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STORMWATER SITE PLAN

Pangborn Memorial Airport
Terminal Apron Reconstruction
Final Stormwater Site Plan -
Revised

Pangborn Memorial Airport
1 Pangborn Drive
East Wenatchee, WA 98802



BPC-2021-046

MEAD & HUNT PROJECT NO: 1622900-210084.01

Revised March 2022

ENGINEER'S DECLARATION/CERTIFICATION

"I, Tal Glass, a Professional Engineer registered in the State of Washington as a Civil Engineer, do hereby declare that the Stormwater Site Plan titled Pangborn Memorial Airport Terminal Apron Reconstruction, and dated March 24, 2022, was prepared by, or under my personal supervision. I hereby affirm that, to the best of my knowledge, the information and belief, of the subject report was prepared in full compliance with the Douglas County Development Standards and all Technical Standards adopted thereunder.



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1. Project Overview

1.1 Project Description

The Pangborn Memorial Airport (EAT, Airport) is a commercial airport in Douglas County, Washington, located southeast of Wenatchee and East Wenatchee with primary roadway access via Grant Road. The Airport is owned and operated by the Port of Chalan County and Port of Douglas County.

The Project includes reconstruction and expansion of the terminal apron which is considered a redevelopment project. The terminal apron will be used for aircraft loading and unloading of passengers at the terminal. Fueling of the aircraft will occur on the terminal ramp. An extension to the apron to the northwest is included for dedicated aircraft deicing activities. The project also includes access road and taxiway improvements. The project vicinity is shown in **Figure 1** and the project location is in **Figure 2**. The project includes replacement of approximately 3.38 acres of existing impervious area and adds approximately 4.95 acres of new impervious area.



FIGURE 1. VICINITY MAP

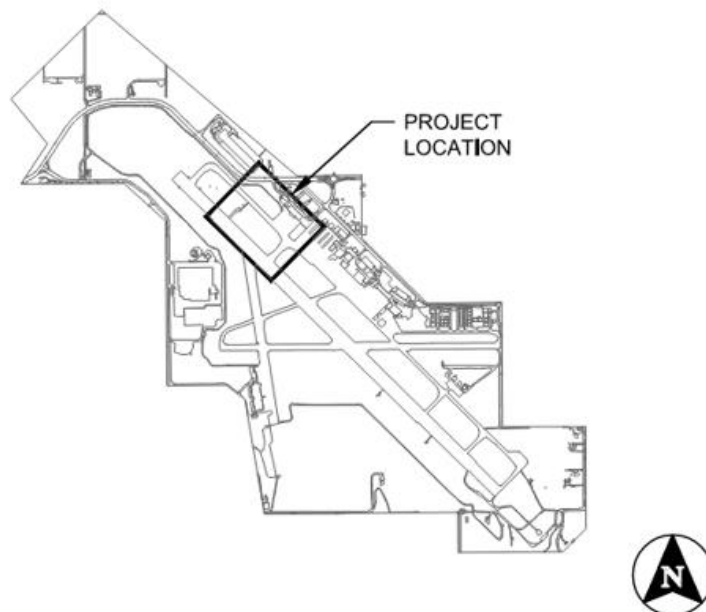


FIGURE 2. PROJECT LOCATION

1.2 Purpose of Report

This Stormwater Site Plan is intended to provide details of the project related to the management of stormwater runoff from the impervious area added by the Project. The Project needs to conform to Federal Aviation Administration (FAA) Advisory Circulars (AC) for design of improvements. In addition, the airport is within Douglas County, a National Pollutant Discharge Elimination System (NPDES) Permitted Phase II municipality. The County enforces the control of stormwater runoff from new development, redevelopment, and construction sites within their municipal boundaries in accordance with their NPDES Phase II Permit. Since the Airport is within the County's NPDES Phase II Permit Area, stormwater management must comply with Washington Department of Ecology (Ecology) Stormwater Management Manual for Eastern Washington (SWMMEW) for improvement projects, dated August 2019. The Airport currently drains to a variety of infiltration facilities around the Airport with no direct discharge to surface waters of the State. As such, the Airport is exempt from coverage under the NPDES Permit for industrial and construction activities. The Project is intended to preserve the natural drainage system and fully infiltrate runoff from the project site. The Airport will implement Best Management Practices (BMPs) including source control, runoff treatment and flow control as described herein to protect groundwater resources within the region.

1.3 Design Requirements

This drainage report is intended to provide drainage design and analysis in accordance with the following standards, codes, and reference documents:

- FAA AC:
 - FAA AC 150/5320-5D, Airport Drainage Design (2013)
 - FAA AC 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports (2020)
- Ecology, Stormwater Management Manual for Eastern Washington (SWMMEW) (2019)
- Washington Department of Transportation (WSDOT) Aviation Stormwater Design Manual (2008)
- Douglas County Municipal Code
 - Chapter 20.34 Stormwater Drainage
 - Chapter 20.36 Construction and Post-Construction Stormwater

The FAA AC 150/5320-5D for Airport Drainage Design specifies requirements for the collection and conveyance of stormwater runoff to provide for safe passage of vehicles and operation of the facility without causing adverse on-site or off-site impacts. For airfields, the typical design storm is the 5-year storm event. Design of drainage systems includes the consideration of stormwater quantity and quality. Local, state, and/or federal regulations often control the allowable quantity and quality of stormwater discharges.

The FAA AC 150/5200-33B Hazardous Wildlife Attractants on or Near Airports recommends that stormwater management systems be designed so as not to create above-ground standing water or drain down within 48-hours after the design storm event. In addition, selection of vegetation needs to consider potential to attract wildlife and eliminate vegetation that may provide food or cover for wildlife. Stormwater management designs will consider the WSDOT Aviation Stormwater Design Manual, which has modified SWMMEW standard BMPs for the airport environment and consideration of wildlife hazards.

The SWMMEW, Figure 2.2, includes a flow chart for determining applicability of the Core Elements for redevelopment projects. Stormwater from the existing site drains to an infiltration trench that will be impacted by the project. Consideration was given to installation of drywells for runoff disposal. However, in accordance with the SWMMEW, UIC wells may not receive stormwater from activities including airplane

deicing and industrial areas that have outdoor handling of materials, such as fuel. Where a UIC is to receive stormwater runoff from these activities, individual authorization under a waste discharge permit is required. Based on discussions with the Ecology during design development, Ecology discouraged individual authorizations for stormwater discharges from these activities to UICs and encouraged use of other infiltration BMPs. As such, the applicability of the SWMMEW Core Elements for the Project are as follows:

- Core Element #1: Preparation of a Stormwater Site Plan
 - Required for new and replaced impervious area
- Core Element #2: Construction Stormwater Pollution Prevention
 - Required for the Project site
- Core Element #3: Source Control of Pollution
 - Required for the Project site
- Core Element #4: Preservation of Natural Drainage Systems
 - Required for new and replaced impervious area
- Core Element #5: Runoff Treatment
 - Required for new and replaced pollution generating impervious surface (PGIS) areas
 - New PGIS requires basic treatment
 - New PGIS associated with the apron requires oil control
 - New PGIS associated with the apron meets the exemptions for metal and phosphorous
- Core Element #6: Flow Control
 - Required for new PGIS areas
- Core Element #7: Operation and Maintenance
 - Required for new PGIS areas
- Core Element #8: Local Requirements
 - Required for new and replaced impervious area

The water quality design storm will be the 6-month, 3-hour short duration storm. The flow control design storm will be the 25-year, 24-hour, SCS Type IA storm, for Region 2 (SWMMEW Table 4.3). Flow control design will also be checked against the 100-year, 24-hour SCS Type II storm per Douglas County Municipal Code 20.34.010 and 20.36.070. BMP selection and design will consider modifications presented in the WSDOT Aviation Stormwater Design Manual.

2. Existing Conditions Summary

The existing apron is bounded to the northeast by the terminal building, the southeast by a grass open area, southwest by a paved taxiway, and northwest by a grass open area. The apron's asphalt pavement is gently sloping and in poor condition. The apron drains to a trench drain which discharges to an infiltration depression in the grass open area northwest of the apron. There is no surface evidence of a UIC well in this location. A portion of the building terminal roof also discharges to this infiltration area. A portion of the apron and grass area to the southeast drains towards the ramp. The adjacent taxiway drains away from the ramp to an open grass infield area with infiltration trenches.

The Natural Resources Conservation Service soil survey maps identify the soil within the project area as Pogue fine sandy loam, which is classified as a Hydrologic Soil Group A. The NRCS soils maps are included in **Appendix A**. Geotechnical investigations associated with the project were completed in March 2021. A final Geotechnical Engineering Evaluation is included in **Appendix B**. Based on that report, site soils encountered in the subgrade were identified as sand and silty sand. Groundwater was not encountered in the borings to a depth of 10.4-ft and it is not anticipated to be encountered in the upper 100-feet of soil

profile.

An existing drainage boundary was delineated encompassing the new development project area for comparison of pre-development and post-development runoff rates for flow control. **Table 1** lists a summary of that drainage basin total area (acre), impervious area (acre) and runoff rate (cubic feet per second) for the flow control design storm. Given the location, rain-on-snow precipitation was chosen for the design of infiltration devices and conveyance design. The 100-year, 24-hour SCS Type II design storm will be evaluated for proposed condition performance but was not evaluated in the existing conditions. The HydroCAD input and output for the existing conditions are included in **Appendix C**.

Table 1. Existing Conditions Drainage Basins

Drainage Basin	Total Area (acre)	Existing Impervious Area (acre)	25-YR, 24-HR Peak Runoff (cfs)	25-YR, 24-HR Rain-on-Snow Peak Runoff (cfs)
EX-1	6.04	3.49	1.64	2.14
EX-2	2.73	0.44	0.09	0.11
EX-3	13.35	4.67	2.06	2.61

3. Permanent Stormwater Control Plan

3.1 Design Overview

This section describes the source control, runoff treatment, flow control and conveyance system design for the Project. The Project is intended to preserve the natural drainage system and fully infiltrate runoff from the project site in compliance with Core Element #4. It is recommended that the runoff from the apron area does not discharge to UICs. UICs are defined and regulated by Chapter 173-218 WAC. Infiltration ponds, dispersion systems, or infiltration trenches that do not contain a perforated pipe are exempt from UIC well status per WAC 173-218-050. Cold climate considerations were taken into account in design of permanent stormwater controls.

3.2 Source Control

Source control BMPs will be implemented to prevent pollutants from coming into contact with stormwater in accordance with Core Element #3. Potential pollutants include oils from fueling operations and deicing chemicals from aircraft deicing activities occurring on the apron.

To address oils from fueling operations, an oil water separator will be located downstream of the trench drains. All flows will be routed through the oil water separator. Mobile fueling of aircraft will occur on the apron, therefore S419E from the 2019 Stormwater Management Manual for Eastern Washington Is Applicable. This describes best practices to avoid spills during mobile fueling. Further instructions applicable to S419E are detailed in Appendix H.

To address the aircraft deicing chemicals, the aircraft deicing activities will be isolated from the stormwater disposal system during the deicing season. The trench drain collection systems will be connected to a manhole with a diversion valve system. During deicing season, the valves will be set to discharge deicing laden runoff to a wastewater collection system. During non-deicing season, the valve will be set to discharge stormwater runoff to the stormwater discharge system. The wastewater collection system is further

described in **Appendix D**.

3.3 Runoff Treatment

To address Core Element #5: Runoff Treatment, stormwater management facilities will include basic treatment BMPs to treat the new and replaced PGIS associated with the Project. The SWMMEW, Figure 5.1, includes a flow chart for selection of runoff treatment BMPs. For surface infiltration, first oil control BMPs are to be applied, if required, then pretreatment prior to discharge to a surface infiltration BMP. Oil control treatments will be applied as described above under Source Control. Pretreatment will be applied using sedimentation features of sump catch basins in the drainage network. Then the runoff will be directed to an infiltration trench. Runoff from the existing terminal roof will be collected and routed to the infiltration trench. The infiltration trench which provides flow control and disposal of stormwater runoff from the project infiltrates the water quality design storm, the 6-month, 3-hour short duration design storm. The design for the infiltration trench is described in the following section.

For access roads, taxiways, and apron shoulder paved areas will not be directly connected to the storm sewer system. Drainage will sheet flow off paved areas to vegetated filter strips to provide runoff treatment prior to discharge to grass areas and/or infiltration trenches. The vegetated filter strip calculations are included in **Appendix E**.

3.4 Flow Control

To address Core Element #6: Flow Control, stormwater management facilities will include surface infiltration to fully infiltrate runoff from the project site. Stormwater runoff from project site will be directed to infiltration trenches. The short-term infiltration rate for the sandy soils was determined to be 6 inches/hour based on field tests. A factor of safety of 2.5 (Table 6.4 SWMMEW) was applied to this rate for a calculated long-term infiltration rate of 2.4 inches/hour for the design.

There will be a large infiltration trench serving the apron runoff which has been designated as Trench 1. There will be smaller infiltration trenches serving infield drainage associated with the taxiway modifications and access road improvements, Trenches 2 (A, B, & C) and 3 (A & B). The infiltration trenches are sized to attenuate the predevelopment peak flow from the 25-year, 24-hour, Type IA Design Storm for rain-on-snow. Minimal surface ponding is expected within these trenches and will not exceed the 48-hour required drawdown time. **Table 2** indicates the inflow and outflow for the proposed infiltration trenches. Drainage areas for the trenches are delineated in **Exhibit 3** and design calculations for the infiltration trench are included in **Appendix F**.

Table 2. Proposed Infiltration Trenches, Flow Control Sizing, 25-year,24-hour, Type IA, Rain-on-Snow

Trench	25-year, 24-hour Rain-on-Snow Inflow (cfs)	25-year, 24-hour Rain-on-Snow Outflow (cfs)
1	2.44	0.46
2 (A, B)	0.39	0.12
3A	0.14	0.04
3B	0.11	0.04

The proposed trenches were checked against the 100-year, 24-hour Type II Design Storm and ponding that does occur will not encroach on the apron or taxiways and does not exceed the 48-hour drawdown time, with elevations shown in **Table 3**.

Runoff from a portion of the widened portion of Taxiway A sheet flows to an existing infiltration trench located in an infield to the southeast of the apron and taxiway. The realignment of the taxiway added impervious area, increasing runoff to the existing trench. The drainage area is shown as INF-EX in **Exhibit 3** and calculations are included in **Appendix F**. Calculations verify the infiltration trench capacity for the new flows based the assumptions the trench was constructed per design plans and the field infiltration rate correlates to the design infiltration rates applied to the infiltration trenches designs for this project. For the 100-year, 24-hour, Type II Design Storm, ponding will occur within the infield but will not encroach on the taxiway or runway and is not expected to exceed the 48-hour drawdown time with flow rates and elevations shown in **Table 3**.

Table 3: Proposed and Existing Infiltration Trenches, Flow Control Sizing, 100-Year, 24-Hour, Type II

Trench	100-year, 24-hour, Type II Inflow (cfs)	100-year, 24-hour, Type II Outflow (cfs)	Elevation at Top of Trench	Ponding Elevation
1	12.20	0.50	1216.40' (grade at 1222.90')	1219.70'
2 (A, B)	2.07	0.30	1223.27'	1223.65'
3A	0.70	0.14	1222.00'	1222.24'
3B	0.62	0.17	1224.00'	1224.21'
Existing	11.08	1.43	1219.00'	1220.00'

3.5 Conveyance System

The drainage conveyance system is required to convey the 5-year, 24-hour design storm event in accordance with FAA requirements and provide for safe passage of the 100-year, 24-hour design storm event. The design meets the design storm event conveyance requirements and the apron overflow route for the 100-year, 24-hour Type II Design Storm is intended to surface flow north toward Infiltration Trench 1.

Pipes are designed with a minimum of two-foot bury depth where possible to account for potential frost depth. Pipe and structures will be reinforced concrete pipe meeting aircraft rated loading.

Design calculations for the conveyance and flow control system were performed using HydroCAD. Those calculations are included in **Appendix G**.

3.6 Site Suitability Criteria

General Site Suitability Criteria is provided in Section 5.4.3 of the 2019 Stormwater Management Manual for Eastern Washington (SWMMEW). All infiltration trenches were reviewed for site suitability. Below is the suitability criteria and our review per the specific site and design.

SSC-1: Setback Criteria

The following setback criteria have been met. No additional mitigations measures are required. See Figure 3 for well locations and travel time areas.

- All project infiltration trenches are >100 feet from drinking water wells, septic tanks, and drain fields.
- All project infiltration trenches are >200 feet from springs used for public drinking water supplies.
- All project infiltration trenches outside of the 1-, 5-, and 10-year time of travel zones of public drinking water wells
- A separate deicing collection system will collect all deicing chemicals. No herbicides will be used.
- No structures in the area are placed below any infiltration trench bottom elevation. No impacted to adjacent structures are expected,

SSC-2: Ground Water Protection Areas

The project site is not located in an aquifer sensitive area, sole source aquifer, wellhead protection area, or critical aquifer recharge area.

SSC-3: High Vehicle Traffic Area

An oil water separator will be located downstream of the high traffic area collection point, see Section 3.2 of the Stormwater Site Plan. Other collections areas do not require high vehicle traffic area BMPs.

SSC-4: Soil Infiltration Rate/Drawdown Time

The field measured (initial) soil infiltration rate was measured as 6 inches/hour. The long-term infiltration rate was calculated to be 2.4 inches/hours. See Section 3.4 of the Stormwater Site Plan.

SSC-4 suggests using a 72-hour drawdown time, however, the FAA requires a 48-hour drawdown time to prevent excessive standing water which can act as a bird attractant. All infiltration trenches are designed based on a 48-hours drawdown time. See Appendix F of the Stormwater Site Plan.

SSC-5: Depth to Bedrock, Ground Water Table, or Impermeable Layer

Groundwater, bedrock, or impermeable layers were not encountered during the geotechnical investigation. The base of all infiltration trenches are greater than 5 feet above ground water table, bedrock, and impermeable layers.

SSC-6: Soil Physical and Chemical Suitability for Treatment

Runoff is treated prior to collections in the infiltration trenches via vegetated filter strips. All filter strips are designed to meet Department of Ecology treatment requirements. See Section 3.3 of the Stormwater Site Plan.

SSC-7: Seepage Analysis and Control

There are no applicable seepage zones adjacent to the infiltration trenches.

SSC-8: Cold Climate and Impact of Roadway Deicing Chemicals

There are no potable water wells within the project area, see SSC-1.

SSC-9: Previously Contaminated Soils or Unstable Soils

There is no record of hazardous material or potentially contaminated soils. No contaminated soils were encountered during the geotechnical investigation.

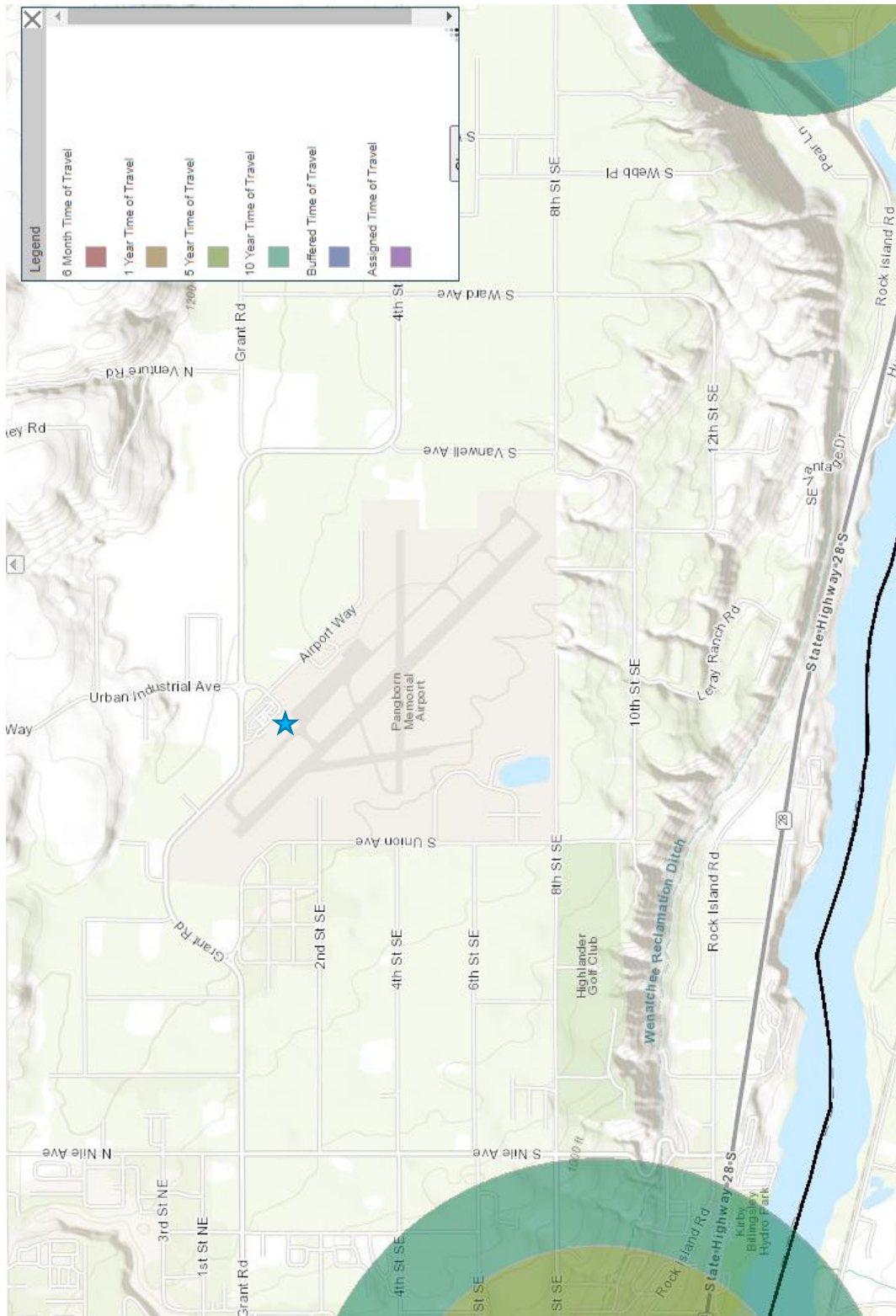


FIGURE 3 - WELL LOCATION & TRAVEL TIME

★ - Project Area

4. Construction Stormwater Pollution Prevention Plan

The Construction Stormwater Pollution Prevention Plan will be provided by others as applicable.

5. Special Reports and Studies

None.

6. Other Permits

Coverage under Ecology's Construction Stormwater General Permit (CSGP) is not required for construction activities that discharge all stormwater to groundwater and have no point source discharge to a surface water or storm sewer that drains to a surface water of the State per Section S1.B. of the CSGP.

7. Operation and Maintenance Manual

See Appendix H.

5.A.6 Maintenance Criteria for Catch Basins

Table 5.40: Maintenance Criteria for Catch Basins

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Trash or debris that is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by > 10%.	No trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) > 60% 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 < 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking > one-third of its height.	Inlet and outlet pipes free of trash or 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.
	Sediment	Sediment (in the basin) > 60% 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 < 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to	Top slab has holes > 2 square inches or cracks > 0.25 inches	Top slab is free of holes and cracks.

Table 5.40: Maintenance Criteria for Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Frame and/or Top Slab	(Intent is to make sure no material is running into basin).	
		Frame not sitting flush on top slab, i.e., separation of > 0.75 inches 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.
	Fractures or Cracks in Basin Walls/Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
	Fractures or Cracks in Basin Walls/Bottom (cont'd)	Grout fillet has separated or cracked > 0.5 inches and > 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking > 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is > 6 inches tall and < 6 inches apart.	No vegetation or root growth present.
Catch Basin Cover	Contamination and Pollution	See "Wetponds" (Table 5.36: Maintenance Criteria for Wetponds).	No pollution present.
	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have < 0.5 inches of thread.	Mechanism opens with proper tools.
	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.
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.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening > 0.875 inches.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking > 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

5.A.3 Maintenance Criteria for Bioinfiltration/Infiltration Trenches/Basins

Table 5.37: Maintenance Criteria for Bioinfiltration/Infiltration Trenches/Basins

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
	Poisonous/Noxious Vegetation	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
	Contaminants and Pollution	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
	Rodent Holes	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of BMP indicates BMP is only working at 90% of its designed capabilities. If ≥ 2 inches of sediment is present, remove).	Sediment is removed and/or BMP is cleaned so that infiltration system works according to design.
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.
Side Slopes of Pond	Erosion	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
Emergency Overflow Spillway and Berms Over 4 Feet in Height	Tree Growth	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
	Piping	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
Emergency Overflow Spillway	Rock Missing	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
	Erosion	See Table 5.36: Maintenance Criteria for Wetponds	See Table 5.36: Maintenance Criteria for Wetponds
Presettling Ponds and Vaults	BMP or Sump Filled With Sediment and/or Debris	6 inches or designed sediment trap depth of sediment.	Sediment is removed.

