ENGINEERING
LAND SURVEYING
ARCHITECTURE
BUILDING SCIENCE
LAND USE PLANNING
LANDSCAPE ARCHITECTURE
INTERIOR DESIGN
GRAPHIC DESIGN
STRATEGIC MARKETING
CONSTRUCTION ADMIN

DRAINAGE REPORT

SOUTH KITSAP REGIONAL PARK – PHASE 1C

SOUTH KITSAP REGIONAL PARK
JACKSON AVENUE AND LUND AVENUE
PORT ORCHARD, WA 98366

KITSAP COUNTY PARKS & RECREATION
614 DIVISION STREET, MS-1
PORT ORCHARD, WA 98366

JULY 9, 2014

Drainage Report

07/09/2014

Project:
South Kitsap Regional Park
Jackson Avenue and Lund Avenue
Port Orchard, WA 98366

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Aug 11 2015 8:38 AM cosign

I hereby state that this report for the South Kitsap Regional Park – Phase 1C project has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers.

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CHAPTER 1 – PROJECT DESCRIPTION

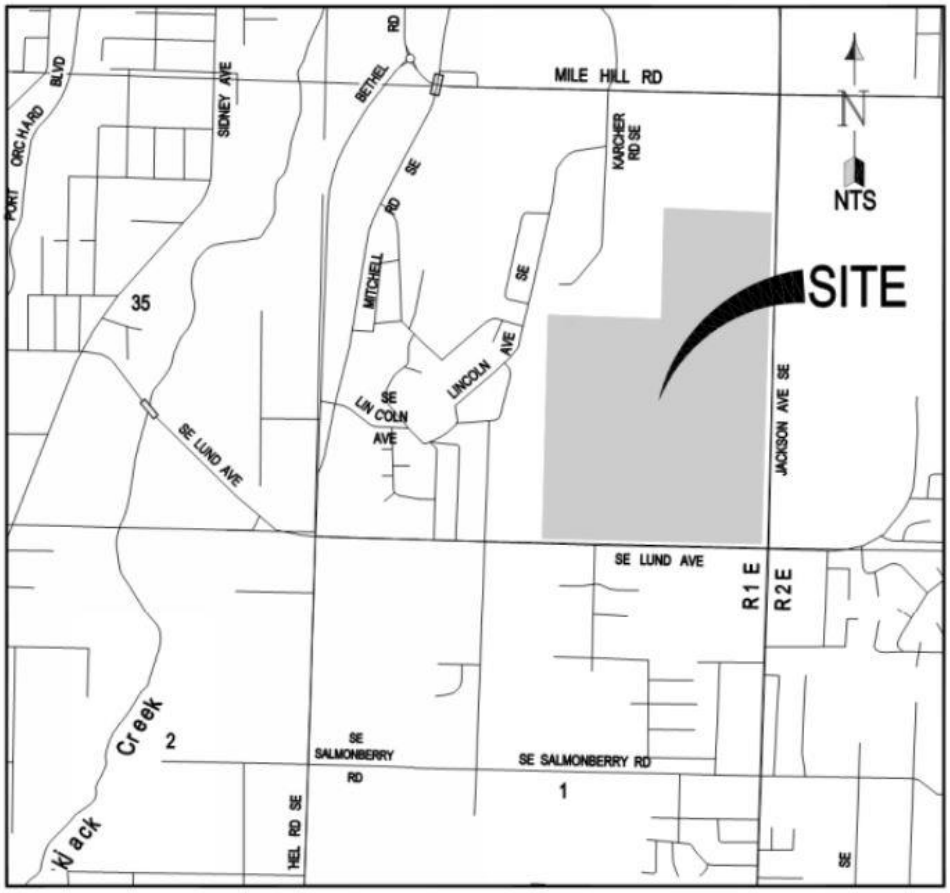
The overall South Kitsap Regional Park project is a community recreation complex composed of a variety of athletic facilities including, but not limited to, sports fields, a skate park, and playgrounds. Due to the size of the project and funding it is being implemented in phases. This particular phase of the overall project will expand the existing athletic and recreational facilities onsite as well as prepare the site for future development. The park is currently owned and operated by Kitsap County.

Previous phases of the project have provided a skate park, a meandering path along the Jackson Avenue and Lund Avenue right-of-way, landscape frontage improvements along the Jackson Avenue and Lund avenue right of way, and a retrofit of an existing Kitsap county stormwater infiltration facility. The current phase consists of an addition to the skate park and associated parking, rough grading and seeding of a future baseball field, construction of a gravel access road and associated stormwater management facilities. The extent of proposed impervious surface is limited to the gravel access road and the addition to the skate park.

The 193 acre site is bounded by Lund Avenue to the South, Jackson Avenue to the East, and several residential communities to the North and West. The project address at the corner of Jackson Avenue and Lund Avenue in Port Orchard, Washington 98366.

The site is located at Kitsap County parcels 362401-4-005-2002, 362401-4-006-2001, and 362401-1-012-2009. The parcels are outside the Port Orchard urban growth boundary. The site is located in Section 36, Township 24 North, Range 1 East, WM in Kitsap County, WA. Refer to the vicinity map on the next page.

Figure 1—1: Vicinity Map



VICINITY MAP

CHAPTER 2 – EXISTING CONDITIONS

The portion of the site encompassed by the skate park addition is fairly flat with slopes ranging from 1% to 5%. Elevations in this area range from 334 to 336. Land cover for this segment of the project is short grass and bare soil and is not tributary to any other drainage area nor are any other drainage areas tributary to it.

The existing portion of the skate park was designed to infiltrate the entirety of the stormwater generated within the limits of the skate park. This was accomplished through the use of an infiltration trench immediately adjacent to the skate park.

The portion of the site encompassed by the grading associated with the future baseball field and the gravel access road is also fairly flat across the majority of the area with slopes ranging from 1% to 5%, to the Northwest of the future baseball field the site contains a slight hill with roughly 11 feet of relief. The slight hill creates slopes ranging from 4% to 8%. Land cover for this section of the project is mainly short grass with segments of forested area and a small segment of impervious surface, consisting of an existing basketball court and access road to be demolished, and is not tributary to any other drainage area nor are any other drainage areas tributary to it.

The existing access road includes a drainage swale connected, via pipe, to the Kitsap county infiltration facility. Runoff not channeled through the drainage swale is primarily handled through infiltration. There are several utilities that fall along or within the proposed gravel access road including a waterline, fire hydrants, sanitary sewer lines, underground power lines, and underground communication lines. A municipal water line is located onsite, within the forested area, approximately 230 feet south of the proposed improvements.

The soils on the site and in the vicinity were characterized in a Geotechnical Engineering Investigation prepared by Krazan and Associates, Inc. on August 17, 2010. The report determined that the site soils were primarily weathered alluvium to a depth of 3.5 feet underlain by alluvial soils. The weathered alluvium was characterized as “loose silty sand” and the alluvium was characterized as “loose to medium dense, fine to medium grained sand with silt.” Towards the Northwest corner of the portion of the site associated with the proposed improvements the report indicated that a layer of stiff silt with lacustrine deposits (fine grained sand and clay) was found extending from a depth of 9 feet to a depth of 12 feet. Groundwater was not encountered in any of the exploratory soil borings. A sieve analysis of the soils sampled was performed to determine a design infiltration rate of 2 in/hr for the site.

The project site area associated with the proposed improvements is divided into 4 basins in the existing condition. A map of the existing basins can be found on the following page.

Basin A is composed of 1 acre of pervious land cover and 0.14 acres of impervious land cover. Basin B is composed of 0.26 acres of forested land cover. Basin C is composed of 4.61 acres of

short grass land cover, 0.93 acres of forested land cover, and 0.22 acres of impervious land cover. Basin D is composed of 0.22 acres of impervious land cover.

Karcher Creek lies approximately a quarter mile to the northwest of the site. The creek empties into the Sinclair Inlet of the Puget Sound approximately two miles north of the project site. The project site is located in a Category 1 Critical Aquifer Recharge Area.

Existing Basin Plan

SOUTH KITSAP REGIONAL PARK

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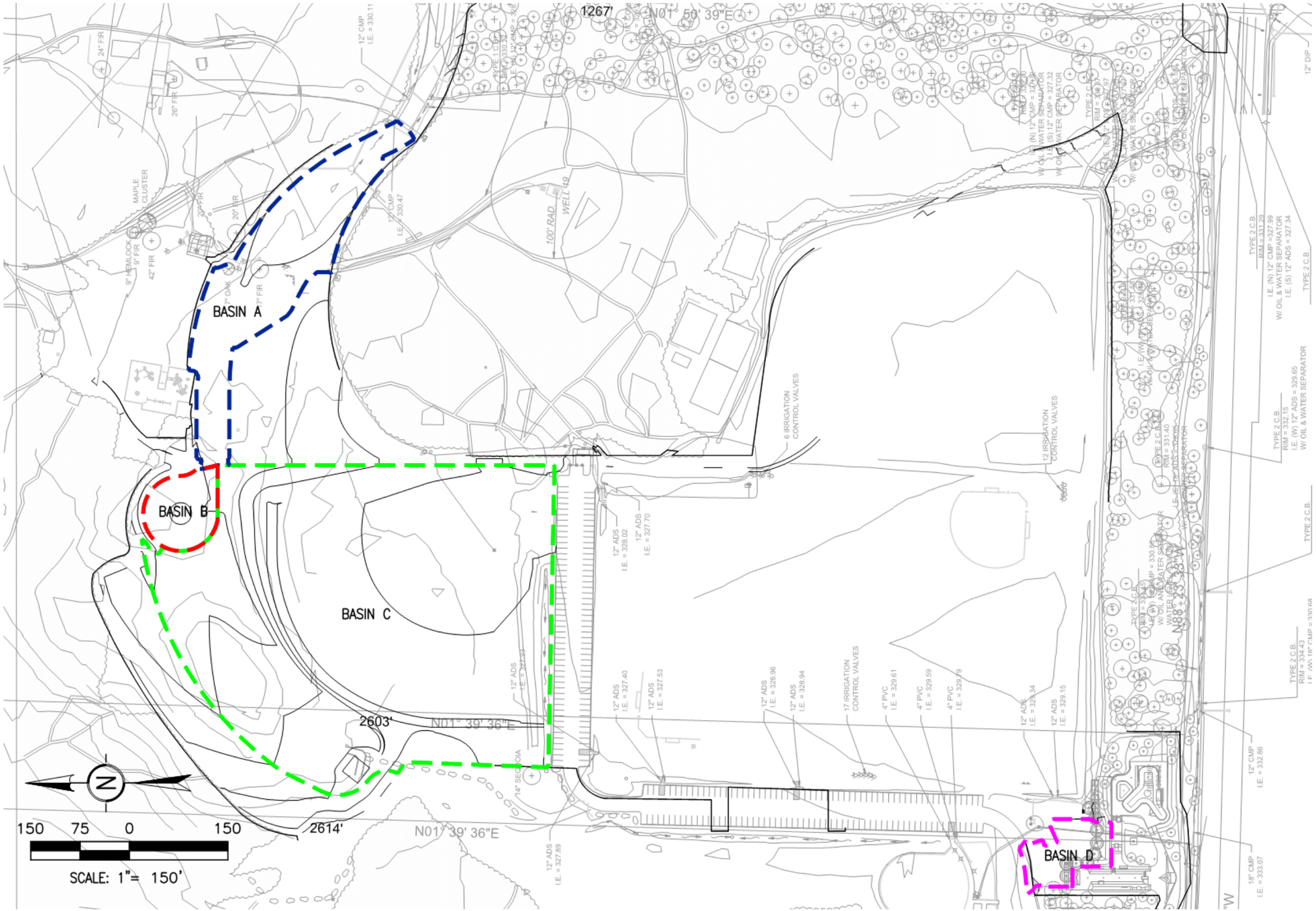

CHAPTER 3 – DEVELOPED SITE DRAINAGE CONDITIONS

The limit of the work is approximately 10.13 acres, for the rough grading associated with the future baseball field and the gravel access road, and 0.30 acres, for the skate park addition. The proposed condition of the project site, within the limits of this phase, consists of rough grading and seeding a large area of the site for future development of a baseball field, the construction of a gravel access road, and an addition to the skate park along the southern side of the site. The proposed condition includes the addition of 1.35 acres of impervious surface while 0.55 acres of existing impervious surface will be converted to new pervious surface.

In addition to the aforementioned improvements, new stormwater management facilities will be provided, and existing stormwater management facilities will be modified to convey and treat the runoff generated on the project site associated with this phase of development. Runoff from pollution-generating surfaces will be treated using BMP 6-13, biofiltration swales, satisfying the groundwater protection requirements stated in section 7.3.4.L.1 of the Kitsap County Stormwater Design Manual. Flow control will be achieved through the usage of a biofiltration cell along the gravel access road, an infiltration pond north of the future baseball field, a bioretention cell north of the skate park expansion, and the expansion of the infiltration trenches that are already employed at the skate park. The flow control facilities mitigate the impact of the proposed improvements, including pervious and impervious surfaces, as shown by the calculations in Chapter 8. As these facilities are sized to infiltrate 100% of the runoff tributary to them, there will not be any increase from the existing stormwater runoff for the site.

All runoff conveyed to the bioinfiltration cells and infiltration pond associated with the baseball field grading and the gravel road will be conveyed via sheet flow and will not require any conveyance components. The skate park will make use of area drains and associated pipes to collect and convey runoff to the underground infiltration facility. StormTech chambers were chosen for the infiltration system associated with the skate park as StormTech chambers are being used there in the existing condition.

For a detailed discussion of the areas tributary to each stormwater management facility please refer to the next chapter of this report.

CHAPTER 4 – DESCRIPTION OF UPSTREAM BASINS

The terrain surrounding the proposed site is flat and is composed of forested terrain, on highly conductive soil. In the event of a major flood event, in which the surrounding soils would become saturated, the terrain surrounding the site would prohibit run-on from an upstream basin.

There was no evidence observed during site visits by BCRA staff of existing drainage or erosion control problems within the project site basins.

CHAPTER 5 – DRAINAGE BASIN DESCRIPTION

As the stormwater runoff generated on site is handled through infiltration there are no areas downstream that receive runoff.

CHAPTER 6 – DOWNSTREAM ANALYSIS

A level 1 analysis is required for this project. The site contains 4 threshold discharge areas. As the 4 areas that make up the extents of work done in this phase are not tributary to any other area nor are there areas tributary to them the threshold discharge areas are made up of the project area associated with this phase only. Refer to the map below for a delineation of the upstream basins.

The study area is based on the topographic survey by Map. LTD. dated 07/31/09. In the existing condition Basin A does make use of the existing storm drainage system at the southeast corner of the basin. Runoff here enters a Type 1 catch basin and flows through a 12" CMP pipe to a Kitsap County infiltration facility located immediately west of Jackson Avenue. As the proposed condition relies entirely on infiltration this pipe will not convey runoff in the proposed condition and can therefore be disregarded in the downstream analysis. Basins B and C sheet flow south across the project site and are intercepted by a swale running along the southern edge of Basin C. Any runoff not infiltrated during the sheet flow across the basin is infiltrated in this swale. Basin D is similarly infiltrated in a swale located on the east side of the access road running north to south through the park.

To our knowledge there are no reported or observed drainage problems associated with this site.

CHAPTER 7 – BASIN MAPS

The project site associated with the proposed improvements relies on a variety of infiltration facilities to infiltrate the runoff, mimicking the existing condition. As there is no upstream tributary area the infiltration facilities were sized for the project site basins alone. All 4 basins were modeled and all infiltration facilities were sized using the Western Washington Hydrology Model (WWHM3 Pro) continuous modeling program.

A map of the proposed basins can be found on the next page.

Proposed Basin Plan

SOUTH KITSAP REGIONAL PARK

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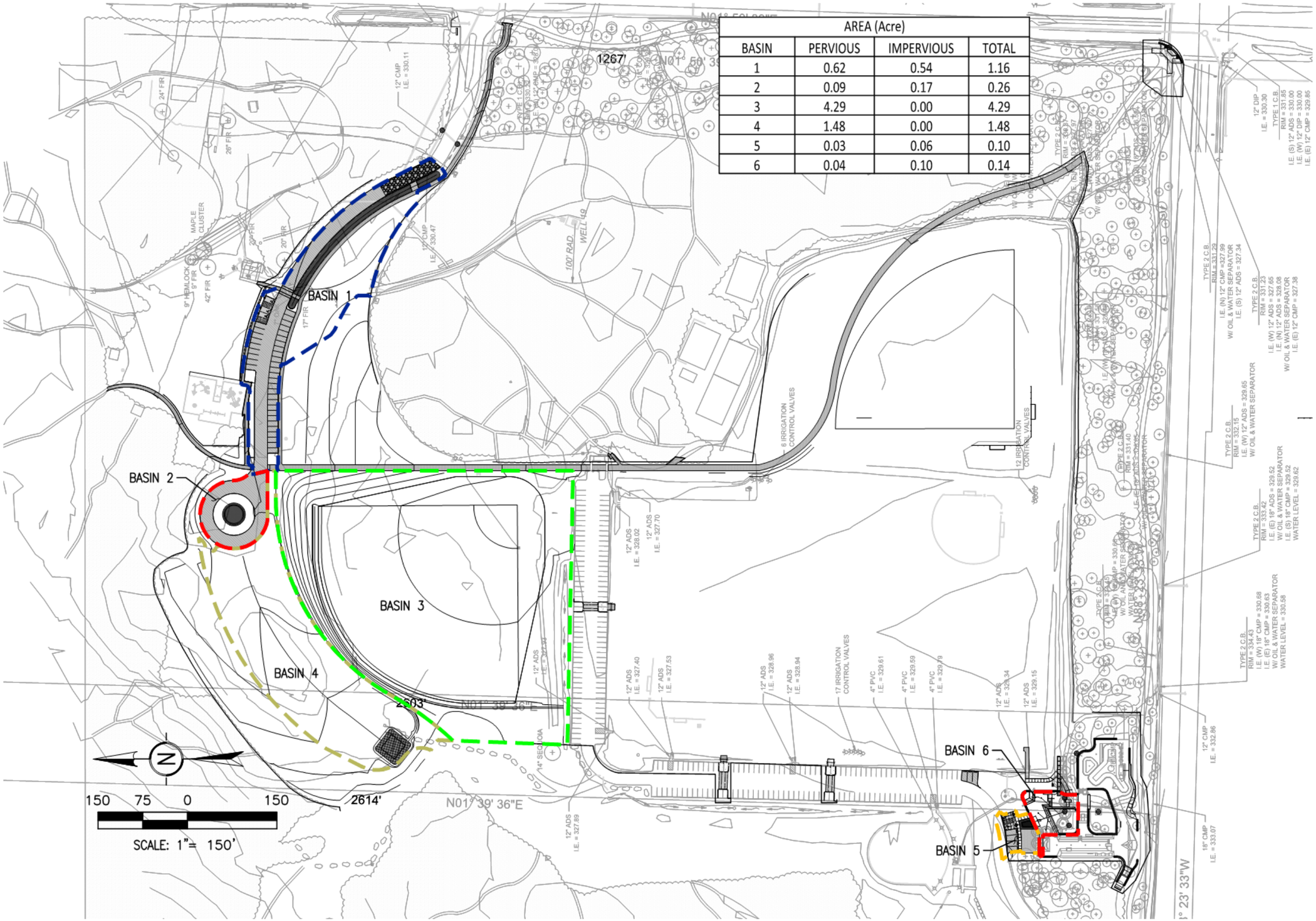
AREA (Acre)			
BASIN	PERVIOUS	IMPERVIOUS	TOTAL
1	0.62	0.54	1.16
2	0.09	0.17	0.26
3	4.29	0.00	4.29
4	1.48	0.00	1.48
5	0.03	0.06	0.10
6	0.04	0.10	0.14



CHAPTER 8 –HYDROLOGICAL ANALYSIS & HYDRAULIC DESIGN COMPUTATIONS

The pre-developed condition to be matched is modeled in the existing condition. This is done because the soil type and land cover is such that the site will reliably infiltrate all the runoff from impervi9ous surfaces and converted pervious surfaces. Input data for the WWHM model for Basins A and B (Basins 1 and 2 in the proposed condition) can be found below in Figure 8—1 through Figure 8—5. Land cover was modeled as hydrologic soil group A/B with land types as designated in the input data below.

