Master

CE 484 PROGRESS MEMORANDUM FORMAT Spring 2019

Group# 2 **Project Name:** Pump Station for the Port

Academic Advisor's Name: Dr. Poor

Industrial Advisor's Name: Brian Freeman

Due Date: 3/15/2019

(3%)1. ACCOMPLISHMENTS SINCE THE LAST MEMORANDUM & PROBLEMS ENCOUNTERED

a) What have you accomplished?

Since our last memo, our group has started working toward the design element of our project. We have the necessary equations and information required to start calculations for our pipes and sizing of the pumps. We have been looking into parallel vs. series pumps, as well as active vs. passive systems. We also started working on our ethics panel assignment, brain storming ideas and splitting up tasks in order to prepare adequately.

b) What have you learned & what challenges have you faced?

The biggest challenge for us thus far is our group's time management and keeping on track with our scheduled plan for accomplishing tasks. We have had multiple setbacks this semester due to various files needed for carrying out calculations. We have received many files from our industry advisor, Brian, which has been very helpful, but also it has been difficult to open some of the files using school computers. We are currently hoping to receive access to survey data soon to finish up some of our calculations and begin the design process.

c) What persons have you contacted?

We have contacted our industry contacts Brian Freeman and Keri Gesner, and our academic advisor Dr. Poor.

d) What resources have you used?

We have used the Port's stormwater master plan, design standards manual, the City of Portland's stormwater management manual, and PumpFLO.

e) What have you concluded?

In order to get back on track, we focused our efforts on the PumpFLO and have a good idea of our pipe sizing. We have decided to split up the ethics assignment work in order to prepare for the panel with the few weeks we have left. We will reconvene the next week to discuss what we have researched and combine our data in order to have a well thought out panel.

(2%)2. COMPARE YOUR PROGRESS WITH YOUR GANTT CHART PREPARED IN CE 483 FALL 2017

Due to spring break and previous set-backs, we are a bit behind in our projected schedule. While we have not started drawings, we have a good idea of the preliminary sizes for our pipes and pumps. Our gantt chart also did not estimate the time we would need in preparing for the ethics panel, which we will also have to focus on in the next week. We plan to put in a few more hours in the upcoming weeks so we can get back on schedule.

Please see attached gantt chart for what we have completed and what we plan to accomplish.

(2%)3. TASKS TO BE COMPLETED BY INDIVIDUAL MEMBERS DURING THE NEXT PERIOD (TO BE SPECIFIED FOR EACH MEMBER)

Madeline Tuff: determine who/what is affected for ethics panel and key values of conflicts, work on PumpFLO and trunkline, practice ethics panel

Camille Morgan: determine who/what is affected for ethics panel and key values of conflicts, continue pipe calculations, practice ethics panel

Brad Hayashi: Begin preliminary drawings, practice ethics panel

Dylan Tran: determine alternatives to ethical issue and analyze using ASCE codes, practice ethics panel

Aaron Madden: determine alternatives to ethical issue and analyze using ASCE codes, practice ethics panel

(2%)4. <u>SUMMARY OF THE TIME SPENT BY INDIVIDUAL MEMBERS SINCE PREVIOUS MEMORANDUM</u> (TABLE OF BILLABLE HOURS)

Basin #7 Team	Madeline Tuff	Camille Morgan	Bradley Hayashi	Dylan Tran	Aaron Madden
Industry/Academic Advisor meeting	1	1	1	1	1
Team Meeting	4	3	1	2	2
Total Hours	5	4	2	3	3

(1%)5. <u>NAME OF THE PRIMARY AUTHOR OF MEMORANDUM</u>

Name: Camille Morgan and Madeline Tuff

January 16, 2019

U:admin/jamies/Mehmet/CE/484(was482)/BiWeeklyProgressMemorandum_Master

CE 484 PROGRESS MEMORANDUM FORMAT Spring 2019

Group# 2 **Project Name:** Pump Station For the Port of Portland
Academic Advisor's Name: Dr. Poor
Industrial Advisor's Name: Brian Freeman
Due Date: 4/5/2019

(3%) 1. ACCOMPLISHMENTS SINCE THE LAST MEMORANDUM & PROBLEMS ENCOUNTERED

a) What have you accomplished?