5.A.10 Maintenance Criteria for Vegetated Filter Strips

Table 5.44: Maintenance Criteria for Vegetated Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance Is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth > 2 inches.	Remove sediment deposits, relevel so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (> 10 inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3 to 4 inches.
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas < 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally > 12 inches wide, the filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

5.A.16 Maintenance Criteria for Coalescing Plate Oil and Water Separators

Table 5.50: Maintenance Criteria for Coalescing Plate Oil and Water Separators

Maintenance Component	Defect	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault > 6 inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and nonfloatables.	Trash and debris removed from vault and inlet/outlet piping.
	Oil Accumulation	Oil accumulation > 1 inch at the water surface.	Oil is extracted from vault using Vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage – Includes Cracks in Walls, Cracks in Bottom, or Damage to Frame and/or Top Slab	Cracks > 0.5 inches or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks > 0.5 inches at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist > 0.25 inches at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

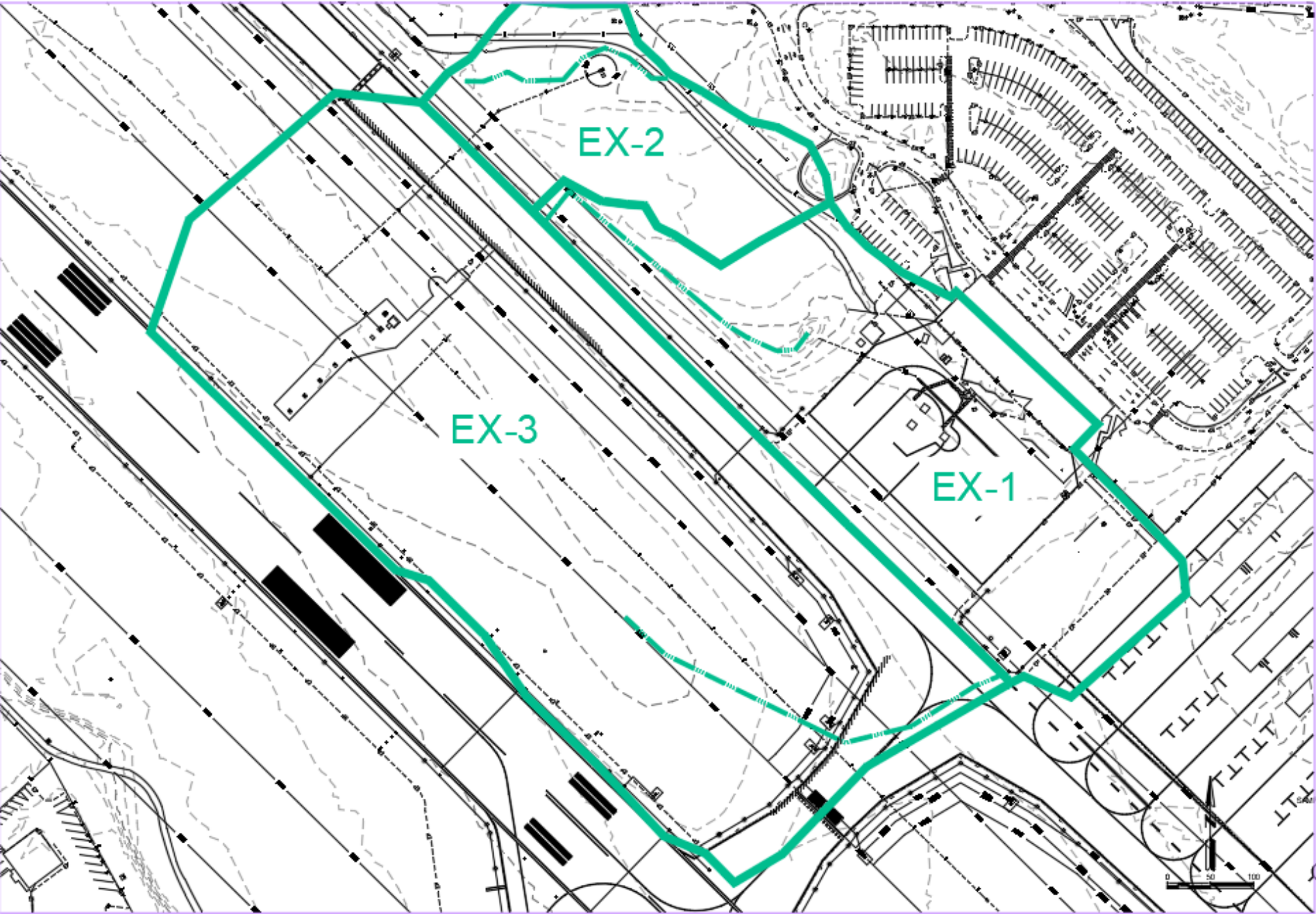
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Exhibit 1. Existing Drainage Area Map



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EXHIBIT 1: EXISTING DRAINAGE AREA MAP



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Exhibit 2. Proposed Drainage Area and BMP Map



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EXHIBIT 2: PROPOSED BASIN AREA AND BMP MAP

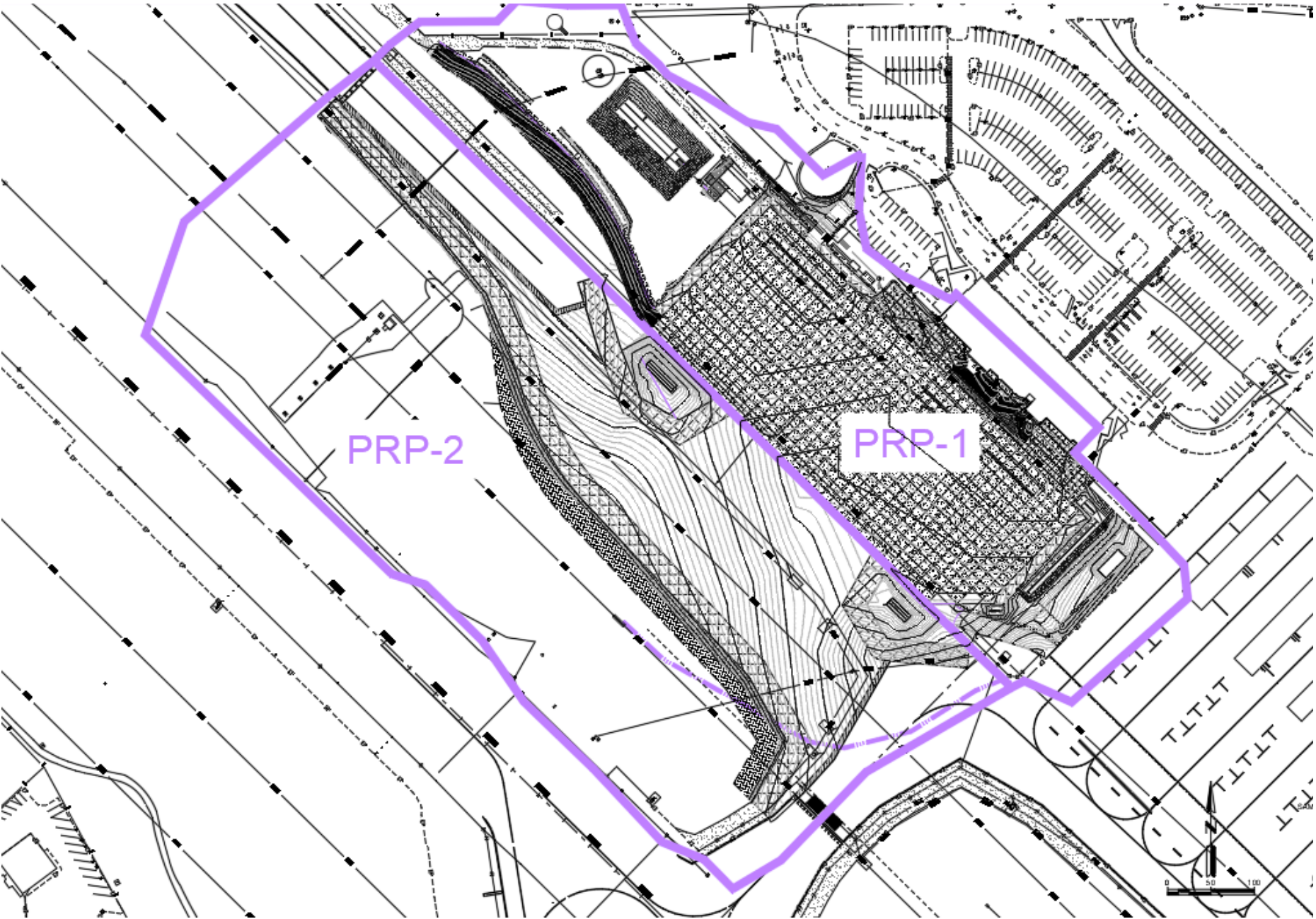
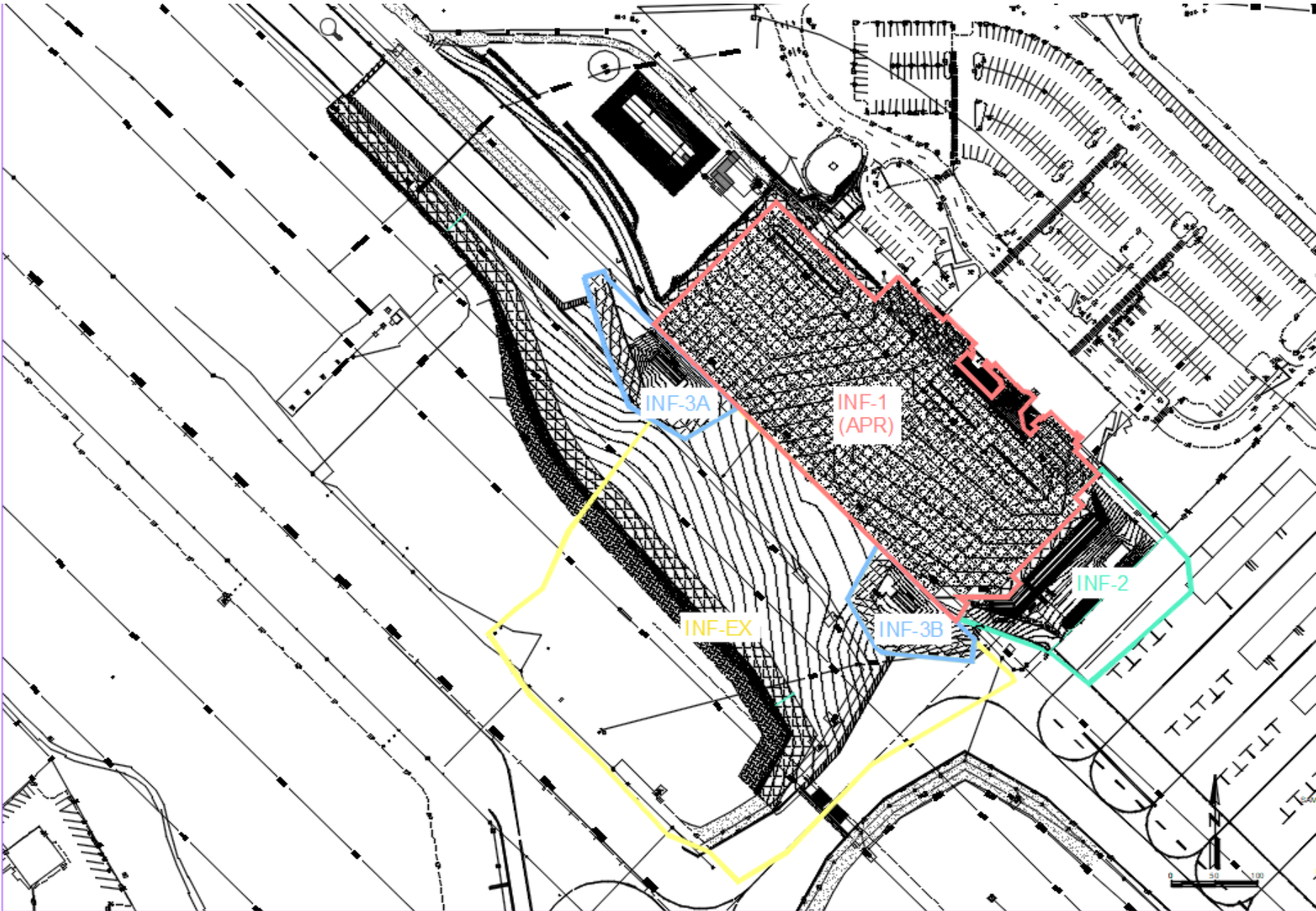


Exhibit 3. Proposed Infiltration Trench Drainage Areas



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EXHIBIT 3: PROPOSED INFILTRATION TRENCH DRAINAGE AREAS



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Appendix A. NRCS Web Soil Survey




Soil Map—Douglas County, Washington (Pangborn Memorial Airport)



Soil Map—Douglas County, Washington
(Pangborn Memorial Airport)

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Douglas County, Washington

Survey Area Data: Version 22, Jun 4, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
262	Pogue fine sandy loam, 3 to 8 percent slopes	7.5	100.0%
Totals for Area of Interest		7.5	100.0%

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Appendix B. Geotechnical Report





April 29, 2021
File: TC20071A

Mr. Chris Mansfield, P.E.
Senior Project Manager
T-O Engineers
1717 South Rustle Street, Suite 201
Spokane, Washington 99224
Email: cmansfield@to-engineers.com

RE: **Geotechnical Engineering Evaluation**
Terminal Apron Reconstruction
Pangborn Memorial Airport - AIP# 3-53-0084-
044-2021
1 Pangborn Drive
East Wenatchee, Washington

Greetings Mr. Mansfield:

STRATA is pleased to provide this Geotechnical Engineering Evaluation (Evaluation) for the proposed Terminal Apron Reconstruction project at the Pangborn Memorial Airport, in East Wenatchee, Washington. Our geotechnical engineering evaluation's purpose was to perform a field exploration, laboratory testing, and provide geotechnical engineering opinions and recommendations to assist project planning, design, and construction. We accomplished our geotechnical services referencing our authorized Task Order 21-01, dated February 10, 2021.

The following evaluation provides specific geotechnical information related to subgrade characterization, earthwork for subgrade preparation, terminal apron pavement design parameters and stormwater disposal system recommendations. The geotechnical information presented herein must be read and understood in its entirety; portions or individual sections of our evaluation cannot be relied upon without the supporting text.

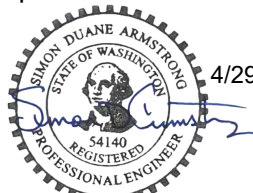
Our opinion is that construction success will depend upon the design team and contractor following our evaluation requirements, project plans and specifications, the contractor adhering to good construction practices, and the Owner and/or contractor providing the required and necessary construction monitoring, testing, and geotechnical consultation to verify the work has been accomplished as required herein. We recommend STRATA be retained to provide monitoring, testing, and consultation services to verify our evaluation recommendations are followed in accordance with the *Federal Aviation Administration* (FAA) requirements.

We appreciate the opportunity to assist T-O Engineers, Inc. (T-O) and the Chelan Douglas Regional Port Authority with this project and look forward to our continued involvement during the construction phase. Please contact us if you have any questions or comments.

Sincerely,
STRATA

A handwritten signature in blue ink, appearing to read "Eric I. Larson".

Eric I. Larson, E.I.T.
Staff Engineer
EIL/SDA/PKA/cm



Simon D. Armstrong, P.E.
Senior Engineer

4/29/2021

A handwritten signature in blue ink, appearing to read "Paxton K. Anderson".

Paxon K. Anderson, P.E.
Chief Operations Officer

Geotechnical Engineering Evaluation

Terminal Apron Reconstruction
Pangborn Memorial Airport
East Wenatchee, Washington
AIP# 3-53-0084-044-2021

PREPARED FOR:

Mr. Chris Mansfield, P.E.
T-O Engineers, Inc.
1717 South Rustle Street, Suite 201
Spokane, Washington 99224

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April 29, 2021



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Geotechnical Engineering Evaluation

Terminal Apron Reconstruction
Pangborn Memorial Airport
East Wenatchee, Washington

INTRODUCTION

The purpose of our geotechnical engineering evaluation was to assess the subsurface soil conditions below the existing terminal apron paved surface and adjacent areas west, and provide geotechnical engineering recommendations to assist project planning, design, and construction for the proposed apron reconstruction project (AIP# 3-53-0084-044-2021), located at the Pangborn Memorial Airport (Airport) located in East Wenatchee, Washington. STRATA performed these services referencing our authorized February 10, 2021 Task Order 21-01.

This evaluation summarizes our field work, laboratory test results, pavement subgrade characteristics, and associated earthwork recommendations for subgrade preparation, stormwater disposal recommendations, and other related project geotechnical considerations. We prepared this evaluation based on our project understanding of the site development plan provided by T-O and by referencing the *Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5320-6F Airport Pavement Design and Evaluation* (FAA Advisory Circular). To provide this evaluation, we accomplished the following:

1. Coordinated with T-O and the Airport to gain site access, to delineate cleanup expectations, to help identify utilities, and to coordinate our activities in a manner to reduce inconvenience to airport operations. Work included completion of FAA safety training and an application for Security Identification Display Area (SIDA) badges.
2. Subcontracted with a private utility location company to perform a ground penetrating radar survey of the exploration locations.
3. Completed 13 explorations (seven borings and six test pits) as illustrated on the attached *Figure 2, Exploration Plan*. The six test pits were advanced to depths ranging from 6.0- to 9.5-feet while the seven borings were advanced to depths ranging from 10.0- to 10.4-feet below the existing ground surface. Each exploration was used to determine subgrade characteristics and obtain subsurface soil samples. In addition, we performed one infiltration test within the TP-28 location to aid in stormwater disposal system design.
4. Logged the subsurface profiles and visually described and classified the soil in reference to the *Unified Soil Classification System (USCS)*.
5. Performed laboratory testing on select soil samples obtained during the exploration program referencing *ASTM International (ASTM)* test standards. Laboratory tests included moisture content, sieve analyses, hydrometer (percent passing 0.02mm), and California Bearing Ratio (CBR).
6. Reviewed subsurface conditions, laboratory test results, conducted geotechnical analyses, and provided geotechnical information and recommendations specific to the following:
 - Subgrade Characterization;
 - Earthwork for airfield pavements;
 - Classify frost susceptibility for pavement subgrade soils;
 - ~~Prepare pavement structures for hot-mix asphalt (HMA) and Portland cement concrete (PCC) pavements based on aircraft loads provided by T-O using FAARField software. Pavement sections were prepared for Complete Frost Protection, Limited Subgrade Frost Protection, and Reduced Subgrade Strength; (Removed from Scope by T-O on April 22, 2021); and~~



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- Stormwater Disposal Recommendations.
7. Prepared and provided a **draft** geotechnical report deliverable for the project design team including exploration logs, laboratory test results, and a site plan illustrating exploration locations.
 8. Prepared this **final** geotechnical report deliverable incorporating design team comments and revisions, thus completing our services for this project.

PROJECT UNDERSTANDING

We understand the Chelan Douglas Regional Port Authority (Port) retained T-O to design and develop construction drawings for design and reconstruction of the Terminal Apron and design for relocation of approximately 700-linear feet of Taxiway A for the Airport. In addition, an on-site stormwater disposal / glycol collection system is planned for either the area west of the existing terminal or at the west end of Taxiway A.

FIELD AND LABORATORY EVALUATION

Field Exploration

From March 4 to March 5, 2021, STRATA observed six exploratory test pits and seven borings to investigate the site subsurface conditions. The excavated depth of the test pits ranged from 6.0- to 9.5-feet while the borings were advanced between 10.0- to 10.4-feet below the existing ground surface. Figure 2, *Exploration Plan* illustrates the approximate exploration locations while the exploration logs are provided in Appendix A. All test pits were advanced with a Kubota KX057-4 mini excavator equipped with a 24.0-inch wide, tooth-blade bucket while the borings were advanced using a G2400 trailer mounted, skid drill with continuous flight, hollow stem augers. We obtained select soil samples from exploratory locations for laboratory testing. A STRATA Staff Engineer described and classified the soil samples referencing Unified Soil Classification System (USCS); a USCS guide is included with our exploration logs in Appendix A. Upon completion, test pits were loosely backfilled with the excavated soil and smoothed approximately level with the surrounding ground surface elevation while the borings were backfilled with bentonite chips to the bottom of the existing pavement and capped with non-shrink grout. Each exploratory location was staked to allow for surveying and remediation during construction, as further discussed in this report's *Test Pit Remediation* section.

Infiltration Testing

We performed one single-ring infiltration test within TP-28 in general accordance with the Stormwater Management Manual of Eastern Washington (SMMEW). The single-ring infiltrometer test was performed at a depth of approximately 3.5-feet beneath the existing ground surface. Results of the infiltration test were 6-inches per hour. Samples were obtained at depth for testing pertinent to drywell recommendations in accordance with the (SSMEW).



Site Conditions

Situated on a bluff overlooking the Columbia River, the project area is characterized by Mission Ridge to the west and Badger Mountain to the east. According to the Rock Island 7.5' topographic map, ground surface elevations at the airport range from 1187 feet to 1248 feet above mean sea level¹ and generally trend from the northeast to the southwest. However, site development has rendered the site nearly level with only modest grade changes on the order of 1-percent or less. The planned apron reconstruction will be immediately adjacent and southwest of the airport terminal building while the Taxiway A improvements will commence at the ILS Hold Line on Taxiway A and terminate at Taxiway A5.

Subsurface Conditions

The general soil profile encountered in the explorations across the site comprised of bare earth (TP-26, TP-27, and TP-30) approximately 1-inch of topsoil (B-25, B-26, TP-25, TP-28, and TP-29) or 3.0- to 5.0-inches of hot mix asphalt (B-27 through B-31) underlain by *Undocumented Fill*. Native soils comprised of Glaciofluvial deposits (Columbia River Flood Deposits) were encountered in each of our explorations and were generally described as:

- **Coarse-Grained Glaciofluvial Deposits (Sand) – Silty Sand (SM), and Poorly-Graded Sand with Silt (SP-SM) and Poorly-Graded Sand (SP):** Light Brown to brown or gray, unconsolidated granular deposits. In general these deposits are composed of fine to medium-grained sands with varying amounts of silt. Based on standard penetration test results, these materials were loose to medium dense and dry to moist.
- **Fine-Grained Glaciofluvial Deposits (Silt) – Silt (ML):** In general, these deposits are composed of non-plastic to low plasticity silt with trace amounts of sand. Based on standard penetration test results, these materials were stiff to very stiff and moist to wet.

Groundwater

We did not encounter groundwater during exploration. Based on our research and review of available well logs in the area obtained from the *Washington State Department of Ecology* (Ecology), we do not anticipate groundwater will be encountered within the upper 100.0-feet of the soil profile. However, groundwater can vary with seasonal changes in precipitation, infiltration, irrigation, and development.

Moisture contents across the site were relatively consistent with a range of 2.3- to 11.6-percent, indicating relatively dry to wet conditions. Generally, natural moisture content was higher where the fine-grained soils or *Undocumented Fill* materials were encountered while the native sands generally decreased in moisture content with depth.

¹ *Rock Island Quadrangle, Washington, 7.5' Series (Topographic)*, AMS 1978 1 NW ed., ser. V891, United States Department of the Interior, Geological Survey, 2017. V891.



Subsurface Variability

Although subsurface soil conditions encountered in our explorations were consistent with respect to soil type, exploratory excavations only allow observation of a relatively small sample of the subsurface conditions at the site. Variations may exist between or beyond exploration locations; these variations would not be apparent until construction. Where such variations exist, it may affect the opinions and recommendations presented in this evaluation, as well as construction timing and costs.

Laboratory Testing

STRATA accomplished laboratory testing on the subsurface soil encountered to assist T-O with their pavement design, stormwater recommendations and soil characterization. We accomplished the following laboratory tests referencing ASTM test standards:

- ASTM D6913 – *Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis*;
- ASTM D1140 – *Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 Sieve*;
- ASTM D7928 – *Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis*;
- ASTM D698 – *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort*; and
- ASTM D1883 – *Standard Test Methods for California Bearing Ratio (CBR) of Laboratory Compacted Soils*.

We will retain soil samples in our Spokane laboratory for three (3) months. Laboratory test results are presented in Appendix B. Index laboratory test results are also presented on the individual exploratory logs in Appendix A.

Table 3. Laboratory Test Results

Exploration ID	Depth (ft)	Moisture Content (%)	Percent Passing No. 200 Sieve (%)
BST-10	0.0 – 1.5	--	5.3
B-26	0.0 – 2.0	11.6	41.2
B-27	0.3 – 2.3	6.0	16.5
B-28	4.3 – 6.3	4.2	3.7
B-29	0.4 – 2.4	2.3	10.4
TP B-5*	3.0 – 4.0	3.1	--
TP B-6*	2.0 -3.0	5.1	--
TP B-6*	7.0 – 8.0	4.6	--
B-31	0.3 – 4.3	4.4	12.2
TP-27	0.0 – 0.5	6.8	15.8
TP-29	1.0 – 3.0	9.3	19.0

Note: * Test pit completed for Budinger Report (Proj. No. X19316, dated 03/24/2020).



Pavement Subgrade Property Characterization

Based on exploration and laboratory test results, the apron area subgrade soil will predominately comprise of coarse-grained sand with varying amounts of silt and gravel (SP, SP-SM, and SM). To evaluate subgrade CBR values, STRATA completed sieve and CBR tests from subgrade samples collected from explorations shown in the following table:

Table 4. Engineering Properties Test Results

Sample Location	Sample Depth, (ft)	Proctor Results		CBR Results, (%)	Frost Soil Group		
		Maximum Dry Density, (pcf)	Optimum Moisture Content, (%)		% Finer than 0.02 mm	Soil Kind	Frost Group
BST-10	0.0 – 1.5	--	--	--	3.7	Sand	FG-2
B-26	0.0 – 2.0	--	--	--	15.5	Sand	FG-4
B-27	0.3 – 2.3	--	--	--	8.6	Sand	FG-3
B-28	4.3 – 6.3	--	--	--	2.4	Sand	FG-2
B-29	0.4 – 2.4	--	--	--	5.7	Gravel	FG-1
B-31	0.3 – 2.3	--	--	--	5.7	Sand	FG-3
TP B-5	3.0 – 4.0	104.2	10.5	17.0	--	Sand	FG-2 ¹
TP B-6	2.0 – 3.0	109.2	14.7	22.0	--	Sand	FG-3 ¹
TP B-6	7.0 – 8.0	111.0	11.4	24.0	--	Sand	FG-2 ¹
TP-27	0.0 – 0.5	119.5	12.5	58.0	8.1	Sand	FG-3
TP-29	1.0 – 3.0	118.0	13.0	38.0	8.3	Sand	FG-3

Note: 1 – Frost group estimated from visual classification only.

Based on laboratory test results prepared by STRATA and Budinger Associates, as well as our visual observations during the subsurface exploration program, a CBR value of

11% is recommended for the planned pavement design based on one standard deviation (18.7) below the mean value of 30.3%.

Pavement Subgrade Frost Characterization

Based on laboratory sieve and hydrometer test results (soil fraction finer than 0.02 mm), the subgrade soils within 1.0-feet and from 1.0- to 4.0-feet of the top of existing paved surface should be characterized as **FG-2** and **FG-3**, respectively according to Table 2-2 – Soil Frost Groups of AC 150/5320-6F. Though the sample tested at B-26 from 0.0 to 2.0-feet below the ground surface classifies as an FG-4, a portion of this sample may include topsoil. We reviewed the Douglas County code requirements to identify the design frost penetration depth used in the area. Accordingly, we determined that the frost depth is 24.0-inches in the project area. Using the most current FAA Circular (AC150/5320-6F) the soils characterized as **FG-3** are moderately susceptible to seasonal frost design



requirements, whereas the soils characterized as **FG-2** are less so. The circular outlines three approaches for frost design, frost protection, or reduced subgrade strength.

Frost Protection – This approach is based on the control of pavement deformations resulting from frost actions. To use this approach the combined thickness of the pavement and non-frost-susceptible material must be sufficient to eliminate or limit the adverse effects of frost penetration into the subgrade.