Figure 8—1: Basins 1 & 2 WWHM Layout

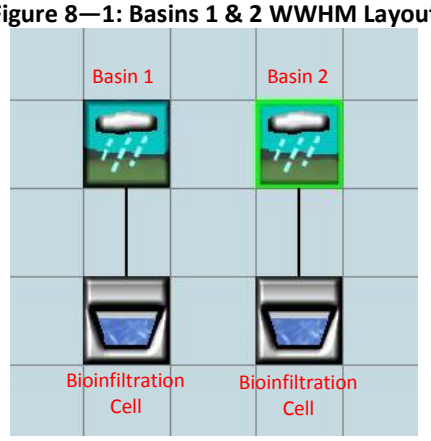


Figure 8—2: Basin 1 WWHM Input

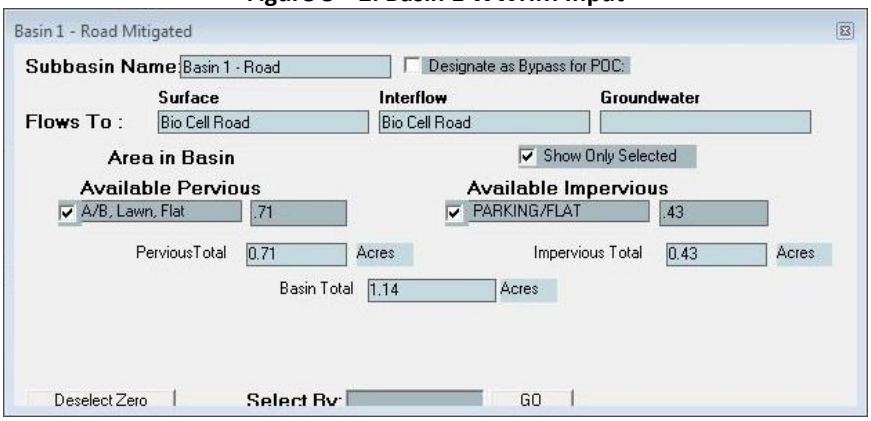


Figure 8—3: Basin 1 Bioinfiltration Cell WWHM Input

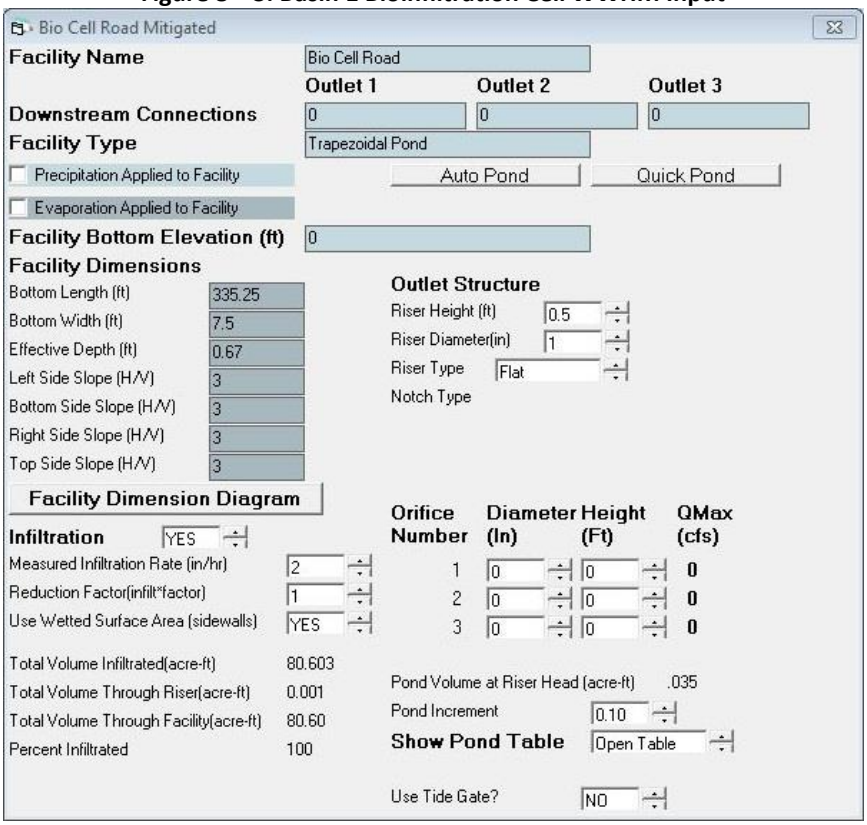


Figure 8—4: Basin 2 WWHM Input

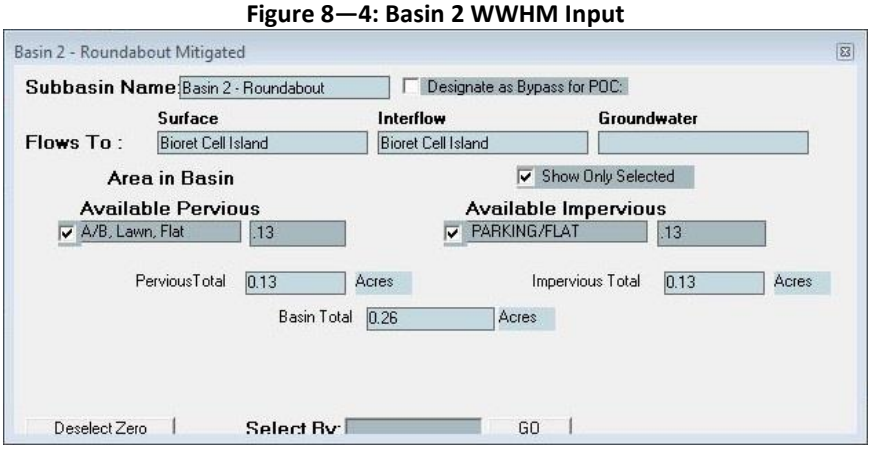
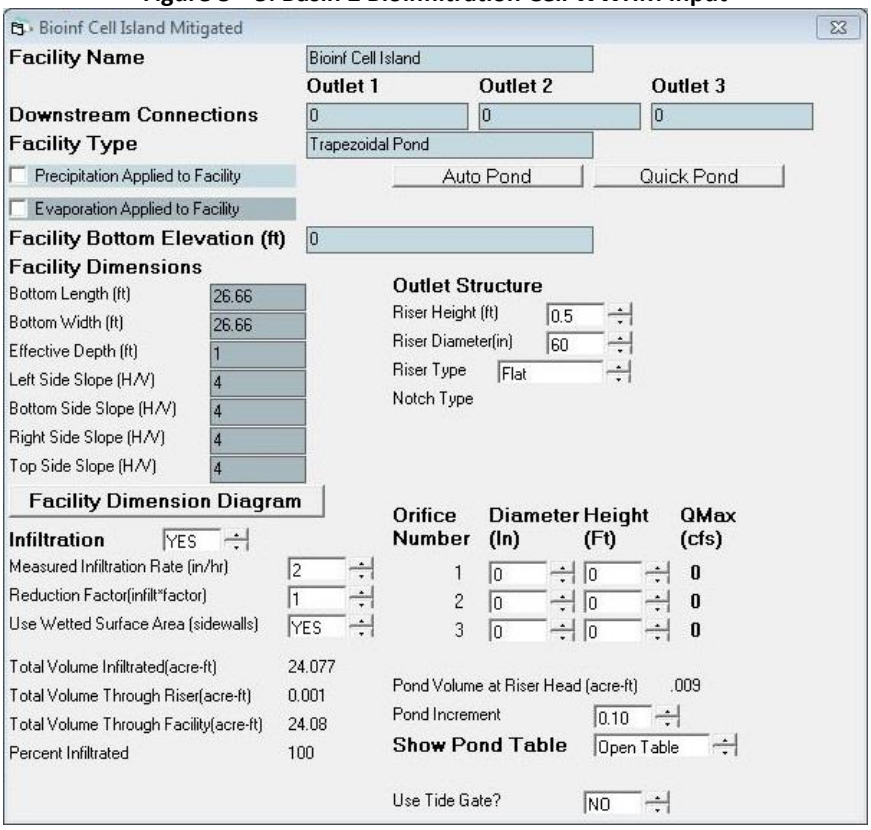


Figure 8—5: Basin 2 Bioinfiltration Cell WWHM Input



Input data for the WWHM model for Basin C (Basins 3 and 4 in the proposed condition) can be found below in Figure 8—6 through Figure 8—11.

Figure 8—6: Basins C, 3, & 4 WWHM Layout

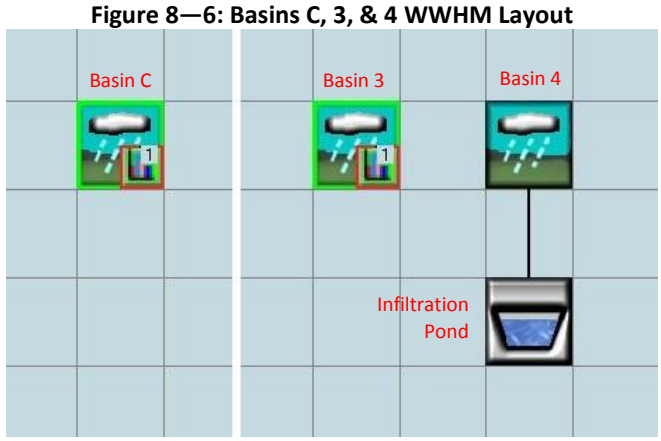


Figure 8—7: Basin C WWHM Input

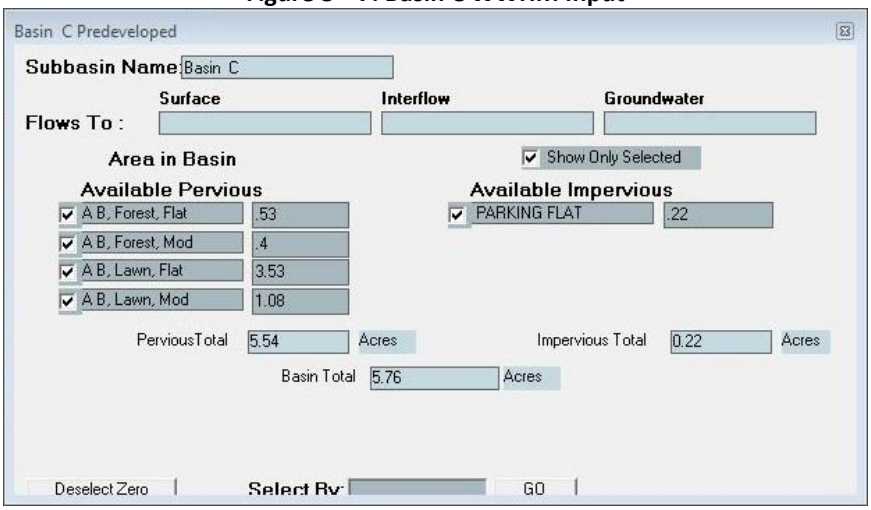


Figure 8—8: Basin 3 WWHM Input

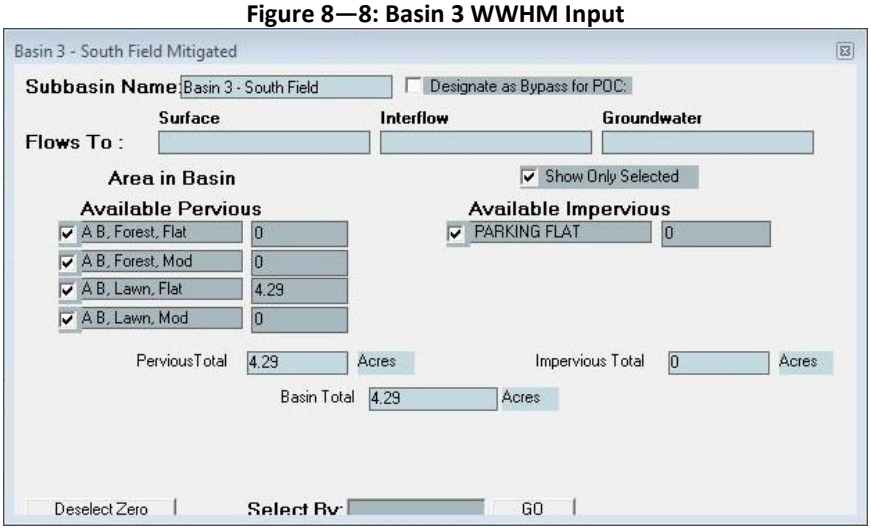


Figure 8—9: Basin 4 WWHM Input

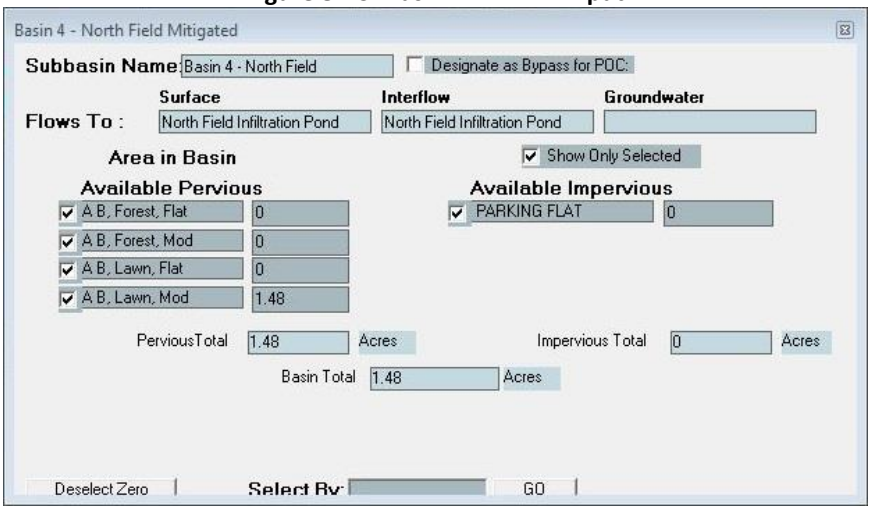
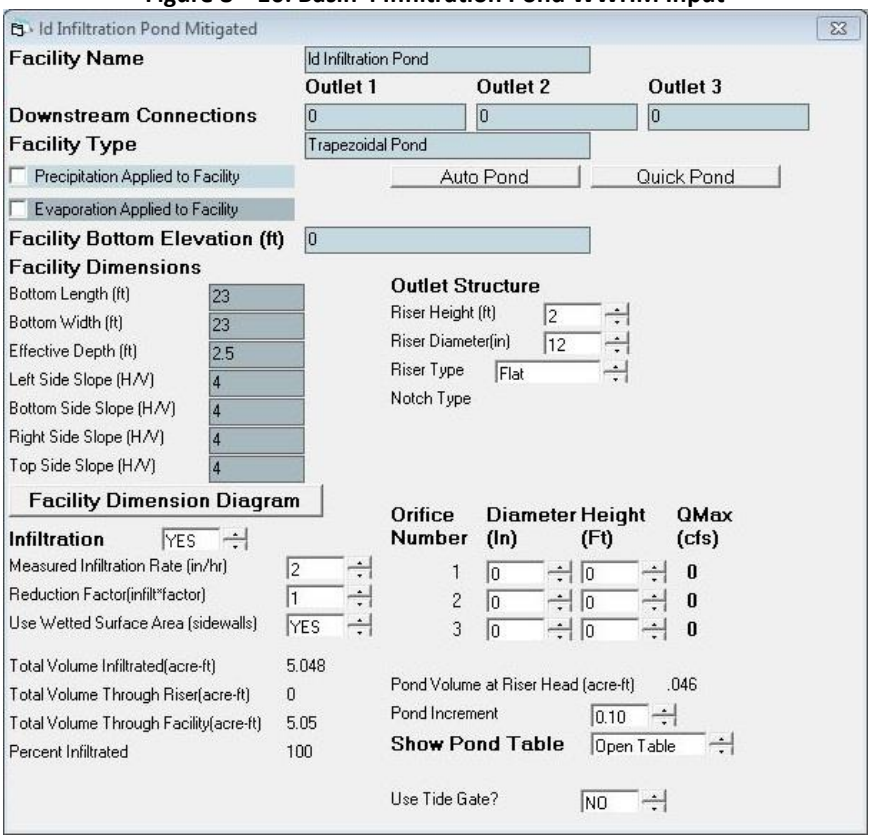
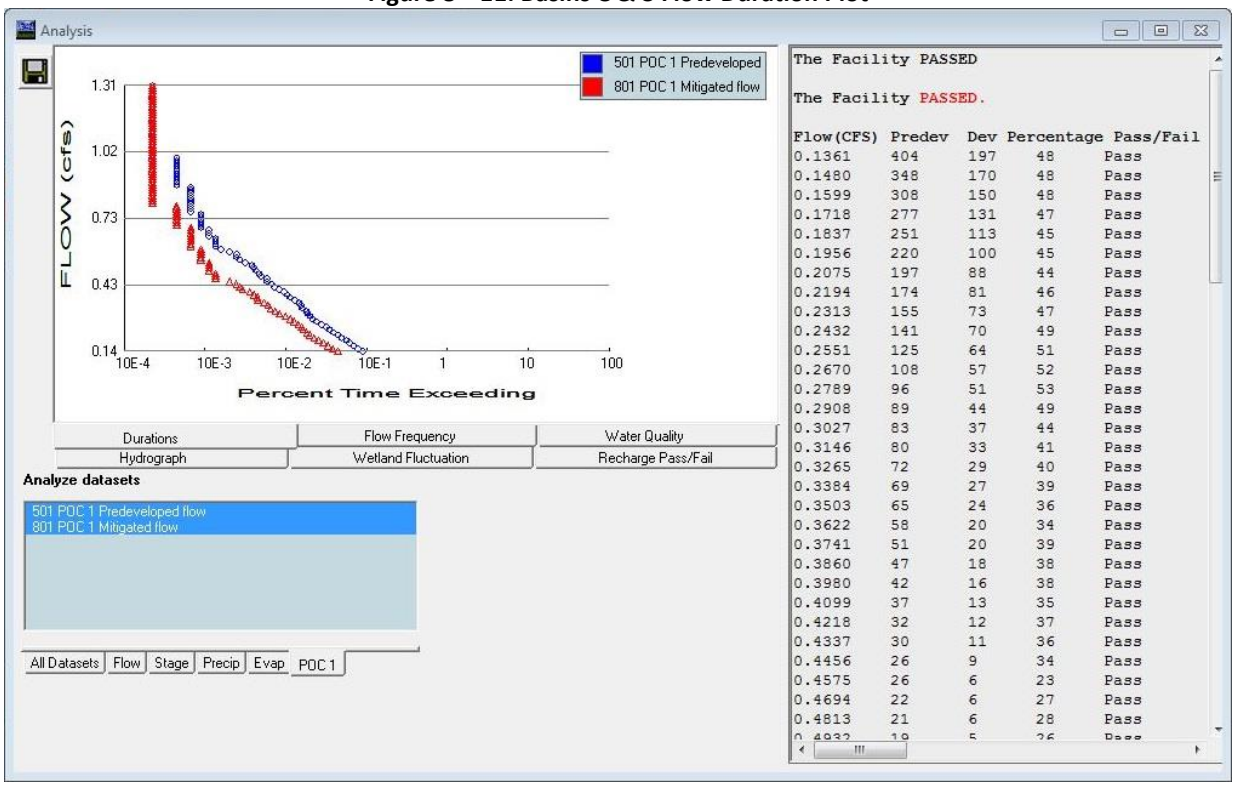


Figure 8—10: Basin 4 Infiltration Pond WWHM Input



As the existing condition of Basin C makes use of a swale for infiltration the proposed condition seeks to make use of this swale as well. Flows from the northern portion of Basin C (Basin 3 in the proposed condition) are diverted to an infiltration pond, sized above, while the southern portion of Basin C (Basin 4 in the proposed condition) follows the existing flow path to the infiltration swale along the southern edge of the basin. By diverting a portion of the flows to the infiltration pond flows discharging to the infiltration swale are reduced in the proposed condition. Refer to the below figure demonstrating the flow durations from the existing condition (Basin C) and the proposed condition (Basin 4) to the existing infiltration swale.

Figure 8—11: Basins C & 3 Flow Duration Plot



Input data for the WWHM model for Basins A and B (Basins 1 and 2 in the proposed condition) can be found below in Figure 8—12 through Figure 8—16.