Since the previous memo, our group has made progress in the design of the pump station. We have finalized our flow, enabling us to complete the design for our pump including the pump curve and pipe sizing. We have determined to use ductile iron for the outlet pipe and High-Density polyethylene (HDPE) for the inflow pipe. We have started progress on the design of the wet well and the trunk line. We are also working on editing the report from the fall semester and incorporating the new requirements for the rough draft due soon.

b) What have you learned & what challenges have you faced?

The biggest challenge for us has been managing the time our group spends on the progress of our design and report, with the time needed for other school work, studying for the FE exam, jobs, etc. It has also been a struggle to figure out how to use the SAA model with the provided data from Brian, but we are managing. We have learned what is required of us to move on in the project and set goals for completion.

c) What persons have you contacted?

We have been in contact with Brian Freeman, our industry advisor, and Dr. Poor, our faculty advisor.

b) What resources have you used?

We have used the Ports design standards manual, the stormwater master plan, SAA modeling program in Autodesk

e) What have you concluded?

We have concluded the necessary requirements of us to complete the project and have split up our efforts for completing the rest of the design work, creating sheets in excel, and finalizing our report.

January 16, 2019

(2%) 2. COMPARE YOUR PROGRESS WITH YOUR GANTT CHART PREPARED IN CE 483 FALL 2018

Due to setbacks and time management issues, we are a little behind our previous schedule. With our original schedule, we were a bit ambitious with our time allotted to specific portions of project completion. However, these ambitions have allowed room to adjust for delivery dates the schedule. We are on track to completing our project by the required due date this April.

(2%) 3. TASKS TO BE COMPLETED BY INDIVIDUAL MEMBERS DURING THE NEXT PERIOD (TO BE SPECIFIED FOR EACH MEMBER)

Madeline Tuff: continue to work on finalizing the report and incorporating sections involving pump design and pipe sizing.

Camille Morgan: continue to work on finalizing the report and incorporating sections involving pump design and pipe sizing. Also work on research involving the bioretention system.

Brad Hayashi: continue drawings, work on finalizing trunk line design, work on finalizing report

Dylan Tran: continue drawings in AutoCAD, work on finalizing report

Aaron Madden: work on finalizing wet well design, work on finalizing report

(2%) 4. SUMMARY OF THE TIME SPENT BY INDIVIDUAL MEMBERS SINCE PREVIOUS MEMORANDUM (TABLE OF BILLABLE HOURS)

Basin #7 Team	Madeline Tuff	Camille Morgan	Bradley Hayashi	Dylan Tran	Aaron Madden
Industry/academic advisor meeting	1	1	1	1	1
Team meetings	4	4	3	3	3
Project work	7	7	4	3	3
Total Hours	12	12	8	7	7

(1%) 5. NAME OF THE PRIMARY AUTHOR OF MEMORANDUM

Name: Aaron Madden

January 16, 2019

U:admin/jamies/Mehmet/CE/484(was482)/BiWeeklyProgressMemorandum_Master

APPENDIX F: PROJECT TEAM CHARTER

Civil Engineering Design Project

Team Contract

Project Name: Port of Portland Pump Station, Group 2

Student Names: Madeline Tuff, Brad Hayashi, Dylan Tran, Aaron Maden, Camille Morgan

How will you communicate with your group? What will your response time be?

Usually through texting, email and/or in person conversations. Unless a response is requested, we can assume that all the group members are receiving the information. If a response is needed, we will try to respond in an hour or two but also take into account that people may be at work or in class.

How often will you meet as a group? When? Length? Where?

Our goal is to meet as a group at least once a week for 30 minutes to an hour or as long as needed until another time restraint. Our goal with both advisors is to meet with them biweekly.