- Complete Frost Protection – This method is intended to place non-frost susceptible materials within the entire frost susceptible zone (24.0-inches). This method is applicable to areas with FG-3 and FG-4 soils that are extremely variable in horizontal extent and are characterized by very large, frequent and abrupt changes in frost heave potential.
- Limited Subgrade Frost Penetration– This method is intended to reduce frost heave to an acceptable level, typically 65.0-percent of full frost penetration. Limited subgrade frost penetration depth in the project area is 16-inches (24.0-inches x 0.65 = 15.6-inches, or 16.0-inches). This method is applicable to areas with FG-1, FG-2, FG-3, and FG-4 soils when the functional requirements of the pavement allow for some frost heave.
- Reduced Subgrade Strength – This design methodology is based on the concept of constructing a pavement section having adequate load-carrying capacity during alternating freeze and thaw cycles to account for such extremely soft subgrade soil conditions. However, this design methodology does not account for frost “heave” during freezing conditions and is applicable only to areas with FG-1, FG-2, and FG-3 soil, which are uniform in the horizontal extent or where functional requirements of the pavement permit some degree of frost heave. **This method is not applicable for the current proposed apron and Taxiway A improvements at the Airport.**

In our opinion, the site soils are **not** extremely variable in horizontal extent and are **not** typically characterized by very large, frequent, and abrupt changes in frost heave potential. Since the majority of soil encountered during exploration was consistent in the areas explored, we do not anticipate zones or areas of inconsistent frost heave during freezing and thawing temperature swings. Our opinion is the Limited Subgrade Frost Penetration method may be used for this pavement design. *Limited Subgrade Frost Penetration* design requires non-frost susceptible materials (P-401, P-209, P-154) to be placed as ballast extending to a depth below finished grade equal to 65.0-percent of the 24.0-inch *Complete Frost Protection* depth. As such, the *Limited Subgrade Frost Penetration* design method requires 16-inches of non-frost susceptible material to be placed as a total pavement section ballast measured from finish grade.

Given the above discussion and our current project understanding, we recommend T-O and the Airport consider the *Limited Subgrade Frost Penetration* method for pavement design, provided historical design and associated performance **do not** suggest a more robust frost protection section is required. Accordingly, we recommend a minimum of 16.0-inches of non-frost susceptible materials.



GEOTECHNICAL OPINIONS AND RECOMMENDATIONS

As summarized herein, several subsurface conditions and considerations have been identified which will impact project construction and should be considered by the project team during final design and also prospective bidding contractors:

- As described in the *Subsurface Conditions* section of this report, *Undocumented Fill* was encountered near the surface within our explorations. There is a high probability that *Undocumented Fill* is encountered across the site due to limited subsurface exploration. Specifically, the project team should expect to encounter *Undocumented Fill* associated with pavement construction, utility trench alignments, and/or previous historical developments. All *Undocumented Fill* encountered during site preparation and construction should be completely removed below pavements and hardscapes to expose native Glaciofluvial deposits. This recommendation is the geotechnical standard-of-care. If encountered, *Undocumented Fill* may be repurposed as *P-154* if it meets the requirements in FAA circulars.
- The extent of *Undocumented Fill* is presently unknown, but can be further evaluated during construction. Providing a project contingency specific to *Undocumented Fill* removal is recommended.
- As shown in Table 3, relatively low insitu density soils underly the existing apron and proposed Taxiway additions. Referring to the pavement design prepared by T-O, reworking of the insitu soils to a depth of 84.0-inches below the finished pavement elevation may be necessary to meeting current FAA pavement design requirements.

The following geotechnical recommendations are presented to assist final design and construction document development for Terminal Apron Reconstruction, Pangborn Memorial Airport, East Wenatchee, Washington. Geotechnical recommendations are based on experience with similar soil and geologic conditions, findings from field and laboratory evaluation, and understanding of the proposed construction. If development plans change, STRATA recommends to be contacted to review any project modifications relative to recommendations and, if necessary, provide any necessary revisions or modifications. Additionally, if subsurface conditions exposed during construction are different than what was encountered during exploration, STRATA should be contacted to review the recommendations and provide any necessary revisions or modifications.



Table 5. Soil Fill Specifications and Allowable Use

Material	Allowable Use	Material Specifications
P-154 Fill¹	<ul style="list-style-type: none"> • Site grading and fill placement • Foundation wall backfill • Over-excavations 	Soil must Meeting the gradation requirements listed in Item P-154 Subbase Course in FAA Design Circular AC 150/5370-10H; Soil may not contain particles larger than 6.0-inches in median diameter; and Soil must contain less than 3.0-percent (by weight) of organics, vegetation, wood, metal, plastic or other deleterious substances.
Undocumented Fill	<ul style="list-style-type: none"> • Site grading and fill placement • Foundation wall backfill • Over-excavations 	Soil must be classified as GP, GW, SP, or SW according to the USCS; Soil may not contain particles larger than 6.0-inches in median diameter; and Soil must contain less than 3.0-percent (by weight) of organics, vegetation, wood, metal, plastic or other deleterious substances.
Unsatisfactory Soil	<ul style="list-style-type: none"> • NONE 	Soil classified as CH, CL, MH, ML, OH, OL or PT may not be used at the project site; Any soil type not maintaining moisture contents within 5.0-percent of optimum during compaction; and Any soil containing more than 3.0-percent (by weight) of organics, vegetation, wood, metal, plastic or other deleterious substances.

1. The on-site native glaciofluvial soil generally meets the intent of recommendations for *P-154 Fill*.

Earthwork for Pavements

The following evaluation sections describe STRATA's earthwork recommendations with respect to the new Taxiway.

Excavation Characteristics

We anticipate the soil within the Taxiway areas may be excavated using standard heavy-duty construction equipment. Excavation of caliche may require relatively large construction equipment or ripping. The near-surface on-site soil is classified as a Type "C" soil according to WISHA requirements. Type "C" soil can be benched 1.5H:1.0V. Therefore, we recommend provisions be made to allow temporary soil excavations to be sloped back at 1.5H:1.0V (horizontal to vertical) or flatter. In general, slopes and excavations must be excavated, shored or braced in accordance with the *Washington Industrial Safety and Health Act* (WISHA) regulations and local codes. It is important that utility trenches slope and are not cut vertical; this allows a uniform transition for varying trench fill depths and reduces the potential for differential performance along the trench line. Ultimately, the selected contractor is responsible for site safety and determining appropriate excavations for the conditions and



soil types encountered during construction. STRATA accepts no responsibility for temporary excavation stability.

Site Subgrade Preparation

It is critical to subgrade performance that site preparations be accomplished by equipment that will not disturb the subgrade soil after the FAA required compaction has been achieved and verified. After excavation to the desired subgrade elevation, the subgrade must be thoroughly moisture-conditioned (wetted or dried) to a moisture content appropriate for compaction through the use of construction discs, rippers or other equipment. Per FAA requirements, the subgrade must be compacted to specified depths and to specified relative compaction levels per the results of a FAARFIELD analysis. The following summarizes the FAARFIELD compaction specifications for a P-3 aircraft and B737-400 aircraft, the controlling aircraft for compaction requirements on Taxiway A and the Terminal Apron, respectively.

Taxiway A Compaction Requirements (depths measured from top of subgrade)

1. 0 – 29 inches, compact to 100% of ASTM D1557
2. 29 – 61 inches, compact to 95% of ASTM D1557
3. 61 – 93 inches, compact to 90% of ASTM D 1557
4. 93 – 129 inches, compact to 85% of ASTM D 1557

Terminal Apron Compaction Requirements (depths measured from top of subgrade)

1. 0 – 28 inches, compact to 100% of ASTM D1557
2. 28 – 59 inches, compact to 95% of ASTM D1557
3. 59 – 89 inches, compact to 90% of ASTM D 1557
4. 89 – 125 inches, compact to 85% of ASTM D 1557

Based on laboratory testing, N_{SPT} test results, and our visual observations noted during the subsurface exploration program, our opinion is it **will likely** be necessary to moisture condition and recompact the upper 59.0- to 120.0-inches of the subgrade (Item P-152) to meet FAA and T-O design compaction requirements per T-O's FAARFIELD analyses. As shown in the following table, a correlation of N_{SPT} blow count and relatively density indicates moderately dense to dense materials supporting the existing pavements. Tabular results of N_{SPT} test data with in-situ soil density is presented in Appendix C.



Table 6: Insitu Relative Density by Depth

Apron Area Depth Range, Inches¹	Relative Compaction Range, %	Taxiway A	Relative Compaction Range, %²
0 – 28	89 – 109	0 – 29	84 – 92
28 – 59	87 – 109	29 – 61	79 – 102
59 – 89	79 – 104	61 – 93	85 – 104
89 – 125	81 – 105	93 - 129	97 – 105

1. Based on STRATA Borings B-27, -28, -29, and -31
2. Based on STRATA Borings B-25, -26, and -30

Alternatives to reworking the subgrade soils include use of a geotextile or amending the subgrade soils with cement (ground improvement).

If soft or unstable pumping and heaving conditions are observed during the subgrade compaction process, the disturbed soil should be removed to medium dense, undisturbed soil and replaced with Item P-154 that has been moisture-conditioned to near optimum moisture content.

We recommend project specifications allow for contingencies for soil removal and replacement with adequately moisture conditioned Items P-152 or P-154 if the contractor has applied sufficient compactive effort and still could not meet project compaction specifications due to environmental conditions, as opposed to inadequate means and methods. Soil removal should only occur after the contractor has made several attempts at compaction using heavy (10.0 tons or larger) compaction equipment and only as authorized by T-O. The number of attempts to achieve soil compaction should be determined by T-O. STRATA can provide additional guidance and recommendations for soil removal during construction.

Test Pit Remediation

All test pits located beneath the planned pavement areas are recommended to be remediated during earthwork construction. Test pits shall be backfilled with imported/on-site Item P-152 soil, meeting the requirements stated in FAA Design Circular for Item P-152. STRATA recommends all test pits within the proposed construction areas to be reviewed by STRATA and the contractor, following site stripping, to determine whether full-depth remediation is necessary based on conditions observed during construction and planned improvements overlying test pit areas.

Wet Weather/Wet Soil Construction

In soft soil areas and during wet weather or wet soil conditions, earthwork contractors must be familiar with the hazards of using large wheel-mounted equipment which exerts a point load on the subgrade. Staggering wheel paths, using tracked equipment to load soil and other techniques are important



processes that reduce the potential for pumping, rutting and contractor rework during wet soil conditions. As presented above, if soft or unstable pumping and heaving conditions are observed during the subgrade compaction process, the disturbed soil should be removed to firm and undisturbed native soil and replaced with approved Item P-154 soil, or the on-site soil should be moisture-conditioned to near optimum moisture content and re-compacted to Item P-154 soil requirements. The depth of over-excavation to remove disturbed subgrade soil should not be less than 12.0-inches. We recommend T-O plan contingencies including time for moisture-conditioning, over-excavation of soft, pumping and rutting areas, and replacement with approved Item P-152 soil.

The subgrade should not be allowed to freeze prior to placing fill or constructing the pavement section. If the subgrade freezes after it has been compacted, the subgrade must be recompact to design requirements within the frozen area after the soil has completely thawed. If the subgrade will remain unpaved through the winter, the subgrade must be recompact within the entire frost penetration depth (24.0-inches) prior to initiating additional earthwork or constructing the pavement section. In summary, careful construction means and methods are paramount to earthwork success during wet soil conditions, inclement weather or low temperature periods of the year.

Subgrade Fill

Although not expected, if Item P-152 soil is required to elevate segments of the apron and Taxiway, the material should be placed and compacted according to FAA specifications for Item P-152. All other imported fill should meet material specifications for supporting aggregate, such as P-209, P-208, or P-154. Item P-152 should be placed in maximum 6.0-inch-thick, loose lifts. We recommend STRATA review Item P-152 soil placements and perform the necessary subgrade observations and in-place density testing to verify FAA and design compaction requirements have been achieved. The on-site soils encountered during our subsurface investigation consisting of poorly-graded gravel to silty sand is expected to be suitable for reuse as P-152.

Fill Placement

Fill shall be placed and compacted according to the current FAA specifications for the applicable item. Care and appropriate staging must be provided during subbase (P-154) and base (P-209 or P-208) placements. Often, contractors elect to moisture-condition the soil in-place above subgrades. However, the site base or subbase are typically coarse and nearly free-draining. Without moisture-conditioning away from the new subgrade and aggregate placement and compaction, the water in aggregate products will drain to the subgrade, saturate it and could increase the potential for pumping and rutting during base and subbase compaction efforts. Where these conditions develop, the aggregate and subgrade must be re-excavated, the subgrade re-compacted and the process of base and subbase placement initiated again, at no expense to the owner.



Stormwater Disposal Recommendations

Stormwater disposal is feasible provided the recommendations presented herein are followed and stormwater facilities are designed and constructed in accordance with the most recent version of the Stormwater Management Manual for Eastern Washington (SMMEW). If the proposed stormwater disposal plan changes from what have been described and assumed herein, STRATA must be contacted to review the planned changes and provide revised recommendations, as necessary. The following sections detail stormwater disposal recommendations.

Pavement Drainage Recommendations

We recommend construction grading and final site grading to cause ground surfaces to slope away from pavement structures to reduce the potential for ponding at subgrades or adjacent to Taxiways and Runways. We recommend final paved surfaces be sloped as much as possible, up to 2.0-percent depending upon site constraints and FAA design standards. All runoff should be directed away from the proposed construction and not be allowed to infiltrate subgrade soil immediately adjacent to pavement structures. Water directed off the edge of asphalt should drain to surface ditches and/or edge drains to reduce subgrade or aggregate (P-154 or P-209) saturation at the pavement's edge.

Surface and subgrade drainage is important to the performance of the pavement section. The life of the pavement will be partially dependent upon achieving adequate drainage throughout the section and especially at the subgrade through the use of edge drains and adequate surface water management.

Infiltration Trenches

Planned Infiltration Trenches should be designed in accordance with Best Management Practice (BMP) T5.20 per SMMEW with a minimum depth of 24-inches with a perforated pipe installed along the trench centerline. A minimum diameter of 6.0-inches should be used for design (per AC 150/5320-5D, BMP 11-6) with the trench backfilled with coarse, durable aggregate. Metal grating across the top of the trench may be necessary for public safety.

Infiltration Swales

Planned Infiltration Trenches should be designed in accordance with BMP T5.21 per SMMEW, with rock or vegetated lining. Rock lining should consist of 3.0- to 5.0-inch river rock or crushed basalt to assist with dust and/or erosion control. At least 18.0-inches of treatment soil is required under rock linings for run-off pre-treatment and should be preceded by a settling basin or vault to reduce the occurrence of plugging. As the project site is located in an arid region, native plant species are recommended for vegetated infiltration swales to reduce the need for irrigation. Planting recommendations are presented in Appendix 5-B of the SMMEW.



Design Considerations

Collected or disposed of stormwater must not be allowed to saturate the soil at the pavement subgrade or near structures. Ensuring on-site, well-drained soil is verified below the planned infiltration trench will be important to help avoid subgrade softening due to stormwater infiltration.

ADDITIONAL RECOMMENDED SERVICES

Geotechnical Design Continuity

The information contained in this evaluation is based on our exploration and laboratory testing. Changes in the site geometry may require additional analyses specific to the actual anticipated construction conditions. Therefore, we recommend we provide geotechnical continuity through the planned design completion and construction, as individual aspects become available during schematic and design development phases of the project. Some of the related continuity tasks are outlined below.

Plan and Specification Review

We recommend we review relevant plans and specifications prior to the issuance of the construction documents for bidding. Our experience has been that having the geotechnical consultant from the design team review the construction documents reduces the potential for errors, and also reduces costly changes to the contract during construction. Furthermore, we strongly encourage STRATA to be retained to review the selected contractors' submittal to verify our geotechnical recommendations are incorporated into design plans.

Construction Observation and Testing

Our opinion is the success of the proposed construction is dependent upon following our geotechnical evaluation recommendations, conducting good construction practices, and providing the necessary construction monitoring, testing, and consultation to verify the work is accomplished as recommended. We recommend we provide construction monitoring, testing, and consultation services to verify the evaluation recommendations are being followed. We can provide such services as part of the FAA required Quality Assurance Program, as a subconsultant to T-O. If, for some reason, we are not retained to perform the recommended Quality Assurance services, we cannot be responsible for soil engineering-related design or construction errors or omissions. These recommended services are not included in this evaluation and would be performed on a time and expense basis.

EVALUATION LIMITATIONS

This evaluation has been prepared in support of the proposed Terminal Apron Reconstruction project at Pangborn Memorial Airport in East Wenatchee, Washington. Our services consisted of providing construction recommendations in accordance with generally accepted geotechnical engineering

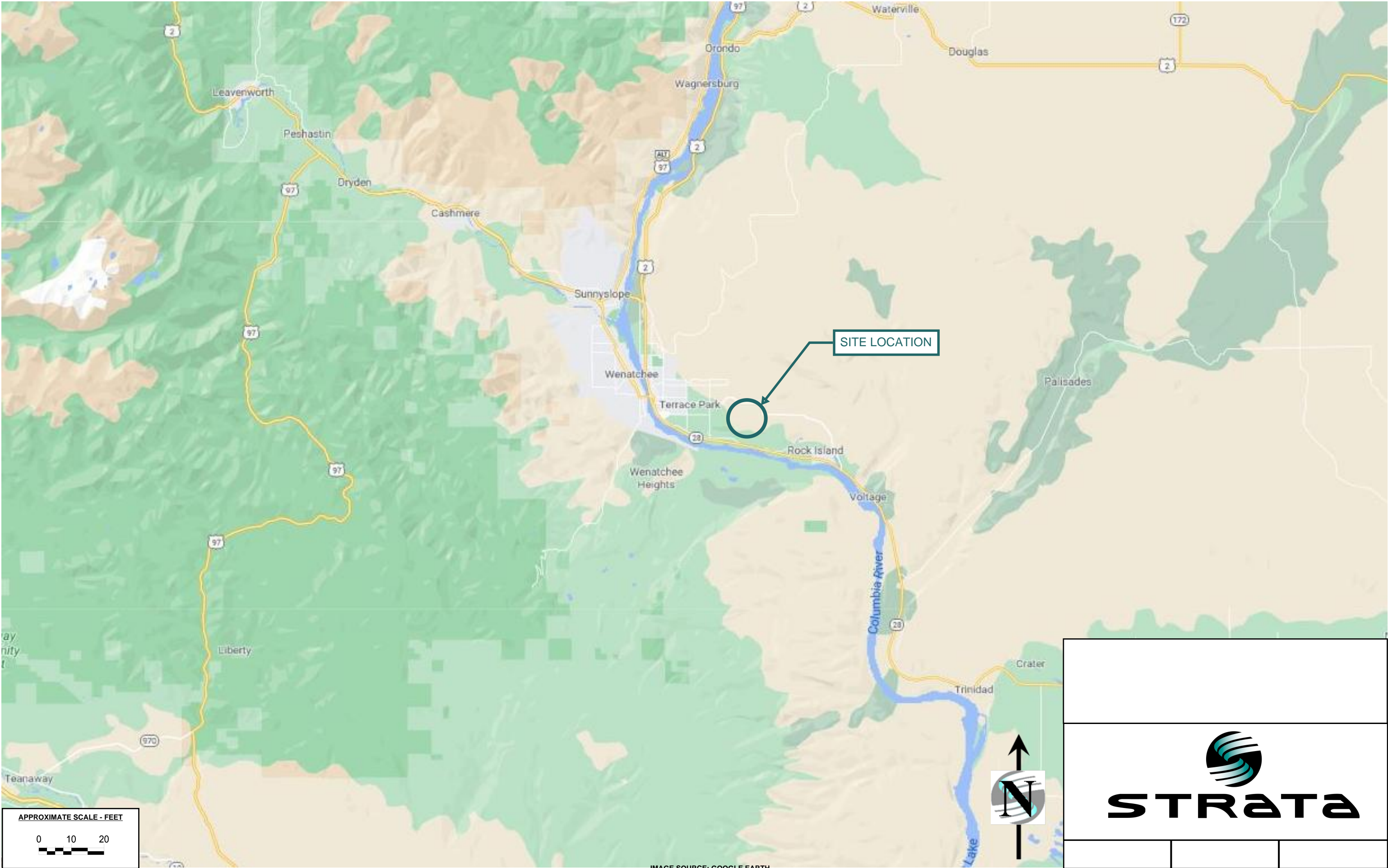


principles and practices as they exist at this time in Central Washington. The geotechnical recommendations provided herein are based on the premise that an adequate program of tests and observations will be conducted by STRATA during construction to verify compliance with our recommendations and to confirm conditions between exploration locations. Such tests are part of the required FAA Quality Assurance Program. This acknowledgement is in lieu of all express or implied warranties.

This evaluation must be read and implemented in its entirety; individual evaluation sections, plates or appendices cannot be relied upon outside the context of the entire evaluation. The recommendations presented in this evaluation were based on surface observations, subsurface exploration, and laboratory testing described herein. If conditions are encountered during construction that differs from those described in this evaluation, we should be provided an opportunity to update our opinions and recommendations.

This evaluation is not intended for use by any other geotechnical or design consultants, or for any other site. Any subsequent project geotechnical or pavement design consultant should notify the owner, project designers, and appropriate regulatory agencies of their status and responsibility for the project. They should also provide their own recommendations for project design and construction. This evaluation has been prepared exclusively for the addressee and for the project as described. We cannot be responsible for any other use of this evaluation.





SITE LOCATION



 STRATA		

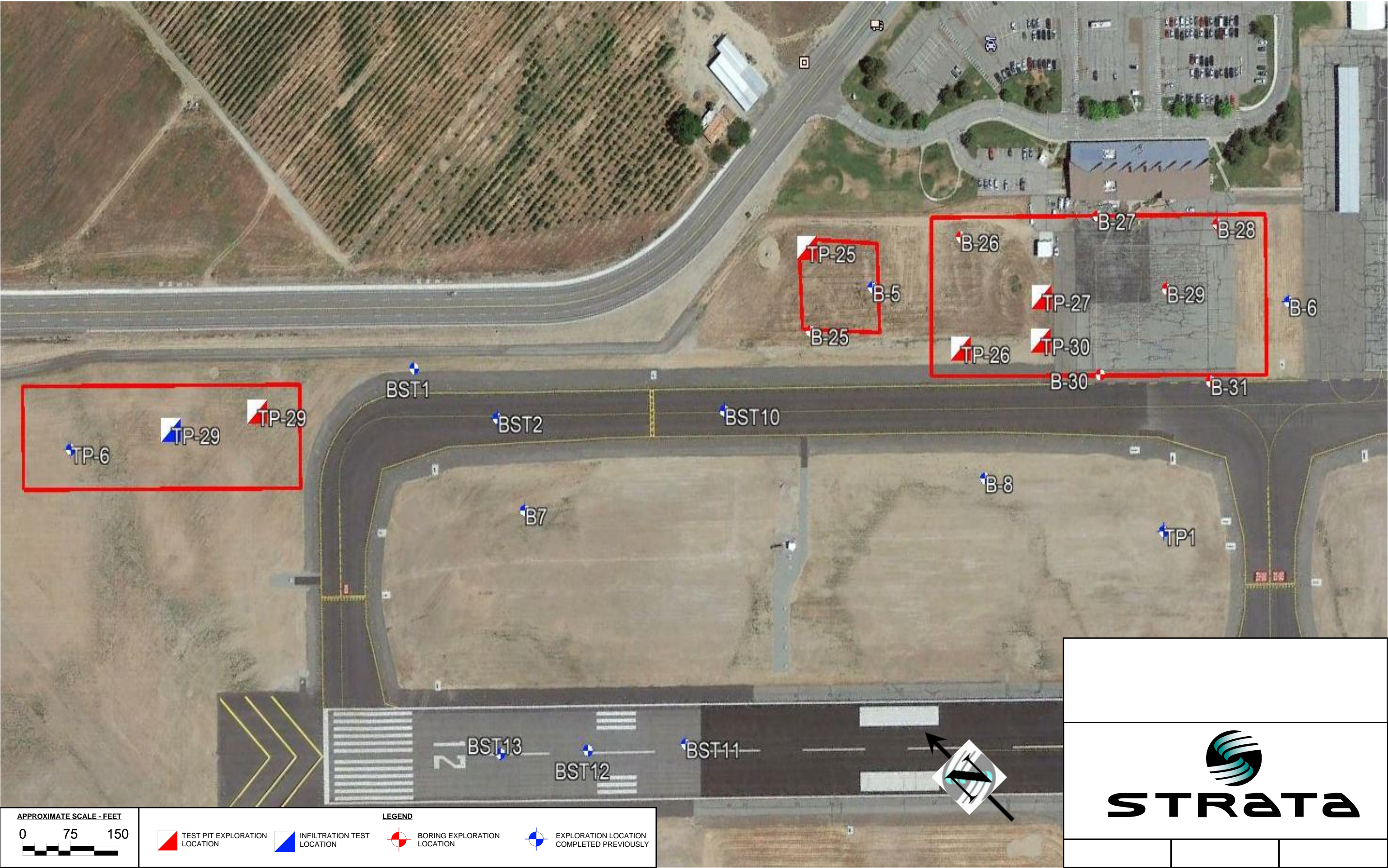


IMAGE SOURCE: GOOGLE EARTH

APPENDIX A

Subsurface Exploration Logs

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL NAMES
COURSE GRAINED SOIL MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% COARSE FRACTION RETAINED #4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES		GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH >12% FINES		GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
				GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-SILT MIXTURES	
	SANDS >50% COARSE FRACTION PASSES #4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES		SW	WELL-GRADED SANDS, GRAVELY SANDS
		SANDS WITH >12% FINES		SP	POORLY-GRADED SANDS, GRAVELY SANDS
				SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND CLAY MIXTURES
FINE GRAINED SOIL MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	INORGANIC		ML	INORGANIC SILTS, SANDY OR CLAYEY SILTS
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY OR SILTY CLAYS
		ORGANIC		OL	ORGANIC SILTS AND CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT 50 OR MORE	INORGANIC		MH	INORGANIC SILTS, MICACEOUS SILTS, PLASTIC SILTS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		ORGANIC		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOIL

SHORTHAND NOTATION

SPT - STANDARD PENETRATION TEST
 PL - PLASTIC LIMIT
 LL - LIQUID LIMIT
 PI - PLASTICITY INDEX
 MC - MOISTURE CONTENT
 DD - DRY DENSITY
 WD - WET DENSITY
 UC - UNCONFINED COMPRESSION
 OC - ORGANIC CONTENT
 BGS - BELOW GROUND SURFACE
 N.E. - NOT ENCOUNTERED

MATERIAL DESCRIPTION CONTACT

————— DISTINCT SOIL LAYER CONTACT WITHIN SOIL PROFILE
 - - - - - APPROXIMATE SOIL LAYER CONTACT WITHIN SOIL PROFILE

NOTES

- MIXED UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOLS ARE USED TO INDICATE DUAL SOIL CLASSIFICATIONS.
- THE SPT N-VALUE, REPORTED IN BLOWS PER FOOT, IS THE SUM OF THE NUMBER OF BLOWS REQUIRED TO DRIVE THE STANDARD SPLIT SPOON SAMPLER A DISTANCE OF 12-INCHES AFTER AN INITIAL 6-INCHES OF PENETRATION. IF A TOTAL OF 50 BLOWS ARE INSUFFICIENT TO ADVANCE ANY OF THE THREE 6-INCH INTERVALS, THE PENETRATION DEPTH AFTER 50 BLOWS IS ALSO REPORTED.