Figure 8—12: Basins 5 & 6 WWHM Layout

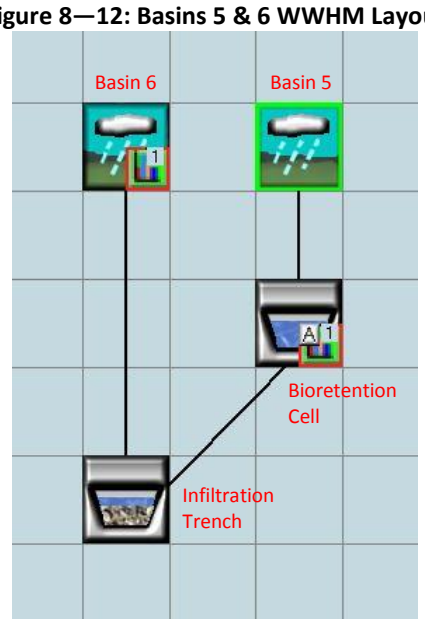


Figure 8—13: Basin 5 WWHM Input

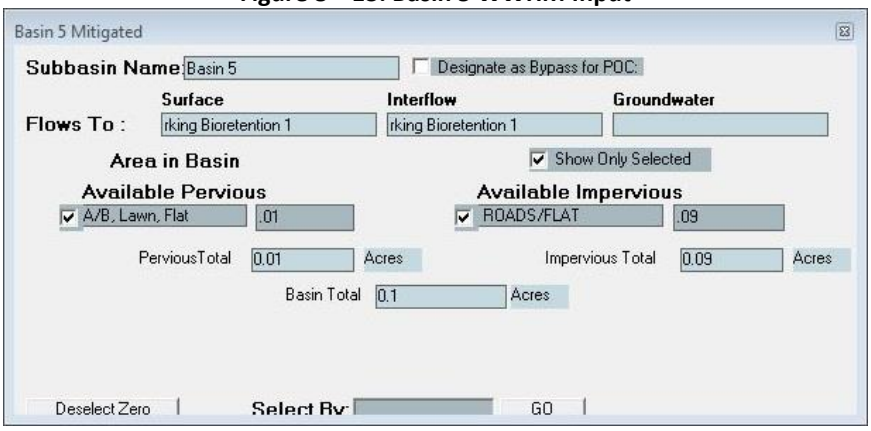


Figure 8—14: Basin 6 WWHM Input

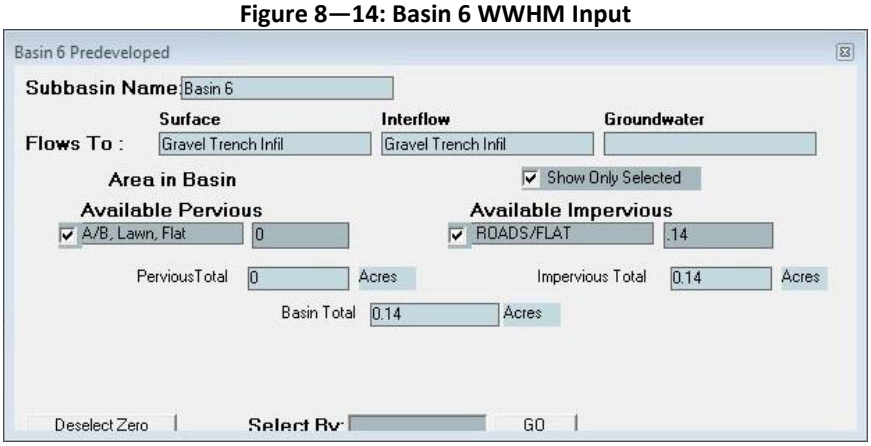


Figure 8—15: Basin 5 Bioretention Cell WWHM Input

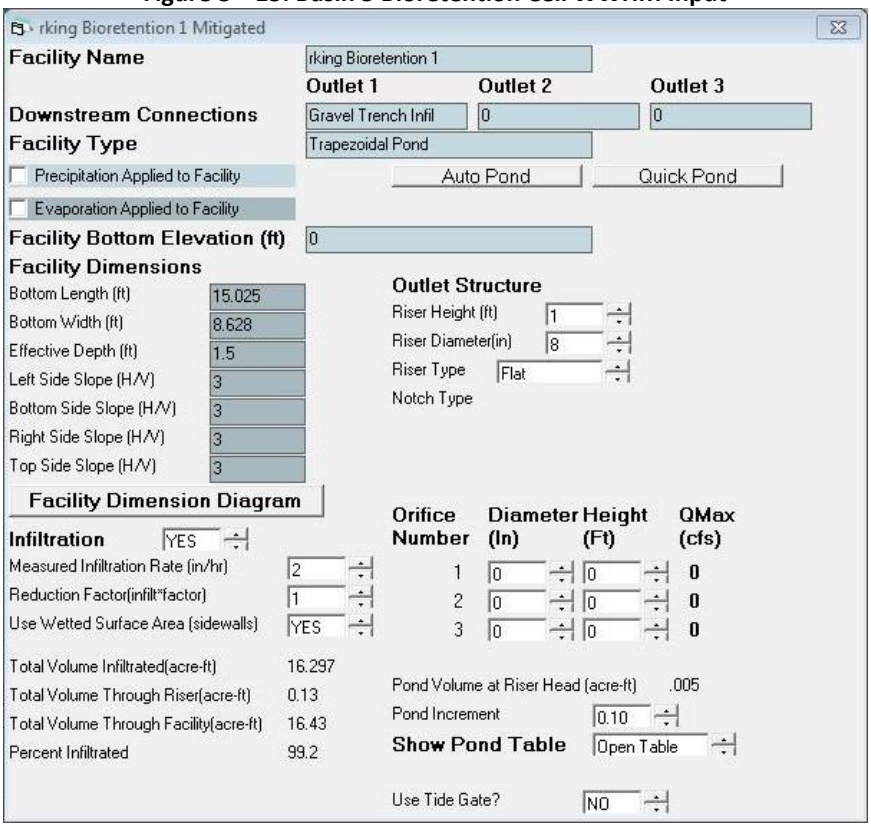
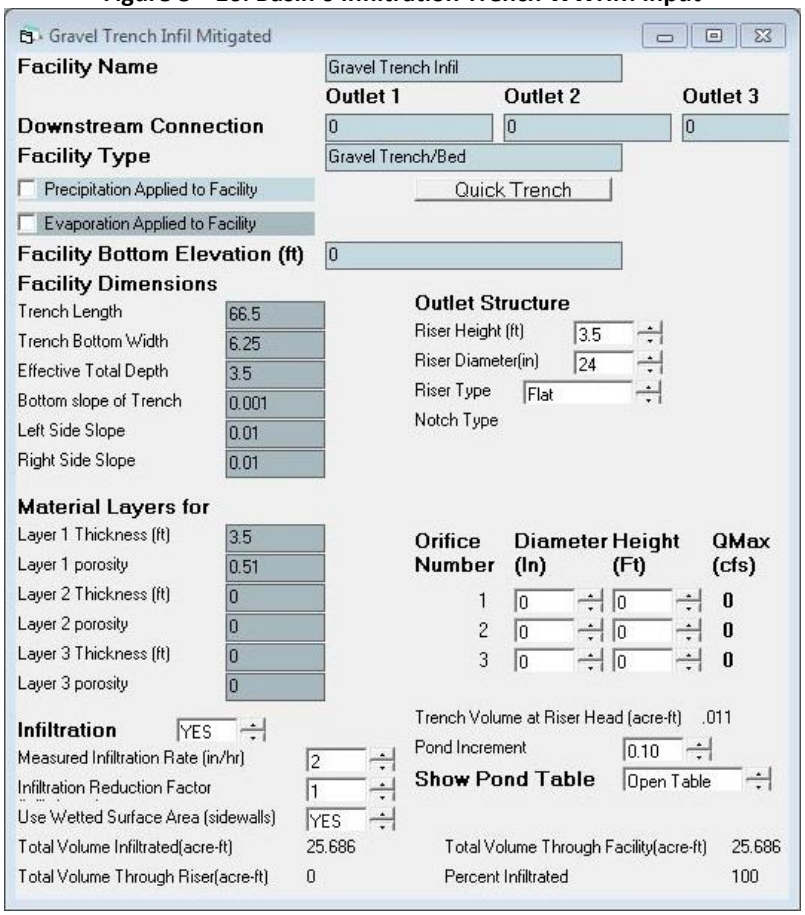


Figure 8—16: Basin 6 Infiltration Trench WWHM Input



As was shown in Figure 8—12 both Basins 5 and 6 are tributary to the infiltration system found in the skate park layout. As the infiltration system was designed to accommodate only the existing skate park additional infiltration will be provided through the expansion seen calculated in the above figure. The expansion of the infiltration system will be composed of 9 SC 740 chambers. Conveying runoff from these two basins to the infiltration system will be a system of pipes. The sizing of these pipes were done through a worst case scenario sizing. By analyzing the worst case pipe in the system and applying the size found in this scenario to all the pipes in the system it follows that all other pipes will be adequately sized. Flows were found through the WWHM Model, refer to Figure 8—17, and were used in conjunction with the Manning's Equation to size the pipe. Refer to the calculations below.

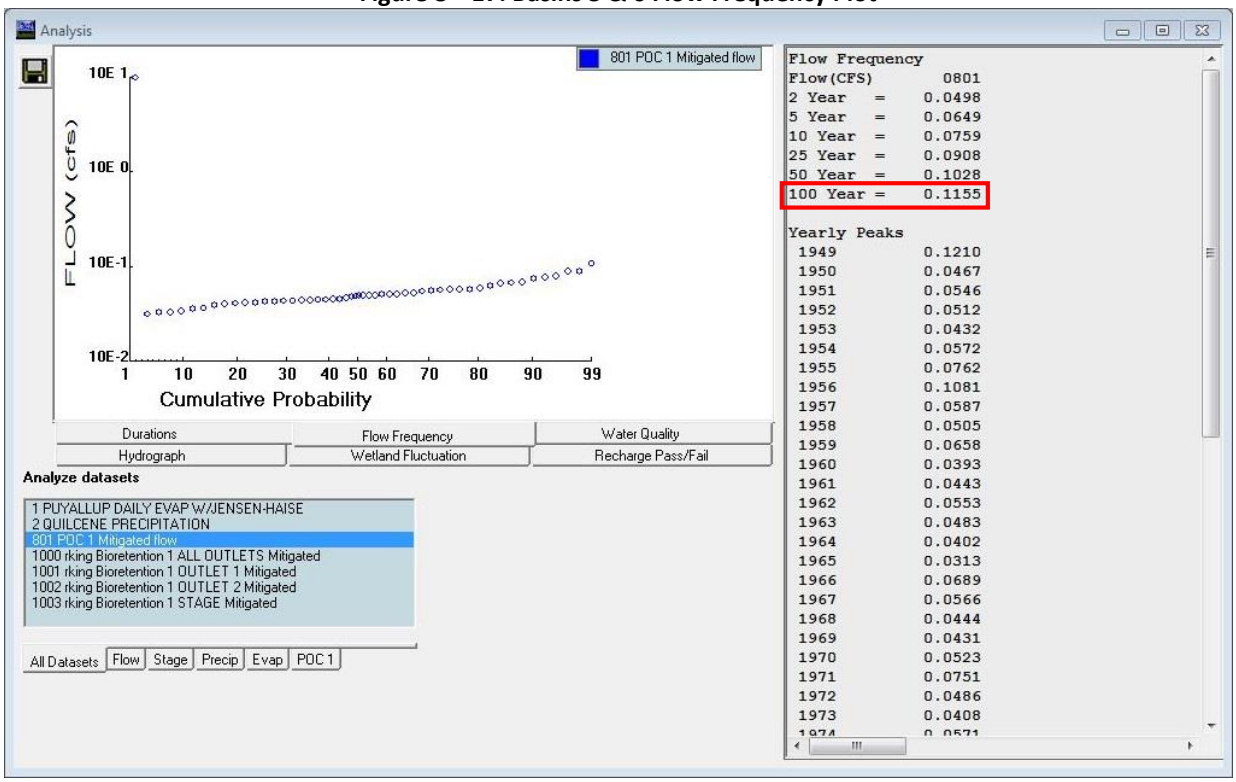
Q_{100} = 0.12 cfs
$Q_{full} = (1.49/n)AR^{2/3}S^{1/2}$

r = 0.25 ft
n = 0.013 (for PVC)
$A = \pi * r^2 = 0.20\ ft^2$
$P = 2*\pi*r = 1.57$ ft

R = A/P = 0.13 ft
S = 0.005 ft/ft
Q_{full} = 0.40 cfs

% Full = (0.12 cfs)/(0.40 cfs) = 0.30 or 30% full

Figure 8—17: Basins 5 & 6 Flow Frequency Plot



It is therefore confirmed that all pipes sized at a minimum of 6” and constructed at a minimum of 0.5% slope are adequate in the design of the skate park.

The point of connection to the existing system was also analyzed to ensure the existing system was not overwhelmed by the additional runoff generated on the skate park expansion. To do this a new model was created modeling the existing and proposed skate park simultaneously. As the existing skate park was previously analyzed refer to Figure 8—13 and Figure 8—14 for WWHM basin inputs, for the existing condition refer to Figure 8—19 and Figure 8—20 below for WWHM basin inputs and Figure 8—21 for the combined infiltration trench WWHM inputs.

Figure 8—18: Existing and Proposed Skate Park WWHM Layout

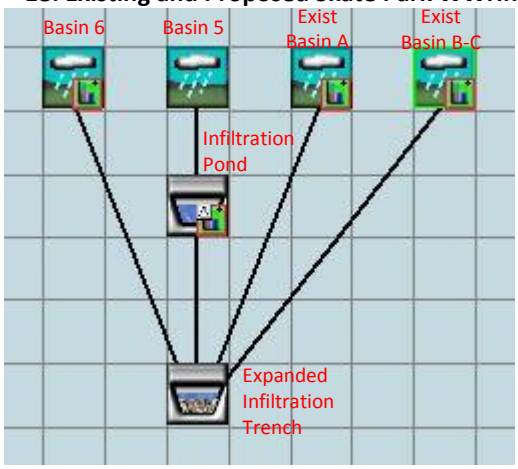


Figure 8—19: Existing Skate Park Basin A WWHM Input

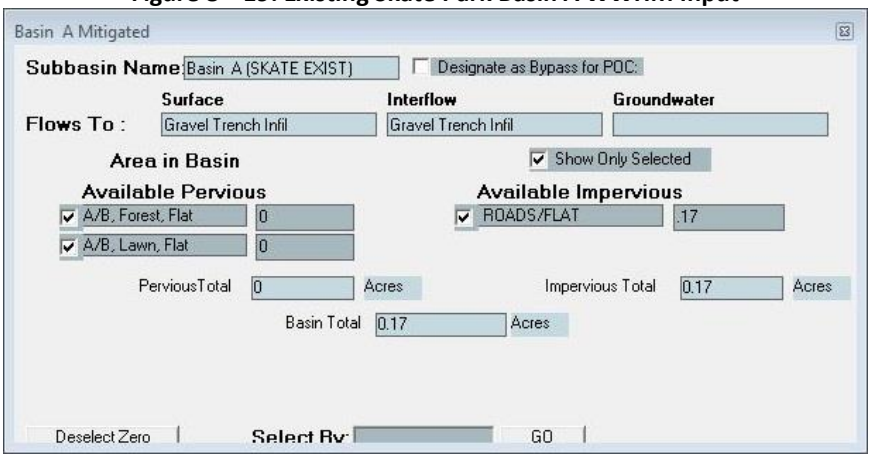


Figure 8—20: Existing Skate Park Basin B-C WWHM Input

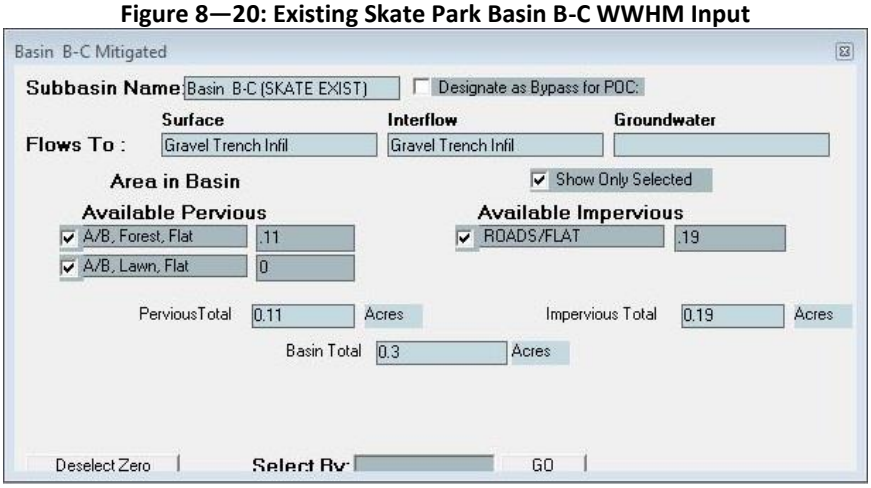
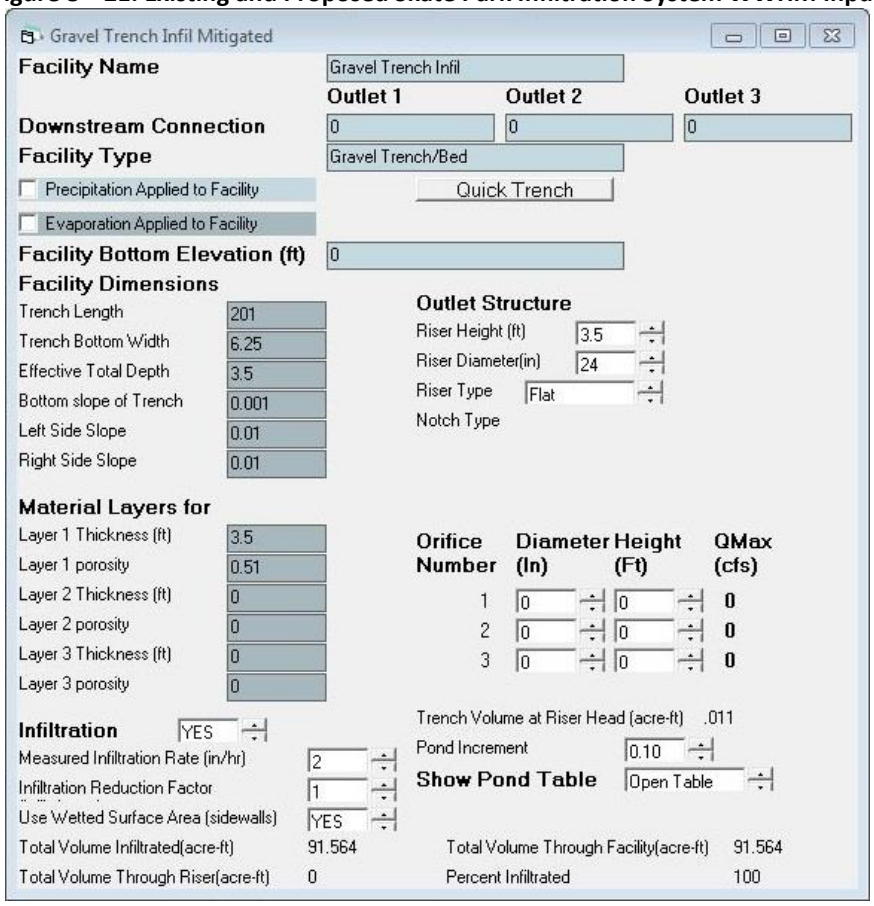


Figure 8—21: Existing and Proposed Skate Park Infiltration System WWHM Input



As was done for the proposed expansion to the skate park a worst case scenario analysis will be used to confirm that the additional area draining to the infiltration system will not cause a drainage problem within the pipe system. The worst case scenario pipe was found to be the pipe immediately adjacent to the infiltration system as it carries runoff from both the existing and proposed areas of the skate park. The pipe is existing as a 12” diameter pipe constructed at a 1% slope. Flows were found through the WWHM Model, refer to Figure 8—22, and were used in conjunction with the Manning’s Equation to size the pipe. Refer to the calculations below.

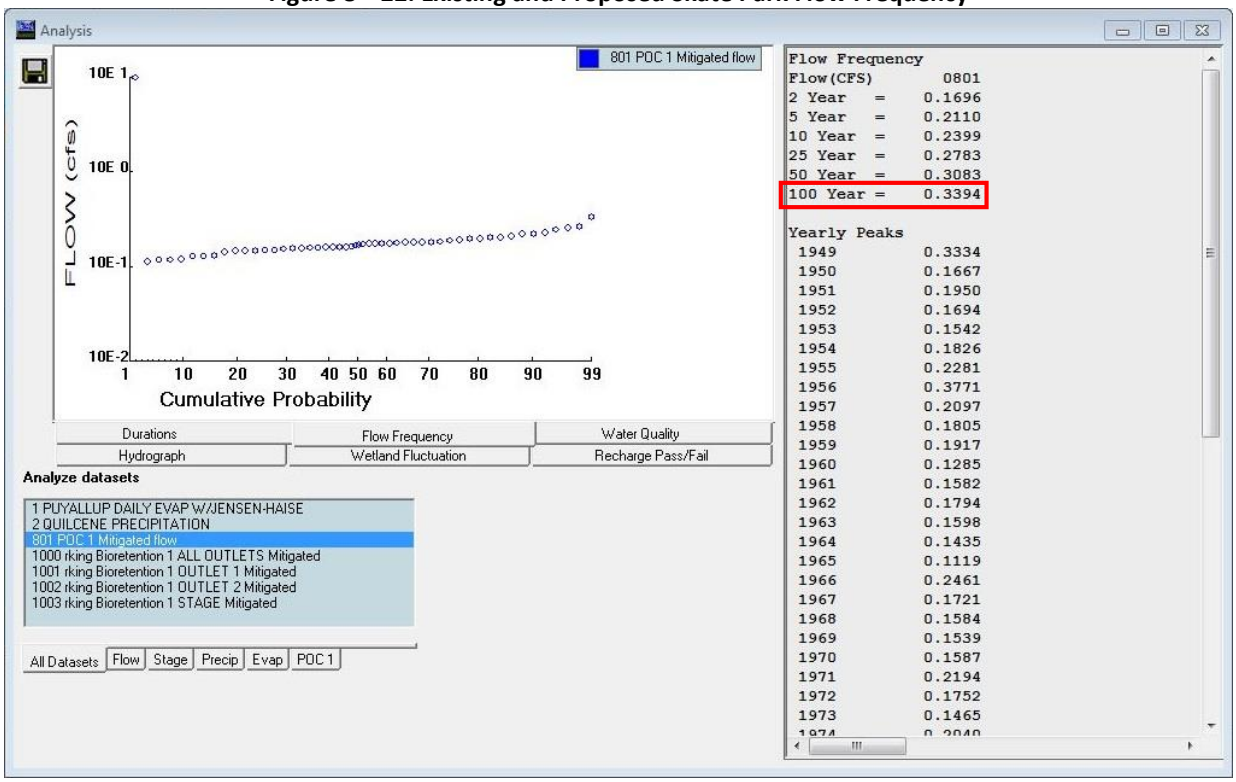
Q_{100} = 0.34 cfs
$Q_{full} = (1.49/n)AR^{2/3}S^{1/2}$

r = 0.5 ft
n = 0.013 (for PVC)
$A = \pi * r^2 = 0.79\ ft^2$
$P = 2*\pi*r = 3.14$ ft
R = A/P = 0.25 ft
S = 0.01 ft/ft

Q_{full} = 3.57 cfs

% Full = (0.34 cfs)/(3.57 cfs) = 0.095 or 9.5% full

Figure 8—22: Existing and Proposed Skate Park Flow Frequency



It is therefore confirmed that the existing pipes will maintain capacity even with the additional runoff generated with the skate park expansion.

CHAPTER 9 – APPENDICIES

APPENDIX A – OPERATIONS AND MAINTENANCE MANUAL

Maintenance Plan Goal

Kitsap County Parks & Recreation will be responsible for the maintenance and operation of the on-site stormwater facilities. The objective of the following plan is to provide the owner a manual for maintaining the on-site stormwater conveyance system. The attached checklists will be used in maintaining the facilities.

Introduction/System Overview

The onsite stormwater management facilities include bioinfiltration cells, a bioretention cell, an infiltration pond, an underground infiltration system, catch basins, and stormwater conveyance system. The bioinfiltration cells are located along the gravel road running east west across the site. The infiltration pond is located north of the future baseball field grading area. The bioretention cell, underground infiltration facility, catch basins, and stormwater conveyance system are all located in or around the skate park along the southern edge of the park. All facilities are designed to achieve full infiltration onsite with no offsite discharge.

A site plan with the locations of the stormwater facilities is provided and can be found on the next page.