How often and when will you meet with your industrial advisor?

We plan to meet with our industrial advisor biweekly.

For your group meetings, how will you assign roles: agenda preparer, leader, note taker, time keeper, action items, etc.?

Roles assigned by anyone interested in a particular role. Roles can switch throughout the year. We plan to have roles of leader, agenda preparer and notetaker, roles can be rotated.

For your industrial advisor meetings, how will you assign roles?

Roles shared amongst the group can be similar to when meeting with industry advisor.

What tasks will you regularly perform in your group meetings?

Update each other on progress from the past week and discuss future plans going forward.

Note taking, individual updates, tasks needed to complete, time spent on certain projects.

How will you assign tasks to be completed for the next meeting?

Try to give an even distribution of work to everyone. Once we have more information about the task, we can assign certain roles specific to the project task.

Evaluate the work load for each group member and determine which tasks are needed to be done. Also assign based on past involvement in a specific task going over tasks together as a way to assure quality performance and consistency.

How will you address group comments regarding your completed tasks?

We will be respectful when evaluating other members work. We want to do our best and consider all opinions when finishing a task. Any feedback is good feedback.

What consequences will the group have for tardiness at group meetings? For not completing tasks on time?

Not doing work is worse than not showing up. As long as there is some type of professional apology, it can be forgiven.

In what group situations will you want Dr. Poor to become involved? How would you want individuals and/or the group to initiate her involvement?

It would be good to have regular meetings with Dr. Poor biweekly to update her on project successes and it would be a good time for us to check in with any big questions we are facing with the project. We have assigned an industrial and academic communicator to schedule meetings with Dr. Poor to make sure there is clear communication between her and our group.

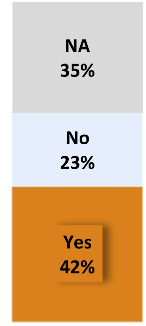
How will you build team cohesion? (fun time, group rituals, etc.)

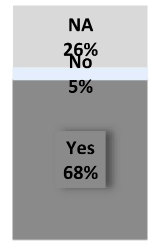
Getting drinks! Etc.

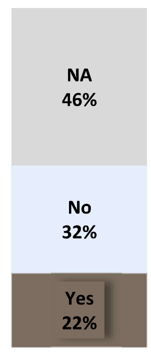
APPENDIX G: MISCELLANEOUS

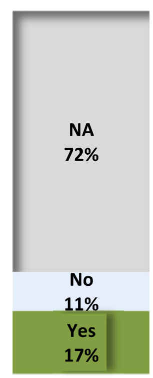
Envision Rating System
Self-Assessment Checklist
For Public Comment Only - Not for Project Use