BORING LOG SYMBOLS

GRAPH SYMBOL	DESCRIPTION
	STANDARD 2-INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER
	MODIFIED CALIFORNIA 3-INCH OUTSIDE DIAMETER SAMPLER
	ROCK CORE
	SHELBY TUBE 3-INCH OUTSIDE DIAMETER SAMPLER

ADDITIONAL MATERIAL SYMBOLS

GRAPH SYMBOL	LETTER SYMBOL	TYPICAL NAMES
	AC	ASPHALT CONCRETE
	CC	CEMENT CONCRETE
	TS	TOPSOIL
	FL	FILL

TEST PIT LOG SYMBOLS

GRAPH SYMBOL	DESCRIPTION
	BAGGIE SAMPLE
	BULK SAMPLE
	RING SAMPLE

GROUNDWATER SYMBOLS

GRAPH SYMBOL	DESCRIPTION
	GROUNDWATER LEVEL AT TIME OF DRILLING
	GROUNDWATER LEVEL AT END OF DRILLING
	GROUNDWATER LEVEL 24 HOURS AFTER DRILLING COMPLETION
04-10-18	DATE OF GROUNDWATER READING

EXPLORATION LOG KEY - SOIL



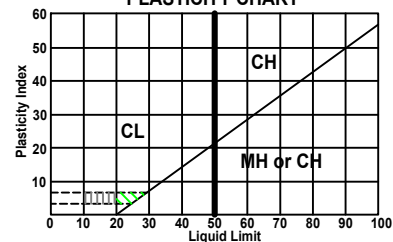
GRAIN SIZE

DESCRIPTION	SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders	>12"	>12"	Larger than basketball-size.
Cobbles	3" - 12"	3" - 12"	Fist-size to basketball-size.
Gravel	coarse 3/4" - 3"	3/4" - 3"	Thumb-sized to fist sized.
	fine #4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized.
Sand	coarse #10 - #4	0.075 - 0.19"	Rock salt-sized to pea-sized.
	medium #40 - #10	0.017 - 0.075"	Sugar-sized to rock salt-sized.
	fine #200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized.
Fines	Passing #200	<0.0029"	Flour-sized and smaller.

MODIFIERS

DESCRIPTION	%
Trace	<5
Few	5-10
Little	15-25
Some	30-45

PLASTICITY CHART



STRATIFICATION

DESCRIPTION	THICKNESS
Parting	1/16 - 1/4"
Lense	1/4 - 4"
Layer	4 - 12"

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to touch.
Moist	Slightly damp, some apparent moisture.
Wet	Saturated, visible free water, soil is below water table.

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness.
Frequent	More than one per foot of thickness.

APPARENT RELATIVE DENSITY OF COARSE-GRAINED SOIL

APPARENT DENSITY	SPT blows/ft	CALIFORNIA SAMPLER blows/ft	D & M SAMPLER blows/ft	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	0-4	<4	<5	0-15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
Loose	5-10	5-12	5-15	15-35	Difficult to penetrate with 1/2" reinforcing rod pushed by hand.
Medium Dense	11-30	12-35	15-40	35-65	Easily penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
Dense	31-50	35-60	40-70	65-85	Difficult to penetrate a foot with 1/2" reinforcing rod driven with 5-lb hammer.
Very Dense	>50	>60	>70	85-100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

CONSISTENCY FINE-GRAINED SOIL

CONSISTENCY	SPT blows/ft	TORVANE	POCKET PENETROMETER	FIELD TEST
		UNDRAINED SHEAR STRENGTH (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by thumb. Extrudes between thumb and finger when squeezed in hand.
Soft	2-3	0.125-0.25	0.25-0.5	Penetrated about 1/4 inch by thumb with moderate effort. Molded by strong finger pressure.
Firm	4-7	0.25-0.5	0.5-1.0	Penetrated about 1/4 inch by thumb with moderate effort. Molded by strong finger pressure.
Stiff	8-14	0.5-1.0	1.0-2.0	Indented about 1/2 inch by thumb only with great effort.
Very Stiff	15-30	1.0-2.0	2.0-4.0	Readily indented with difficulty by thumbnail.
Hard	>30	>2.0	>4.0	Indented with difficulty by thumbnail.

REACTION WITH HCl

None	No visible reaction.
Weak	Some reaction, with bubbles forming slowly.
Strong	Violent reaction, with bubbles forming immediately.

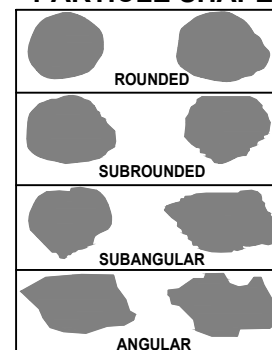
CEMENTATION

Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

STRUCTURE

Stratified	Alternating layers of varying material or color with layers at least 1/4" thick; note thickness.
Laminated	Alternating layers of varying material or color with layers at least 1/2" thick; note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small macular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soil, such as small lenses or sand scattered through a mass of clay; note thickness.
Homogeneous	Same color and thickness throughout.


PARTICLE SHAPE




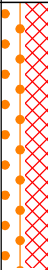
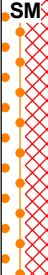



EXPLORATION LOG KEY - SOIL





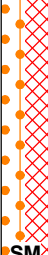

TEST BOREHOLE - STRATA.GDT - 4/23/21 14:42 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A_PANGBORN_TERMINAL_APRON_RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Boring: B-25				
Client: T-O Engineers			Drill Rig: G2400 Skid Rig											
Date Drilled: 03-04-2021			Borehole Diameter: 6-inch OD"											
Depth to Groundwater: N.E.			Logged By: SDA											
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	Recovery (in)	Blows Per 6 Inches	SPT N-Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1221.6													Note: BGS = Below Ground Surface
	1221.5	Topsoil												
	1220.7	Fill - Sandy Silt (ML) - Brown, moist, soft to medium stiff, low plasticity.	ML											
		Fill - Silty Sand (SM) - Brown, moist, very loose to loose.			20	2 3 3 1	6	0.75						
									11.6		29.7			
2.5					21	1 1 0 2	1							
			SM											
5.0					18	5 1 5 4	6							
	1214.6	Glaciofluvial - Poorly Graded Sand with Silt (SP-SM) - Brown to light brown, dry, loose.			22	2 3 2 3	5							
7.5									3.2		6.7			
			SP-SM											
					19	3 3 3 3	6							
10.0	1211.6	Borehole Terminated at 10.0 Feet.												
Latitude: 47.4052 Longitude: -120.2128														


TEST BOREHOLE - STRATA.GDT - 4/23/21 14:42 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Boring: B-26					
Client: T-O Engineers			Drill Rig: G2400 Skid Rig												
Date Drilled: 03-04-2021			Borehole Diameter: 6-inch OD"												
Depth to Groundwater: N.E.			Logged By: SDA												
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	Recovery (in)	Blows Per 6 Inches	SPT N-Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks	
0.0	1222.4													Note: BGS = Below Ground Surface	
	1222.2	Topsoil													
		Fill - Silty Sand (SM) - Brown, dry, loose, fine grained.			20	2 3 3 4	6		11.6						
2.5					16	5 5 5 5	10								
	1217.9	Glaciofluvial - Poorly Graded Sand with Silt (SP-SM) - Gray, dry, loose, medium grained.			18	5 4 3 4	7								
5.0					22	2 2 2 3	4								
7.5					24	3 3 3 3	6								
10.0	1212.4	Borehole Terminated at 10.0 Feet.													
Latitude: 47.4049 Longitude: -120.2116															


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Project: TC20071A										<div></div>			Boring: B-27	
Client: T-O Engineers					Drill Rig: G2400 Skid Rig									
Date Drilled: 03-04-2021					Borehole Diameter: 6-inch OD"									
Depth to Groundwater: N.E.					Logged By: SDA									
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	Recovery (in)	Blows Per 6 Inches	SPT N-Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1223.9													Note: BGS = Below Ground Surface
	1223.6	Asphalt Concrete Pavement - Black. 3" thick												
		Fill - Silty Sand with Gravel (SM) - Gray, moist, medium dense to dense, fine to medium grained, subangular to angular.			16	12 16 13 13	29		6					
2.5					18	12 19 16 16	35							
	1219.6	Glaciofluvial - Silty Sand with Gravel (SM) - Gray light brown, dry, loose to medium dense, medium grained.							8.2	29.6				
5.0					22	9 6 3 3	9							
					24	4 6 5 4	11							
7.5														
					18	3 4 3 4	7							
10.0	1213.6	Borehole Terminated at 10.3 Feet.												
Latitude: 47.4044 Longitude: -120.2107														


TEST BOREHOLE - STRATA.GDT - 4/23/21 14:42 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A										<div></div>				Boring: B-28	
Client: T-O Engineers					Drill Rig: G2400 Skid Rig										
Date Drilled: 03-04-2021					Borehole Diameter: 6-inch OD"										
Depth to Groundwater: N.E.					Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	Recovery (in)	Blows Per 6 Inches	SPT N-Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks	
0.0	1223.9													Note: BGS = Below Ground Surface	
	1223.6	Asphalt Concrete Pavement - Black. 3" thick													
	1222.9	Fill - Silty Sand (SM) - Brown, dry, medium dense, fine grained.	SM												
		Fill - Poorly Graded Sand with Silt (SP-SM) - Light brown brown, dry, medium dense, fine to medium grained.			16	11 12 8 10	20								
2.5			SP-SM		18	4 5 6 5	11								
	1219.6	Glaciofluvial - Poorly Graded Sand with Gravel (SP) - Light brown brown, dry, loose, medium grained.							4.2		2.4				
5.0					20	3 4 4 4	8								
			SP		24	3 3 3 4	6								
7.5															
					24	3 3 3 3	6								
10.0	1213.6	Borehole Terminated at 10.3 Feet.													
										Latitude: 47.404 Longitude: -120.2101					


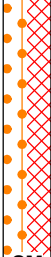



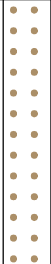

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Project: TC20071A								<div></div>			Boring: B-29			
Client: T-O Engineers				Drill Rig: G2400 Skid Rig										
Date Drilled: 03-04-2021				Borehole Diameter: 6-inch OD"										
Depth to Groundwater: N.E.				Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	Recovery (in)	Blows Per 6 Inches	SPT N-Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1224.8													Note: BGS = Below Ground Surface
	1224.4	Asphalt Concrete Pavement - Black. 5" thick												
		Fill - Poorly Graded Gravel with Silt and Sand (SP-SM) - Gray, dry, very dense, medium grained, subangular to angular.	SP-SM		14	23 33 37 22	70		2.3					
2.5	1222.4	Fill - Silty Sand (SM) - Brown, dry, medium dense, fine to medium grained.	SM		18	6 7 5 5	12							
5.0					22	7 7 7 7	14							
7.5	1218.4	Glaciofluvial - Poorly Graded Sand with Silt (SP-SM) - Gray, dry, loose, medium grained.	SP-SM		24	4 3 3 3	6							
					19	3 4 3 4	7							
10.0														
	1214.4	Borehole Terminated at 10.4 Feet.												
										Latitude: 47.404 Longitude: -120.2107				


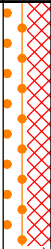





TEST BOREHOLE - STRATA.GDT - 4/23/21 14:42 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A										<div></div>		Boring: B-30		
Client: T-O Engineers				Drill Rig: G2400 Skid Rig										
Date Drilled: 03-04-2021				Borehole Diameter: 6-inch OD"										
Depth to Groundwater: N.E.				Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	Recovery (in)	Blows Per 6 Inches	SPT N-Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1226.5	Asphalt Concrete Pavement - Black. 5" thick												Note: BGS = Below Ground Surface
	1226.0	Fill - Poorly Graded Sand with Silt and Gravel (SP-SM) - Brown, moist, dense, fine to medium grained, subangular to angular.	SP-SM		16	19 25 17 11	42							
	1224.5	Fill - Silty Sand (SM) - Brown, moist, medium dense, fine to medium grained.	SM		19	8 8 8 10	16							
2.5														
	5.0				15	3 12 11 10	23							
	1220.0	Glaciofluvial - Poorly Graded Sand with Silt (SP-SM) - Gray, dry, loose to medium dense, medium grained.	SP-SM		18	4 6 6 6	12							
7.5														
					24	5 5 5 5	10							
10.0														
	1216.0	Borehole Terminated at 10.4 Feet.												
										Latitude: 47.404 Longitude: -120.2114				


TEST BOREHOLE - STRATA.GDT - 4/23/21 14:42 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A								<div></div>			Boring: B-31			
Client: T-O Engineers				Drill Rig: G2400 Skid Rig										
Date Drilled: 03-04-2021				Borehole Diameter: 6-inch OD"										
Depth to Groundwater: N.E.				Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	Recovery (in)	Blows Per 6 Inches	SPT N-Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1226.7													Note: BGS = Below Ground Surface
	1226.4	Asphalt Concrete Pavement - Black. 4" thick												
		Fill - Silty Sand with Gravel (SM) - Gray, moist, medium dense to dense, fine to medium grained.			15	28 18 32 30	50		4.4					
2.5														
					18	11 13 15 11	28							
	1222.2													
5.0		Glaciofluvial - Silty Sand with Gravel (SM) - Brown, dry, medium dense, fine to medium grained.			20	6 6 5 4	11							
	1220.7													
		Glaciofluvial - Poorly Graded Sand (SP) - Gray, dry, loose, medium grained.			24	4 4 6 4	10							
7.5														
					21	3 3 3 3	6							
10.0														
	1216.4	Borehole Terminated at 10.3 Feet.												
Latitude: 47.4036 Longitude: -120.2109														


TEST PIT - STRATA.GDT - 4/23/21 14:41 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A_PANGBORN_TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Test Pit: TP-25			
Client: T-O Engineers			Backhoe: KX05704 Mini Trackhoe										
Date Excavated: 03-05-2021			Bucket Width: 2-ft										
Depth to Groundwater: N.E.			Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	DCP Blows	DCP Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
													Note: BGS = Below Ground Surface
0.0	1222.5	Fill - Silty Sand (SM) - Brown to gray, moist, medium dense, fine to medium grained.						8.8		13.5			
2.5													
1218.5		Glaciofluvial - Silty Sand (SM) - Brown, moist, medium dense, fine grained.											
5.0													
1215.5		Glaciofluvial - Poorly Graded Sand with Silt (SP-SM) - Gray to brown, dry, loose to medium dense, medium grained.											
7.5													
1213.5		Terminated at 9.0 Feet.											
													Latitude: 47.4041 Longitude: -120.2109






TEST PIT - STRATA.GDT - 4/23/21 14:41 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Test Pit: TP-26			
Client: T-O Engineers			Backhoe: KX05704 Mini Trackhoe										
Date Excavated: 03-05-2021			Bucket Width: 2-ft										
Depth to Groundwater: N.E.			Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	DCP Blows	DCP Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1223.9												Note: BGS = Below Ground Surface
	1223.8	Topsoil 1" thick											
	1223.4	Fill - Poorly Graded Sand (SP) - Light brown to brown, moist, loose to medium dense.	SP					6.8		4.8			
		Glaciofluvial - Poorly Graded Sand with Silt (SP-SM) - Brown to light brown, dry, loose, medium grained.											
2.5			SP-SM										
5.0	1218.9	Glaciofluvial - Silt (ML) - Brown, moist, stiff, low plasticity, no dilatancy.	ML										
	1216.9												
Terminated at 7.0 Feet.													
Latitude: 47.4046 Longitude: -120.2121													






TEST PIT - STRATA.GDT - 4/23/21 14:41 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A_PANGBORN_TERMINAL_APRON_RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Test Pit: TP-27			
Client: T-O Engineers			Backhoe: KX05704 Mini Trackhoe										
Date Excavated: 03-05-2021			Bucket Width: 2-ft										
Depth to Groundwater: N.E.			Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	DCP Blows	DCP Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
													Note: BGS = Below Ground Surface
0.0	1223.0												
	1222.5	Fill - Silty Sand with Gravel (SM) - Brown to red, moist, dense, medium grained, subangular to angular.	SM										
	1221.5	Fill - Silty Sand with Gravel (SM) - Brown, moist, dense, fine to medium grained.	SM										
2.5		Fill - Silty Sand (SM) - Gray gray, dry, very dense, HCl reaction: none, fine grained, weak to moderate cementation.	SM										
5.0			SM										
	1216.5	Glaciofluvial - Silt (ML) - Brown, moist to wet, stiff to very stiff, low plasticity, no dilatancy.	ML										
7.5													
	1214.0												
Terminated at 9.0 Feet.													
Latitude: 47.4044 Longitude: -120.2114													


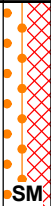

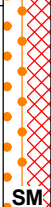

TEST PIT - STRATA.GDT - 4/23/21 14:41 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Test Pit: TP-28			
Client: T-O Engineers			Backhoe: KX05704 Mini Trackhoe										
Date Excavated: 03-05-2021			Bucket Width: 2-ft										
Depth to Groundwater: N.E.			Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	DCP Blows	DCP Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1215.3												Note: BGS = Below Ground Surface
	1215.2	Topsoil 1" Thick Glaciofluvial - Silty Sand (SM) - Brown, moist to dry, medium dense, medium grained.						9.3		25.5			
2.5													
	1212.3	Glaciofluvial - Poorly Graded Sand (SP) - Gray, dry, medium dense, medium grained.											
5.0													
7.5													
	</												

TEST PIT - STRATA.GDT - 4/23/21 14:41 - V:\ENGINEERING\SOFTWARE\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Test Pit: TP-29			
Client: T-O Engineers			Backhoe: KX05704 Mini Trackhoe										
Date Excavated: 03-05-2021			Bucket Width: 2-ft										
Depth to Groundwater: N.E.			Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	DCP Blows	DCP Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1218.0												Note: BGS = Below Ground Surface
	1217.9	Topsoil 1" Thick											
		Glaciofluvial - Silty Sand (SM) - Brown, dry, medium dense, fine to medium grained.						9.3		19.1			
2.5													
	1214.5	Glaciofluvial - Poorly Graded Sand (SP) - Gray, dry, loose, medium grained.											
5.0													
7.5													
	1210.0												
Terminated at 8.0 Feet.													
Latitude: 47.4071 Longitude: -120.2161													

TEST PIT - STRATA.GDT - 4/23/21 14:41 - V:\ENGINEERING\SOFTWARE\GINT\PROJECTS\TC20071A PANGBORN TERMINAL APRON RECONSTRUCTION.GPJ

Project: TC20071A					<div></div>					Test Pit: TP-30			
Client: T-O Engineers			Backhoe: KX05704 Mini Trackhoe										
Date Excavated: 03-05-2021			Bucket Width: 2-ft										
Depth to Groundwater: N.E.			Logged By: SDA										
Depth (ft)	Elevation	USCS Description	Symbol	Sample Type	DCP Blows	DCP Value	Pocket Pen (TSF)	Moisture Content (%)	Dry Density (pcf)	Percent Passing the No. 200 Sieve	Liquid Limit	Plasticity Index	Remarks
0.0	1223.8	Fill - Silty Sand (SM) - Brown, dry to moist, medium dense, fine to medium grained.						9.2		23.7			Note: BGS = Below Ground Surface
2.5													
	1220.8	Fill - Silty Sand (SM) - Gray, dry to moist, dense to very dense, fine grained, weak to moderate cementation.											
5.0													
	1217.8												
Terminated at 6.0 Feet.													
Latitude: 47.4049 Longitude: -120.2116													




APPENDIX B

Exploration Logs from Previous
Projects

TEST PIT TP1

Date: 1-23-20
Excavator: Budinger & Assoc., Inc.
Equipment: JD 310L Backhoe w/24" bucket
Location: accross taxiway Alpha from terminal
Surface: sparse grass and weeds

Elevation: 1222 ft
Logged by: R. Lloyd
Size of hole: 12 X 3 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS									
					ATTERBERG LIMITS PL ——— LL WATER CONTENT ○									
0					10	20	30	40	50	60	70	80	90	
		moist, light olive gray	SAND, medium, angular, Fill											
5			(zones of silty sand, bedded in approximately 1 foot intervals)											
10														
		no free groundwater observed	End of Excavation @ 11 ft											
15														



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TEST PIT LOGS

FIGURE 2-15

Project: Pangborn Airport Assessment
 Location: East Wenatchee, WA
 Number: X19316

TEST PIT B2

Date: 1-21-20
Excavator: Budinger & Assoc., Inc.
Equipment: JD 310L Backhoe w/24" bucket
Location: SE of Roundabout on Grant Rd
Surface: garden

Elevation: 1216 ft
Logged by: R. Lloyd
Size of hole: 10 X 2.5 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS									
					ATTERBERG LIMITS PL ——— LL WATER CONTENT ○									
0					10	20	30	40	50	60	70	80	90	
		moist, moderate brown	SILTY SAND, medium, angular (frost to 9 inches)											
5														
		moist, salt and pepper	SAND, medium, angular											
		no free groundwater observed	(Seepage test: 200 gallons of water were introduced into a 2 x 2 ft area in 13:28 minutes) End of Excavation @ 7 ft											
10														
15														



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TEST PIT LOGS

FIGURE 2-1

Project: Pangborn Airport Assessment
Location: East Wenatchee, WA
Number: X19316

TEST PIT B5			
Date:	1-23-20	Elevation:	1225 ft
Excavator:	Budinger & Assoc., Inc.	Logged by:	R. Lloyd
Equipment:	JD 310L Backhoe w/24" bucket	Size of hole:	12 X 2.5 feet
Location:	NE of terminal		
Surface:	sparse grass and weeds		

Elevation: 1225 ft
Logged by: R. Lloyd
Size of hole: 12 X 2.5 feet

[illegible]

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TEST PIT LOGS **FIGURE 2-16**

Project: Pangborn Airport Assessment
Location: East Wenatchee, WA
Number: X19316

TEST PIT B6

Date: 1-22-20
Excavator: Budinger & Assoc., Inc.
Equipment: JD 310L Backhoe w/24" bucket
Location: SW of Terminal
Surface: sparse grass and weeds

Elevation: 1227 ft
Logged by: R. Lloyd
Size of hole: 10.5 X 2.5 feet

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS									
					ATTERBERG LIMITS PL ——— LL WATER CONTENT ○									
0		moist, moderate brown	SILTY SAND, medium, anthropogenic debris as CMU block, wood, metal, aluminum cans, wood ash, rebar, wire, ect.											
		no free groundwater observed	2 inch buried conduit at south end of test pit											
5														
10			End of Excavation @ 8.5 ft											
15														



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TEST PIT LOGS



FIGURE 2-13

Project: Pangborn Airport Assessment
Location: East Wenatchee, WA
Number: X19316

TEST PIT B7

Date: 1-28-20
Excavator: Budinger & Assoc., Inc.
Equipment: Hand Auger
Location: W of taxiway Alpha south of old Grant road alignment
Surface: sparse grass and weeds

Elevation: 1219 ft
Logged by: R. Lloyd
Size of hole: 4 inch O.D.

DEPTH	SAMPLES	MOISTURE, COLOR, CONDITION	DESCRIPTION	SOIL LOG	TEST RESULTS									
					ATTERBERG LIMITS PL ——— LL WATER CONTENT ○									
0					10	20	30	40	50	60	70	80	90	
		moist, moderate brown	SILTY SAND, medium, angular											
5														
		most, salt and pepper	SAND (sample not returned)											
		no free groundwater observed	End of Excavation @ 7 ft											
10														
15														



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TEST PIT LOGS

FIGURE 2-29

Project: Pangborn Airport Assessment
 Location: East Wenatchee, WA
 Number: X19316

TEST PIT B8			
Date:	1-23-20	Elevation:	1223 ft
Excavator:	Budinger & Assoc., Inc.	Logged by:	R. Lloyd
Equipment:	JD 310L Backhoe w/24" bucket	Size of hole:	10 X 3 feet
Location:	N of taxiway Bravo		
Surface:	sparse grass and weeds		

Elevation: 1223 ft
Logged by: R. Lloyd
Size of hole: 10 X 3 feet

[illegible]

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TEST PIT LOGS **FIGURE 2-14**

Project: Pangborn Airport Assessment
Location: East Wenatchee, WA
Number: X19316

APPENDIX C

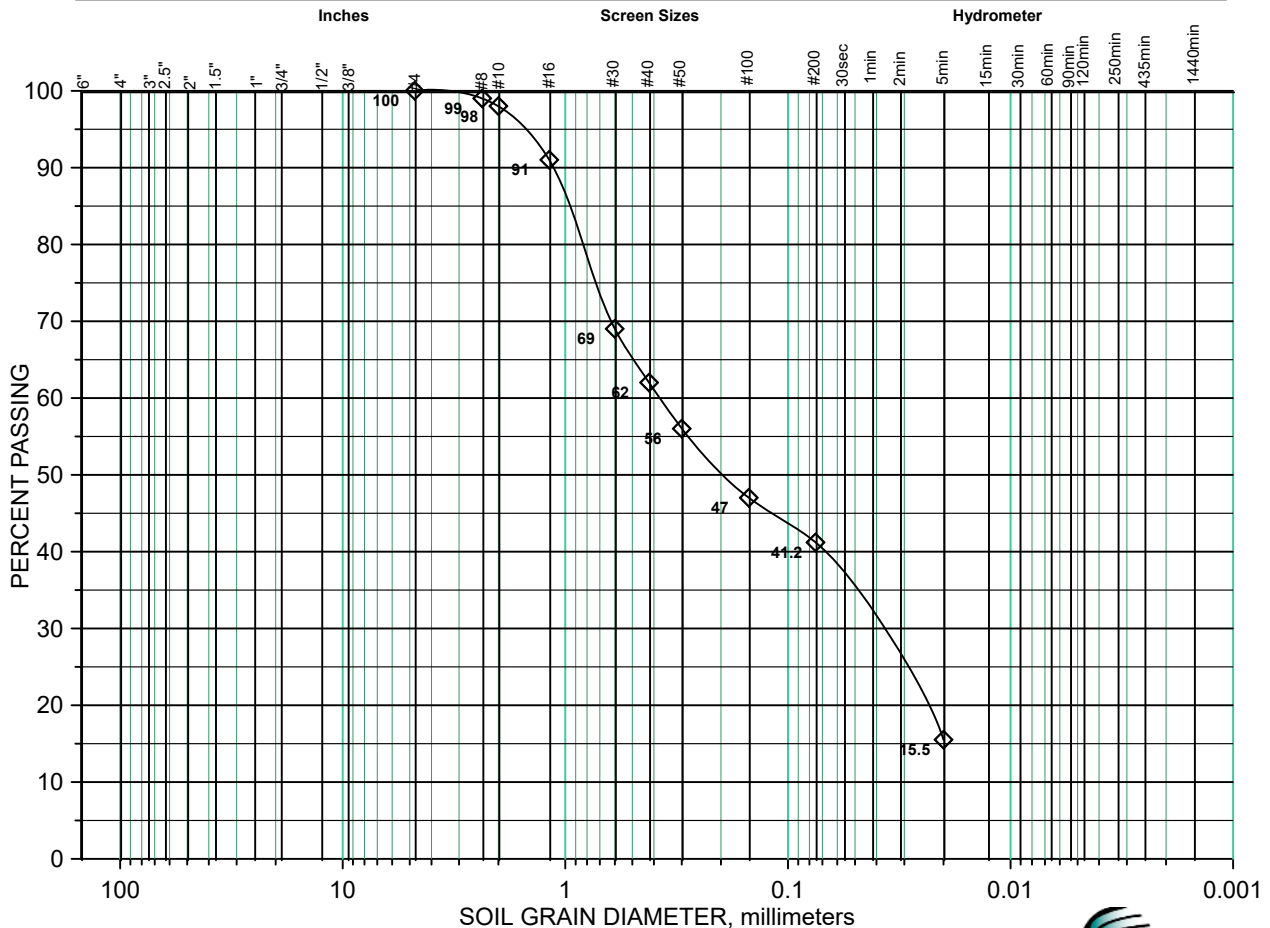
Laboratory Testing Results

HYDROMETER ANALYSIS

ASTM D422

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation
Client: T-O Engineers
File: TC20071A
Sample No.: 27527
Sample Location: Boring B-26 from 0.0 to 2.0 feet BGS
Description: Silty SAND (SM)
Date Sampled: March 4, 2021 By: S. Armstrong
Date Tested: March 23, 2021 By: R. Matteson / K. Fadde