Operations & Maintenance Manual Map

SOUTH KITSAP REGIONAL PARK

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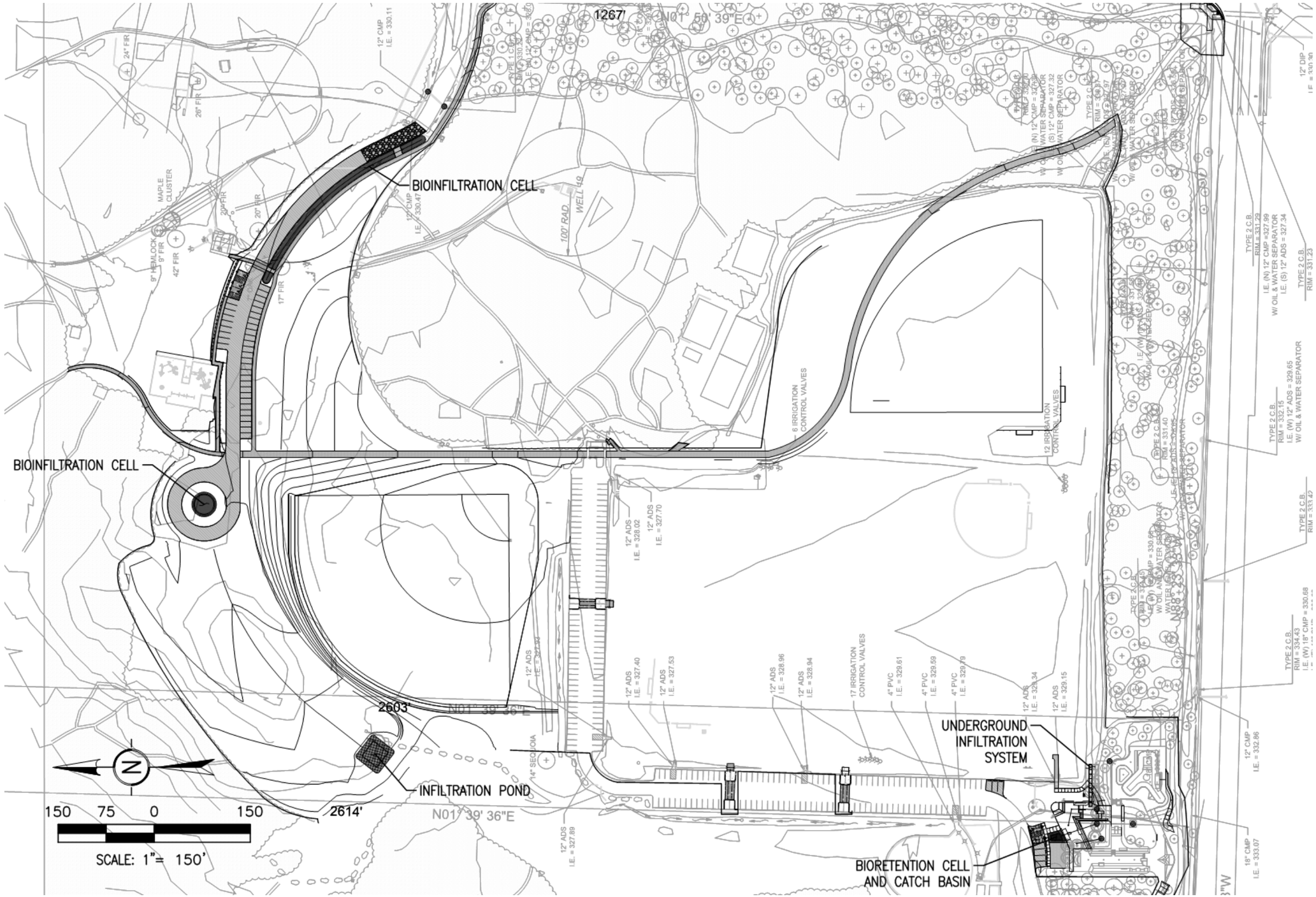
BCRA



Refer to sheets C3.02, C3.04, and C4.02 in Appendix E for detailed drawings for the bioinfiltration cell, bioretention cell, infiltration pond, and other storm drainage structures.

The on-site storm system requires regular maintenance. The conveyance system must be inspected after large storm events. Leaves and debris shall be swept clean of the catch basin grates. Sumps of the catch basins must also be cleaned periodically. Kitsap County Parks & Recreation will be the entity responsible for the maintenance of the onsite storm system. The address and contact information for Kitsap County Parks & Recreation is:

Kitsap County Parks & Recreation
614 Division Street, MS-1
Port Orchard, WA 98366
(360) 337-5361

The maintenance standards are used as inspection forms for the system and its associated components. Record the date each time an inspection is completed and note any problems and actions taken, records of inspection and maintenance must be kept for five (5) years. A sample maintenance log is provided at the end of this document and is kept onsite at all times. Keep completed forms with the Operations and Maintenance Manual onsite. Kitsap County Parks & Recreation shall keep the Operations and Maintenance Manual available for maintenance personnel. County staff may request to review the maintenance forms as a part of their inspection process. Some components or facilities do not need to be looked at every time an inspection is conducted. Use the suggested frequency at the left of each item as a guideline for activities to be completed with each inspection.

A brief description of each stormwater facility and its function is provided below:

- The bioinfiltration and bioretention cells onsite are shown on sheet C3.02 and C3.04 in Appendix E. The cells are designed to collect stormwater from the pollution generating impervious surfaces and treat by filtering the water through their soil media.
- The infiltration ponds onsite are shown on sheet C4.02 in Appendix E. The ponds are designed to collect stormwater from pervious surfaces and infiltrate it onsite.
- An catch basin's function is to collect, convey, and temporarily store stormwater sheet flow or stormwater conveyance. The catch basin is a concrete or plastic box or cylinder that will have a grate to allow stormwater to flow into the drain.
- Conveyance pipes are located underground and are connected to catch basins. Conveyance pipes use gravity to convey stormwater downstream.

Pollution Source Control

In addition to regular maintenance, Kitsap County Parks & Recreation shall be responsible for controlling potential pollutants at their point of use or generation. Pollution source control is the application of pollution prevention practices to prevent contamination of stormwater runoff. The plan of action will include elements such as a centralized area for the storage of equipment, lubricants, pesticides, etc. The owner may elect to follow the detailed guidance on control of sediment pollutants as outlined in the DOE Manual. The most important practice is to ensure that no hazardous wastes, such as oil, will be dumped into the storm drainage system.

The attached checklists indicate maintenance actions which must be performed to keep the system in proper operating condition. The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceeding these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

An estimate for maintaining each stormwater drainage system has been provided below. These values are an estimate and are subject to change. The estimate shall not be considered the final cost of maintenance for each system and is estimated to be the cost of a single unit.

1. Bioinfiltration and Bioretention Cells:
    a. Remove debris and sediment buildup, repair cracks in planter, replenish mulch, replace clogged bio retention soil, eradicate noxious weeds. Variable cost for repairs.

2. Infiltration Ponds:
    a. Remove debris and sediment buildup, repair cracks in planter, replenish mulch, eradicate noxious weeds. Variable cost for repairs.

3. Catch Basin:
    a. For each catch basin it is estimated to cost $600-800 to vacuum, pressure wash, replace filter, and dispose of waste.

Maintenance tasks and frequencies of each task for each facility are provided on the next page.

Maintenance Program Cover Sheet

Inspection Period: _____

Number of Sheets Attached: _____

Date Inspected: _____

Name of Inspector: _____

Inspector's Signature: _____

Instructions for Use of Maintenance Checklists

The following pages contain maintenance needs for most of the components that are part of the onsite drainage system, as well as for some components that may not be part of the onsite drainage system. Inform Kitsap County if there are any components that are missing from these pages. Ignore requirements that do not apply to the onsite system. A checklist should be completed for all onsite system components on the following schedule:

(1) Monthly from November through April.
(2) Twice a year for catch basins, preferably once in late summer (September) and in early spring.
(3) After any major storm (use 1-inch in 24 hours as a guideline).

Use photocopies of the Operation and Maintenance Manual to check off any problems found with the onsite stormwater facilities every time an inspection takes place. Add comments on problems found and actions taken. Keep the "checked" sheets filed for future reference, as they will be used to write an annual report. Some items do not need to be looked at every time an inspection is done. Use the suggested frequency stated for each item as a guideline during inspection.

#2 – Maintenance Checklist for Infiltration Facilities

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
M,S	General					Trash and Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one 32 gallon garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
A	General					Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined in the Kitsap County Noxious Weeds List	No danger of poisonous vegetation where maintenance personnel or the public might normally be. Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies required
M,S	General					Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants	No contaminants or pollutants present. (Coordinate removal/cleanup with Department of Ecology Spill Response 800-424-8802.)
M	General					Rodent Holes	If the facility is constructed with a dam or berm, look for rodent holes or any evidence of water piping through the dam or berm.	Rodents removed and dam or berm repaired. (Coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
M	General					Beaver Dams	Beaver dam results in an adverse change in the functioning of the facility.	Facility is returned to design function. (Contact WDFW Region 6 to identify the appropriate Nuisance Wildlife Control Operator)
A	General					Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted integrated pest management policies.
S	General					Performance	Check crest gauge against design expectations (see maintenance plan)	Record reading. Notify county if not meeting design performance.
M, S	Crest Gage					Crest Gage Missing/Broken	Crest gage is not functioning properly, has been vandalized, or is missing.	Repair/replace

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
M	Storage Area					Water Not Infiltrating	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration (24 hours or design infiltration time). (A percolation test pit or test of facility indicates facility is only working at 90 percent of its designed capabilities. If 2 inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
M	Filter Bags (if applicable)					Filled with Sediment and Debris	Sediment and debris fill bag more than one-half full.	Filter bag is replaced or system is redesigned.
M,S	Rock Filters					Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
A,S	Trenches					Observation Well (Use surface of trench if well is not present)	Water ponds at surface during storm events. Less than 90 percent of design infiltration rate.	Remove and Replace/Clean rock and geomembrane.
M	Ponds					Vegetation	Exceeds 18 inches.	Mow
M	Ponds					Vegetation	Bare spots.	Revegetate and stabilize immediately.
M	Side Slopes of Pond					Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
A	Pond Berms (Dikes)					Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
A	Pond Berms (Dikes)					Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential eliminated.

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
A	General					Hazard Trees	If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Remove hazard trees
A	General					Tree Growth and Dense Vegetation	Tree growth and dense vegetation which impedes inspection, maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements).	Trees and vegetation that does not hinder inspection or maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).
A	Pond Berms (Dikes)					Tree Growth	Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
A	Emergency Overflow/ Spillway					Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
A	Emergency Overflow/ Spillway					Rock Missing	Only one layer of rock exists above native soil in area 5 square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Riprap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
A	Emergency Overflow/ Spillway					Erosion	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
M	Presettling Ponds and Vaults					Facility or sump filled with Sediment and/or debris	6 inches or designed sediment trap depth of sediment.	Sediment is removed.

If you are unsure whether a problem exists, please contact a professional engineer.

Key:

(M) Monthly from October through April.
(A) Once in late summer (preferably September)
(S) After any major storm (use 1 inch in 24 hours as a guideline).

#5 – Maintenance Checklist for Catch Basins

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
A	General					"Dump no pollutants" Stencil or stamp not visible	Stencil or stamp should be visible and easily read	Warning signs (e.g., "Dump No Waste-Drains to Stream") shall be painted or embossed on or adjacent to all storm drain inlets.
M,S	General					Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10 percent.	No trash or debris located immediately in front of catch basin or on grate opening.
M	General					Trash and Debris	Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
M	General					Trash and Debris	Trash or debris in any inlet or outlet pipe blocking more than one-third of its height.	Inlet and outlet pipes free of trash or debris.
M	General					Trash and Debris	Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
M	General					Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
A	General					Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than one-fourth inch (intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
A	General					Structure Damage to Frame and/or Top Slab	Frame not sitting flush on top slab, i.e., separation of more than three-fourth inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
A	General					Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
A	General					Fractures or Cracks in Basin Walls/ Bottom	Grout fillet has separated or cracked wider than one-half-inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
A	General					Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
M	General					Vegetation	Vegetation growing across and blocking more than 10 percent of the basin opening.	No vegetation blocking opening to basin.
M	General					Vegetation	Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth present.
M	General					Contamination and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants.	No contaminants or pollutants present. (Coordinate removal/cleanup with Department of Ecology Spill Response 800-424-8802.)
A	Catch Basin Cover					Cover Not in Place	Cover is missing or only partially in place.	Any open catch basin requires maintenance. Catch basin cover is closed
A	Catch Basin Cover					Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half-inch of thread.	Mechanism opens with proper tools.
A	Catch Basin Cover					Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
A	Ladder					Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
	Grates					Grate opening Unsafe	Grate with opening wider than seven-eighths of an inch.	Grate opening meets design standards.

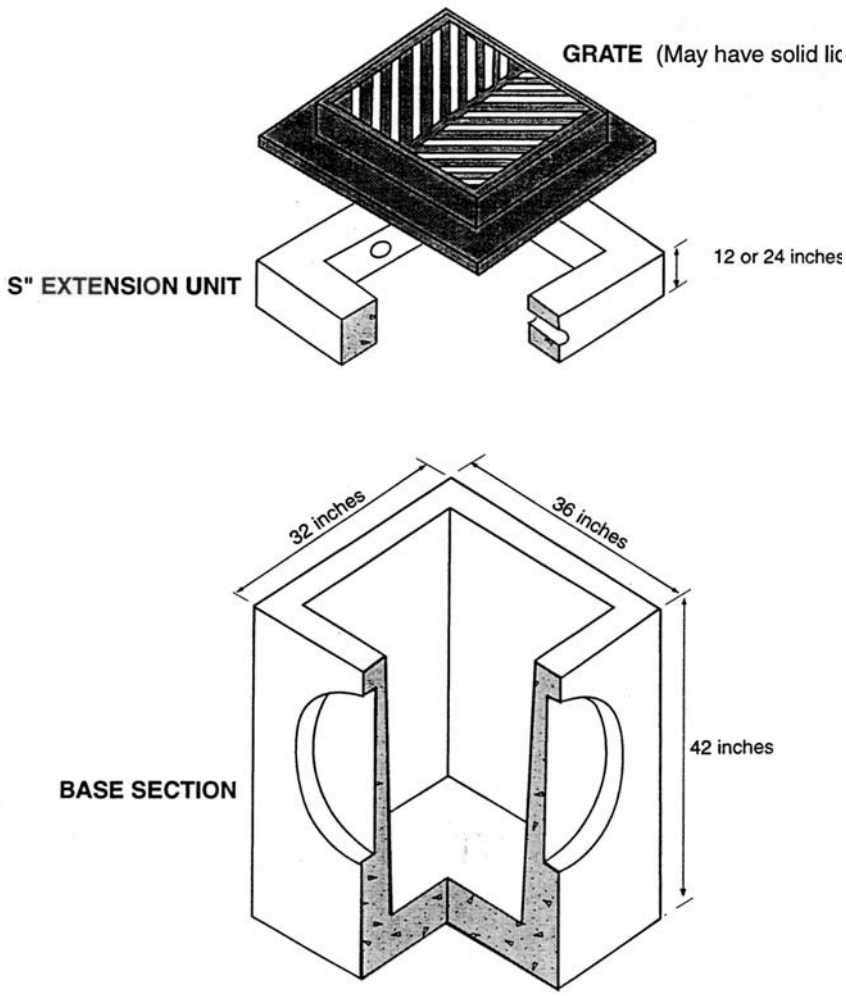
		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
M,S	Grates					Trash and Debris	Trash and debris that is blocking more than 20 percent of grate surface inletting capacity.	Grate free of trash and debris.
A	Grates					Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

If you are unsure whether a problem exists, please contact a professional engineer.

Key:

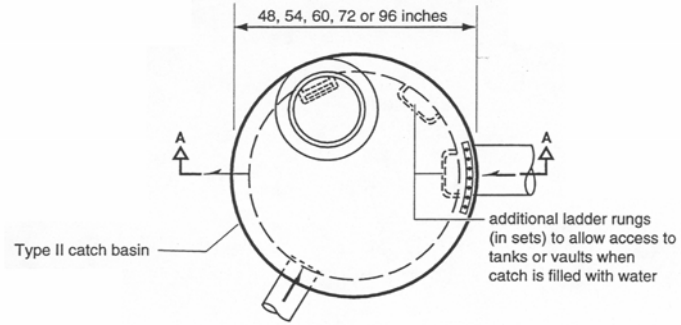
(M) Monthly from October through April.
(A) Once in late summer (preferably September)
(S) After any major storm (use 1 inch in 24 hours as a guideline).

Type I Catch Basin



Type II Catch Basin

(Round concrete structure)



PLAN VIEW
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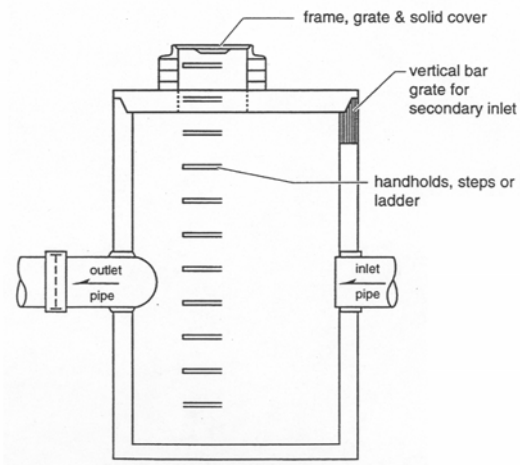


SECTION A-A
not to scale

#21 – Maintenance Checklist for Grounds (Landscaping)

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
M	General					Weeds (nonpoisonous)	Weeds growing in more than 20 percent of the landscaped area (trees and shrubs only). See also Kitsap County Noxious weeds list.	Weeds present in less than 5 percent of the landscaped area.
M	General					Insect Hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.
M,S	General					Trash or Litter	See Ponds Checklist.	See Ponds Checklist.
M,S	General					Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded.
A	Trees and shrubs					Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25 percent of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
M	Trees and shrubs					Damage	Trees or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.
A	Trees and shrubs					Damage	Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Place stakes and rubber-coated ties around young trees/shrubs for support.

If you are unsure whether a problem exists, please contact a professional engineer.

Key:

(M) Monthly from October through April.
(A) Once in late summer (preferably September)
(S) After any major storm (use 1 inch in 24 hours as a guideline).

#29 – Bioretention (Swales and Planters)

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
B	Ponding Area					Cracks or Failure in concrete planter reservoir	Cracks wider than ½ inch or maintenance/inspection personnel determine that the vault is not structurally sound	Vault repaired or replaced so that vaults meets design specifications and is structurally sound.
B	Ponding Area					Failure in earthen reservoir (embankments, dikes, berms, and side slopes)	Erosion (gullies/rills) greater than 2 inches around inlets, outlet, and along side slopes.	Eliminate source of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control blanket)
B	Ponding Area					Failure in earthen reservoir embankments, dikes, berms, and side slopes)	Settlement greater than 4 inches (relative to undisturbed sections of berm)	Restore to design height
A	Ponding Area					Failure in earthen reservoir (embankments, dikes, berms, and side slopes)	Downstream face of berm or embankment wet, seeps or leaks evident	Plug holes. Contact geotechnical engineer ASAP.
A	Ponding Area					Failure in earthen reservoir (embankments, dikes, berms, and side slopes)	Any evidence of rodent holes or water piping around holes if facility acts as dam or berm	Eradicate rodents/repair holes (fill and compact)
Q	Ponding Area					Sediment or debris accumulation	Accumulation of sediment or debris	Remove excess sediment or debris. Identify and control the sediment source, if feasible. Facility should be free of material. May contain standing water.
A	Ponding Area					Rockery reservoir or walls	Rock walls are insecure.	Stabilize walls
B	Ponding Area					Basin inlet via surface flow	Soil is exposed or signs of erosion are visible.	Repair and control erosion sources

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
B	Ponding Area					Basin inlet via concentrated flow (e.g., curb cuts)	Sediment, vegetation, or debris partially or fully blocking inlet structure.	Clear the blockage. Identify the source of the blockage and take actions to prevent future blockages.
B	Ponding Area					Basin inlet splash block failure	Water splashes adjacent buildings.	Reconfigure/repair blocks
B	Ponding Area					Basin inlet splash block failure	Water disrupts soil media.	Reconfigure/repair blocks
B	Ponding Area					Inlet/outlet pipe failure	Pipe is damaged.	Repair/replace
B	Ponding Area					Inlet/outlet pipe failure	Pipe is clogged.	Remove roots or debris
B	Ponding Area					Outlet pipe/structure failure	Sediment, vegetation, or debris partially or fully blocking inlet structure	Clear the blockage. Identify the source of the blockage and take actions to prevent future blockages.
B	Ponding Area					Trash rack failure	Trash or debris present on trash rack.	Clean and dispose trash
B	Ponding Area					Trash rack failure	Bar screen damaged or missing.	Replace
B	Ponding Area					Check dams and Weirs failures	Sediment, vegetation, or debris partially or fully blocking check dam or weir.	Clear the blockage. Identify the source of the blockage and take actions to prevent future blockages.
B	Ponding Area					Check dams and Weirs failures	Erosion and/or undercutting is present	Repair and take preventative measures to prevent future erosion and/or undercutting
B	Ponding Area					Flow Spreader problems	Sediment blocks 35% or more of ports/notches or, sediment fills 35% or more of sediment trap.	Remove and dispose
B	Ponding Area					Flow Spreader problems	Grade board/baffle damaged or not level.	Remove and reinstall to level position
B	Ponding Area					Overflow/ emergency spillway	Overflow spillway is partially or fully plugged with sediment or debris.	Remove/dispose
B	Ponding Area					Overflow/ emergency spillway	Native soil is exposed or other signs of erosion damage are present.	Repair erosion and stabilize surface of spillway
B	Ponding Area					Overflow/emergency spillway	Spillway armament is missing.	Replace armament

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
B	Ponding Area					Bioretention soil	Water remains in the basin 48 hours or longer after the end of a storm.	Ensure that under drain (if present) is not clogged. If necessary, clear under drain. If this is not the problem, the bioretention soil is likely clogged. Remove upper 2 to 3 inches of soil and replace with imported bioretention soil. Identify sources of clogging and correct.
B	Vegetation					Bottom swale vegetation	Less than 80% of swale bottom is covered with healthy wetland vegetation.	Plant additional vegetation. Ideally, planting should be performed in the fall or winter.
B	Vegetation					Upland slope vegetation	Less than 70% of upland slopes are covered with healthy vegetation.	Plant additional vegetation. Ideally, planting should be performed in the fall or winter.
A	Vegetation					Trees and shrubs	Large trees and shrubs interfere with operation of the basin or access for maintenance.	Prune or remove large trees and shrubs
A	Vegetation					Trees and shrubs	Standing dead vegetation is present.	Remove standing dead vegetation when covering greater than 10% of basin area. Replace dead vegetation annually or immediately if necessary to control erosion (e.g., on a steep slope).
A	Vegetation					Mulch	Bare spots (without much cover) are present or mulch covers less than 3 inches deep for compost or 4 inches deep for course woody mulch.	Replenish mulch to cover bare spots and augment to minimum depth.
As needed	Vegetation					Clippings	Grass or other vegetation clippings accumulate to 2 inches or greater in depth.	Remove clippings
M	Vegetation					Noxious weeds	Listed noxious vegetation is present. See Kitsap County noxious weed list.	By law, noxious weeds must be removed and disposed immediately. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.
Q	Vegetation					Weeds	Weeds are present (unless on edge and providing erosion control)	Remove and dispose of weed material. It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality.