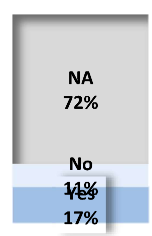
#	Category	Subcategory	Credit	Y	N	NA	Score
1	QUALITY OF LIFE	PURPOSE	QL1.1 Improve community quality of life	3	0	0	3 of 3
2			QL1.2 Stimulate sustainable growth and development	0	0	3	0 of 0
3			QL1.3 Develop local skills and capabilities	2	0	1	2 of 2
4		COMMUNITY	QL2.1 Enhance public health and safety	1	0	0	1 of 1
5			QL2.2 Minimize noise and vibration	0	1	0	0 of 1
6			QL2.3 Minimize light pollution	0	1	0	0 of 1
7			QL2.4 Improve community mobility and access	1	2	0	1 of 3
8			QL2.5 Encourage alternative modes of transportation	1	1	0	1 of 2
9			QL2.6 Improve site accessibility, safety and wayfinding	2	0	1	2 of 2
10		WELLBEING	QL3.1 Preserve historic and cultural resources	0	0	2	0 of 0
11			QL3.2 Preserve views and local character	0	0	2	0 of 0
12			QL3.3 Enhance public space	1	1	0	1 of 2
			TOTAL	11	6	9	11 of 17
13	LEADERSHIP	COLLABORATION	LD1.1 Provide effective leadership and commitment	2	1	0	2 of 3
14			LD1.2 Establish a sustainability management system	1	0	0	1 of 1
15			LD1.3 Foster collaboration and teamwork	2	0	1	2 of 2
16			LD1.4 Provide for stakeholder involvement	2	0	1	2 of 2
17		MANAGEMENT	LD2.1 Pursue by-product synergy opportunities	0	0	1	0 of 0
18			LD2.2 Improve infrastructure integration	2	0	1	2 of 2
19		PLANNING	LD3.1 Plan for long-term monitoring and maintenance	2	0	0	2 of 2
20			LD3.2 Address conflicting regulations and policies	1	0	1	1 of 1
21			LD3.3 Extend useful life	1	0	0	1 of 1
			TOTAL	13	1	5	13 of 14
22	RESOURCE ALLOCATION	MATERIALS	RA1.1 Reduce Net Embodied Energy	0	0	2	0 of 0
23			RA1.2 Support Sustainable Procurement Practices	2	0	1	2 of 2
24			RA1.3 Use Recycled Materials	0	2	0	0 of 2
25			RA1.4 Use Regional Materials	2	0	0	2 of 2
26			RA1.5 Divert Waste from Landfills	0	0	3	0 of 0
27			RA1.6 Reduce Excavated Materials Taken off Site	2	0	1	2 of 2
28			RA1.7 Provide for Deconstruction and Recycling	0	2	1	0 of 2
29		ENERGY	RA2.1 Reduce energy consumption	0	3	0	0 of 3
30			RA2.2 Use renewable energy	0	2	0	0 of 2
31			RA2.3 Commission and monitor energy systems	0	1	2	0 of 1
32		WATER	RA3.1 Protect fresh water availability	1	2	4	1 of 3
33			RA3.2 Reduce potable water consumption	1	1	2	1 of 2
34			RA3.3 Monitor water systems	1	0	3	1 of 1
			TOTAL	9	13	19	9 of 22
35	NATURAL WORLD	SITING	NW1.1 Preserve prime habitat	0	0	5	0 of 0
36			NW1.2 Protect wetlands and surface water	1	0	2	1 of 1
37			NW1.3 Preserve prime farmland	0	0	1	0 of 0
38			NW1.4 Avoid adverse geology	0	0	3	0 of 0
39			NW1.5 Preserve floodplain functions	1	0	5	1 of 1
40			NW1.6 Avoid unsuitable development on steep slopes	1	0	1	1 of 1
41			NW1.7 Preserve greenfields	0	1	1	0 of 1
42		LAND & WATER	NW2.1 Manage stormwater	2	0	0	2 of 2
43			NW2.2 Reduce pesticide and fertilizer impacts	0	0	5	0 of 0
44			NW2.3 Prevent surface and groundwater contamination	0	3	0	0 of 3
45		BIODIVERSITY	NW3.1 Preserve species biodiversity	0	0	4	0 of 0
46			NW3.2 Control invasive species	0	0	3	0 of 0
47			NW3.3 Restore disturbed soils	1	1	0	1 of 2
48			NW3.4 Maintain wetland and surface water functions	2	0	3	2 of 2
			TOTAL	8	5	33	8 of 13
49	CLIMATE	EMISSION	CR1.1 Reduce greenhouse gas emissions	0	0	2	0 of 0
50			CR1.2 Reduce air pollutant emissions	0	0	2	0 of 0
51		RESILIENCE	CR2.1 Assess climate threat	0	1	0	0 of 1
52			CR2.2 Avoid traps and vulnerabilities	0	1	1	0 of 1
53			CR2.3 Prepare for long-term adaptability	1	0	0	1 of 1
54			CR2.4 Prepare for short-term hazards	0	0	2	0 of 0
55			CR2.5 Manage heat islands effects	0	0	1	0 of 0
			TOTAL	1	2	8	1 of 3