Cobbles	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



Reviewed by: *Simon D. Cumstey*



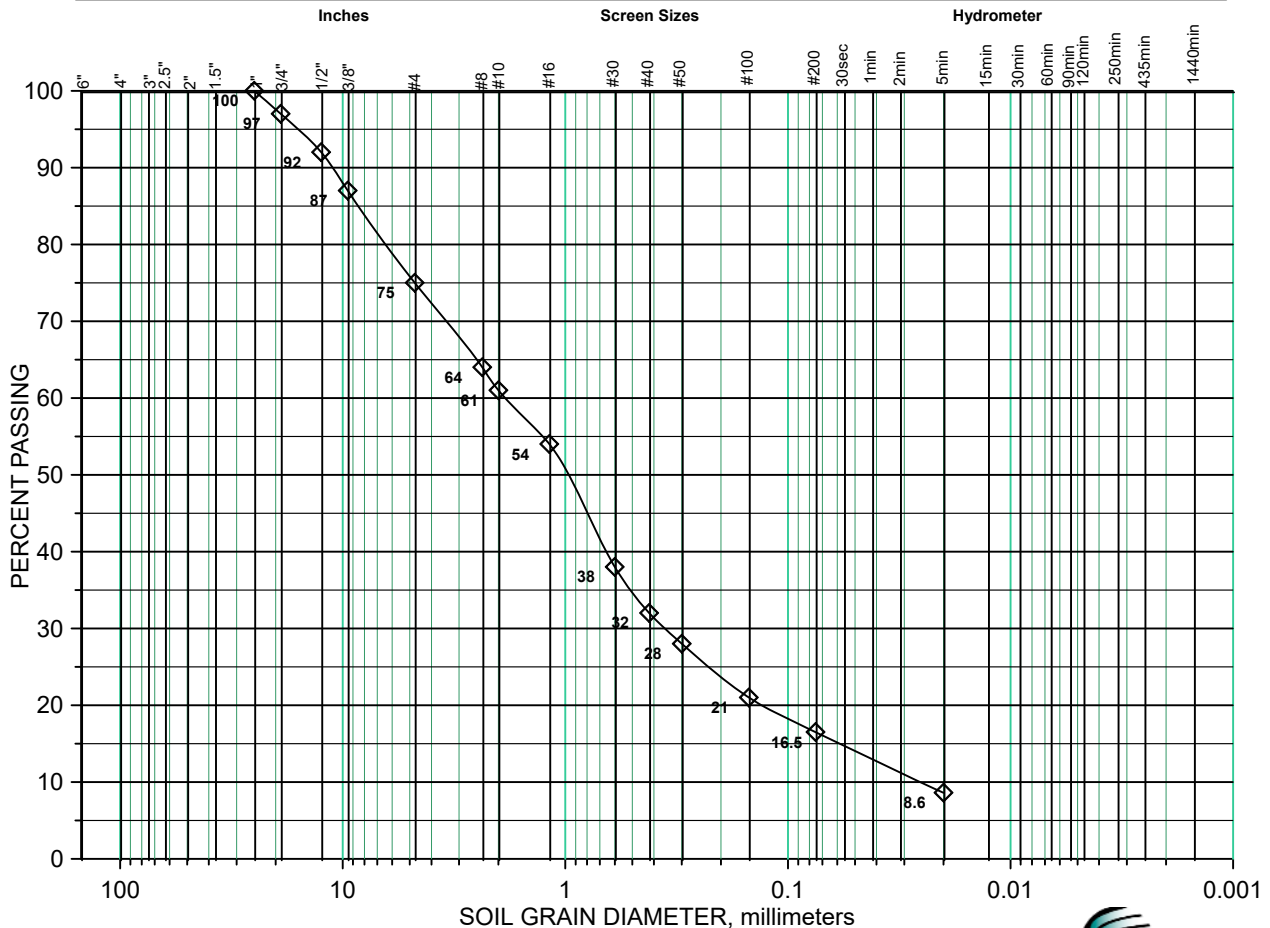
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HYDROMETER ANALYSIS

ASTM D422

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation
Client: T-O Engineers
File: TC20071A
Sample No.: 27528
Sample Location: Boring B-27 from 0.3 to 2.3 feet BGS
Description: Silty SAND with Gravel (SM)
Date Sampled: March 4, 2021 By: S. Armstrong
Date Tested: March 23, 2021 By: R. Matteson / K. Fadde

Cobbles	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



Reviewed by: Simon D. Clumaty



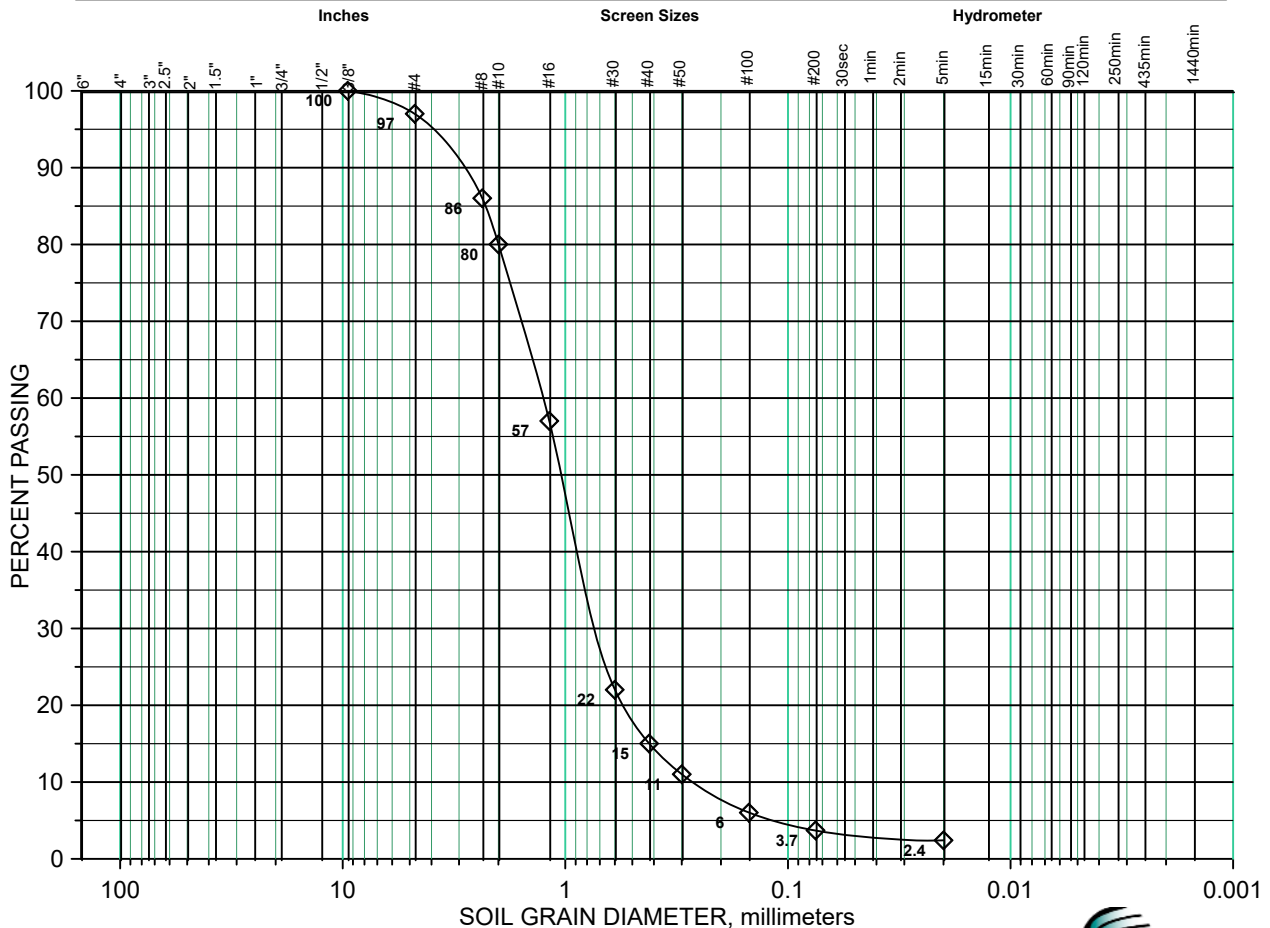
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HYDROMETER ANALYSIS

ASTM D422

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation
Client: T-O Engineers
File: TC20071A
Sample No.: 27530
Sample Location: Boring B-28 from 4.3 to 6.3 feet BGS
Description: Poorly-Graded SAND with Gravel (SP)
Date Sampled: March 4, 2021 By: S. Armstrong
Date Tested: March 23, 2021 By: R. Matteson / K. Fadde

Cobbles	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



S. D. Crumley

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HYDROMETER ANALYSIS

ASTM D422

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation

Client: T-O Engineers

File: TC20071A

Sample No.: 27531

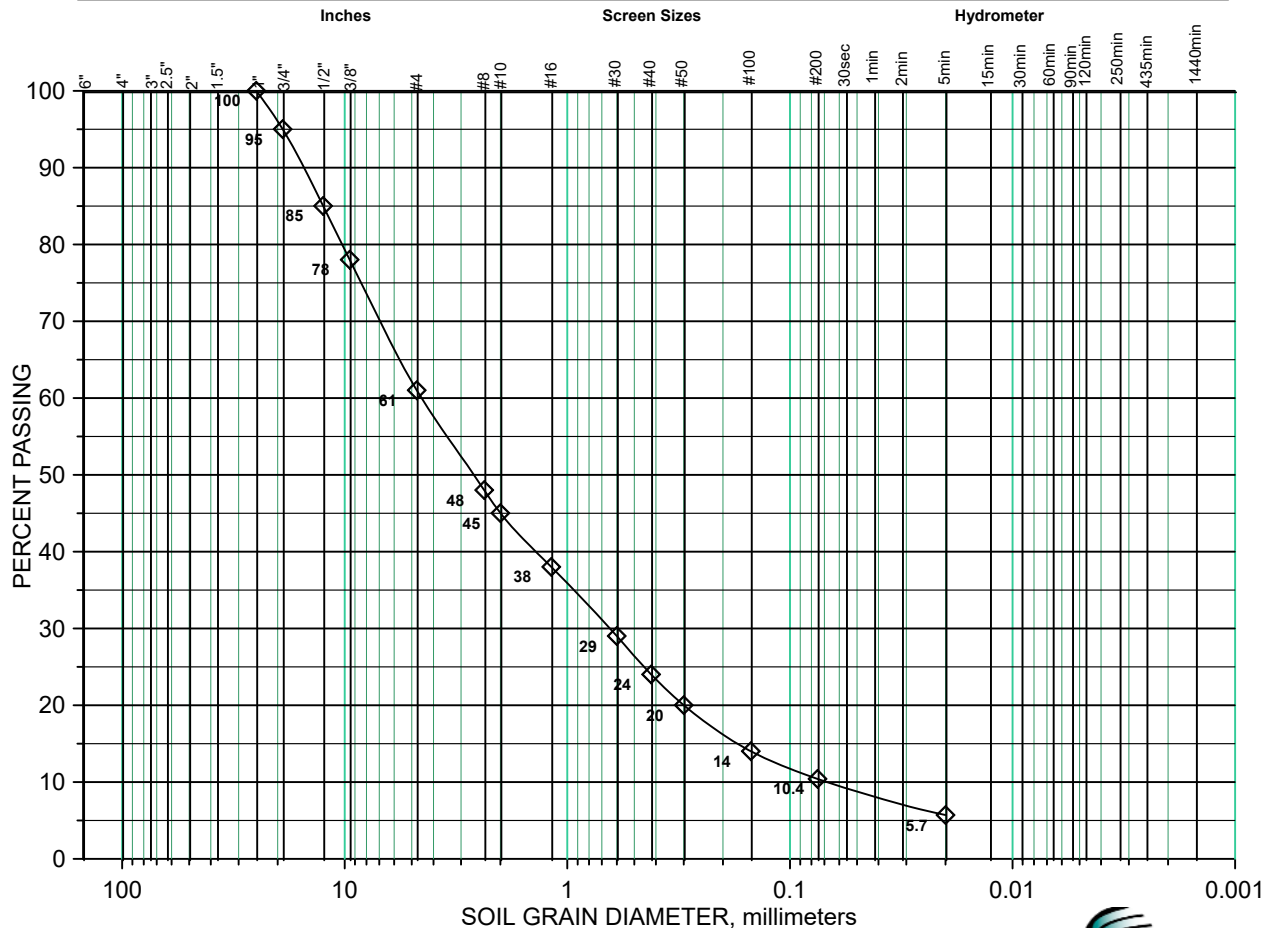
Sample Location: Boring B-29 from 0.4 to 2.4 feet BGS

Description: Poorly-Graded GRAVEL with Silt and Sand (GP-GM)

Date Sampled: March 4, 2021 By: S. Armstrong

Date Tested: March 23, 2021 By: R. Matteson / K. Fadde

Cobbles	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



Reviewed by: _____

Simon D. Cumstey



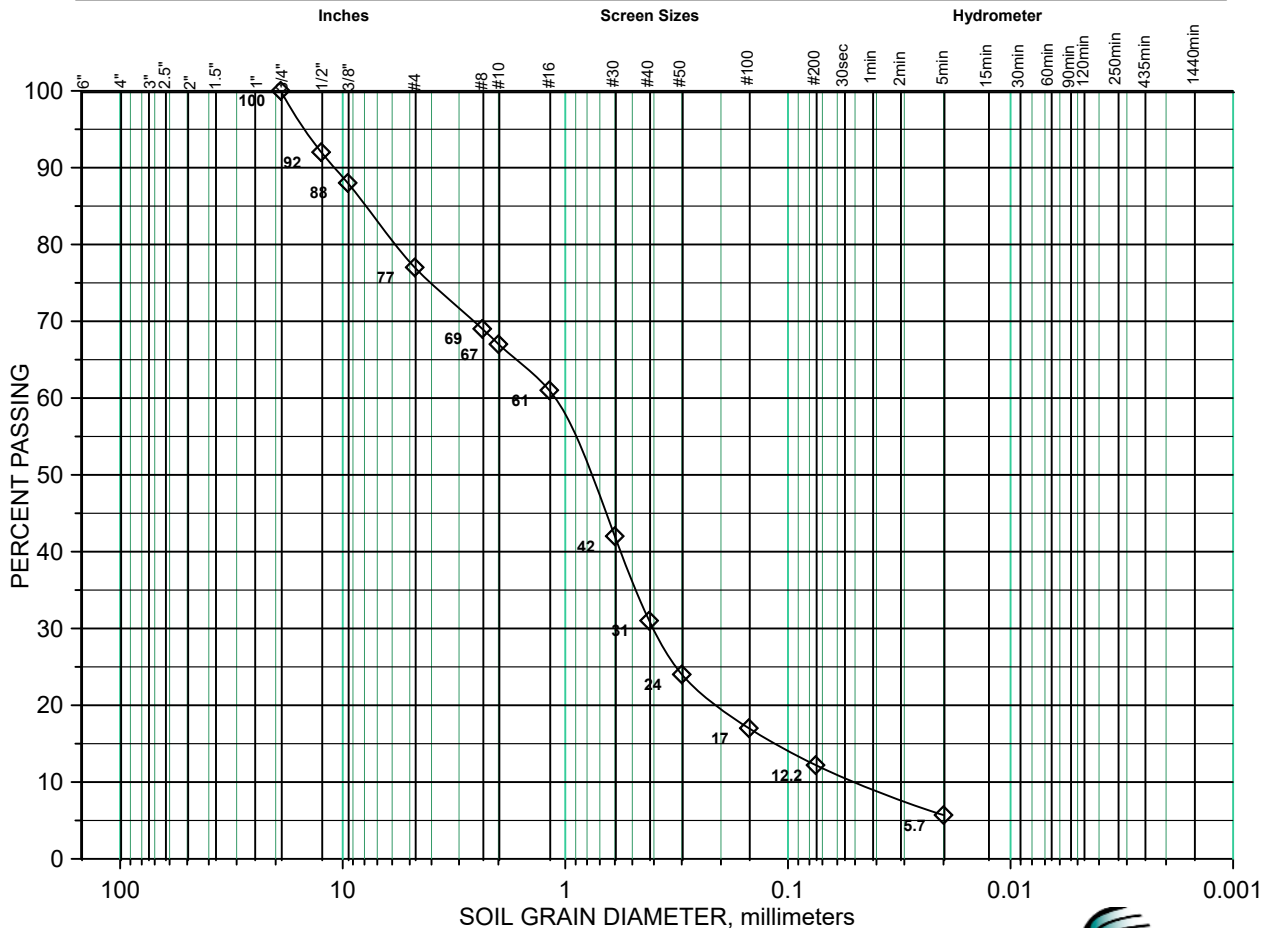
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HYDROMETER ANALYSIS

ASTM D422

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation
Client: T-O Engineers
File: TC20071A
Sample No.: 27532
Sample Location: Boring B-31 from 0.3 to 4.3 feet BGS
Description: Silty SAND with Gravel (SM)
Date Sampled: March 4, 2021 By: S. Armstrong
Date Tested: March 23, 2021 By: R. Matteson / K. Fadde

Cobbles	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



Reviewed by: Simon D. Dumitru



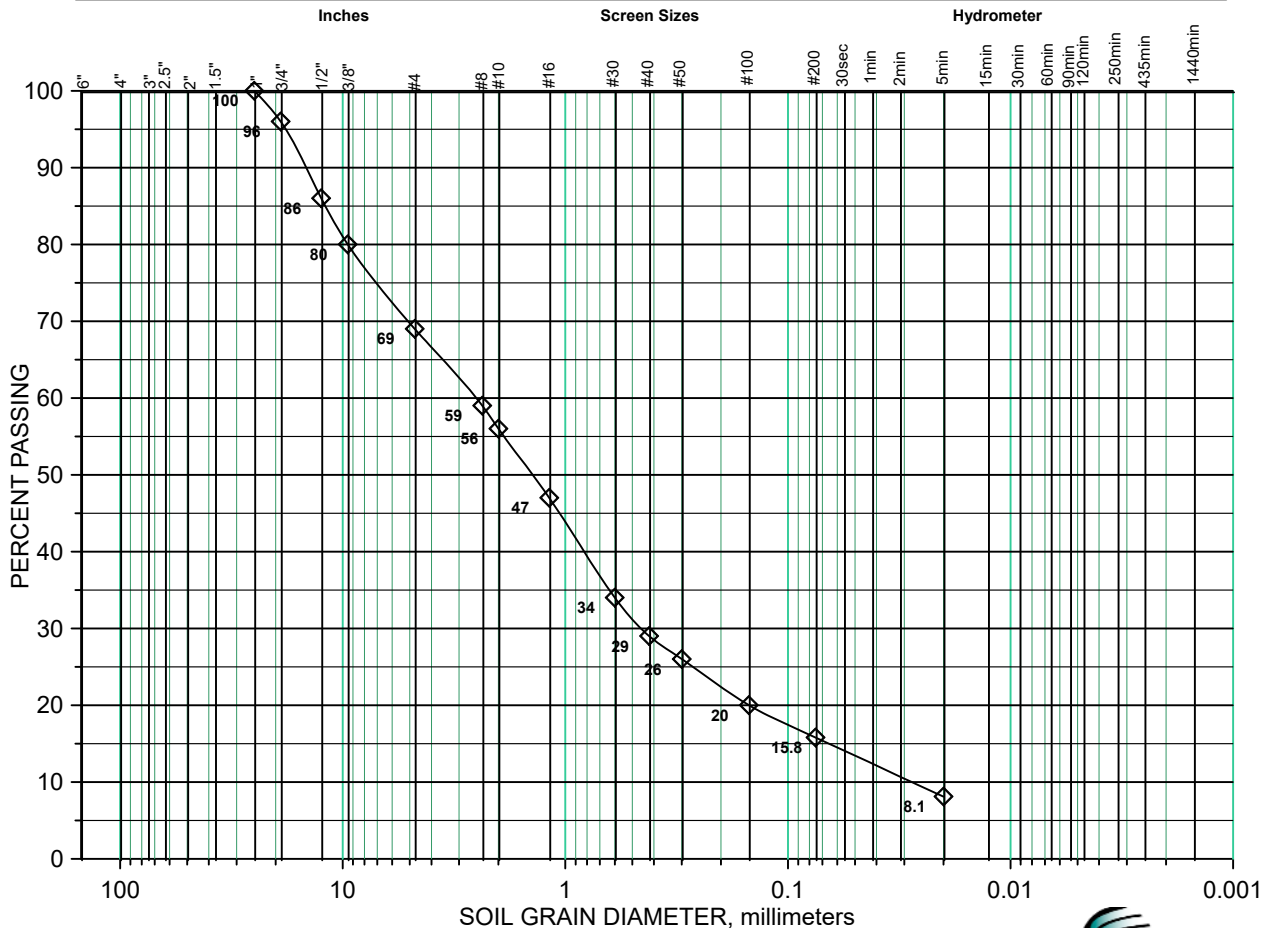
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HYDROMETER ANALYSIS

ASTM D422

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation
Client: T-O Engineers
File: TC20071A
Sample No.: 27536
Sample Location: Test Pit TP-27 from 0.0 to 0.5 feet BGS
Description: Silty SAND with Gravel (SM)
Date Sampled: March 4, 2021 By: S. Armstrong
Date Tested: March 24, 2021 By: R. Matteson / K. Fadde

Cobbles	Gravel		Sand			Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay



Reviewed by: Simon D. Dumstrey



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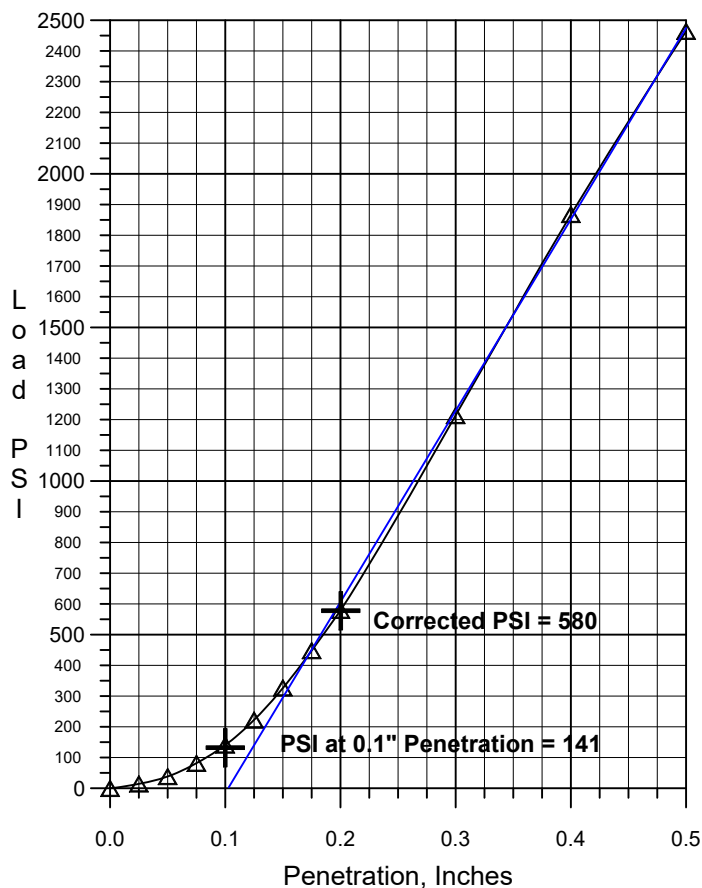
CALIFORNIA BEARING RATIO ASTM D1883

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation
Client: T-O Engineers
Sample Location: Test Pit TP-27 from 0.0 to 0.5 feet BGS
Sample Description: Silty SAND with Gravel (SM)

File Number: TC20071A
Lab Number: 27536
Date Sampled: March 4, 2021
Dates Tested: March 30 - April 3, 2021
Sampled By: S. Armstrong
Tested By: R. Matteson

CBR = 58.0
Test Dry Density = 136.2 pcf
Test Specimen Remolded at 6.5 % Moisture
Remold Percentage of Proctor = 99.4 %
Test Performed at 6.5 % Moisture (Top 1")
Percent Swell = 0.0 %
Soak Time = 96 hrs
Surcharge = 75 psf

CBR CURVE



Reviewed by: _____

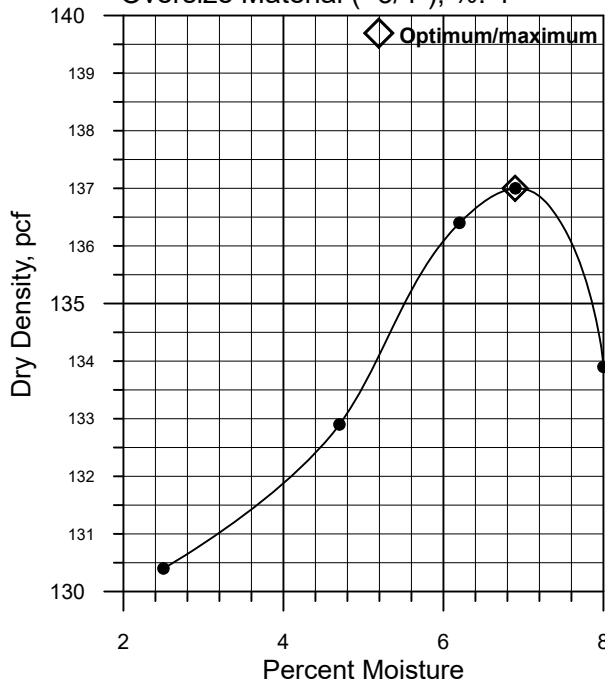
Simon D. Clumsty

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MOISTURE-DENSITY CURVE

ASTM D1557 Method C

Maximum Dry Density, pcf: 137.0
Optimum Moisture Content, %: 6.9
Oversize Material (+3/4"), %: 4