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
Based on manufacturers instructions	Irrigation					Irrigation system (if any)	Irrigation system present.	Follow manufacturer's instructions for O&M
Weekly (May – September)	Irrigation					Plant watering	Plant establishment period (1-3 years).	Water weekly during periods of no rain to ensure plant establishment
As Needed	Irrigation					Plant watering	Longer term period (3+ years).	Water during drought conditions or more often if necessary to maintain plant cover
Ongoing	Spill Prevention and Response					Spill prevention	Storage or use of potential contaminants in the vicinity of facility.	Exercise spill prevention measures whenever handling or storing potential contaminants
As needed	Spill Prevention and Response					Spill response	Release of pollutants. Call to report any spill to the Washington Dept of Emergency Management 1-800-258-5990	Cleanup spills as soon as possible to prevent contamination of stormwater
At startup	Training and Documentation					Training / written guidance	Training / written guidance is required for proper O&M.	Provide property owners and tenants with proper training and a copy of the O&M manual and Landscape and Maintenance Manual.
A	Safety					Safety (slopes)	Erosion of sides causes slope to exceed 1:4 or otherwise becomes a hazard.	Take actions to eliminate the hazard
A	Safety					Safety (hydraulic structures)	Hydraulic structures (pipes, culverts, vaults, etc.) become a hazard to children playing in and around the facility.	Take actions to eliminate the hazard (such as covering and securing any openings)
A	Safety					Line of sight	Vegetation causes some visibility (line of sight) or driver safety issues.	Prune
A	Aesthetics					Aesthetics	Damage/vandalism/debris accumulation.	Restore facility to original aesthetic conditions
A	Aesthetics					Grass/vegetation	Less than 75% of planted vegetation is healthy with a generally good appearance.	Take appropriate maintenance actions. (e.g., remove/replace plants, amend soil, etc.)
A	Aesthetics					Edging	Grass is starting to encroach on swale.	Repair edging

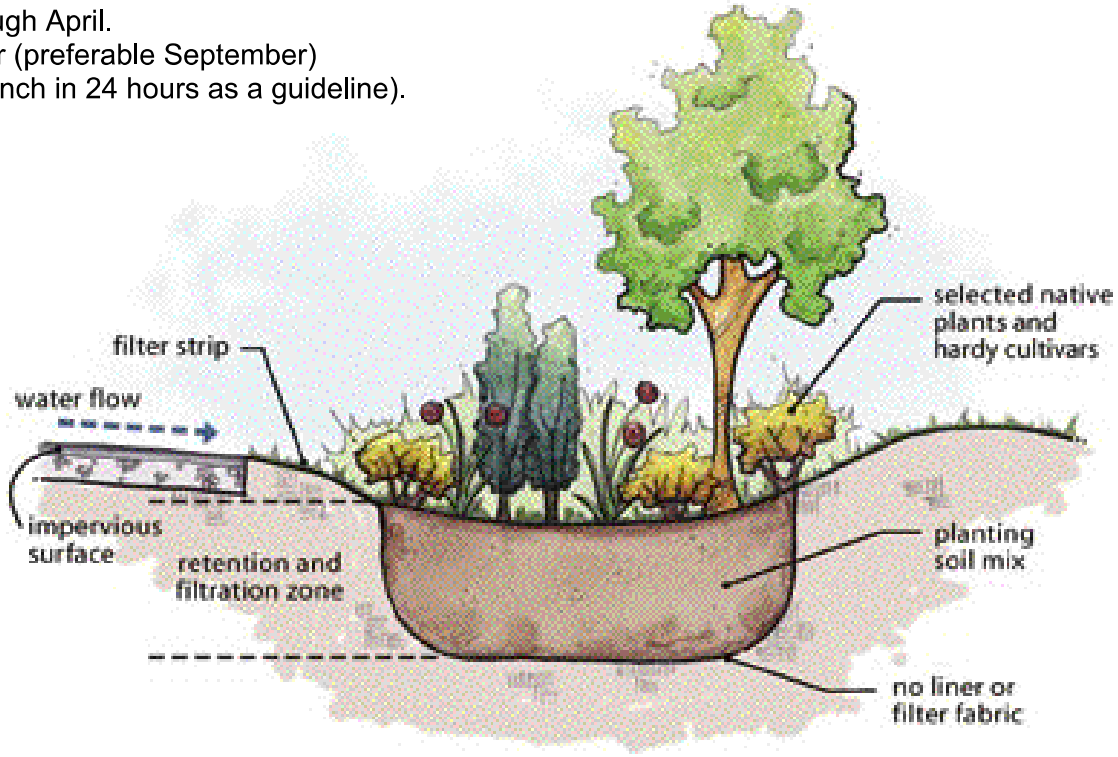
		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
B	Pest Control					Mosquitoes	Standing water remains in the basin for more than three days following storms.	Identify the cause of the standing water and take appropriate actions to address the problem (see Bioretention Soil above)
A	Pest Control					Rodents	Rodent holes are present near the facility.	Fill and compact soil around the holes (refer to integrated pest management?)

If you are unsure whether a problem exists, please contact a professional engineer.

Comments:

Key:

(M) Monthly from November through April.
(A) Annually, once in late summer (preferable September)
(S) After any major storm (use 1-inch in 24 hours as a guideline).
(B) Biannually (spring and fall)
(Q) Quarterly



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Save Valuable Land and Protect Water Resources

Isolator® Row O&M Manual

StormTech® Chamber System for Stormwater Management

1.0 The Isolator® Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

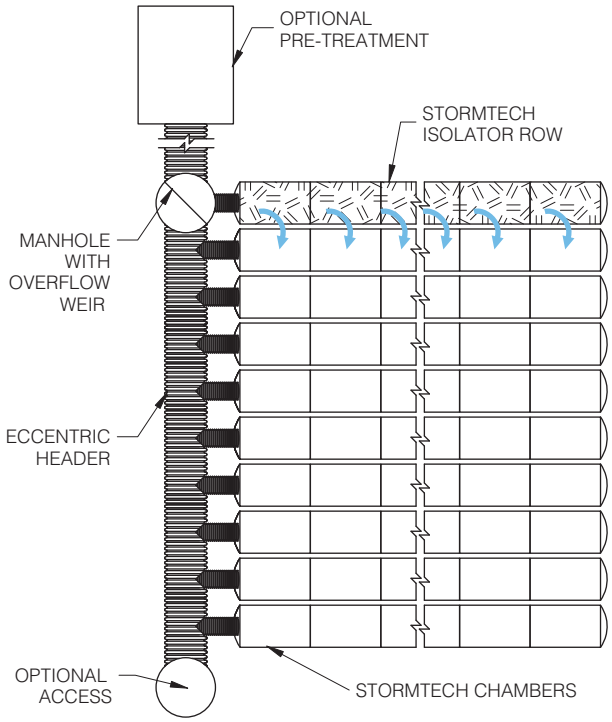
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.0 Isolator Row Inspection/Maintenance

StormTech

2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

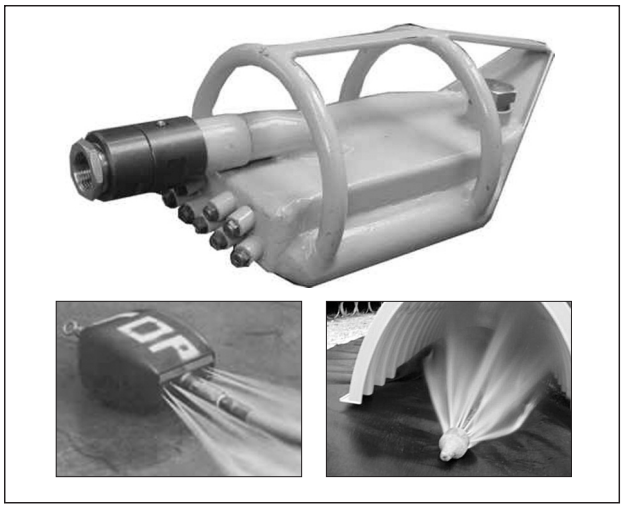
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

2.2 MAINTENANCE

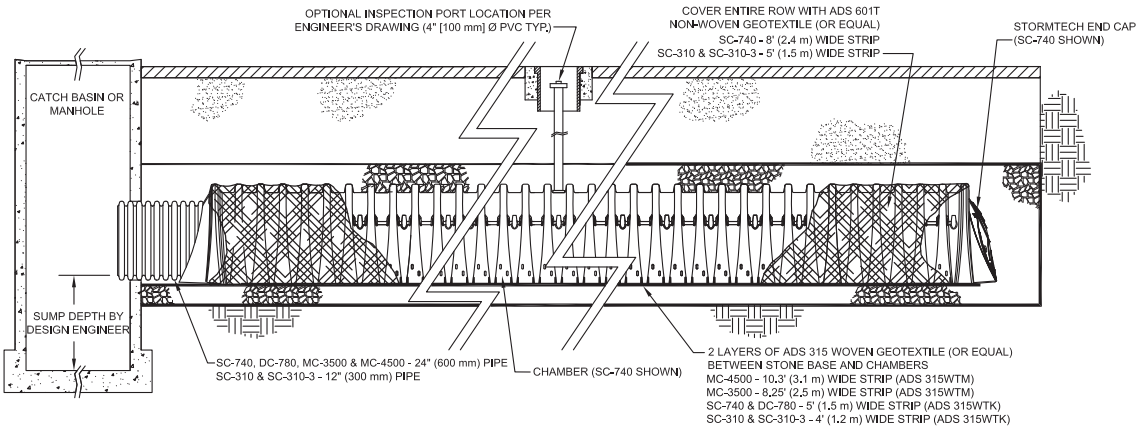
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.

iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

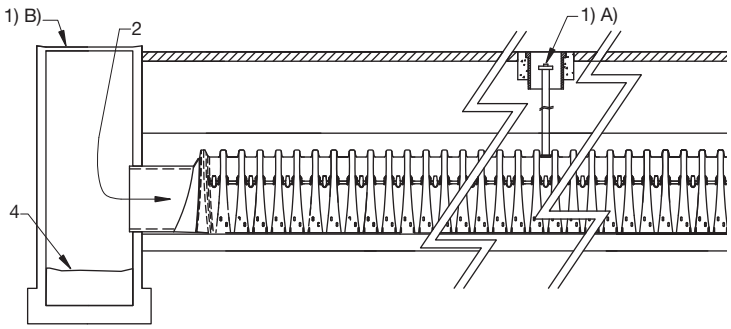
i. Remove cover from manhole at upstream end of Isolator Row

ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Mirrors on poles or cameras may be used to avoid a confined space entry
2. Follow OSHA regulations for confined space entry if entering manhole

iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable

B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings		Sediment Depth (1) - (2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

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SAMPLE MAINTENACNCE ACTIVITY LOG

Maintenance Program Cover Sheet

Inspection Period: _____

Number of Sheets Attached: _____

Date Inspected: _____

Name of Inspector: _____

Inspector's Signature: _____

Instructions for Use of Maintenance Checklists

The following pages contain maintenance needs for most of the components that are part of the onsite drainage system, as well as for some components that may not be part of the onsite drainage system. Inform Kitsap County if there are any components that are missing from these pages. Ignore requirements that do not apply to the onsite system. A checklist should be completed for all onsite system components on the following schedule:

(1) Monthly from November through April.
(2) Twice a year for area drains, preferably once in late summer (September) and in early spring.
(3) After any major storm (use 1-inch in 24 hours as a guideline).

Use photocopies of the Operation and Maintenance Manual to check off any problems found with the onsite stormwater facilities every time an inspection takes place. Add comments on problems found and actions taken. Keep the "checked" sheets filed for future reference, as they will be used to write an annual report. Some items do not need to be looked at every time an inspection is done. Use the suggested frequency stated for each item as a guideline during inspection.

#3 – Maintenance Checklist for Closed Detention Systems (Tanks/Vaults)

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
M	Storage Area					Plugged Air Vents	One-half of the cross-section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
M	Storage Area	9/1/13				Debris and Sediment	Accumulated sediment depth exceeds 10 percent of the diameter of the storage area for one-half length of storage vault or any point depth exceeds 15 percent of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than one-half length of tank.)	All sediment and debris removed from storage area. REMOVED TRASH AND DEBRIS. CONTROL STRUCTURE IS NOT BLOCKED
A	Storage Area					Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability.)	All joint between tank/pipe sections are sealed.
A	Storage Area					Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10 percent of its design shape. (Review required by engineer to determine structural stability.)	Tank/pipe repaired or replaced to design.
A	Storage Area					Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound.	Vault replaced or repaired to design specifications and is structurally sound.
A	Storage Area					Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than one-fourth inch wide at the joint of the inlet/outlet pipe.
M, S	Crest Gage					Crest Gage Missing/Broken	Crest gage is not functioning properly, has been vandalized, or is missing.	Repair/replace
A	Manhole	9/1/13				Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed. RESEATED MANHOLE COVER

SAMPLE

		Date						
Frequency	**Drainage System Feature**	✓	✓	✓	✓	**Problem**	**Conditions to Check For**	**Maintenance Activities and Conditions That Should Exist**
A	Manhole					Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
A	Manhole	9/1/13				Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person. REPLACED MANHOLE COVER
A	Manhole					Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.

If you are unsure whether a problem exists, please contact a professional engineer.

Tanks and vaults are a confined space. Visual inspections should be performed aboveground. If entry is required it should be performed by qualified personnel.

Key:

(M) Monthly from October through April.
(A) Once in late summer (preferably September).
(S) After any major storm (use 1 inch in 24 hours as a guideline).

SAMPLE

APPENDIX B – OTHER REPORTS, AS NOTED

GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED SOUTH KITSAP COUNTY
REGIONAL PARK IMPROVEMENTS
NW CORNER OF JACKSON AVE SE & SE LUND AVENUE
PORT ORCHARD, WASHINGTON

PROJECT NO. 092-10038
AUGUST 17, 2010

Prepared for:

KITSAP COUNTY PARKS & RECREATION
ATTN: MS. MARTHA DROGE
614 DIVISION STREET, MS-1
PORT ORCHARD, WASHINGTON 98366

Prepared by:

KRAZAN & ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING DIVISION
11715 N. CREEK PARKWAY S., C-106
BOTHELL, WASHINGTON 98011
(425) 485-5519

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

August 17, 2010

KA Project No. 092-10038

Kitsap County Parks & Recreation
614 Division Street, MS-1
Port Orchard, Washington 98366

Attention: **Martha Droge – Parks Project Coordinator**

Reference: **GEOTECHNICAL ENGINEERING INVESTIGATION**
South Kitsap Regional Park Additions Project
NW Corner of Jackson Avenue SE & SE Lund Avenue
Port Orchard, Washington 98366

Dear Ms. Droge:

In accordance with your request, we have completed a Geotechnical Engineering Investigation for the referenced site. The results of our investigation are presented in the attached report.

If you have any questions, or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Amjad I. Khan, P.E.G., P.G.
Regional Director Professional Services

JL/gs

Offices Serving The Western United States
11715 N. Creek Parkway S., C-106 • Bothell, Washington 98011 • (425) 485-5519 • Fax: (425) 485-6837

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Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

August 17, 2010 KA Project No. 092-10038

GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED SOUTH KITSAP REGIONAL PARK IMPROVEMENTS PROJECT
NW CORNER OF JACKSON AVENUE SE AND SE LUND AVENUE
PORT ORCHARD, WASHINGTON

INTRODUCTION

This report presents the results of our Geotechnical Engineering Investigation for the proposed Park Improvements Project, located at the northwest corner of Jackson Avenue SE and SE Lund Avenue in Port Orchard, Washington. Discussions regarding site conditions are presented herein, together with conclusions and recommendations pertaining to site preparation, excavations, structural fill, utility trench backfill, infiltration, drainage and landscaping, erosion control, foundations, concrete floor slabs and exterior flatwork, and pavement design.

A site plan showing the approximate soil boring locations is presented in Figure 2, following the text of this report. A description of the field investigation and the exploratory soil boring logs are presented in Appendix A. Appendices B and C contain guides to aid in the development of earthwork and impervious pavement specifications. When conflicts in the text of the report occur with the general specifications in the appendices, the recommendations in the text of the report have precedence.

PURPOSE AND SCOPE

This investigation was conducted to evaluate the shallow soil and groundwater conditions at the site to develop geotechnical engineering recommendations for use in the design of specific construction elements, and to provide criteria for site preparation and structural fill placement.

Our scope of services was performed in general accordance with our proposal for this project, dated July 20, 2010 (Proposal Number G10-089WAB) and included the following:

- A field investigation consisting of drilling and sampling 5 exploratory test borings that provided general coverage of the areas of the park to be developed. The exploratory test borings ranged in depth from approximately 9.0 to 16.5 feet below the existing site grades.

- Evaluation of the data obtained from the investigation and completion of engineering analyses to develop geotechnical conclusions and recommendations, including foundation design

parameters, drainage considerations, erosion control, utility trench backfill, soil compaction criteria and suitability of the on-site soil for reuse as fill.

- Preparation of this report summarizing our findings, the results of our analyses and our geotechnical conclusions and recommendations for this investigation.

PROPOSED CONSTRUCTION

We have been provided with preliminary site plan for the project by BCRA Engineering to aid in our preparation of this report. The site plan generally includes a new stormwater management system, parking areas, ball fields, spectator bleachers and landscaping.

We anticipate that site grading will include minimal cuts and fills. Foundation loads are expected to be light.

SITE LOCATION AND DESCRIPTION

The site is located at the northwest corner of Jackson Avenue SE and SE Lund Avenue in Port Orchard, Washington. The general location of the site is shown on Figure 1.

The site is irregularly shaped with approximate dimensions of 2,000 feet from north to south, and 2,000 feet from east to west. The park is developed, including the existing pavement areas, sidewalks, maintenance shed, landscaping and playfields. Site conditions include nearly level playfields and parking areas, to moderately undulating land, including small wooded ravines.

GEOLOGIC SETTING

The site lies within the central Puget Lowland. The lowland is part of a regional north-south trending trough that extends from southwestern British Columbia to near Eugene, Oregon. North of Olympia, Washington, this lowland is glacially carved, with a depositional and erosional history including at least four separate glacial advances/retreats. The Puget Lowland is bounded to the west by the Olympic Mountains, and to the east by the Cascade Range. The lowland is filled with glacial and nonglacial sediments consisting of interbedded gravel, sand, silt, till, and peat lenses.

The Geologic Map of Washington – Northwest Quadrant by Joe D. Dragovich, et al. (Washington Department of Natural Resources – Washington Division of Geology and Earth Resources, 2002) indicates that the site vicinity is underlain by Quaternary glacial advance outwash (Qga). Advance outwash generally consists of compact, moderately to well sorted, inter-layered, glaciofluvial (glacial meltwater stream and river) deposits and areas of lacustrine (lake and pond) deposits. Glaciofluvial materials typically include sand and gravel, and lacustrine deposits generally include clay, silt, and sand.

The USDA (United States Department of Agriculture) Soil Conservation Services (SCS) Soil Survey for Kitsap County, Washington maps native soils in the project vicinity as Ragnar Fine Sandy Loam with 0 to 6 percent slopes. Ragnar soils originated in glacial outwash.

FIELD INVESTIGATION

A field investigation consisting of five (5) geotechnical borings and one (1) hand test pit was completed to evaluate the subsurface soil and groundwater conditions in the site area. The soil borings ranged in depth from approximately 9.0 to 16.5 feet below existing grade. The test pit was about four feet deep and was excavated for infiltration testing. The site drilling work was completed on August 3, 2010 by Environmental Drilling, Inc. (a Krazan subcontractor).

Representative samples of the subsurface soils encountered in the geotechnical explorations were collected and sealed in plastic bags. These samples were transported to our laboratory for further examination and verification of the field classifications. The soils encountered in the exploratory borings were continuously examined and visually classified in accordance with the Unified Soil Classification System (USCS). A more detailed description of the field investigation is presented in Appendix A.

Laboratory sieve analyses were performed on selected soil samples to evaluate the physical characteristics and engineering properties. The laboratory testing program was formulated with an emphasis on the evaluation gradation of the materials encountered. Details of the laboratory testing program and results of the laboratory tests are summarized in Appendix A. This information, along with the field observations, was used to prepare the final exploratory soil logs, which are presented in Appendix A.

SOIL PROFILE AND SUBSURFACE CONDITIONS

The soils encountered in the exploratory borings were generally typical of those found in the described glacial advance outwash geologic unit.

Exploratory Boring B-1 encountered loose silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose silty sand was underlain by loose, fine to medium grained sand with silt (alluvium) to a depth of approximately 9.0 feet. Below this material, the soil boring encountered a layer of stiff silt with a little fine grained sand and clay (lacustrine deposits) to a depth of approximately 12.0 feet. This material was underlain by medium dense, fine to medium grained sand (advance outwash) to the termination depth of Exploratory Boring B-1 at about 16.5 feet below existing grade.

Exploratory Boring B-2 encountered loose silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose silty sand was underlain by loose to medium dense, fine to medium grained sand with silt (alluvium) to the termination depth of Exploratory Boring B-2 at approximately 9.0 feet below the existing ground surface.

Exploratory Boring B-3 encountered loose to medium dense silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose to medium dense silty sand was underlain by medium dense, fine to medium grained sand with silt

(alluvium) to a depth of approximately 9.0 feet. Below this material, the soil boring encountered a layer of stiff silt with a little fine grained sand and clay (lacustrine deposits) to a depth of approximately 12.0 feet. This material was underlain by medium dense, fine to medium grained sand (advance outwash) to the termination depth of Exploratory Boring B-3 at about 16.5 feet below the existing ground surface.

Exploratory Boring B-4 encountered loose to medium dense silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose to medium dense silty sand was underlain by medium dense, fine to medium grained sand with silt (alluvium) to the termination depth of Exploratory Boring B-4 at approximately 9.0 feet below existing grade.

Exploratory Boring B-5 encountered loose to medium dense silty sand to a depth of approximately 3.5 feet below existing grade. This material was interpreted to be weathered alluvium. The loose to medium dense silty sand was underlain by medium dense, fine to medium grained sand with silt (alluvium) to the termination depth of Exploratory Boring B-5 at approximately 11.5 feet below the existing ground surface.

Test Pit TP-1 was excavated near B-1 for stormwater infiltration testing. Exploratory Test Pit TP-1 encountered loose silty sand (weathered alluvium) to a depth of approximately 3.5 feet below existing grade. Below this material, loose sand with silt was encountered to the termination depth of Exploratory Test Pit TP-1 of about 4.0 feet below existing grade.

We understand that the alluvium also could be interpreted as recessional outwash.

For additional information about the soils encountered, please refer to the logs of the geotechnical explorations in Appendix A.