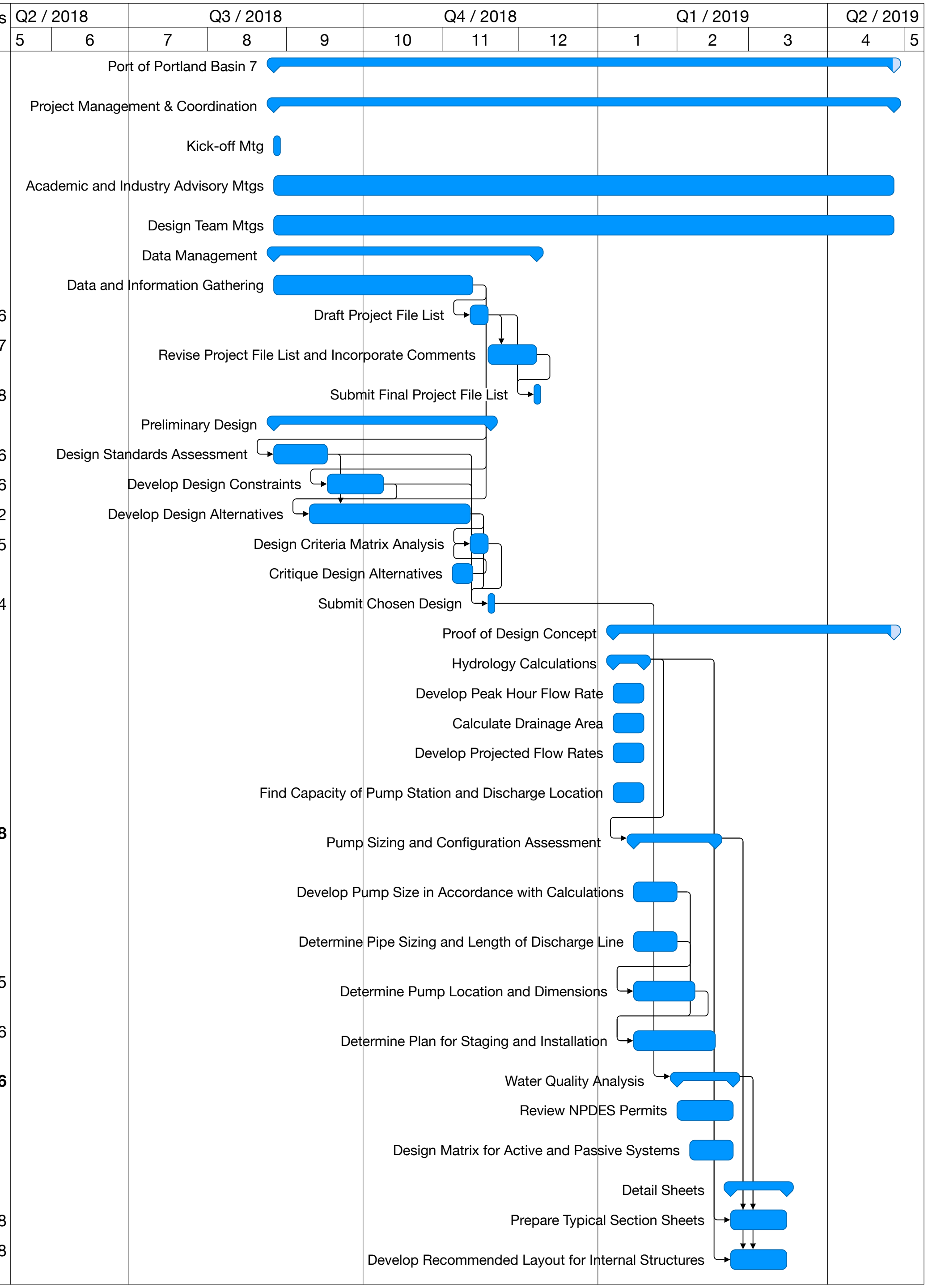








#	Traits	Title	Expected Duration	Actual Start	Expected End	Predecessors
0		**Port of Portland Basin 7**	**8.8m?**	**Aug 27, 2018**	**Apr 26, 2019**	
1		**Project Management & Coordination**	**8.8m**	**Aug 27, 2018**	**Apr 26, 2019**	
2		Kick-off Mtg	2 days	Aug 27, 2018	Aug 28, 2018	
3		Academic and Industry Advisory Mtgs	8.8m	Aug 27, 2018	Apr 26, 2019	
4		Design Team Mtgs	8.8m	Aug 27, 2018	Apr 26, 2019	
5		**Data Management**	**3.8m**	**Aug 27, 2018**	**Dec 7, 2018**	
6		Data and Information Gathering	2.8 months	Aug 27, 2018	Nov 12, 2018	
7		Draft Project File List	1 week	Nov 12, 2018	Nov 19, 2018	6
8		Revise Project File List and Incorporate Comments	3 weeks	Nov 19, 2018	Dec 7, 2018	7
9		Submit Final Project File List	1 day	Dec 7, 2018	Dec 7, 2018	7; 8
10		**Preliminary Design**	**3m**	**Aug 27, 2018**	**Nov 19, 2018**	
11		Design Standards Assessment	3 weeks	Aug 27, 2018	Sep 16, 2018	6
12		Develop Design Constraints	3.2 weeks	Sep 17, 2018	Oct 8, 2018	6
13		Develop Design Alternatives	2.2m	Sep 10, 2018	Nov 11, 2018	6; 11; 12
14		Design Criteria Matrix Analysis	1 week	Nov 12, 2018	Nov 18, 2018	13; 15
15		Critique Design Alternatives	1.2 weeks	Nov 5, 2018	Nov 12, 2018	
16		Submit Chosen Design	1 day	Nov 19, 2018	Nov 19, 2018	11; 12; 13; 14
17		**Proof of Design Concept**	**4 months ?**	**Jan 7, 2019**	**Apr 26, 2019**	