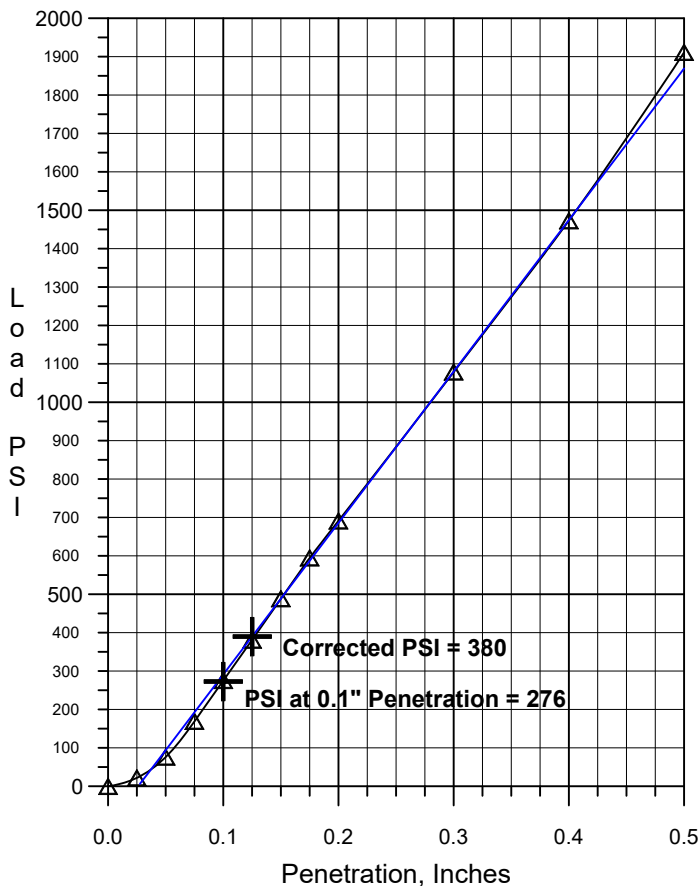
CALIFORNIA BEARING RATIO ASTM D1883

Project: Pangborn Memorial Airport -
Terminal Apron Reconstruction & Taxiway A Relocation
Client: T-O Engineers
Sample Location: Test Pit TP-29 from 1.0 to 3.0 feet BGS
Sample Description: Silty SAND (SM)

File Number: TC20071A
Lab Number: 27538
Date Sampled: March 4, 2021
Dates Tested: March 30 - April 3, 2021
Sampled By: S. Armstrong
Tested By: R. Matteson

CBR = 38.0
Test Dry Density = 126.3 pcf
Test Specimen Remolded at 7.6 % Moisture
Remold Percentage of Proctor = 99.3 %
Test Performed at 9.9 % Moisture (Top 1")
Percent Swell = 0.0 %
Soak Time = 96 hrs
Surcharge = 75 psf

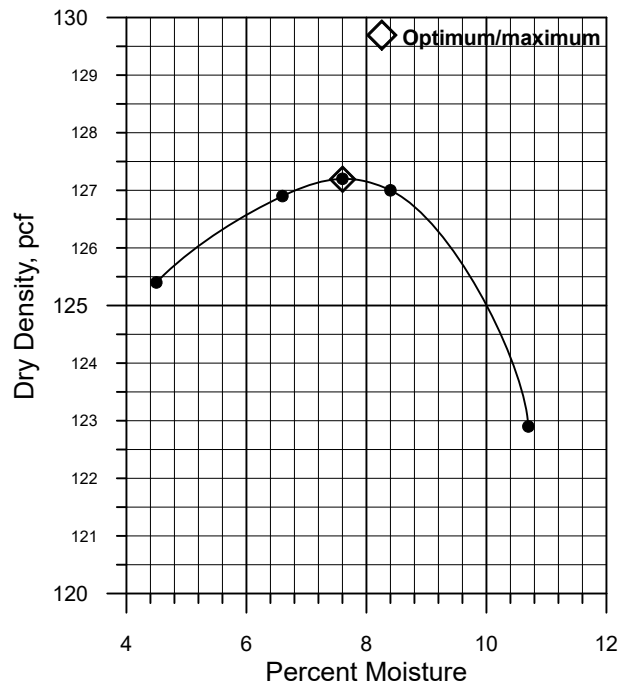
CBR CURVE



MOISTURE-DENSITY CURVE

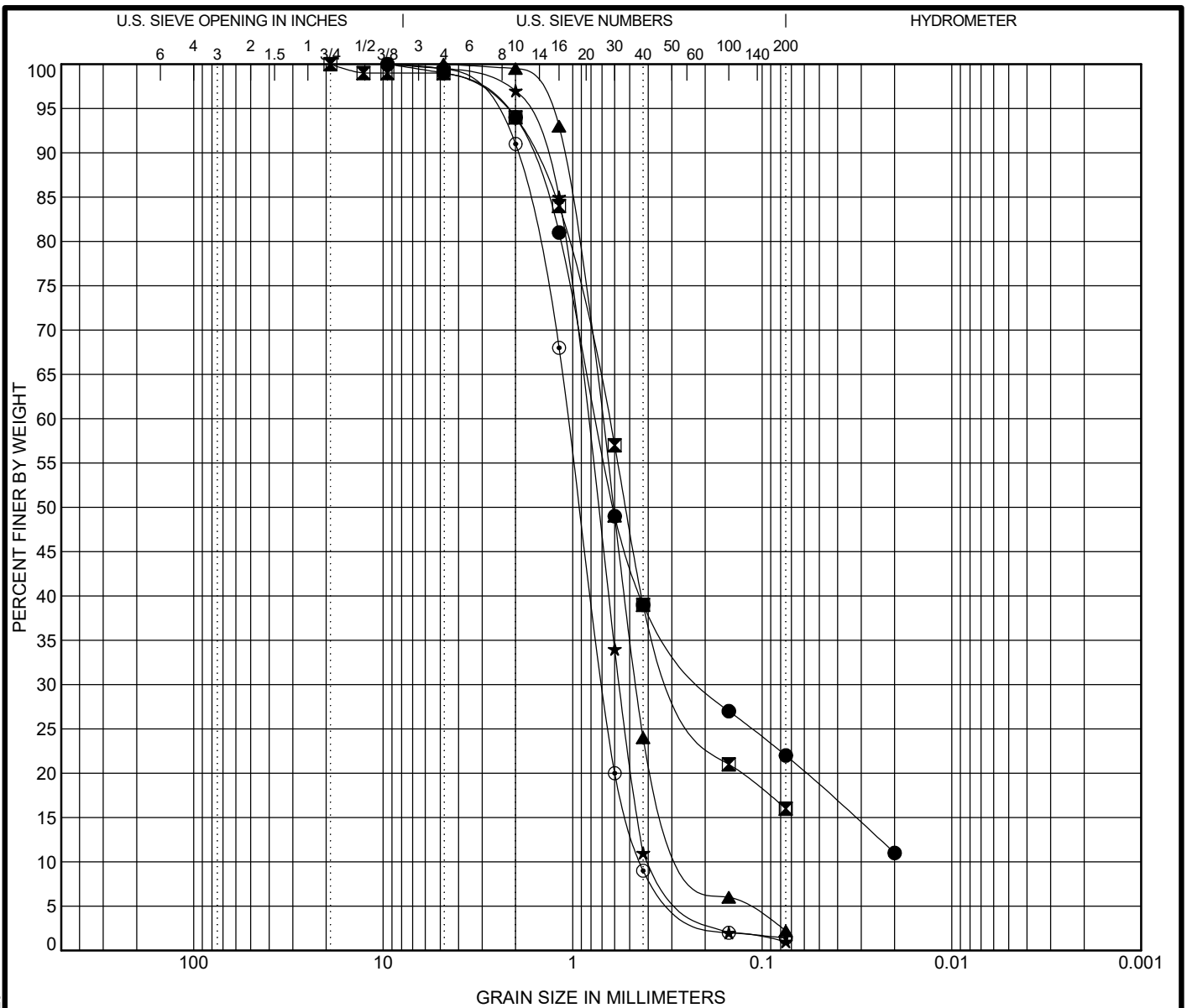
ASTM D1557 Method A

Maximum Dry Density, pcf: 127.2
Optimum Moisture Content, %: 7.6



Reviewed by: S. Dumstrey

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification			LL	PL	PI	Cc	Cu
●	B10	1.0	SILTY SAND(SM)			NP	NP	NP		
⊠	B3	0.0	SILTY SAND(SM)			NP	NP	NP		
▲	B3	2.0	POORLY GRADED SAND(SP)						1.59	3.76
★	B3	3.5	POORLY GRADED SAND(SP)						1.00	2.24
⊙	B9	2.0	POORLY GRADED SAND(SP)						1.03	2.40
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B10	1.0	9.5	0.757	0.195		1.1	76.9	22.0	
⊠	B3	0.0	19	0.647	0.252		1.1	82.9	16.0	
▲	B3	2.0	4.8	0.711	0.462	0.189	0.0	97.8	2.2	
★	B3	3.5	9.5	0.847	0.565	0.379	0.5	98.5	1.0	
⊙	B9	2.0	9.5	1.054	0.691	0.439	0.6	98.0	1.4	



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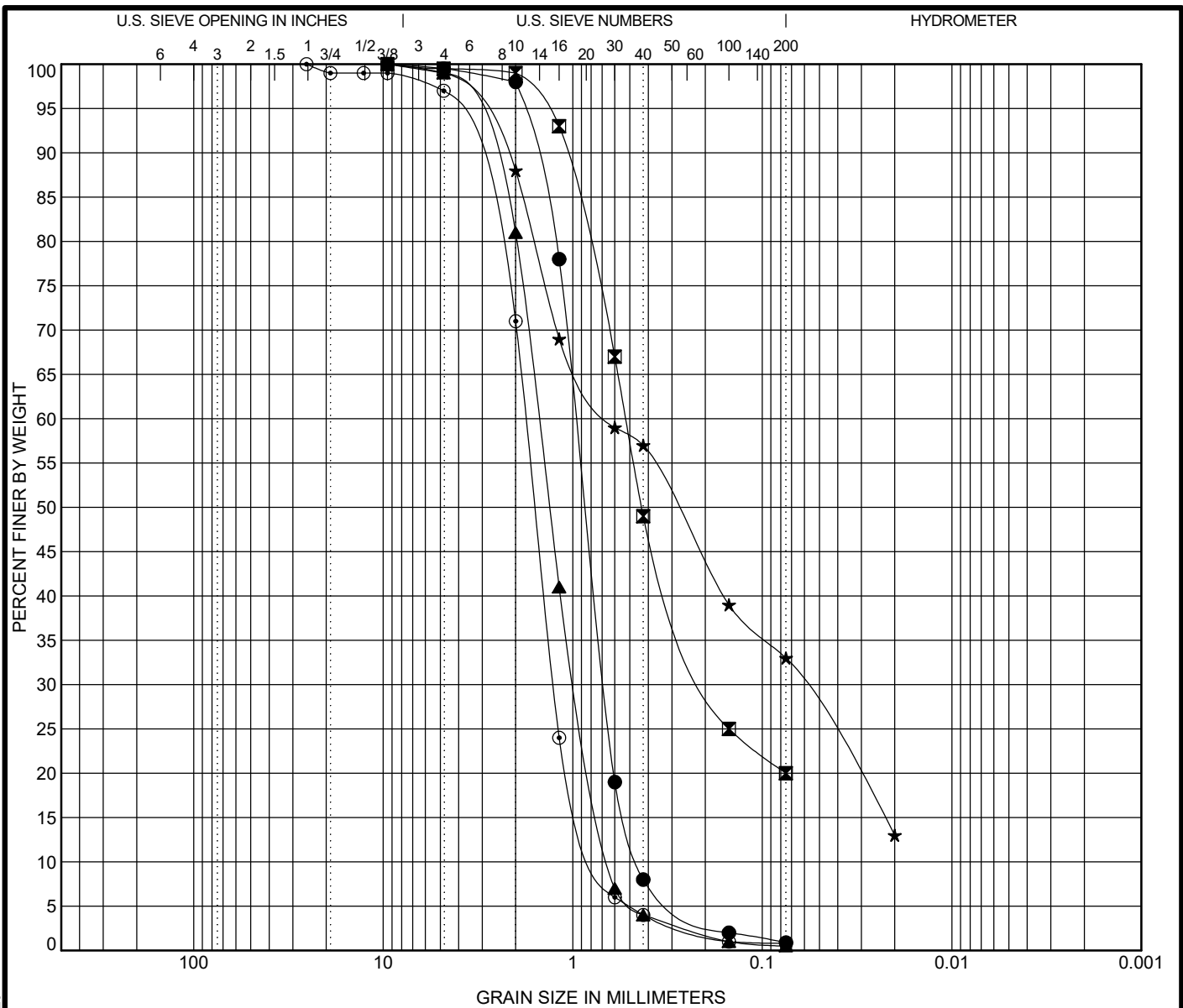
GRAIN SIZE DISTRIBUTION

Project: Pangborn Airport Assessment

Location: East Wenatchee, WA

Number: X19316

Figure 6-1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification				LL	PL	PI	Cc	Cu
●	B10	12.0	POORLY GRADED SAND(SP)						1.07	2.12
✕	B11	0.0	SILTY SAND(SM)				NP	NP	NP	
▲	B11	3.0	POORLY GRADED SAND(SP)						0.93	2.38
★	B16	0.5	SILTY SAND(SM)				NP	NP	NP	
⊙	B16	4.0	POORLY GRADED SAND(SP)						1.29	2.53
Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	
●	B10	12.0	9.5	0.96	0.681	0.452	0.5	98.6	0.9	
✕	B11	0.0	9.5	0.525	0.186		0.5	79.5	20.0	
▲	B11	3.0	9.5	1.516	0.948	0.637	1.2	98.3	0.5	
★	B16	0.5	9.5	0.642	0.062		1.1	65.9	33.0	
⊙	B16	4.0	25.4	1.768	1.262	0.697	3.3	95.9	0.8	



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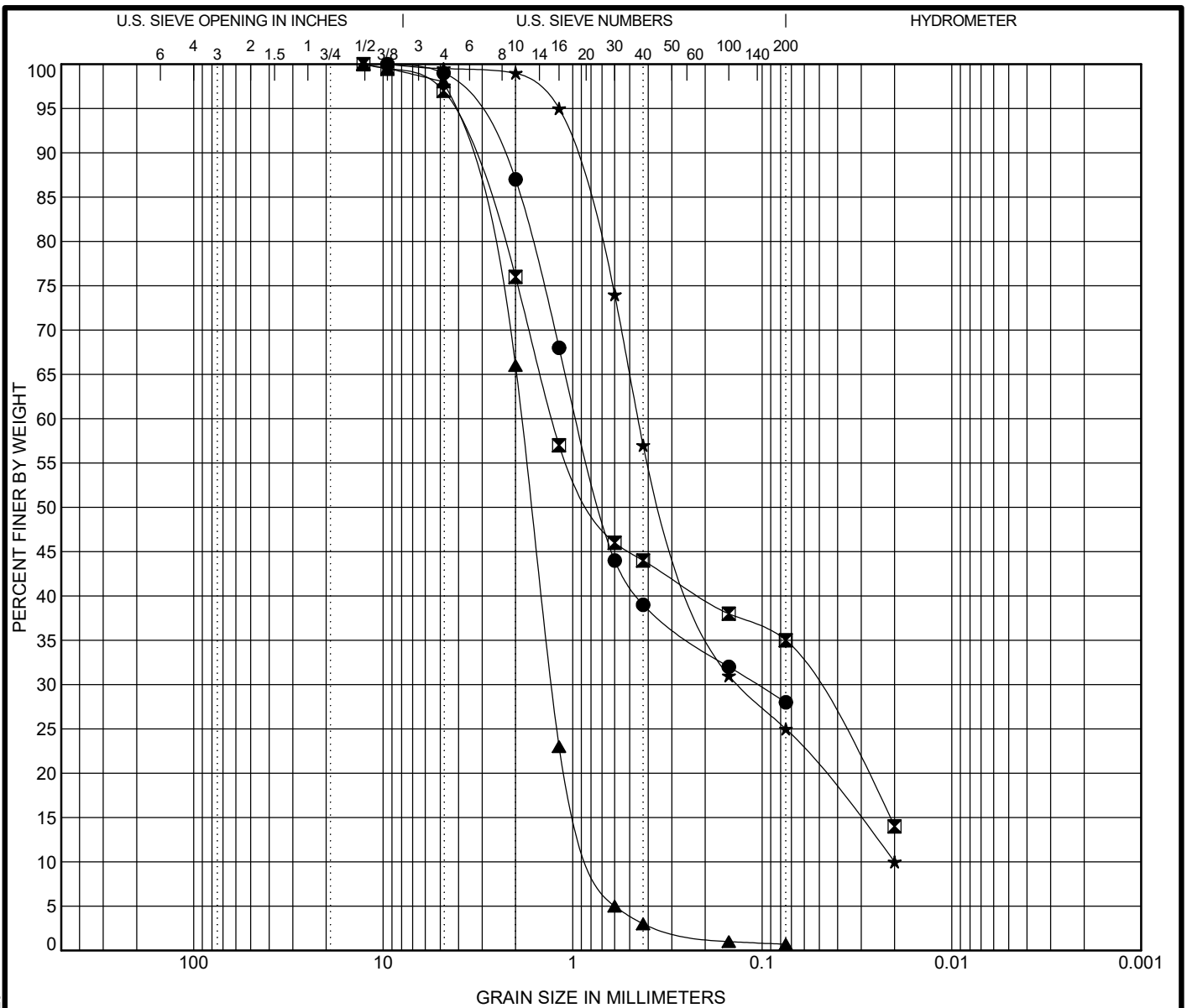
GRAIN SIZE DISTRIBUTION

Project: Pangborn Airport Assessment

Location: East Wenatchee, WA

Number: X19316

Figure 6-2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	LL	PL	PI	Cc	Cu
● B18	0.0	SILTY SAND(SM)	NP	NP	NP		
☒ B20	2.0	SILTY SAND(SM)	NP	NP	NP		
▲ B20	6.0	POORLY GRADED SAND(SP)				1.23	2.57
★ TP4	5.0	SILTY SAND(SM)	NP	NP	NP	1.98	22.58

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B18	0.0	9.5	0.942	0.106		1.1	70.9	28.0	
☒ B20	2.0	12.7	1.283	0.055		3.3	61.7	35.0	
▲ B20	6.0	12.7	1.858	1.286	0.724	2.4	96.9	0.7	
★ TP4	5.0	9.5	0.452	0.134	0.02	0.5	74.5	25.0	



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GRAIN SIZE DISTRIBUTION

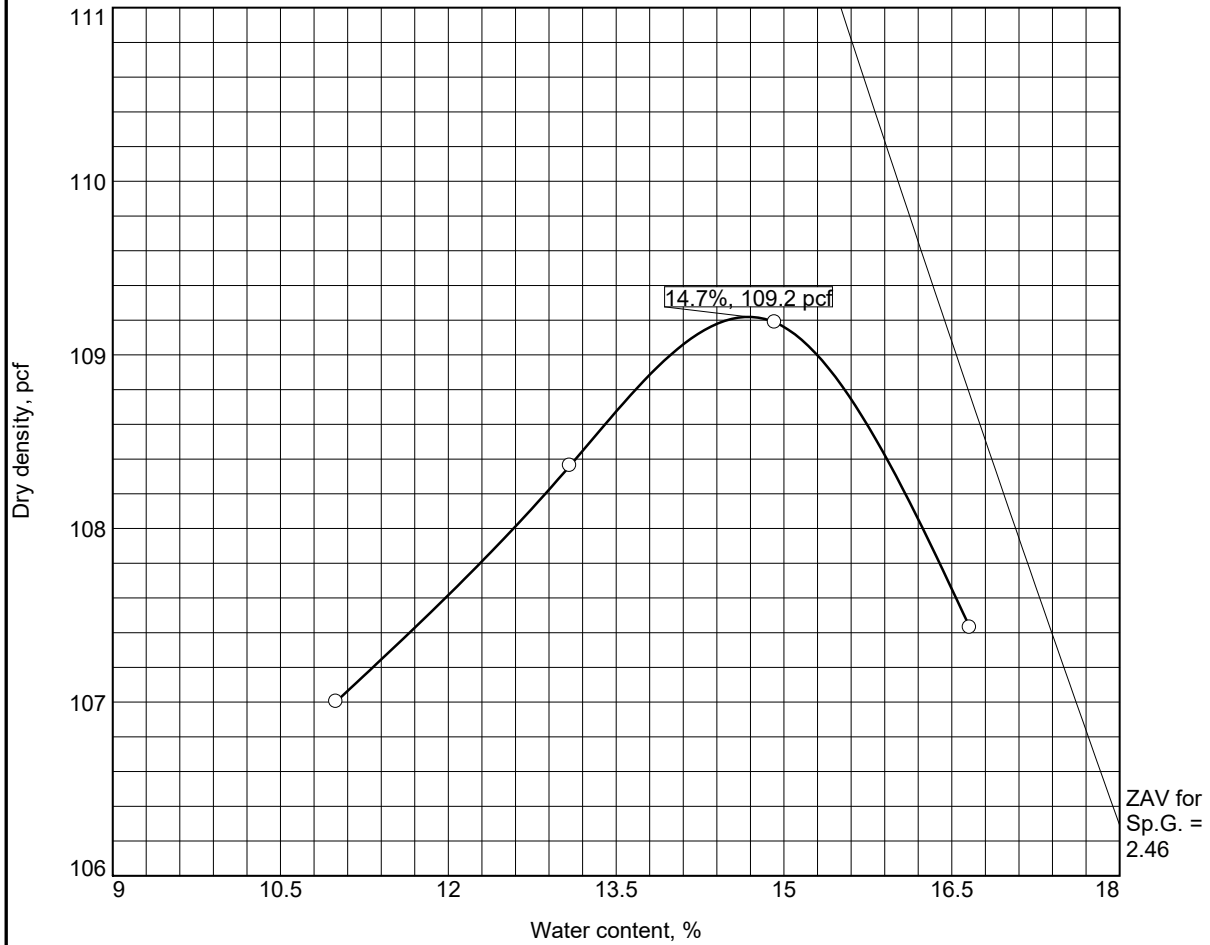
Project: Pangborn Airport Assessment

Location: East Wenatchee, WA

Number: X19316

Figure 6-3

Moisture-Unit Weight Relationship



Test specification: ASTM D 1557-07 Method C Modified

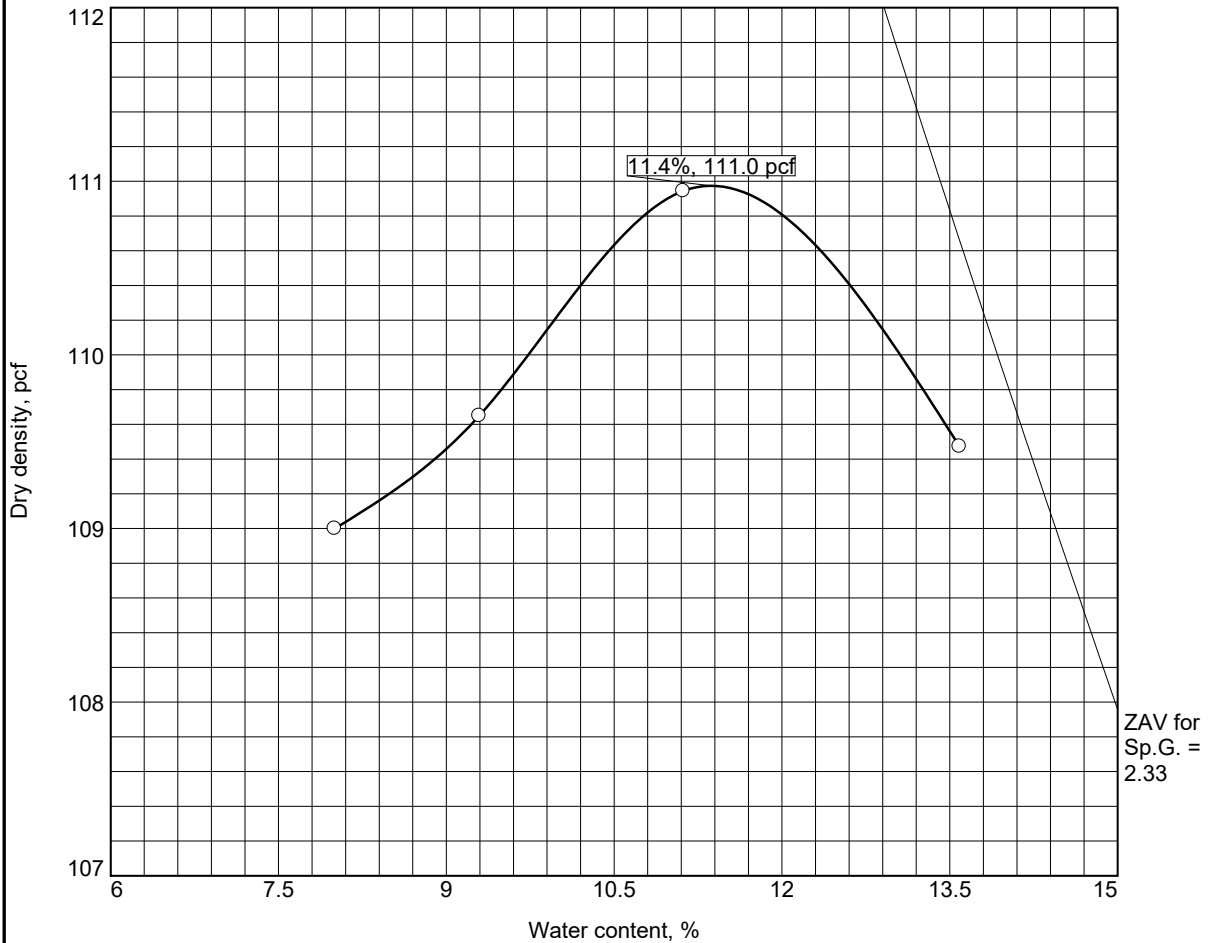
Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
			5.1				0.0	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 109.2 pcf Optimum moisture = 14.7 %	Fine sand with trace silt
Project No. X19316 Client: T-O Engineers Project: Pangborn EA SOW <input type="radio"/> Source of Sample: On-site Sample Number: 20-5038	Remarks: Sampled By B&A Sampled At TP6@2-3
BUDINGER & ASSOCIATES, INC.	
Date: 2/5/20	