GROUNDWATER

The exploratory test borings were checked for the presence of groundwater during and immediately following the drilling operations. Groundwater was not encountered in the borings within the explored depths at the time of our investigation.

It should be recognized that water table elevations may fluctuate with time. The groundwater level will be dependent upon seasonal precipitation, irrigation, land use, and climatic conditions, as well as other factors. The primary factor that influences groundwater levels at this site is precipitation. Therefore, water levels at the time of the field investigation may be different from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

GEOLOGIC HAZARDS

Erosion Concern/Hazard

The Soil Conservation Service (SCS) map indicates that these soils will have a "Slight" erosion potential in a disturbed state due to their composition.

It has been our experience that soil erosion can be minimized through landscaping and surface water runoff control. Typically, erosion of exposed soils will be most noticeable during periods of rainfall and may be controlled by the use of normal temporary erosion control measures, i.e., silt fences, hay bales, mulching, control ditches or diversion trenching, and contour furrowing. Erosion control measures should be in place before the onset of wet weather.

Seismic Hazard

The soils encountered in the explorations below the undocumented fill were generally medium dense to dense. The soil profile corresponds to a soil profile Site Class *D* as defined by Table 1613.5.2 of the 2006 International Building Code (2006 IBC) with regard to the proposed structure. A Site Class *D* applies to a profile which includes stiff or medium dense to dense soils.

We referenced the U.S. Geological Survey (USGS) Earthquake Hazards Program Website to obtain values for S_S, S_1, F_a, and F_v. The USGS website includes the most updated published data on seismic conditions. The site specific seismic design parameters and adjusted maximum spectral response acceleration parameters are as follows:

PGA	(Peak Ground Acceleration, in percent of g)
34.68	(10% Probability of Exceedence in 50 years)
67.72	(2% Probability of Exceedence in 50 years)
S_S	151.50% of g
S_1	53.40% of g
F_A	1.0
F_V	1.5

Additional seismic considerations include liquefaction potential and amplification of ground motions by soft soil deposits. The liquefaction potential is highest for loose sand with a high groundwater table. Based on the results of our explorations, we interpret that the site to be underlain by relatively dense deposits within the potential groundwater depths and the liquefaction potential is low.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the findings of this investigation, it is our opinion that the on-site infiltration is feasible and that proposed structures may be supported on shallow foundation systems bearing on the medium dense native soils or on properly compacted structural fill placed on the medium dense native soils. For areas of shallow loose soils, we recommend over-excavation of the loose soils and placement of structural fill to support planned structures/ loads. The over-excavation of the loose soils need not exceed 5 feet in depth for footing subgrade preparation.

Site Preparation

Site clearing should be limited to the areas necessary for construction of the structure and associated parking areas. Clearing should include removal of vegetation; trees and associated root systems; wood; existing utilities; structures including foundations, basement walls and floors; rubble; and rubbish. Site stripping should extend to a minimum depth of 0.5 feet (preliminary; based on our test boring locations), or until all organics in excess of 3 percent by volume are removed. These materials will not be suitable for use as structural fill. However, stripped topsoil may be stockpiled and reused in landscape or non-structural areas.

After stripping operations and removal of any loose soils and undocumented fill (if present), the subgrade areas for structures should be visually inspected to identify any loose areas. Any remaining loose soils should be overexcavated to the level of the medium dense native soils. The resulting excavations should be filled with approved on site material, or imported structural fill. Structural fill material should be within ± 2 percent of the optimum moisture content, and the soils should be compacted to a minimum of 95 percent of the maximum dry density based on ASTM Test Method D1557.

During wet weather conditions, typically October through May, subgrade stability problems and grading difficulties may develop due to excess moisture, disturbance of sensitive soils and/or the presence of perched groundwater. Construction during the extended wet weather periods could create the need to overexcavate exposed soils if they become disturbed and cannot be recompacted due to elevated moisture contents. The on site native soils have variable silt contents and are considered moisture sensitive. If overexcavation is necessary, it should be confirmed through continuous monitoring and testing by a qualified geotechnical engineer or senior geologist. Soils that have become unstable may require drying and recompaction. Selective drying may be accomplished by scarifying or windrowing surficial material during extended periods of dry, warm weather (typically during the summer months).

If the soils cannot be dried back to a workable moisture condition, remedial measures may be required. General project site winterization should consist of the placement of aggregate base and the protection of exposed soils during the construction phase. It should be understood that even if Best Management Practices (BMP's) for wintertime soil protection are implemented and followed there is a significant chance that moisture disturbed soil mitigation work will still be required.

Any buried structures encountered during construction should be properly removed and backfilled. Excavations, depressions, or soft and pliant areas extending below the planned finish subgrade levels should be cleaned to firm undisturbed soil, and backfilled with structural fill. In general, any septic tanks, underground storage tanks, debris pits, cesspools, or similar structures should be completely removed. Concrete footings should be removed to an equivalent depth of at least 3 feet below proposed footing elevations or as recommended by the geotechnical engineer. The resulting excavations should be backfilled with structural fill.

A representative of our firm should be present during all site clearing and grading operations to test and observe earthwork construction. This testing and observation is an integral part of our service, as acceptance of earthwork construction is dependent upon compaction and stability of the material. The geotechnical engineer may reject any material that does not meet compaction and stability requirements. Further recommendations, contained in this report, are predicated upon the assumption that earthwork construction will conform to the recommendations set forth in this section and in the Structural Fill Section.

Temporary Excavations

The on site soils have variable cohesion strengths, therefore the safe angles to which these materials may be cut for temporary excavations is limited, as the soils may be prone to caving and slope failures in temporary excavations deeper than 4 feet. Temporary excavations in the medium dense to dense soils should be sloped no steeper than 1H:1V (horizontal to vertical) where room permits. For loose soils, or if the soil in the excavation is subject to vibration from heavy traffic, the temporary excavation should be sloped no steeper than 1½H:1V.

All temporary cuts should be in accordance with the Washington Administrative Code (WAC) Part N, Excavation, Trenching, and Shoring. The temporary slope cuts should be visually inspected daily by a qualified person during construction work activities and the results of the inspections should be included in daily reports. The contractor is responsible for maintaining the stability of the temporary cut slopes and minimizing slope erosion during construction. The temporary cut slopes should be covered with visqueen to help minimize erosion during wet weather and the slopes should be closely monitored until the permanent retaining systems are complete. Materials should not be stored and equipment operated within 10 feet of the top of any temporary cut slope.

A Krazan & Associates geologist or geotechnical engineer should observe, at least periodically, the temporary cut slopes during the excavation work. The reasoning for this is that all soil conditions may not be fully delineated during the previous geotechnical exploratory work. In the case of temporary

slope cuts, the existing soil conditions may not be fully revealed until the excavation work exposes the soil. Typically, as excavation work progresses the maximum inclination of the temporary slope will need to be reevaluated by the geotechnical engineer so that supplemental recommendations can be made. Soil and groundwater conditions can be highly variable. Scheduling for soil work will need to be adjustable, to deal with unanticipated conditions, so that the project can proceed smoothly and required deadlines can be met.

If any variations or undesirable conditions are encountered during construction Krazan & Associates should be notified so that supplemental recommendations can be made.

Structural Fill

Best Management Practices (BMP's) should be followed when considering the suitability of native material for use as structural fill. The native soils have variable fines (silt and clay) contents and are considered moisture sensitive. The native soils may also have elevated natural moisture contents, and may need to be dried back during dry, warm weather (typically during the summer months). The native glacial soils are generally considered suitable for reuse as structural fill, provided the soil is relatively free of organic material and debris, and it is within ± 2 percent of the optimum moisture content. If the native glacial soils are stockpiled for later use as structural fill, the stockpiles should be covered to help protect the soil from wet weather conditions. We recommend that a representative of Krazan & Associates be on site during the excavation work to determine which soils are suitable for structural fill.

It should not be taken for granted that the on site soils may be used as the sole source for structural fill (especially during winter construction activities). During wet weather conditions the soils with higher silt and clay contents will be moisture sensitive, easily disturbed and most likely will not meet compaction requirements. Furthermore, during the winter, the native soils typically have elevated natural moisture contents, which will limit the use of these materials as structural fill without proper mitigation measures. The contractor should use Best Management Practices to protect the soils during construction activities and be familiar with wet weather and wintertime soil work. An allowance for importing structural fill should be incorporated into the construction cost of the project (for wintertime construction this may be as high as 100 percent import).

Imported structural fill material should consist of well-graded gravel or a sand and gravel mixture with a maximum grain size of 3 inches and less than 5 percent fines (material passing the U.S. Standard No. 200 Sieve). All structural fill material should be submitted for approval to the geotechnical engineer at least 48 hours prior to delivery to the site.

Fill soils should be placed in horizontal lifts not exceeding 8 inches loose thickness, moisture-conditioned as necessary, (moisture content of soil shall not vary by more than ±2 percent of optimum moisture) and the material should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. In place density tests should be performed on all structural fill to verify

proper moisture content and adequate compaction. Additional lifts should not be placed if the previous lift did not meet the compaction requirements or if soil conditions are not considered stable.

Groundwater Influence on Structures/Construction

Groundwater was not encountered during our field exploration work. If groundwater is encountered during the construction work, the groundwater will be most likely perched on silt layers encountered in the borings. This perched groundwater develops where vertical infiltration of surface precipitation is impeded by a relatively impermeable soil layer, resulting in horizontal migration of the groundwater within overlying more permeable soils. If groundwater is encountered during construction, we should observe the conditions to determine if de-watering will be needed. Design of temporary dewatering systems to remove groundwater should be the responsibility of the contractor.

If earthwork is performed during or soon after periods of precipitation, the subgrade soils may become saturated. These soils may "pump," and the materials may not respond to densification techniques. Typical remedial measures include: discing and aerating the soil during dry weather; mixing the soil with drier materials; removing and replacing the soil with an approved fill material. A qualified geotechnical engineering firm should be consulted prior to implementing remedial measures to observe the unstable subgrade conditions and provide appropriate recommendations.

Erosion Control

Erosion and sediment control (ESC) is used to minimize the transportation of sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. Erosion and sediment control measures should be taken and these measures should be in general accordance with local regulations. As a minimum, the following basic recommendations should be incorporated into the design of the erosion and sediment control features of the site:

1) Phase the soil, foundation, utility, and other work, requiring excavation or the disturbance of the site soils, to take place during the dry season (generally May through September). However, provided precautions are taken using Best Management Practices (BMP's), limited grading activities can be undertaken during the wet season (generally October through April). It should be noted that this typically increases the overall cost of the project.

2) All site work should be completed and stabilized as quickly as possible.

3) Additional perimeter erosion and sediment control features may be required to reduce the possibility of sediment entering the surface water. This may include additional silt fences, silt fences with a higher Apparent Opening Size (AOS), construction of a berm, or other filtration systems.

4) Any runoff generated by dewatering discharge should be treated through construction of a sediment trap if there is sufficient space. If space is limited other filtration methods will need to be incorporated.

5) Vegetation should be re-established in landscaped and slope areas prior to the onset of wet weather (typically October through April).

Drainage and Landscaping

The ground surface should slope away from building pads and pavement areas, toward appropriate drop inlets or other surface drainage devices. It is recommended that adjacent exterior grades be sloped a minimum of 2 percent for a minimum distance of 5 feet away from structures. Roof drains should be tightlined away from foundations and slope surfaces. Roof drains should not be connected to the footing drains, but may use the same outfall piping if connected well away from the structure such that roof water will not backup into the footing drains. Subgrade soils in pavement areas should be sloped a minimum of 1 percent and drainage gradients should be maintained to carry all surface water to collection facilities, and/or dispersion trenches, away from slope surfaces. These grades should be maintained for the life of the project. The collection facilities and/or dispersion trenches should be tightlined away from slopes that exceed 30 percent and disposed of where down slope properties, structures and slopes are not jeopardized.

Specific recommendations for and design of storm water disposal systems or septic disposal systems are beyond the scope of our services and should be prepared by other consultants that are familiar with design and discharge requirements. Infiltration systems should not be located on slopes that exceed 30 percent nor should systems be "stacked" or lined up with one another down the slope. Infiltration systems should not be located up slope of residences or retaining structures.

Utility Trench Backfill

Utility trenches should be excavated in accordance with Occupational Safety and Health Administration (OSHA) standards, by a contractor experienced in such work. The responsibility for the safety of open trenches should be borne by the contractor. Traffic and vibration adjacent to trench walls should be minimized; cyclic wetting and drying of excavation side slopes should be avoided. Depending upon the location and depth of some utility trenches, groundwater flow into open excavations could be experienced, especially during or shortly following periods of precipitation.

Relatively silty and sandy soil conditions were encountered at shallow depths at this site. These soils have variable cohesion and can cave in trench wall excavations. Shoring or sloping back trench sidewalls may be required within these soils.

All utility trench backfill should consist of imported structural fill or suitable on-site material. Utility trench backfill placed in or adjacent to buildings and exterior slabs should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. The upper 5 feet of utility

trench backfill placed in pavement areas should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Below 5 feet, utility trench backfill in pavement areas should be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. Pipe bedding should be in accordance with the pipe manufacturer's recommendations.

The contractor is responsible for removing all water-sensitive soils from the trenches regardless of the backfill location and compaction requirements. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during fill placement and compaction.

Floor Slabs and Exterior Flatwork

If slab on grade structures are proposed and reducing floor dampness is desired, such as in areas covered with moisture sensitive floor coverings, we recommend that concrete slab-on-grade floors be underlain by a water vapor retarder system. The water vapor retarder system should be installed in accordance with ASTM Specification E164-94 and Standard Specifications E1745-97. According to ASTM Guidelines, the water vapor retarder should consist of a vapor retarder sheeting underlain by a minimum of 4-inches of compacted clean (less than 5 percent passing the U.S. Standard No. 200 Sieve), open-graded coarse rock of ¾-inch maximum size. The vapor retarder sheeting should be protected from puncture damage.

The exterior floors should be placed separately in order to act independently of the walls and foundation system. All fills required to bring the building pads to grade should be structural fill.

Moisture within the structures may be derived from water vapors, which were transformed from the moisture within the soils. This moisture vapor can travel through the vapor membrane and penetrate the slab-on-grade. This moisture vapor penetration can affect floor coverings and produce mold and mildew in the structures. To minimize moisture vapor intrusion, it is recommended that a vapor retarder be installed in accordance with ASTM guidelines. It is recommended that the utility trenches within the structures be compacted as specified in our report to minimize the transmission of moisture through the utility trench backfill. Special attention to the immediate drainage and irrigation around the buildings is recommended. Positive drainage should be established away from the structures and should be maintained throughout the lives of the structures. Ponding of water should not be allowed adjacent to the structures. Over-irrigation within landscaped areas adjacent to the structures should not be performed. In addition, ventilation of the structures (i.e. ventilation fans) is recommended to reduce the accumulation of interior moisture.

Foundations

The proposed structures may be supported on shallow foundation systems (continuous, column or slab) bearing on the medium dense native soils or on properly compacted structural fill placed on the medium dense to dense native soils. Foundations resting on medium dense or better native soils or structural fill extending to native bearing soils may be designed for a net allowable bearing pressure of 2,000 pounds

per square foot (psf) dead plus live load, if the footings bear directly on medium dense to dense native soils or on structural fill placed on the medium dense to dense native soils.

We recommend that the structures rest on medium dense or better native soil or on structural fill extending to medium dense or better native soils. Overexcavation will be necessary to remove loose soils or undocumented fill (if present) from the footing and slab areas. The loose soils/fill should be removed below all foundation elements and the overexcavation should extend horizontally a distance equal to the depth of the overexcavation in all directions around the footings. The resulting excavations may be backfilled with structural fill or geotechnically approved native soils. Over-excavation of any remaining loose soils or undocumented fill during footing subgrade preparation need not exceed 5 feet in depth prior to placement of structural fill provided that the overexcavated subgrade is well compacted in-situ.

A 1/3 increase in the above value may be used for short duration, wind and seismic loads. Structural fill placed on bearing, native subgrade should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Footing excavations should be inspected to verify that the foundations will bear on suitable material.

Exterior footings should have a minimum depth of 18 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower. Interior footings should have a minimum depth of 12 inches below pad subgrade (soil grade) or adjacent exterior grade, whichever is lower. Footings should have a minimum width of 12 inches regardless of load.

If constructed as recommended, the total settlement is not expected to exceed 1 inch. Differential settlement, along a 20-foot exterior wall footing, or between adjoining column footings, should be less than ½ inch, producing an angular distortion of 0.002. Most settlement is expected to occur during construction, as the loads are applied. However, additional post-construction settlement may occur if the foundation soils are flooded or saturated or if a strong seismic event results in liquefaction of the underlying soils. It should be noted that the risk of liquefaction is considered low, given the composition and density of the native, on site soils.

Seasonal rainfall, water run-off, and the normal practice of watering trees and landscaping areas around the proposed structure, should not be permitted to flood and/or saturate footings. To prevent the buildup of water within the footing areas, continuous footing drains (with cleanouts) should be provided at the bases of the footings. The footing drains should consist of a minimum 4-inch diameter perforated pipe, sloped to drain, with perforations placed down and enveloped by 1-inch sized washed rock in all directions and filter fabric to prevent the migration of fines.

Resistance to lateral footing displacement can be computed using an allowable friction factor of 0.30 acting between the bases of foundations and the supporting subgrade. Lateral resistance for footings can alternatively be developed using an allowable equivalent fluid passive pressure of 225 pounds per cubic foot (pcf) acting against the appropriate vertical footing faces. The allowable friction factor and allowable equivalent fluid passive pressure values include a factor of safety of 1.5. The frictional and

passive resistance of the soil may be combined without reduction in determining the total lateral resistance. A 1/3 increase in the above values may be used for short duration, wind and seismic loads.

Infiltration Rates

We understand that infiltration systems may be utilized on site, potentially near the area of Boring B-1 and Test Pit TP-1 based on a review of the site plan. We visually examined the samples from B-1 and TP-1, and performed sieve analyses to determine the United Stated Department of Agriculture (USDA) classification. The soil samples at 3.5 and 4.0 feet depth in TP-1 are classified as sand with silt, based on the sieve analysis results. Our infiltration rate determination is based on the criteria in Volume III of the Department of Ecology's Stormwater Design Manual, and estimated long-term infiltration rates are based on particle size analysis of selected site soils (ASTM D422) and the Kitsap County Stormwater Design Manual. The Kitsap County Manual recommends for the soils that have less than 12.5% fines, a design infiltration rate of 2 inches per hour. The soils encountered in B-1 and in TP-1 below a depth of 3.5 feet contain less that 12.5 % fines (passing #200 sieve).

The soil infiltration rates based on visual textural analyses are presented in the following table.

INFILTRATION RATE BASED ON TEXTURAL ANALYSIS			
Test Pit Number	**Sample Depth (feet)**	**Long Term Design Infiltration Rate (inches/hour)**	**Visual USDA Soil Classification**
TP-1	3.5	2	Sand
TP-1	1	0.5	Loamy Sand

We recommend that the stormwater infiltration system be located within the sandy soils, approximately 3.5 feet below the existing site grades. We should evaluate the soil conditions during construction of the system to ensure that soil conditions do not differ from those that are anticipated.

On-Site Infiltration

The measured soil infiltration rates from Boring B-1 based on the *Falling Head Percolation Test* Procedure, are presented in the following table.

INFILTRATION RATES BASED ON IN-PLACE FALLING HEAD TESTING			
Test Pit Number	**Test Elevation (feet below grade)**	**Observed Infiltration Rate (min/inch, inches/hr) No Factor of Safety**	**USDA Soil Classification**
TP-1	3.5	4 min/in (15 in/hr)	Sand

The typical soil infiltration rates for soil types in the infiltration exploration, based on USDA soil classification in conjunction with the Kitsap County Stormwater Management Design Manual are presented in the following table. These infiltration rates are less reliable than actual in-place field infiltration test results.

The typical infiltration rates presented above are based on soil textural analysis and do not incorporate a factor of safety. Therefore, at a minimum the above infiltration rates should incorporate a factor of safety for the infiltration system design, to account for possible soil clogging, biological activity and deterioration as well as site variability according to Kitsap County Stormwater Design Manual.

Field Infiltration Testing

The more reliable actual infiltration rates presented are based on field falling head infiltration testing with clear water and do not incorporate a factor of safety. We recommend that Safety Factors for Field Infiltration Measurements be applied according to Kitsap County Stormwater Design Manual. Considering the results of infiltration testing, it can be summarized that the Falling Head Percolation Tests indicate that the soils found in Infiltration Test Pit TP-1 have a moderate percolation/infiltration rate in their current condition.

According to the Washington State Department of Ecology (DOE) Stormwater Management Manual for Western Washington, a range of safety factors may apply. If the system is well-designed and well-maintained, a combined correction factor of six (6) would be applied to the test results. Should the system not be regularly maintained and without good influent control, a combined correction factor of eighteen (18) may be more appropriate. The manual provides this range of correction factors based on site variability and number of locations tested, degree of long-term maintenance to prevent siltation and bio-buildup, and degree of influent control to prevent siltation and bio-buildup. The soils encountered in the test borings are interpreted to have a moderate percolation/infiltration rate in their current conditions.

Based on in-place field infiltration testing, the observed raw infiltration rate is approximately 15 inch per hour without any factors of safety. Accordingly, we recommend that a long-term design infiltration rate of 2 inches per hour for a well-designed and well-maintained system. If the system is not regularly maintained and without good influent control, we recommend a long-term design infiltration rate of 1 inch per hour.

Geotechnical Design of Pervious Asphalt and Pervious Concrete Pavements

We understand that pervious pavements are planned for light duty parking areas. We have referenced the Low Impact Development Technical Guidance Manual for Puget Sound by Hinman (2005) and 1993 AASHTO Pavement Design Guidelines.

Traffic loading information is not available. However, we understand that these parking areas will have to service cars only (light duty).

The upper soils within a depth of approximately 3 feet could be classified as Loamy Sand per USDA. A design infiltration rate of 0.5 inch per hour is applicable for these soils.

The following tables provide minimum pervious pavement sections based on geotechnical stability. We understand that hydrological design will be performed by others. Thicker pavement sections may be required based on hydrological design by others. Gradation of the aggregate course shall be also based on the hydrological design. We recommend that the final design sections be reviewed by the geotechnical engineer with respect to geotechnical aspects.