18		**Hydrology Calculations**	**2 weeks**	**Jan 7, 2019**	**Jan 18, 2019**	
19		Develop Peak Hour Flow Rate	2 weeks	Jan 7, 2019	Jan 18, 2019	
20		Calculate Drainage Area	2 weeks	Jan 7, 2019	Jan 18, 2019	
21		Develop Projected Flow Rates	2 weeks	Jan 7, 2019	Jan 18, 2019	
22		Find Capacity of Pump Station and Discharge Location	2 weeks	Jan 7, 2019	Jan 18, 2019	
23		**Pump Sizing and Configuration Assessment**	**1.2 months**	**Jan 15, 2019**	**Feb 15, 2019**	**18**
24		Develop Pump Size in Accordance with Calculations	2.6 weeks	Jan 15, 2019	Jan 31, 2019	
25		Determine Pipe Sizing and Length of Discharge Line	2.6 weeks	Jan 15, 2019	Jan 31, 2019	
26		Determine Pump Location and Dimensions	3.6 weeks	Jan 15, 2019	Feb 7, 2019	24; 25
27		Determine Plan for Staging and Installation	1.2 months	Jan 15, 2019	Feb 15, 2019	24; 25; 26
28		**Water Quality Analysis**	**3.2 weeks**	**Feb 1, 2019**	**Feb 22, 2019**	**16**
29		Review NPDES Permits	3.2 weeks	Feb 1, 2019	Feb 22, 2019	
30		Design Matrix for Active and Passive Systems	2.6 weeks	Feb 6, 2019	Feb 22, 2019	
31		**Detail Sheets**	**3.2 weeks**	**Feb 22, 2019**	**Mar 15, 2019**	
32		Prepare Typical Section Sheets	3.2 weeks	Feb 22, 2019	Mar 15, 2019	18; 23; 28
33		Develop Recommended Layout for Internal Structures	3.2 weeks	Feb 22, 2019	Mar 15, 2019	18; 23; 28