Tested By: KC Checked By: TB

Figure 7-1

Moisture-Unit Weight Relationship



Test specification: ASTM D 1557-07 Method C Modified

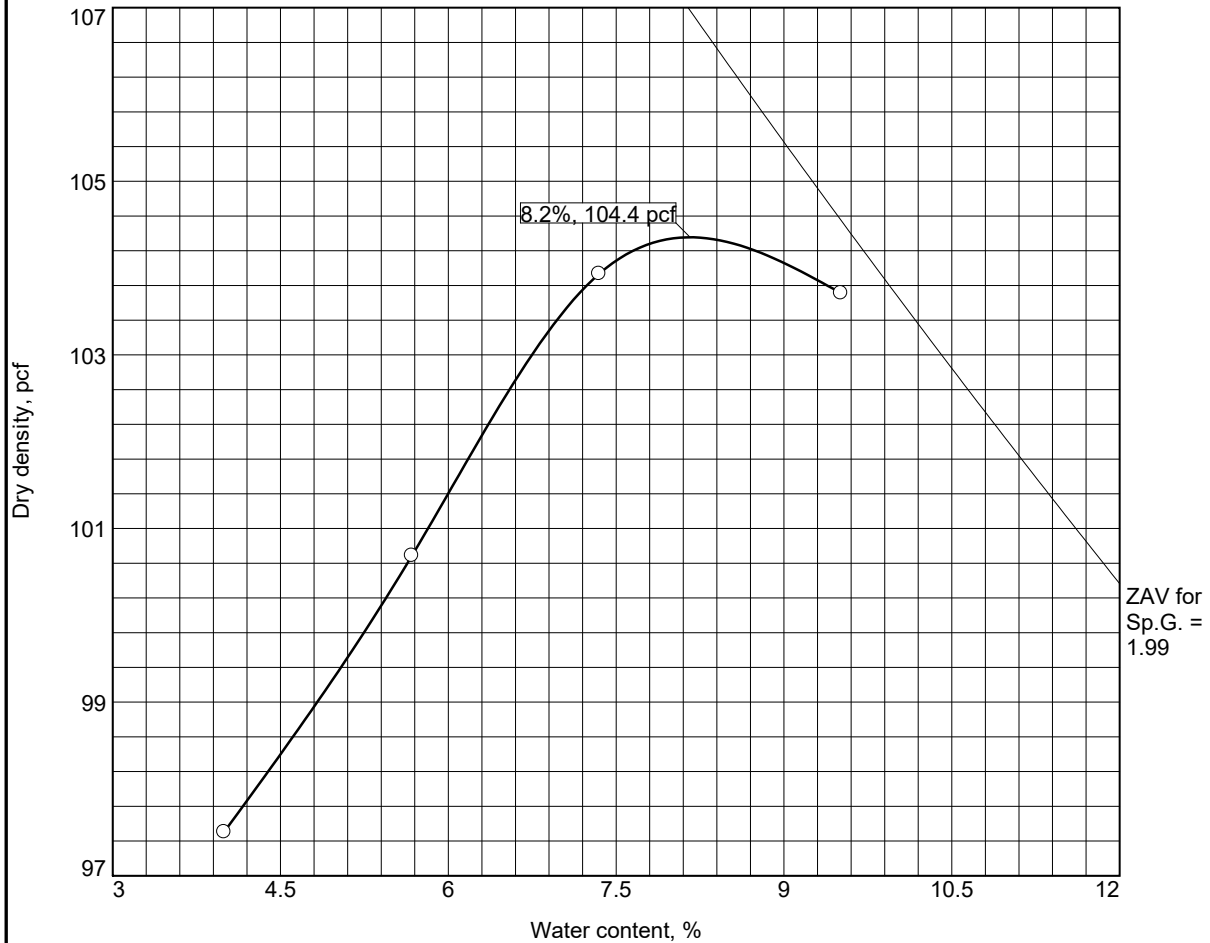
Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
			4.6				0.4	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 111.0 pcf Optimum moisture = 11.4 %	Course sand with trace slit trace gravel
Project No. X19316 Client: T-O Engineers Project: Pangborn EA SOW <input type="radio"/> Source of Sample: On-site Sample Number: 20-5039	Remarks: Sampled By B&A Sampled at TP6@7-8
BUDINGER & ASSOCIATES, INC.	
Date: 2/5/20	

Tested By: KC Checked By: TB

Figure 7-2

Moisture-Unit Weight Relationship



Test specification: ASTM D 1557-07 Method C Modified

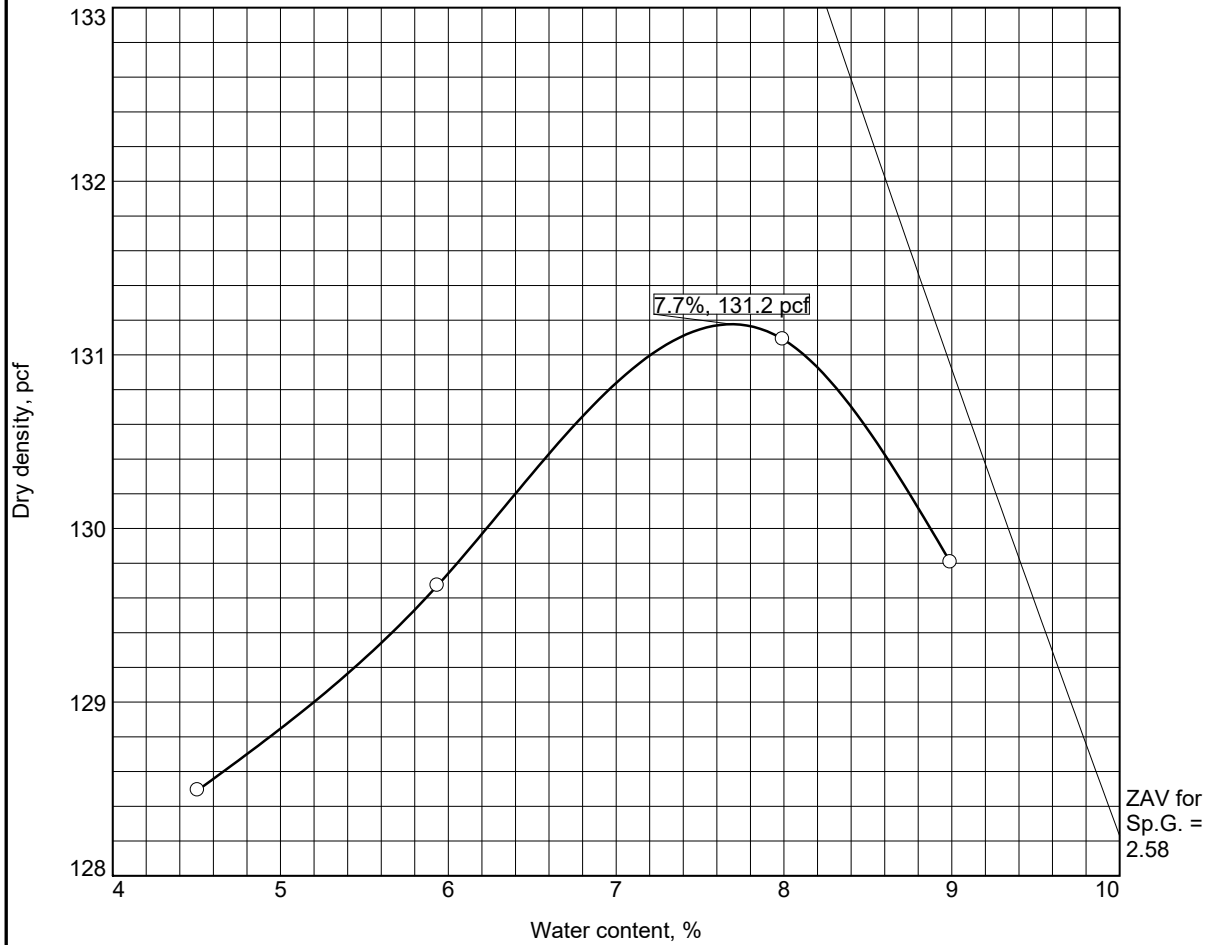
Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
			5.8				0.0	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 104.4 pcf Optimum moisture = 8.2 %	Course sand
Project No. X19316 Client: T-O Engineers Project: Pangborn EA SOW <input type="radio"/> Source of Sample: On-site Sample Number: 20-5041	Remarks: Sampled By B&A Sampled at B24@1-2
BUDINGER & ASSOCIATES, INC.	
Date: 2/5/20	

Tested By: KC Checked By: TB

Figure 7-4

Moisture-Unit Weight Relationship



Test specification: ASTM D 1557-07 Method C Modified

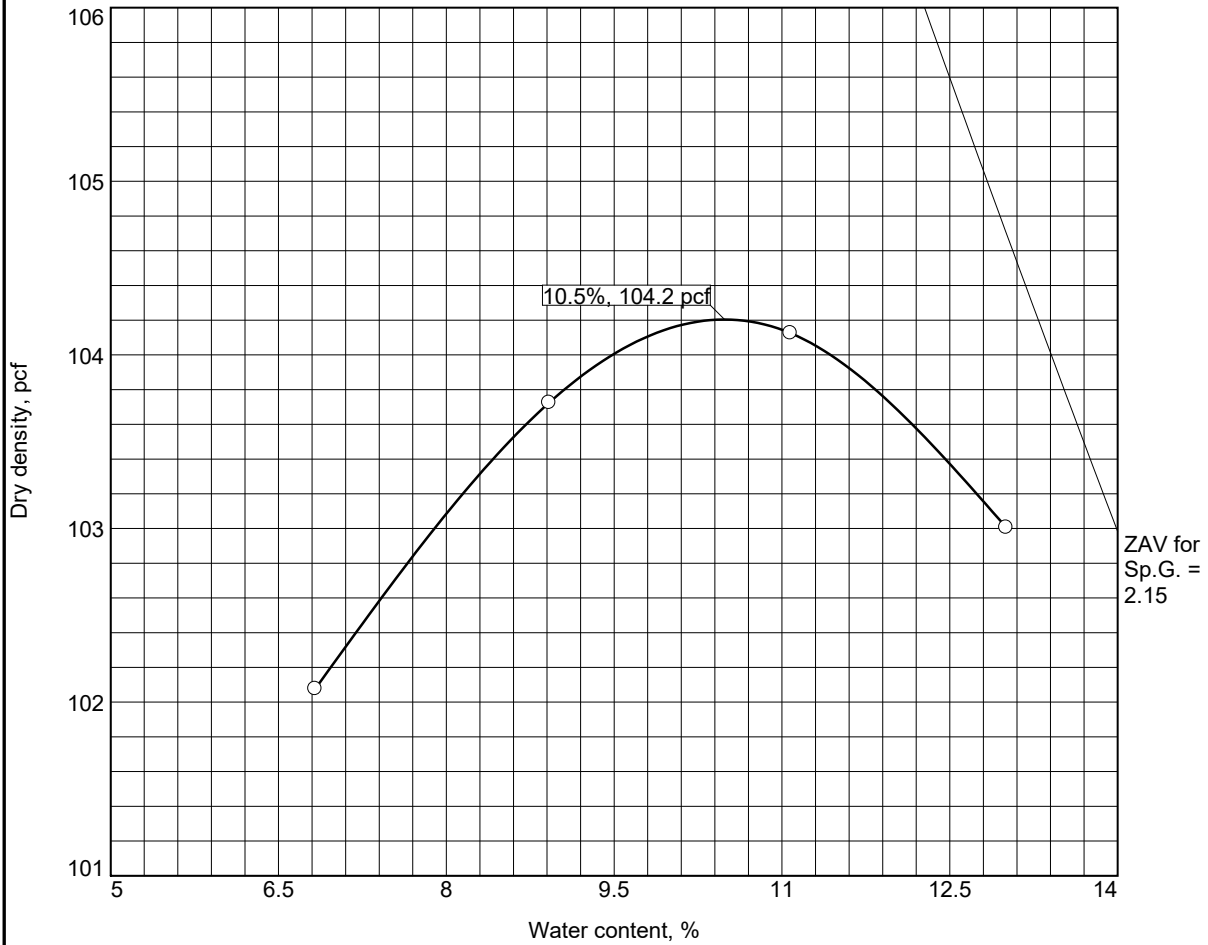
Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
			2.6				0.0	

TEST RESULTS		MATERIAL DESCRIPTION
Maximum dry density = 131.2 pcf		Silt with some sand
Optimum moisture = 7.7 %		
Project No. X19316 Client: T-O Engineers Project: Pangborn EA SOW		Remarks: Sampled By B&A Sampled at B23@.5-1.5
<input type="radio"/> Source of Sample: On-site Sample Number: 20-5042		
BUDINGER & ASSOCIATES, INC.		
		Date: 2/11/20

Tested By: KC Checked By: TB

Figure 7-5

Moisture-Unit Weight Relationship



Test specification: ASTM D 1557-07 Method C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
			3.1				0.0	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 104.2 pcf Optimum moisture = 10.5 %	Course sand
Project No. X19316 Client: T-O Engineers Project: Pangborn EA SOW <input type="radio"/> Source of Sample: On-site Sample Number: 20-5043	Remarks: Sampled By B&A Sampled at TP5@3-4
BUDINGER & ASSOCIATES, INC.	
Date: 2/11/20	

Tested By: TS Checked By: KC

Figure 7-6

CALIFORNIA BEARING RATIO TEST RESULTS **ASTM D-1883**

Sample Location: Pangborn Airport

Sample Source: TP6 @2-3

Lab Number: 20-5038

Maximum density (pcf): 109.2

ASTM D-1557

56 blow

Dry density (pcf): 111.6
% of maximum density: 102.2%
CBR= 22

CBR Moisture: 14.3%
CBR Moisture after soak: 15.7
CBR Swell: 0.0%
Surcharge: 30 pounds

Penetration (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	12	35
0.050	32	72
0.075	60	125
0.100	93	187
0.125	131	258
0.150	170	331
0.175	218	421
0.200	261	502
0.250	342	654
0.300	416	793
0.400	537	1020
0.500	612	1161

25 blow

Dry density (pcf): 107.4
% of maximum density: 98.4%
CBR= 13

CBR Moisture: 14.5%
CBR Moisture after soak: 19.6%
CBR Swell: 0.1%
Surcharge: 30 pounds

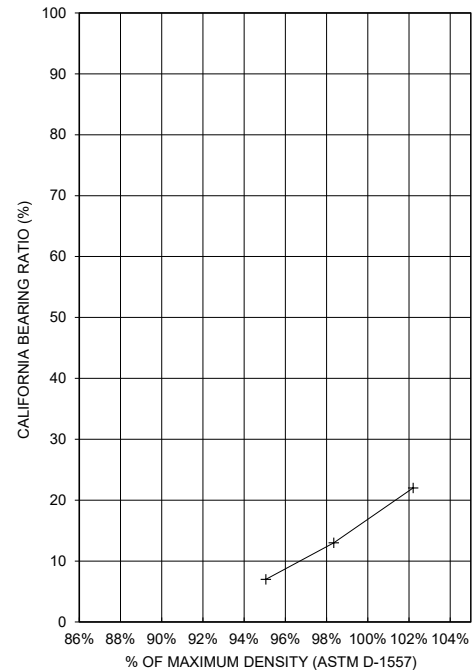
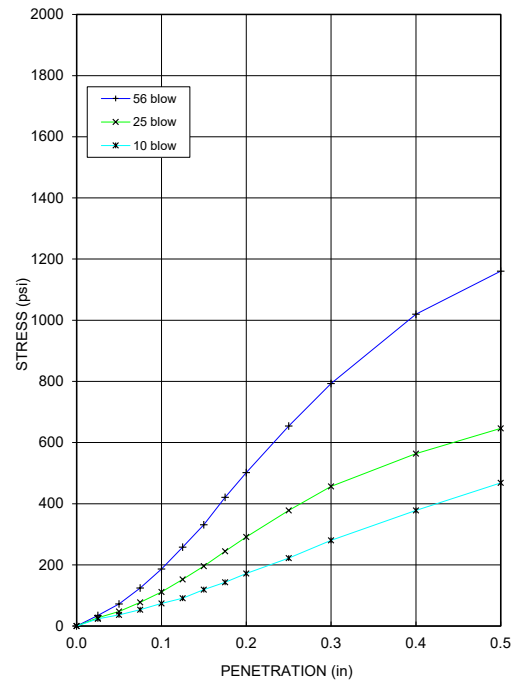
pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	8	27
0.050	19	48
0.075	35	78
0.100	53	111
0.125	75	153
0.150	98	196
0.175	124	245
0.200	149	292
0.250	195	378
0.300	237	457
0.400	294	564
0.500	338	646

10 blow

Dry density (pcf): 103.8
% of maximum density: 95.1%
CBR= 7

CBR Moisture: 14.9%
CBR Moisture after soak: 20.2%
CBR Swell: 0.2%
Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	6	23
0.050	13	36
0.075	22	53
0.100	33	74
0.125	42	91
0.150	57	119
0.175	70	143
0.200	85	172
0.250	112	222
0.300	143	280
0.400	195	378
0.500	243	468



CALIFORNIA BEARING RATIO TEST RESULTS
ASTM D-1883

Sample Location: Pangborn Airport

Sample Source: TP6 @7-8

Lab Number: 20-5039

Maximum density (pcf): 111.0

ASTM D-1557

56 blow

Dry density (pcf): 114.7
 % of maximum density: 103.3%
 CBR= 24

CBR Moisture: 12.2%
 CBR Moisture after soak: 14.5%
 CBR Swell: 0.0%
 Surcharge: 30 pounds

Penetration (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	20	50
0.050	49	104
0.075	83	168
0.100	119	235
0.125	161	314
0.150	201	389
0.175	243	468
0.200	290	556
0.250	370	706
0.300	446	849
0.400	582	1104
0.500	700	1326

25 blow

Dry density (pcf): 107.7
 % of maximum density: 97.0%
 CBR= 15

CBR Moisture: 12.1%
 CBR Moisture after soak: 15.5%
 CBR Swell: 0.0%
 Surcharge: 30 pounds

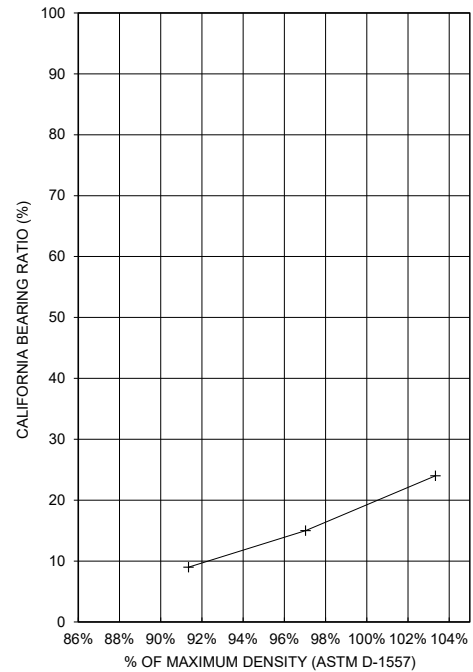
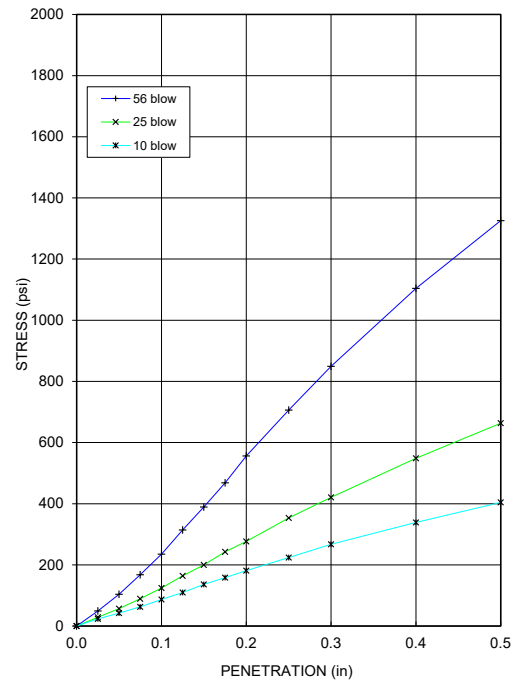
pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	9	29
0.050	24	57
0.075	41	89
0.100	60	125
0.125	81	164
0.150	100	200
0.175	123	243
0.200	141	277
0.250	182	354
0.300	218	421
0.400	286	549
0.500	347	663

10 blow

Dry density (pcf): 101.4
 % of maximum density: 91.4%
 CBR= 9

CBR Moisture: 11.5%
 CBR Moisture after soak: 16.2%
 CBR Swell: 0.1%
 Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	6	23
0.050	16	42
0.075	27	63
0.100	40	87
0.125	52	110
0.150	66	136
0.175	78	158
0.200	90	181
0.250	113	224
0.300	136	267
0.400	174	339
0.500	209	404



CALIFORNIA BEARING RATIO TEST RESULTS **ASTM D-1883**

Sample Location: Pangborn Airport

Sample Source: B24 @ 1-2

Lab Number: 20-5041

Maximum density (pcf): 104.4

ASTM D-1557

56 blow

Dry density (pcf): 106.0

% of maximum density: 101.5%

CBR= 33

CBR Moisture: 8.1%

CBR Moisture after soak: 9.9%

CBR Swell: 0.02%

Surcharge: 30 pounds

Penetration (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	11	33
0.050	27	63
0.075	50	106
0.100	79	160
0.125	112	222
0.150	146	286
0.175	186	361
0.200	222	429
0.250	287	551
0.300	341	652
0.400	432	823
0.500	503	956

25 blow

Dry density (pcf): 99.8

% of maximum density: 95.6%

CBR= 19

CBR Moisture: 8.0%

CBR Moisture after soak: 10.0%

CBR Swell: 0.02%

Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	11	33
0.050	25	59
0.075	48	102
0.100	65	134
0.125	86	173
0.150	106	211
0.175	124	245
0.200	143	280
0.250	178	346
0.300	209	404
0.400	260	500
0.500	306	586

10 blow

Dry density (pcf): 95.2

% of maximum density: 91.2%

CBR= 10

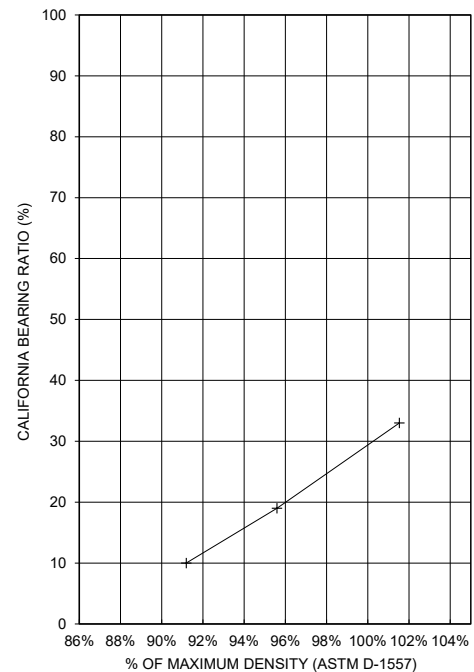
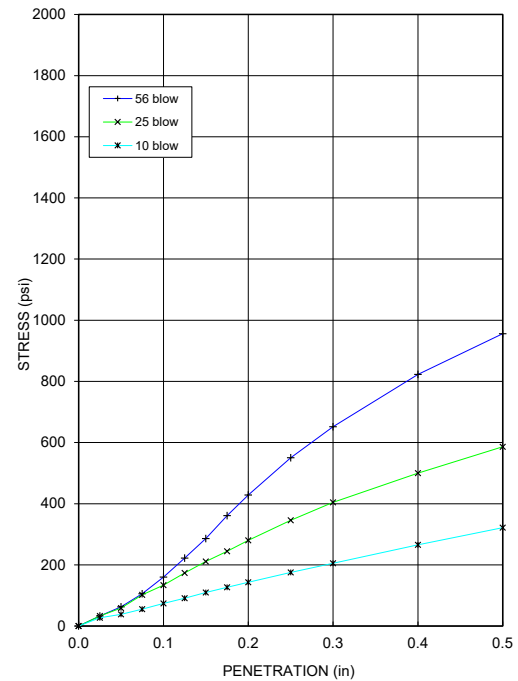
CBR Moisture: 8.1%

CBR Moisture after soak: 10.5%

CBR Swell: 0.04%

Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	8	27
0.050	14	38
0.075	23	55
0.100	33	74
0.125	42	91
0.150	52	110
0.175	61	127
0.200	70	143
0.250	87	175
0.300	103	205
0.400	135	265
0.500	165	322



CALIFORNIA BEARING RATIO TEST RESULTS
ASTM D-1883

Sample Location: Pangborn Airport

Sample Source: B23 @0.5-1.5

Lab Number: 20-5042

Maximum density (pcf): 131.2

ASTM D-1557

56 blow

Dry density (pcf): 131.1
 % of maximum density: 99.9%
 CBR= 91

CBR Moisture: 7.6%

CBR Moisture after soak: 9.4%

CBR Swell: 0.02%

Surcharge: 30 pounds

Penetration (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	106	211
0.050	254	489
0.075	460	875
0.100	670	1269
0.125	820	1551
0.150	957	1808
0.175	1070	2020
0.200	1166	2200
0.250	1310	2471
0.300	1404	2647
0.400	1509	2844
0.500	1636	3082

25 blow

Dry density (pcf): 127.3
 % of maximum density: 97.0%
 CBR= 67

CBR Moisture: 7.8%

CBR Moisture after soak: 10.7%

CBR Swell: 0.02%

Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	80	162
0.050	179	348
0.075	274	526
0.100	350	669
0.125	412	785
0.150	475	904
0.175	529	1005
0.200	577	1095
0.250	665	1260
0.300	745	1410
0.400	875	1654
0.500	997	1883

10 blow

Dry density (pcf): 121.8
 % of maximum density: 92.8%
 CBR= 20

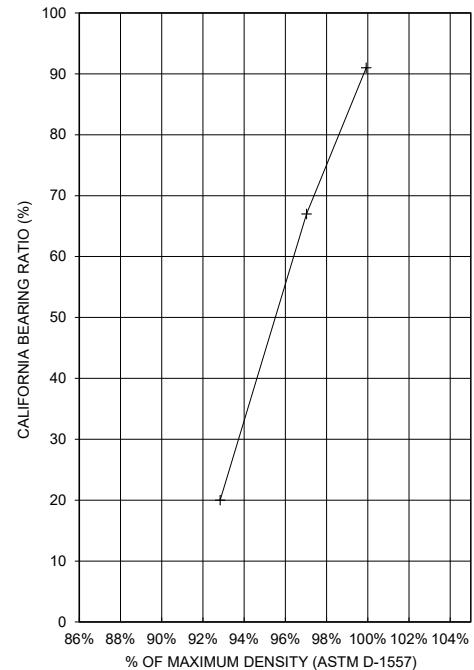
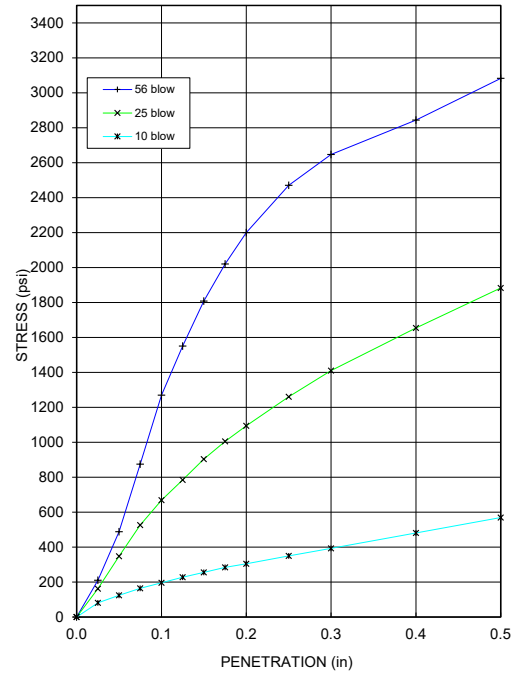
CBR Moisture: 8.0%