PERVIOUS ASPHALTIC CONCRETE (FLEXIBLE) PAVEMENT – MINIMUM SECTION
LIGHT DUTY

Pervious Asphaltic Concrete	Leveling Aggregate/ Filter Course (1-1/2" Minus – AASHTO No. 57)	Stone Reservoir Course (2-1/2" Minus – AASHTO No. 3)**
3.0 in.	3.0 in.	6.0 in.**

*** Geotextile Separation fabric(Mirafi 160N or equivalent) is recommended below the Stone Course*
90% compaction based on AST M Test Method D1557 is adequate for Subgrade

PERVIOUS PORTLAND CEMENT CONCRETE PAVEMENT – MINIMUM SECTION

LIGHT DUTY

Min. PPCC Depth	Leveling Aggregate/ Filter Course (1-1/2" Minus – AASHTO No. 57)	Stone Reservoir Course (2-1/2" Minus – AASHTO No. 3)**
6.0 in.	3.0 in.	6.0 in.

*** Geotextile Separation fabric(Mirafi 160N or equivalent) is recommended below the Stone Course*
90% compaction based on AST M Test Method D1557 is adequate for Subgrade

Stone Reservoir course aggregate layer should be crushed (angular) thoroughly washed stone (AASHTO No. 3).

Recommended Gradation for Stone Reservoir Course Aggregate

U.S. Standard Sieve	Percentage Material Passing
2-1/2"	100
2"	90-100
1-1/2"	35-70
1"	0-15
½"	0-5

Filter Course aggregate layer should be crushed (angular) thoroughly washed stone (AASHTO No. 57).

Recommended Gradation for Filter Course Aggregate

U.S. Standard Sieve	Percentage Material Passing
1-1/2"	100
1"	95-100
½"	25-60
No. 4	0-10
No. 8	0-5

Pervious Hot Mix Asphalt (PHMA) be Class ½ inch and meet Section 5-04 of WSDOT Specifications with the following exceptions:

Gradation shall be according to the following table:

Recommended Gradation for Pervious Asphalt Gradation

U.S. Standard Sieve	Percentage Material Passing
1/2"	100
3/8"	92-98
No. 4	32-38
No. 8	12-18
No. 16	7-13
No. 30	0-5
No. 200	0-3

Compaction of aggregates and pervious asphalt be performed using static rollers. Overcompaction should be avoided.

We recommend that the pervious concrete and pervious asphalt specifications be also according to the hydrological design requirements.

Slopes should be avoided as much as possible or kept to a minimum, not to exceed 2%.

Subgrade Preparation for Pervious Pavements

Subgrade preparation is an important aspect as infiltration capacity will be affected by the methods employed. We recommend avoiding overcompaction and sealing to minimize the reduction of infiltration capacity during subgrade preparation. All construction traffic should be directed away from pavement subgrade areas to mitigate transport of fine materials (from other areas of the site to pervious pavement areas), resulting in reduction in infiltration capacity of the pavement subgrade materials. Heavy construction traffic should be minimized on the subgrade. Static rolling is recommended for the upper 2 feet of soils where heavy vibratory rolling should be avoided.

A regular maintenance program is required to maintain adequate level of performance.

In general, we recommend that the design and construction of pervious pavements be in general conformance with the Low Impact Development Technical Guidance Manual for Puget Sound by Hinman (2005).

Impervious Pavement Design

The near surface subgrade soils generally consist of silty sand with variable amounts of gravel and fine to medium grained sand with variable amounts of gravel. These soils are rated as fair for pavement subgrade material. We estimate that the subgrade will have a California Bearing Ratio (CBR) value of 10 and a modulus of subgrade reaction value of k = 200 pci, provided the subgrade is prepared in general accordance with our recommendations.

We recommend that, at a minimum, 18 inches of the existing subgrade material be moisture conditioned (as necessary) and re-compacted to prepare for the construction of pavement sections. The subgrade should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Test Method D1557. In place density tests should be performed to verify proper moisture content and adequate compaction. However, if the subgrade soil consists of firm and unyielding native glacial soils a proof roll of the pavement subgrade soil may be performed in lieu of re-compacting the subgrade and compaction tests. The recommended flexible and rigid pavement sections are based on design CBR and modulus of subgrade reaction (k) values that are achieved, only following proper subgrade preparation. It should be noted that subgrade soils that have relatively high silt contents may be highly sensitive to moisture conditions. The subgrade strength and performance characteristics of a silty subgrade material may be dramatically reduced if this material becomes wet.

Traffic loads were not provided, however, based on our knowledge of the proposed project, we expect the traffic to range from light duty (passenger automobiles) to heavy duty (large trucks). The following tables show the recommended pavement sections for light duty and heavy duty use.

ASPHALTIC CONCRETE (FLEXIBLE) PAVEMENT
LIGHT DUTY

Asphaltic Concrete	Aggregate Base*	Compacted Subgrade* **
2.0 in.	6.0 in.	18.0 in.

** 95% compaction based on ASTM Test Method D1557*
*** A proof roll may be performed in lieu of in place density tests*

HEAVY DUTY

Asphaltic Concrete	Aggregate Base*	Compacted Subgrade* **
3.0 in.	6.0 in.	18.0 in.

** 95% compaction based on ASTM Test Method D1557*
*** A proof roll may be performed in lieu of in place density tests*

PORTLAND CEMENT CONCRETE (RIGID) PAVEMENT

Aggregate Base*	Min. PCC Depth	Compacted Subgrade* **
6.0 in.	6.0 in.	18.0 in.

** 95% compaction based on AST M Test Method D1557*
*** A proof roll may be performed in lieu of in place density tests*

The asphaltic concrete depth in the flexible pavement tables should be a surface course type asphalt, such as Washington State Department of Transportation (WSDOT) Commercial HMA. The rigid pavement design is based on a Portland Cement Concrete (PCC) mix that has a 28 day compressive strength of 4,000 pounds per square inch (psi). The design is also based on a concrete flexural strength or modulus of rupture of 550 psi.

Testing and Inspection

A representative of Krazan & Associates, Inc. should be present at the site during the earthwork activities to confirm that actual subsurface conditions are consistent with the exploratory fieldwork. This activity is an integral part of our services as acceptance of earthwork construction is dependent upon compaction testing and stability of the material. This representative can also verify that the intent of these recommendations is incorporated into the project design and construction. Krazan & Associates, Inc. will not be responsible for grades or staking, since this is the responsibility of the Prime Contractor. Furthermore, Krazan & Associates is not responsible for the contractor's procedures, methods, scheduling or management of the work site.

LIMITATIONS

Geotechnical engineering is one of the newest divisions of Civil Engineering. This branch of Civil Engineering is constantly improving as new technologies and understanding of earth sciences improves. Although your site was analyzed using the most appropriate current techniques and methods, undoubtedly there will be substantial future improvements in this branch of engineering. In addition to improvements in the field of geotechnical engineering, physical changes in the site either due to

excavation or fill placement, new agency regulations or possible changes in the proposed structure after the time of completion of the soils report may require the soils report to be professionally reviewed. In light of this, the owner should be aware that there is a practical limit to the usefulness of this report without critical review. Although the time limit for this review is strictly arbitrary, it is suggested that two years be considered a reasonable time for the usefulness of this report.

Foundation and earthwork construction is characterized by the presence of a calculated risk that soil and groundwater conditions have been fully revealed by the original foundation investigation. This risk is derived from the practical necessity of basing interpretations and design conclusions on limited sampling of the earth. Our report, design conclusions and interpretations should not be construed as a warranty of the subsurface conditions. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. The recommendations made in this report are based on the assumption that soil conditions do not vary significantly from those disclosed during our field investigation. The findings and conclusions of this report can be affected by the passage of time, such as seasonal weather conditions, manmade influences, such as construction on or adjacent to the site, natural events such as earthquakes, slope instability, flooding, or groundwater fluctuations. If any variations or undesirable conditions are encountered during construction, the geotechnical engineer should be notified so that supplemental recommendations can be made.

The conclusions of this report are based on the information provided regarding the proposed construction. If the proposed construction is relocated or redesigned, the conclusions in this report may not be valid. The geotechnical engineer should be notified of any changes so that the recommendations can be reviewed and reevaluated.

Misinterpretations of this report by other design team members can result in project delays and cost overruns. These risks can be reduced by having Krazan & Associates, Inc. involved with the design teams meetings and discussions after submitting the report. Krazan & Associates, Inc. should also be retained for reviewing pertinent elements of the design team's plans and specifications. Contractors can also misinterpret this report. To reduce this, risk Krazan & Associates. Inc. should participate in pre-bid and preconstruction meetings, and provide construction observations during the site work.

This report is a geotechnical engineering investigation with the purpose of evaluating the soil conditions in terms of foundation design. The scope of our services did not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands. Any statements, or absence of statements, in this report or on any boring log regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous and/or toxic assessments.

The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments. We emphasize that this report is valid for this project as outlined above, and should not

be used for any other site. Our report is prepared for the exclusive use of our client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (425) 485-5519.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

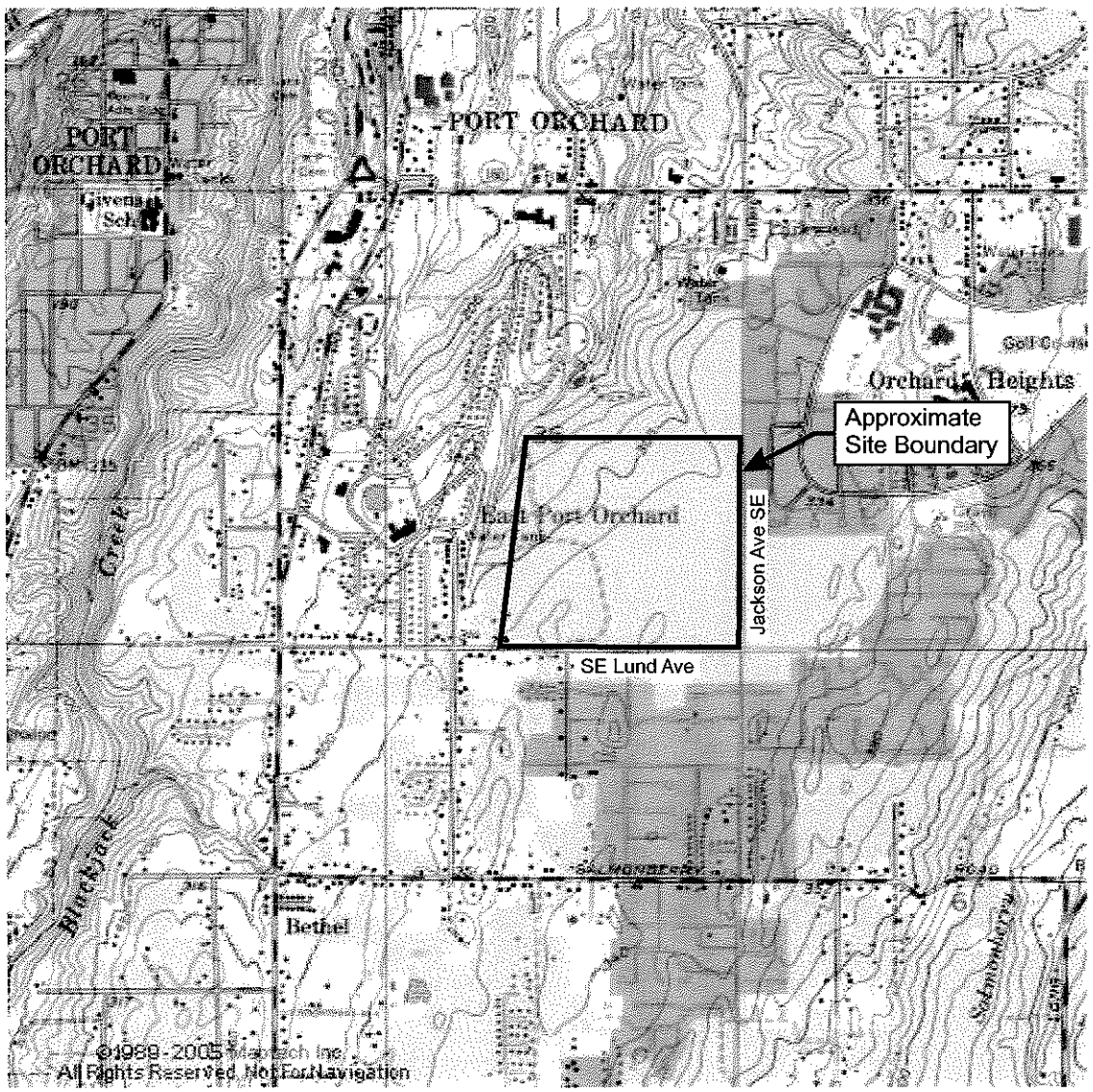
Jeffrey League
Geotechnical Staff

Gopal A. Singam, P.E.
Geotechnical Division Manager

JL/gs

Vicinity Map

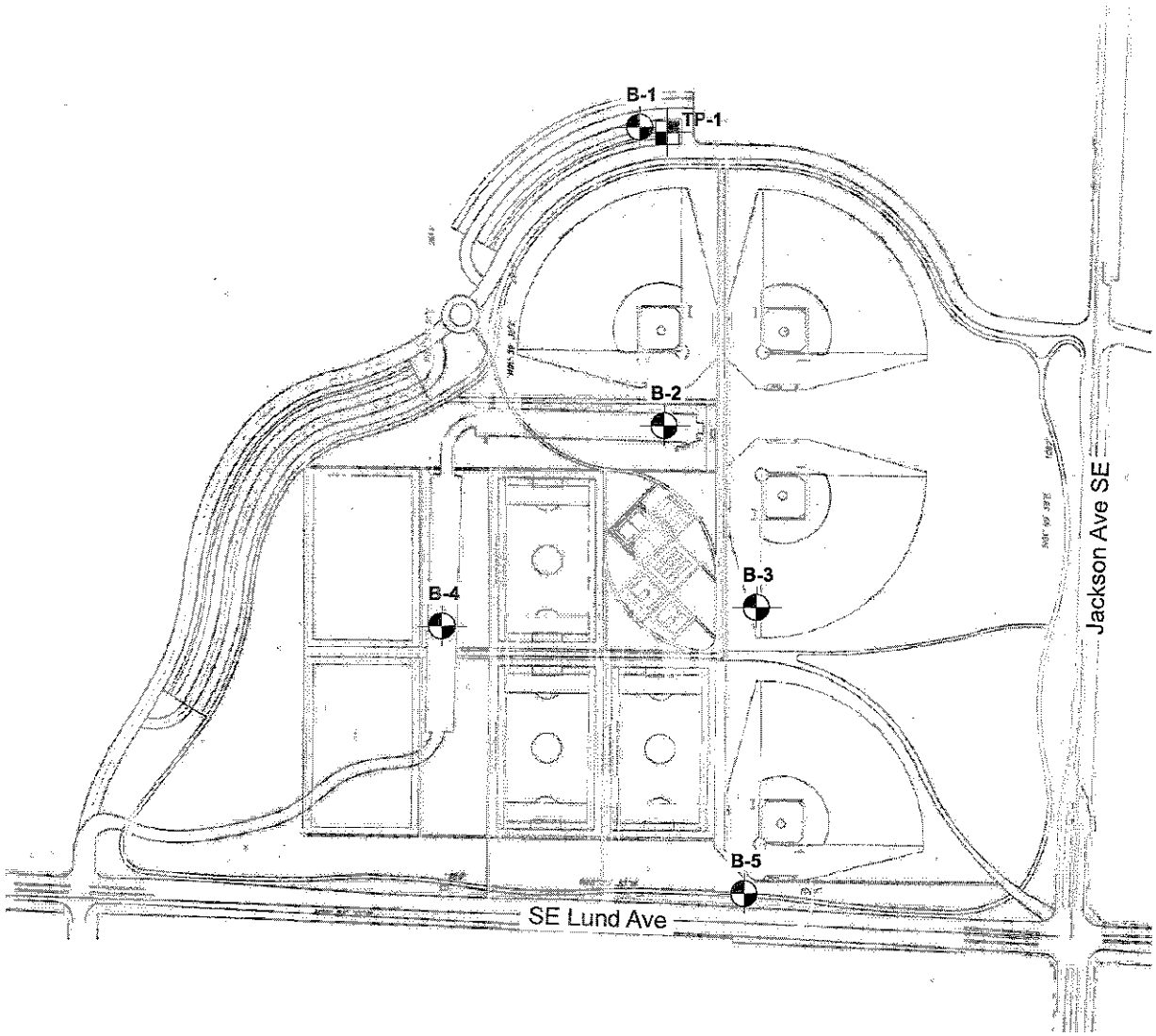
N



Port Orchard Area, Kitsap County, WA

Krazan & ASSOCIATES, INC.		
South Kitsap Regional Park, Port Orchard, WA		
Date: August 2010	Reference: Maptech	
Drawn By: JL	Figure 1	Project Number: 092-10038

Site Plan
(Not To Scale)



LEGEND

B-1 Number and Approximate Location of Soil Boring

TP-1 Number and Approximate Infiltration TP Location

Note: Site Plan is based on a drawing provided by Kitsap County

Not to scale.

Krazan & ASSOCIATES, INC.		
South Kitsap Regional Park, Port Orchard, WA		
Date: August 2010	Project Number: 092-10038	
Drawn By: JL	Figure 2	Not To Scale

APPENDIX A

FIELD INVESTIGATION

Field Investigation

The field investigation consisted of a surface reconnaissance and a subsurface exploration program. Five exploratory soil borings and one test pit were excavated and sampled for the subsurface geotechnical investigation at this site. The geotechnical explorations reached depths of approximately 4.0 to 16.5 feet below the existing grades. The approximate exploration locations are shown on the site plan (Figure 2). The depths shown on the attached soil logs are from the existing ground surface at the time of our exploration.

The soils encountered were logged in the field during the exploration are described in accordance with the Unified Soil Classification System (USCS).

All samples were returned to our Bothell laboratory for evaluation. The logs of the explorations are presented in this appendix. Sieve results of a sample collected in Test Pit 1 are also presented in this appendix.

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

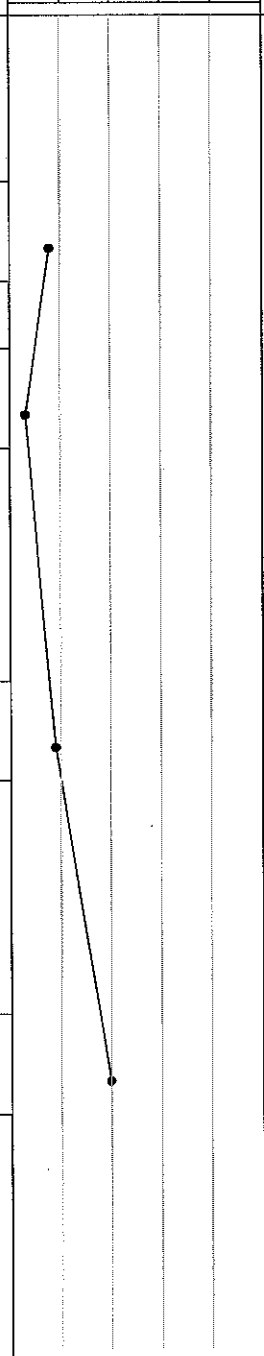
LOG OF EXPLORATORY BORING B-1

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

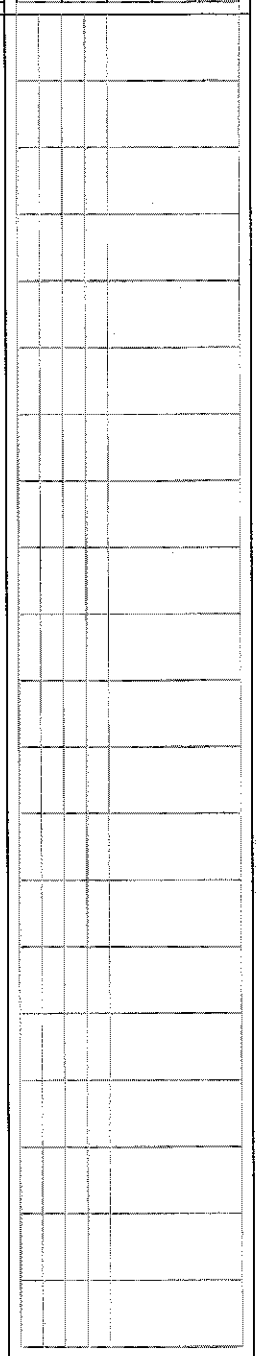
DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	3, 4, 4	8	
5			**Poorly Graded Sand with Silt (SP-SM)** Loose, fine to medium grained sand with silt, light brown to gray, moist. (Alluvium)	2, 1, 2	3	
10			**Silt (ML)** Stiff silt with a little clay and fine grained sand, brown, moist to wet. (Lacustrine Deposit)	4, 4, 5	9	
15			**Poorly Graded Sand (SP)** Medium dense, fine to medium grained sand, gray, moist. (Advance Outwash)	8, 10, 10	20	
20			End of Exploratory Boring			

N-VALUE (GRAPH)



Natural Moisture Content and Atterberg Limits



Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

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Bothell, Washington 98011

LOG OF EXPLORATORY BORING B-2

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES	N-VALUE (GRAPH) 10 20 30 40	Natural Moisture Content and Atterberg Limits 0 20 40 60 80 100
			Silty Sand with Gravel (SM) Loose, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	5 4 4	8			
5			**Poorly Graded Sand with Silt (SP-SM)** Loose to medium dense, fine to medium grained sand with silt, light brown to gray, moist. (Alluvium)	3 5 7	12			
10			End of Exploratory Boring					
15								
20								

Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

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11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