34	QA/QC	1m	Mar 15, 2019	Apr 12, 2019	
35	Submit to Port of Portland for Review of 50%	2.2 weeks	Mar 1, 2019	Mar 15, 2019	
36	Incorporate Port of Portland Comments	2.2 weeks	Mar 15, 2019	Mar 29, 2019	35
37	Submit to Port of Portland for Review of 90%	2.2 weeks	Mar 29, 2019	Apr 12, 2019	36
38	Incorporate Port of Portland Comments	1 week	April 5, 2019	Apr 12, 2019	37
39	Submit Design Draft	1.2 weeks	Apr 12, 2019	Apr 19, 2019	34; 38
40	Revise Design and Incorporate Comments	1 week	Apr 19, 2019	Apr 25, 2019	39
41	Submit Final Design	1 day ?	Apr 26, 2019	Apr 26, 2019	40
42	**Technical Report**	**8.8m?**	**Aug 27, 2018**	**Apr 26, 2019**	
43	**Phase 1**	**3.8m**	**Aug 27, 2018**	**Dec 7, 2018**	
44	Background Research and Assessment	1.2 months	Aug 27, 2018	Sep 27, 2018	
45	Develop Scope of Work	2.5 months	Aug 27, 2018	Nov 2, 2018	
46	Design Approach and Alternatives	3.4 weeks	Sep 27, 2018	Oct 19, 2018	44
47	Compile Appendices	3.2 weeks	Oct 5, 2018	Oct 26, 2018	44
48	QA/QC	3.4 weeks	Oct 26, 2018	Nov 19, 2018	44; 45; 46; 47
49	Submit Report to Industry Advisor	1.2 weeks	Nov 19, 2018	Nov 26, 2018	48
50	Incorporate Comments	1.8 weeks	Nov 26, 2018	Dec 6, 2018	49
51	Submit Draft Technical Report	1.2 weeks	Nov 19, 2018	Nov 26, 2018	48
52	Incorporate Comments	1.8 weeks	Nov 26, 2018	Dec 6, 2018	51
53	Submit Final Technical Report	1 day	Dec 7, 2018	Dec 7, 2018	50
54	**Phase 2**	**4 months ?**	**Jan 7, 2019**	**Apr 26, 2019**	
55	Incorporate Design Approach	1 month	Feb 1, 2019	Feb 28, 2019	
56	Incorporate Chosen Design Analysis	2m	Feb 1, 2019	Mar 31, 2019	
57	Update Calculations	3.2 weeks	Feb 1, 2019	Feb 22, 2019	
58	Update Appendices	3 months	Jan 7, 2019	Mar 31, 2019	
59	Finalize File List	1 week	Mar 31, 2019	April 5, 2019	55; 56; 57; 58
60	QA/QC	1 week	April 6, 2019	Apr 12, 2019	59
61	Submit Report to Industry Advisor	1.2 weeks	Apr 12, 2019	Apr 19, 2019	60
62	Incorporate Comments	1 week	Apr 19, 2019	Apr 25, 2019	61
63	Submit Draft Technical Report	1.2 weeks	Apr 12, 2019	Apr 19, 2019	60
64	Incorporate Comments	1 week	Apr 19, 2019	Apr 25, 2019	63
65	Submit Final Technical Report	1 day ?		Apr 26, 2019	64
66	**Presentations**	**5m**	**Nov 30, 2018**	**Apr 19, 2019**	
67	**Phase 1**	**1.2 weeks**	**Nov 30, 2018**	**Dec 7, 2018**	
68	Oral Presentation	1 day	Nov 30, 2018	Nov 30, 2018	
69	Poster Presentation	1 day	Dec 7, 2018	Dec 7, 2018	
70	**Phase 2**	**0 days**	**Apr 19, 2019**	**Apr 19, 2019**	
71	Oral Presentation	0 days	Apr 19, 2019	Apr 19, 2019