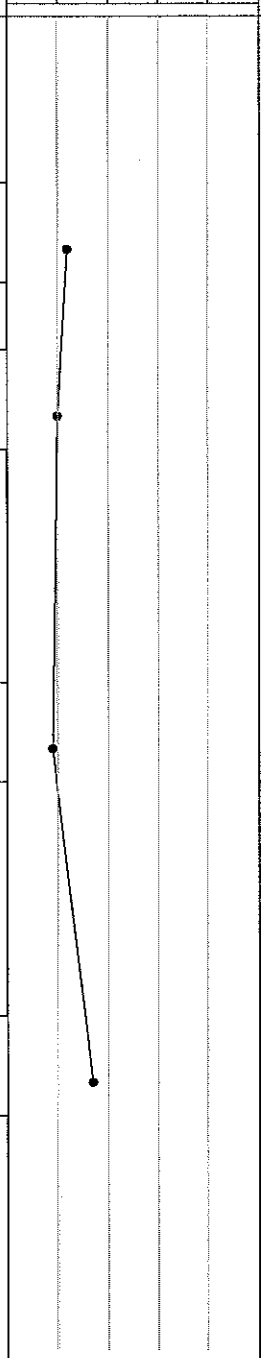
LOG OF EXPLORATORY BORING B-3

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

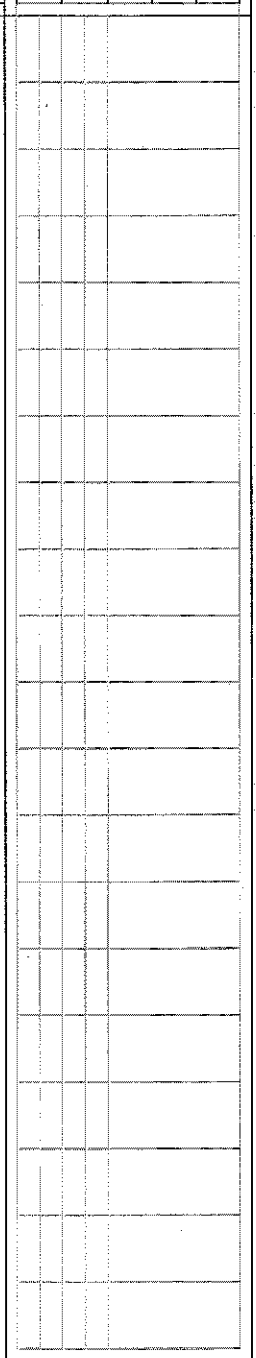
DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose to medium dense, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	4, 5, 7	12	
5			**Poorly Graded Sand with Silt (SP-SM)** Medium dense, fine to medium grained sand with silt, gray, moist. (Alluvium)	3, 4, 6	10	
10			**Silt (ML)** Stiff silt with a little clay and fine grained sand, brown, moist to wet. (Lacustrine Deposit)	2, 4, 5	9	
15			**Poorly Graded Sand (SP)** Medium dense, fine to medium grained sand, gray, moist. (Advance Outwash)	4, 7, 10	17	
20			End of Exploratory Boring			

N-VALUE (GRAPH)



Natural Moisture Content and Atterberg Limits



Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

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Suite C-106
Bothell, Washington 98011

LOG OF EXPLORATORY BORING B-4

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose to medium dense, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	4 6 7	13	
5			**Poorly Graded Sand with Silt (SP-SM)** Medium dense, fine to medium grained sand with silt, gray, moist. (Alluvium)	6 8 12	20	
10			End of Exploratory Boring			
15						
20						

N-VALUE (GRAPH): 10 20 30 40

Natural Moisture Content and Atterberg Limits: 0 20 40 60 80 100

Water Level Initial: ▽ Final: ▼

Water Observations: None Observed

Notes:

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Suite C-106
Bothell, Washington 98011

LOG OF EXPLORATORY BORING B-5

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
LOGGED BY: JL
CONTRACTOR: EDI
SAMPLE METHOD: Split Spoon

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
BORING TYPE: Hollow Stem Auger
LOCATION: Port Orchard, WA

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	BLOW COUNTS (per 6")	N-VALUE (Last 12" of SPT)	SAMPLES
			Silty Sand with Gravel (SM) Loose to medium dense, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)	4, 6, 6	12	
			Poorly Graded Sand with Silt (SP-SM) Medium dense, fine to medium grained sand with silt, gray, moist. (Alluvium)	5, 6, 10	16	
				5, 6, 9	15	
			End of Exploratory Boring			

N-VALUE (GRAPH): 10 20 30 40

Natural Moisture Content and Atterberg Limits: 0 20 40 60 80 100

Water Level Initial: Final:

Water Observations: None Observed

Notes:

KRAZAN AND ASSOCIATES
11715 North Creek Parkway South
Suite C-106
Bothell, Washington 98011

LOG OF EXPLORATORY TEST PIT TP-1

PROJECT: South Kitsap Regional Park
PROJECT NO.: 092-10038
CONTRACTOR:
SAMPLE METHOD: Grab

DATE: 8-3-10
PAGE: 1 of 1
SURFACE ELEVATION:
LOCATION: Port Orchard, WA

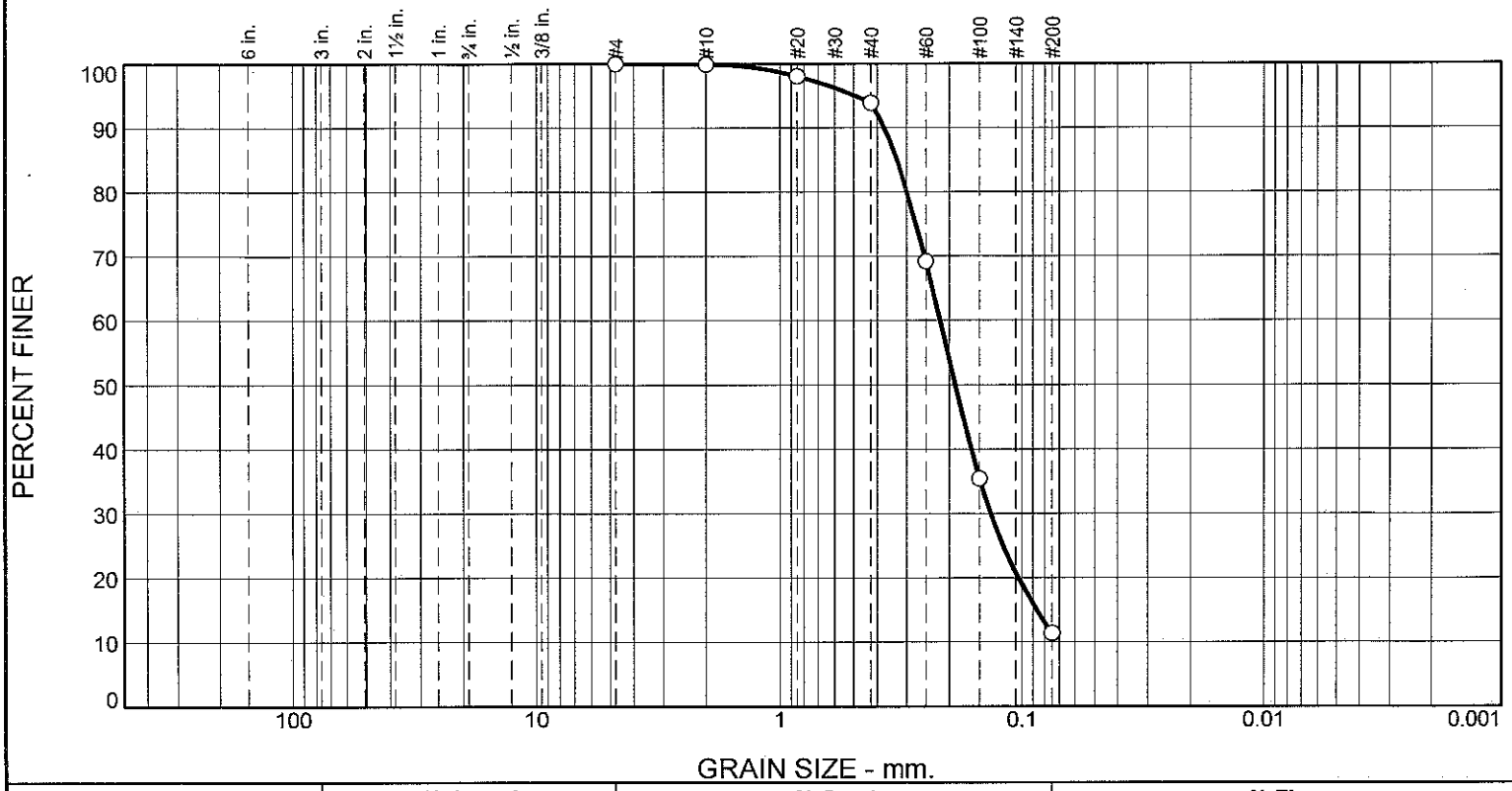
DEPTH (ft)	USC SYMBOL	WATER LEVEL	MATERIAL DESCRIPTION	SAMPLE No.	SAMPLE TYPE	Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 0 10 20 30 40 50 60 70 80 90)
			Silty Sand (SM) Loose, silty fine to medium grained sand, brown, moist. (Weathered Alluvium)			
1						
2						
3						
			Poorly Graded Sand with Silt (SP-SM) Loose, fine to medium grained sand with silt, light brown to gray, moist. (Alluvium)	S-1	G	
4				S-2	G	
			End of Exploratory Test Pit			
5						
6						
7						
8						
9						
10						
11						

Water Level Initial: ▽ Final: ▼

Water Observations: None Encountered.

Notes:

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	6.0	82.5	11.4	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	98.1		
#40	93.9		
#60	69.2		
#100	35.5		
#200	11.4		

* (no specification provided)

Material Description

Dark yellowish-brown poorly graded SAND with silt.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.3748 D_{85}= 0.3322 D_{60}= 0.2181
D_{50}= 0.1888 D_{30}= 0.1347 D_{15}= 0.0867
D_{10}= C_u= C_c=

Remarks

Sample ID: 38554-A.
TP-1 @ 3'

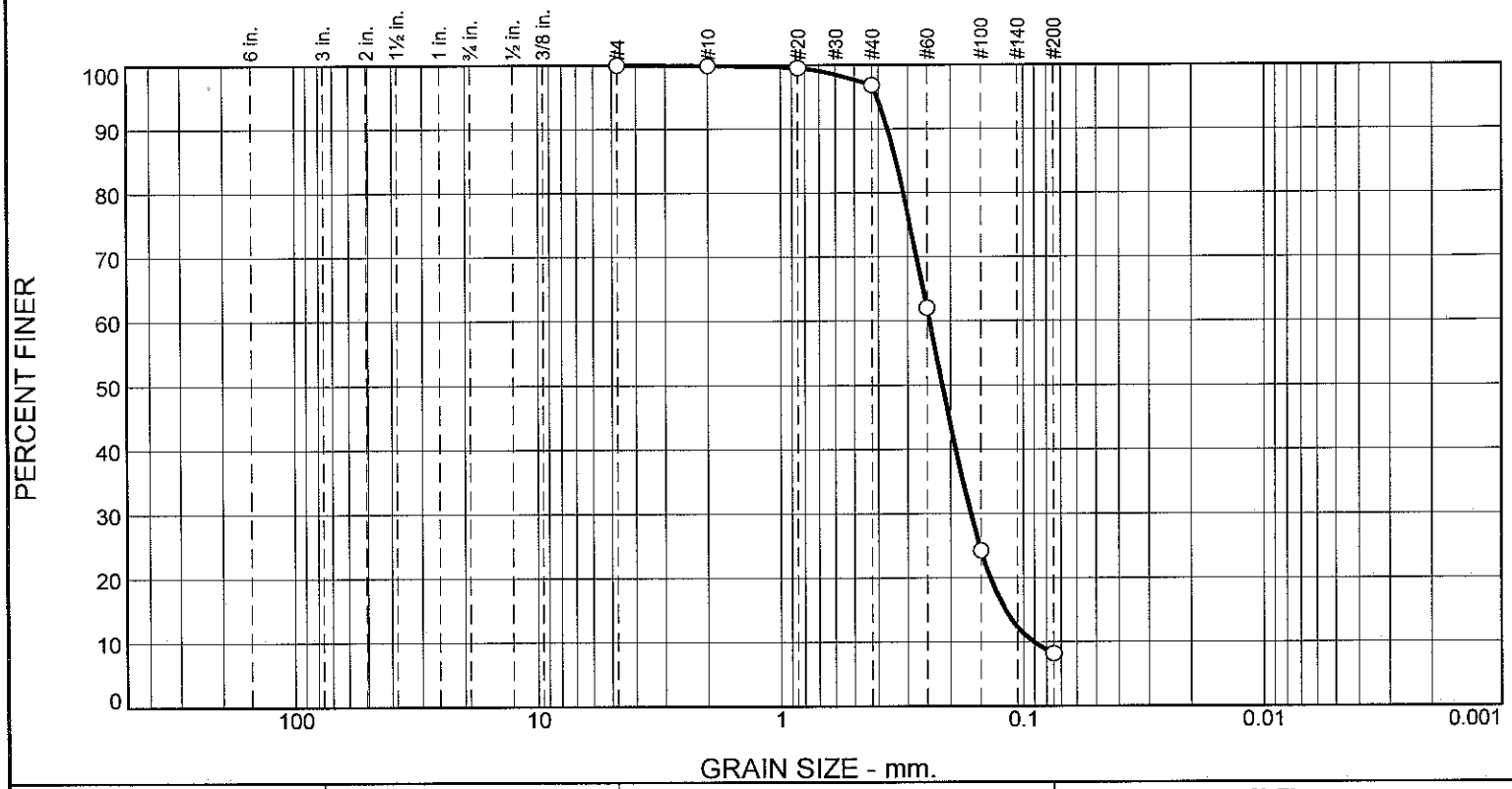
Date Received: 8/5/10 **Date Tested:** 8/6/10
Tested By: Chris McMillen
Checked By: Corbett Mercer
Title: Lab Manager

Location: Test Pit 1
Sample Number: 38554-A **Depth:** 3'
Date Sampled: 8/5/10

Krazan

Client: Kitsap County Facilities, Parks and Recreation
Project: South Kitsap Regional Parks Addition
Project No: 09210038

Krazan & Assoc. Sieve Analysis



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	3.0	88.7	8.2	

Test Results (ASTM C 136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	99.6		
#40	96.9		
#60	62.0		
#100	24.3		
#200	8.2		

* (no specification provided)

Material Description

Light olive-brown poorly graded SAND with silt.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=**

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.3674 D_{85}= 0.3385 D_{60}= 0.2440
D_{50}= 0.2161 D_{30}= 0.1653 D_{15}= 0.1188
D_{10}= 0.0909 C_u= 2.68 C_c= 1.23

Remarks

Sample ID: 38554-B.
Tp-1 @ 4'

Date Received: 8/5/10 **Date Tested:** 8/6/10
Tested By: Chris McMillen
Checked By: Corbett Mercer
Title: Lab Manager

Location: Test Pit 1
Sample Number: 38554-B **Depth:** 4'
Date Sampled: 8/5/10

Krazan

Client: Kitsap County Facilities, Parks and Recreation
Project: South Kitsap Regional Parks Addition
Project No: 09210038

APPENDIX B

EARTHWORK SPECIFICATIONS

GENERAL

When the text of the report conflicts with the general specifications in this appendix, the recommendations in the report have precedence.

SCOPE OF WORK: These specifications and applicable plans pertain to and include all earthwork associated with the site rough grading, including but not limited to the furnishing of all labor, tools, and equipment necessary for site clearing and grubbing, stripping, preparation of foundation materials for receiving fill, excavation, processing, placement and compaction of fill and backfill materials to the lines and grades shown on the project grading plans, and disposal of excess materials.

PERFORMANCE: The Contractor shall be responsible for the satisfactory completion of all earthwork in accordance with the project plans and specifications. This work shall be inspected and tested by a representative of Krazan and Associates, Inc., hereinafter known as the Geotechnical Engineer and/or Testing Agency. Attainment of design grades when achieved shall be certified to by the project Civil Engineer. Both the Geotechnical Engineer and Civil Engineer are the Owner's representatives. If the contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory as determined by both the Geotechnical Engineer and Civil Engineer. No deviation from these specifications shall be made except upon written approval of the Geotechnical Engineer, Civil Engineer or project Architect.

No earthwork shall be performed without the physical presence or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least 2 working days prior to the commencement of any aspect of the site earthwork.

The Contractor agrees that he shall assume sole and complete responsibility for job site conditions during the course of construction of this project, including safety of all persons and property; that this requirement shall apply continuously and not be limited to normal working hours; and that the Contractor shall defend, indemnify and hold the Owner and the Engineers harmless from any and all liability, real or alleged, in connection with the performance of work on this project, except for liability arising from the sole negligence of the Owner of the Engineers.

TECHNICAL REQUIREMENTS: All compacted materials shall be densified to a density not less than 95 percent of maximum dry density as determined by ASTM Test Method D1557 as specified in the technical portion of the Geotechnical Engineering Report. The results of these tests and compliance with these specifications shall be the basis upon which satisfactory completion of work will be judged by the Geotechnical Engineer.

SOIL AND FOUNDATION CONDITIONS: The Contractor is presumed to have visited the site and to have familiarized himself with existing site conditions and the contents of the data presented in the soil report.

The Contractor shall make his own interpretation of the data contained in said report, and the Contractor shall not be relieved of liability under the contractor for any loss sustained as a result of any variance between conditions indicated by or deduced from said report and the actual conditions encountered during the progress of the work.

DUST CONTROL: The work includes dust control as required for the alleviation or prevention of any dust nuisance on or about the site or the borrow area, or off-site if caused by the Contractor's operation either during the performance of the earthwork or resulting from the conditions in which the Contractor leaves the site. The Contractor shall assume all liability, including Court costs of codefendants, for all claims related to dust or windblown materials attributable to his work.

SITE PREPARATION

Site preparation shall consist of site clearing and grabbing and preparations of foundation materials for receiving fill.

CLEARING AND GRUBBING: The Contractor shall accept the site in this present condition and shall demolish and/or remove from the area of designated project, earthwork all structures, both surface and subsurface, trees, brush, roots, debris, organic matter, and all other matter determined by the Geotechnical Engineer to be deleterious. Such materials shall become the property of the Contractor and shall be removed from the site.

Tree root systems in proposed building areas should be removed to a minimum depth of 3 feet and to such an extent which would permit removal of all roots larger than 1 inch. Tree root removed in parking areas may be limited to the upper 1½ feet of the ground surface. Backfill or tree root excavation should not be permitted until all exposed surfaces have been inspected and the Geotechnical Engineer is present for the proper control of backfill placement and compaction. Burning in areas, which are to receive fill materials, shall not be permitted.

SUBGRADE PREPARATION: Surfaces to receive Structural fill shall be prepared as outlined above, excavated/scarified to a depth of 12 inches, moisture-conditioned as necessary, and compacted to 95 percent compaction.

Loose and/or areas of disturbed soils shall be moisture conditioned and compacted to 95 percent compaction. All ruts, hummocks, or other uneven surface features shall be removed by surface grading prior to placement of any fill material. All areas which are to receive fill materials, shall be approved by the Geotechnical Engineer prior to the placement of any of the fill material.

EXCAVATION: All excavation shall be accomplished to the tolerance normally defined by the Civil Engineer as shown on the project grading plans. All over excavation below the grades specified shall be backfilled at the Contractor's expense and shall be compacted in accordance with the applicable technical requirements.

FILL AND BACKFILL MATERIAL: No material shall be moved or compacted without the presence of the Geotechnical Engineer. Material from the required site excavation may be utilized for construction site fills provided prior approval is given by the Geotechnical Engineer. All materials utilized for constructing site fills shall be free from vegetable or other deleterious matter as determined by the Geotechnical Engineer.

PLACEMENT, SPREADING AND COMPACTION: The placement and spreading of approved fill materials and the processing and compaction of approved fill and native materials shall be the responsibility of the Contractor. However, compaction of fill materials by flooding, ponding, or jetting shall not be permitted unless specifically approved by local code, as well as the Geotechnical Engineer.

Both cut and fill shall be surface compacted to the satisfaction of the Geotechnical Engineer prior to final acceptance.

SEASONAL LIMITS: No fill material shall be placed, spread, or rolled while it is frozen or thawing or during unfavorable wet weather conditions. When the work is interrupted by heavy rains, fill operations shall not be resumed until the Geotechnical Engineer indicates that the moisture content and density of previously placed fill are as specified.

APPENDIX C

IMPERVIOUS PAVEMENT SPECIFICATIONS

1. DEFINITIONS – The term "pavement" shall include asphalt concrete surfacing, untreated aggregate base, and aggregate subbase. The term "subgrade" is that portion of the area on which surfacing, base, or subbase is to be placed.

2. SCOPE OF WORK – This portion of the work shall include all labor, materials, tools and equipment necessary for and reasonable incidental to the completion of the pavement shown on the plans and as herein specified, except work specifically notes as "Work Not Included."

3. PREPARATION OF THE SUBGRADE – The Contractor shall prepare the surface of the various subgrades receiving subsequent pavement courses to the lines, grades, and dimensions given on the plans. The upper 12 inches of the soil subgrade beneath the pavement section shall be compacted to a minimum compaction of 95% of maximum dry density as determined by test method ASTM D1557. The finished subgrades shall be tested and approved by the Geotechnical Engineer prior to the placement of additional pavement of additional pavement courses.

4. AGGREGATE BASE – The aggregate base shall be spread and compacted on the prepared subgrade in conformity with the lines, grades, and dimensions shown on the plans. The aggregate base should conform to WSDOT Standard Specification for Crushed Surfacing Base Course or Top Course (Item 9-03.9(3)). The base material shall be compacted to a minimum compaction of 95% as determined by ASTM D1557. Each layer of subbase shall be tested and approved by the Geotechnical Engineer prior to the placement of successive layers.

5. ASPHALTIC CONCRETE SURFACING – Asphaltic concrete surfacing shall consist of a mixture of mineral aggregate and paving grade asphalt, mixed at central mixing plant and spread and compacted on a prepared base in conformity with the lines, grades, and dimensions shown on the plans. The viscosity grade of the asphalt shall be AR-4000. The mineral aggregate shall be WSDOT Class B. The drying, proportioning, and mixing of the materials shall conform to WSDOT Specifications.

The prime coat, spreading and compacting equipment, and spreading and compacting the mixture shall conform to WSDOT Specifications, with the exception that no surface course shall be placed when the atmospheric temperature is below 50 degrees F. The surfacing shall be rolled with combination steel-wheel and pneumatic rollers, as described in WSDOT Specifications. The surface course shall be placed with an approved self-propelled mechanical spreading and finishing machine.

6. TACK COAT – The tack (mixing type asphaltic emulsion) shall conform to and be applied in accordance with the requirements of WSDOT Specifications.

APPENDIX C – DRAWINGS