CBR Moisture after soak: 12.4%

CBR Swell: 0.04%

Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	37	81
0.050	60	125
0.075	81	164
0.100	98	196
0.125	115	228
0.150	130	256
0.175	145	284
0.200	156	305
0.250	180	350
0.300	203	393
0.400	250	481
0.500	297	569



CALIFORNIA BEARING RATIO TEST RESULTS **ASTM D-1883**

Sample Location: Pangborn Airport

Sample Source: TP5 @3-4

Lab Number: 20-5043

Maximum density (pcf): 104.2

ASTM D-1557

56 blow

Dry density (pcf): 104.3
 % of maximum density: 100.1%
 CBR= 17

CBR Moisture: 10.9%

CBR Moisture after soak: 12.4%

CBR Swell: 0.0%

Surcharge: 30 pounds

Penetration (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	18	46
0.050	40	87
0.075	60	125
0.100	86	173
0.125	106	211
0.150	133	262
0.175	154	301
0.200	179	348
0.250	230	444
0.300	273	524
0.400	350	669
0.500	415	791

25 blow

Dry density (pcf): 98.8
 % of maximum density: 94.8%
 CBR= 14

CBR Moisture: 10.3%

CBR Moisture after soak: 11.9%

CBR Swell: 0.0%

Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	9	29
0.050	21	51
0.075	33	74
0.100	49	104
0.125	61	127
0.150	76	155
0.175	89	179
0.200	103	205
0.250	130	256
0.300	154	301
0.400	198	384
0.500	237	457

10 blow

Dry density (pcf): 93.9
 % of maximum density: 90.1%
 CBR= 9

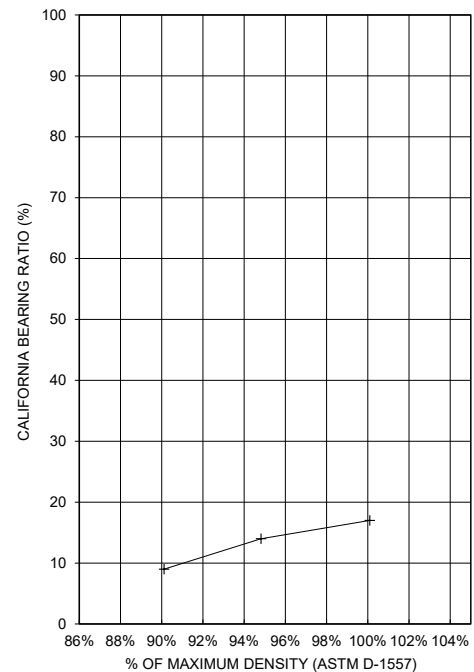
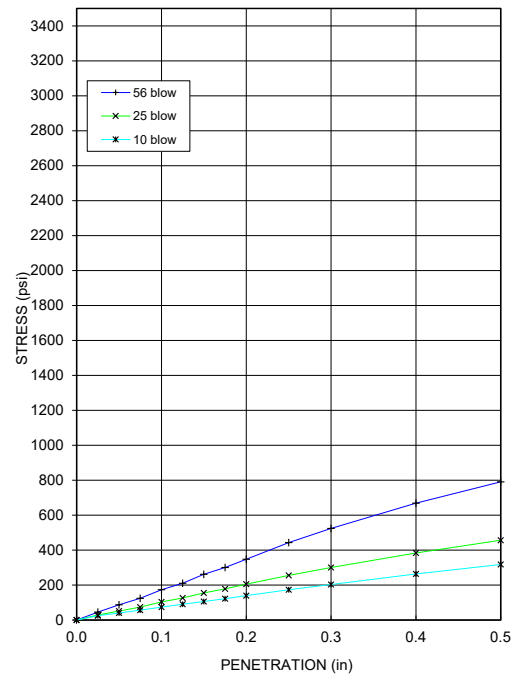
CBR Moisture: 10.6%

CBR Moisture after soak: 11.9%

CBR Swell: 0.0%

Surcharge: 30 pounds

pen (in)	Load Cell (div)	Stress (psi)
0.000	0	0
0.025	7	25
0.050	15	40
0.075	24	57
0.100	33	74
0.125	42	91
0.150	50	106
0.175	59	123
0.200	68	140
0.250	86	173
0.300	102	203
0.400	134	264
0.500	163	318



APPENDIX D

Insitu Soil Density Table

Depth	B-25	N _{SPT}	Insitu Density, pcf	Insitu Density, %	B-26	N _{SPT}	Insitu Density, pcf	Insitu Density, %	B-27	N _{spt}	Insitu Density, pcf	Insitu Density, %	B-28	N _{spt}	Insitu Density, pcf	Insitu Density, %
0	ML	2	XXX	XXX	SM	2			Asphalt	12			Asphalt	11		
0.5	(REPLACE)	3	XXX	XXX	MDD = 127.2	3	107	84%	SM w/ Gr	16	123	90%	SM	12	122	96%
1	SM - 29.7%	3				3			MDD = 137.0	13			SP-SM	8		
1.5	MDD = 127.2	1	115	90%		4	110	86%		13	122.5	89%	MDD = 111.0	10	121	109%
2		1				5				12				4		
2.5		1	100	79%		5	115	90%		19	123	90%		5	113	102%
3		0				5				16				6		
3.5		2	100	79%		5	115	90%		16	123	90%		5	115.5	104%
4		5				5			SM w/ Gr	9			SP - 2.4%	3		
4.5		1	109	86%	SP-SM	4	113	102%	MDD = 137.0	6	119	87%	MDD = 104.4	4	114	109%
5		5			MDD = 111.0	3				3				4		
5.5		4	114	90%		4	110	99%		3	108	79%		4	114.5	110%
6		2				2				4				3		
6.5		3	108	85%		2	105	95%		6	115	84%		3	108	103%
7	SP-SM - 6.7%	2				2				5				3		
7.5	MDD = 111.0	3	108	97%		3	108	97%		4	114	83%		4	101	97%
8		3				3				3				3		
8.5		3	109	98%		3	108	97%		4	111	81%		3	108	103%
9		3				3				3				3		
9.5		3	109	98%		3	108	97%		4	111	81%		3	108	103%
10	EOB @ 10.0				EOB @ 10.0				EOB @ 10.3				EOB @ 10.3			

Legend

Fill
Silty Sand
Poorly-Graded Sand
Poorly-Graded Sand w/ Silt

BOH = Bottom of Hole

EOB = End of Boring

Lab Testing Results

STRATA TP-27, Silty Sand w/ Gravel, MDD = 137.0 pcf

STRATA TP-29, Silty Sand, MDD = 127.2 pcf

Budinger TP6, Coarse Sand with trace silt, trace gravel (SP-SM), MDD = 111.0 pcf

Budinger TP24, Coarse Sand (SP), MDD = 104.4 pcf



**Pangborn Memorial Airport
Terminal Apron Reconstruction
AIP# 3-53-0084-044-2021**

B-29	N _{spt}	Insitu Density, pcf	Insitu Density, %	B-30	N _{SPT}	Insitu Density, pcf	Insitu Density, %	B-31	N _{SPT}	Insitu Density, pcf	Insitu Density, %
Asphalt	23			Asphalt	19			Asphalt	28		0
SP-SM MDD = 137.0	33	134	98%	SP-SM MDD = 137.0	25	126.5	92%	SM w/ Gr MDD = 137.0	18	127.5	93%
	37				17				32		1
	22	136	99%		11	123	90%		30	136.4	100%
	6				8				11		2
SM MDD = 127.2	7	118	93%	SM MDD = 127.2	8	120	94%		13	122.3	89%
	5				8				15		3
	5	115	90%		10	121	95%		11	122.5	89%
	7				3				6		4
	7	118.4	93%		12	119	94%	SM w/ Gr MDD = 137.0	6	117	85%
	7				11				5		5
	7	118.4	93%		10	122	96%		4	116	85%
	4				4			SP MDD = 104.4	4		6
SP-SM MDD = 111.0	3	110	99%	SP-SM MDD = 111.0	6	115	104%		4	122	117%
	3				6				6		7
	3	108	97%		6	117	105%		4	115	110%
	3				5				3		8
	4	110	99%		5	115	104%		3	109	104%
	3				5				3		9
	4	110	99%		5	115	104%		3	109	104%

EOB @ 10.4

EOB @ 10.4

EOB @ 10.3

Legend

Fill
Silty Sand
Poorly-Graded Sand
Poorly-Graded Sand w/ Silt
BOH = Bottom of Hole
EOB = End of Boring

Lab Testing Results

STRATA TP-27, Silty Sand w/ Gravel, MDD = 137.0 pcf
 STRATA TP-29, Silty Sand, MDD = 127.2 pcf
 Budinger TP6, Coarse Sand with trace silt, trace gravel (SP-SM), MDD = 111.0 pcf
 Budinger TP24, Coarse Sand (SP), MDD = 104.4 pcf



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Appendix C. Existing HydroCAD Results

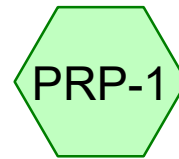




EX-1



EX-2



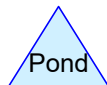
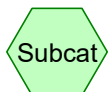
PRP-1



EX-3



PRP-2



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Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	25-YR 24-HR	Type IA 24-hr		Default	24.00	1	2.10	2
2	25-YR 24-HR RS	Type IA 24-hr		Default	24.00	1	2.63	2

EAT Calculations - 100%

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Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
15.878	49	50-75% Grass cover, Fair, HSG A (EX-3, PRP-2)
5.810	68	<50% Grass cover, Poor, HSG A (EX-1, PRP-1)
2.294	39	>75% Grass cover, Good, HSG A (EX-2)
1.048	96	Gravel surface, HSG A (EX-1, EX-2, EX-3, PRP-1, PRP-2)
18.953	98	Paved parking, HSG A (EX-1, EX-2, EX-3, PRP-1, PRP-2)
0.530	98	Unconnected roofs, HSG A (EX-1, PRP-1)
44.513	74	TOTAL AREA

EAT Calculations - 100%

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Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
44.513	HSG A	EX-1, EX-2, EX-3, PRP-1, PRP-2
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
44.513		TOTAL AREA

EAT Calculations - 100%

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Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
15.878	0.000	0.000	0.000	0.000	15.878	50-75% Grass cover, Fair	EX-3, PRP-2
5.810	0.000	0.000	0.000	0.000	5.810	<50% Grass cover, Poor	EX-1, PRP-1
2.294	0.000	0.000	0.000	0.000	2.294	>75% Grass cover, Good	EX-2
1.048	0.000	0.000	0.000	0.000	1.048	Gravel surface	EX-1, EX-2, EX-3, PRP-1, PRP-2
18.953	0.000	0.000	0.000	0.000	18.953	Paved parking	EX-1, EX-2, EX-3, PRP-1, PRP-2
0.530	0.000	0.000	0.000	0.000	0.530	Unconnected roofs	EX-1, PRP-1
44.513	0.000	0.000	0.000	0.000	44.513	TOTAL AREA	

EAT Calculations - 100%*Type IA 24-hr 25-YR 24-HR Rainfall=2.10"*

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Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points

Runoff by SBUH method, Split Pervious/Imperv.

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX-1: EX-1

Runoff Area=6.309 ac 54.46% Impervious Runoff Depth=1.12"

Tc=5.0 min CN=68/98 Runoff=1.64 cfs 0.591 af

SubcatchmentEX-2: EX-2

Runoff Area=2.729 ac 8.02% Impervious Runoff Depth=0.15"

Flow Length=317' Tc=18.8 min CN=44/98 Runoff=0.09 cfs 0.034 af

SubcatchmentEX-3: EX-3

Runoff Area=13.350 ac 33.13% Impervious Runoff Depth=0.62"

Flow Length=595' Tc=7.9 min CN=50/98 Runoff=2.06 cfs 0.691 af

SubcatchmentPRP-1: PRP-1

Runoff Area=8.775 ac 62.63% Impervious Runoff Depth=1.28"

Tc=5.0 min CN=70/98 Runoff=2.63 cfs 0.934 af

SubcatchmentPRP-2: PRP-2

Runoff Area=13.350 ac 44.26% Impervious Runoff Depth=0.83"

Flow Length=597' Tc=7.9 min CN=51/98 Runoff=2.75 cfs 0.925 af

Total Runoff Area = 44.513 ac Runoff Volume = 3.176 af Average Runoff Depth = 0.86"**56.23% Pervious = 25.030 ac 43.77% Impervious = 19.483 ac**

EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

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Summary for Subcatchment EX-1: EX-1

Runoff = 1.64 cfs @ 7.88 hrs, Volume= 0.591 af, Depth= 1.12"

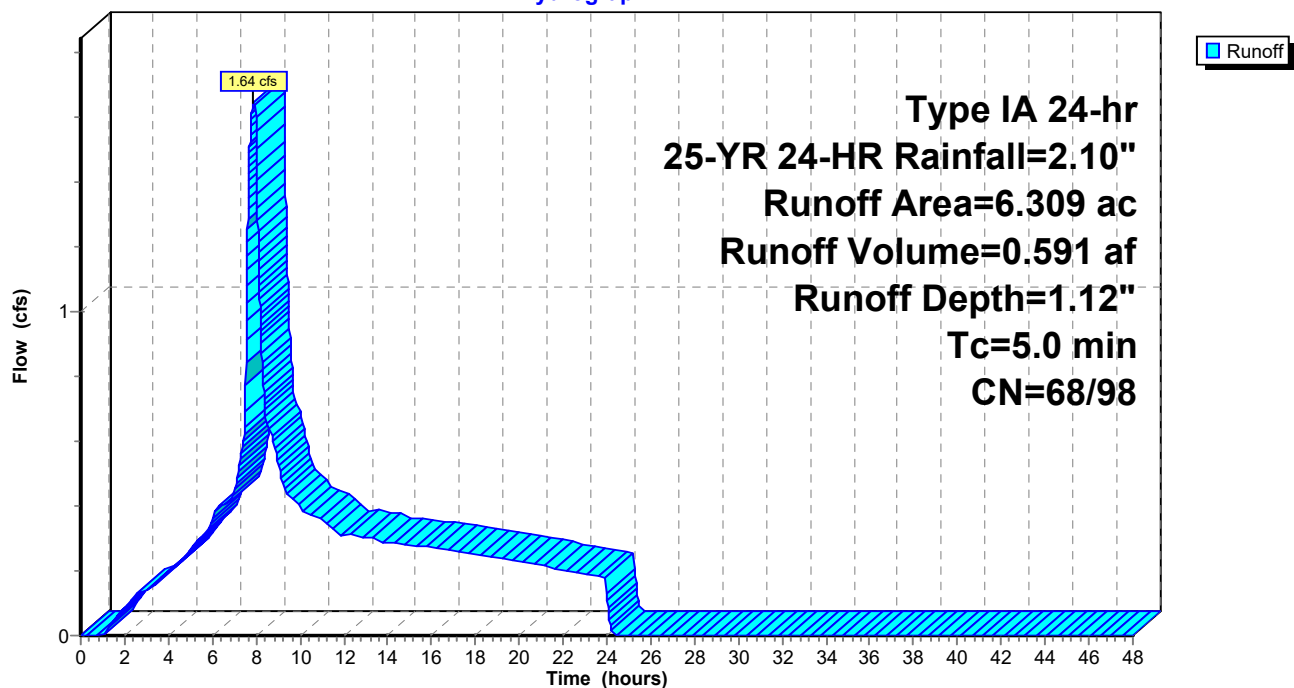
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

Area (ac)	CN	Description
2.822	68	<50% Grass cover, Poor, HSG A
3.171	98	Paved parking, HSG A
0.051	96	Gravel surface, HSG A
0.265	98	Unconnected roofs, HSG A
6.309	85	Weighted Average
2.873	68	45.54% Pervious Area
3.436	98	54.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment EX-1: EX-1

Hydrograph



EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

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Summary for Subcatchment EX-2: EX-2

Runoff = 0.09 cfs @ 8.00 hrs, Volume= 0.034 af, Depth= 0.15"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

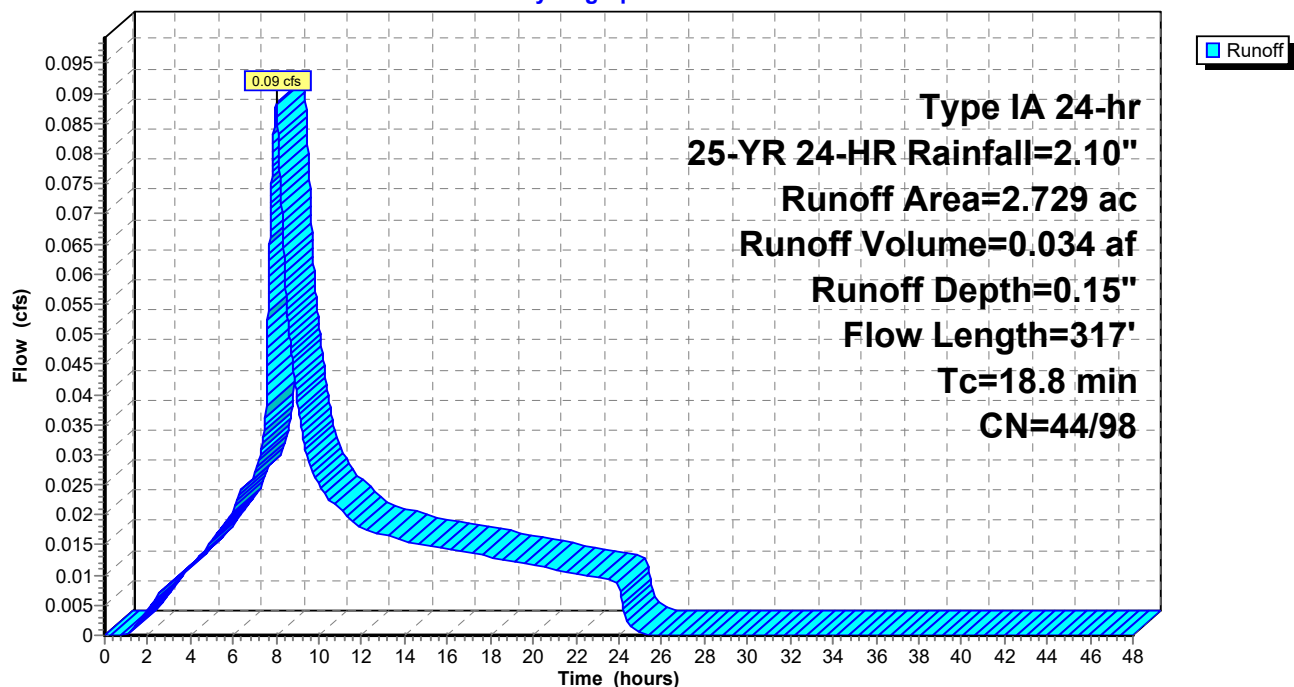
Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

Area (ac)	CN	Description
2.294	39	>75% Grass cover, Good, HSG A
0.219	98	Paved parking, HSG A
0.216	96	Gravel surface, HSG A
2.729	48	Weighted Average
2.510	44	91.98% Pervious Area
0.219	98	8.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.6	142	0.0200	0.13		Sheet Flow, Sheet
					Grass: Short n= 0.150 P2= 1.73"
1.2	175	0.0230	2.44		Shallow Concentrated Flow, Shallow
					Unpaved Kv= 16.1 fps
18.8	317	Total			

Subcatchment EX-2: EX-2

Hydrograph



EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

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Summary for Subcatchment EX-3: EX-3

Runoff = 2.06 cfs @ 7.93 hrs, Volume= 0.691 af, Depth= 0.62"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

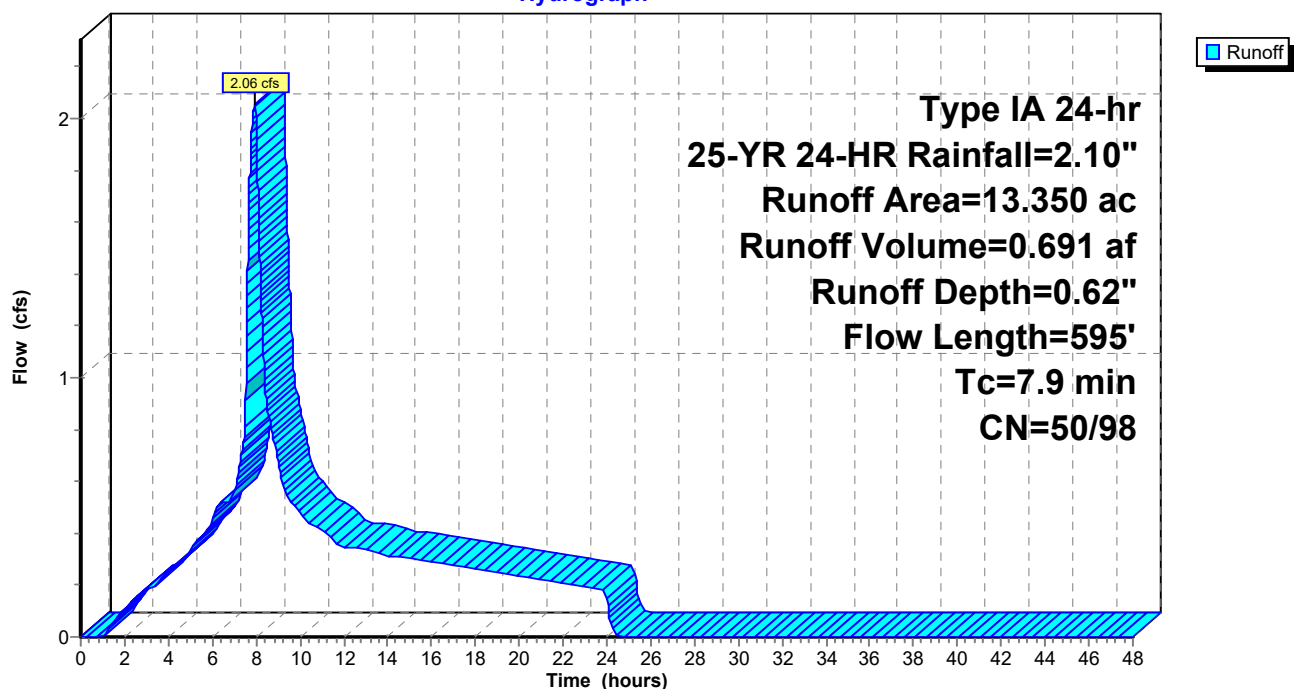
Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

Area (ac)	CN	Description
8.682	49	50-75% Grass cover, Fair, HSG A
4.423	98	Paved parking, HSG A
0.245	96	Gravel surface, HSG A
13.350	66	Weighted Average
8.927	50	66.87% Pervious Area
4.423	98	33.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	145	0.0120	0.89		Sheet Flow, Sheet - Pavement Smooth surfaces n= 0.011 P2= 1.73"
1.0	143	0.0140	2.40		Shallow Concentrated Flow, Shallow - Pavement Paved Kv= 20.3 fps
4.2	307	0.0150	1.22		Shallow Concentrated Flow, Shallow - Grass Infield Nearly Bare & Untilled Kv= 10.0 fps
7.9	595	Total			

Subcatchment EX-3: EX-3

Hydrograph



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Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

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Summary for Subcatchment PRP-1: PRP-1

Runoff = 2.63 cfs @ 7.88 hrs, Volume= 0.934 af, Depth= 1.28"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

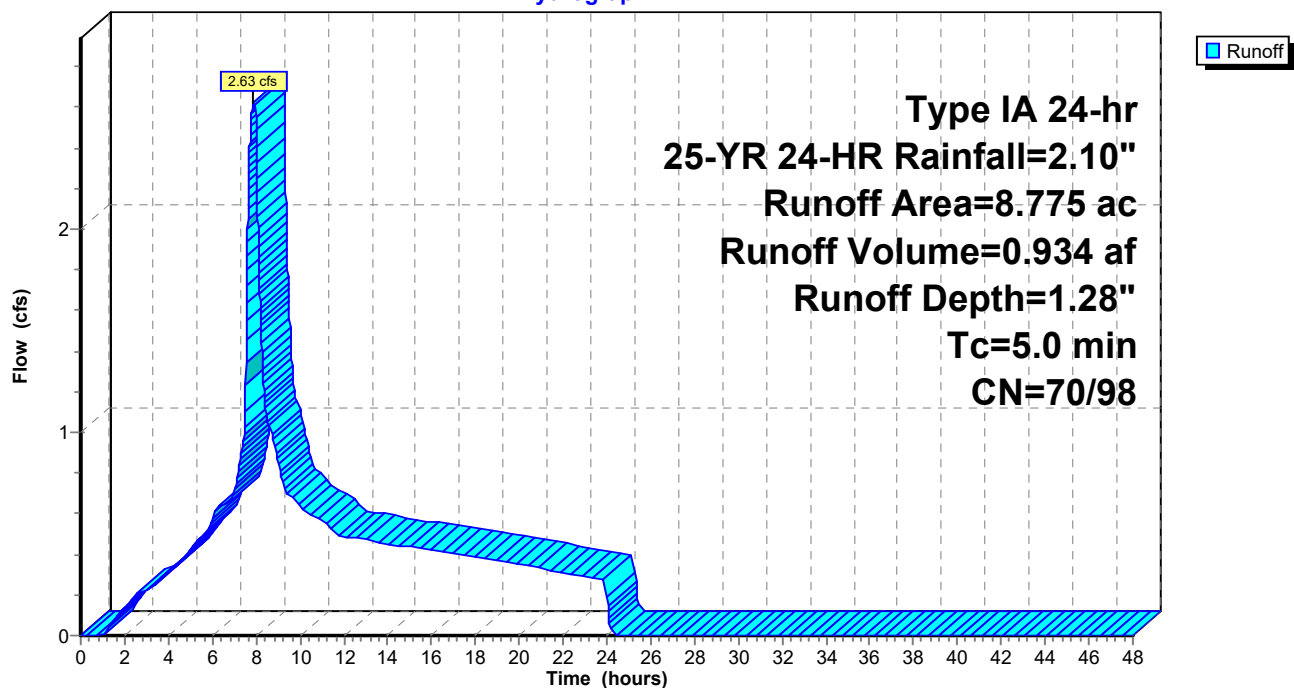
Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

Area (ac)	CN	Description
2.988	68	<50% Grass cover, Poor, HSG A
5.231	98	Paved parking, HSG A
0.291	96	Gravel surface, HSG A
0.265	98	Unconnected roofs, HSG A
8.775	88	Weighted Average
3.279	70	37.37% Pervious Area
5.496	98	62.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment PRP-1: PRP-1

Hydrograph



EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

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Summary for Subcatchment PRP-2: PRP-2

Runoff = 2.75 cfs @ 7.93 hrs, Volume= 0.925 af, Depth= 0.83"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

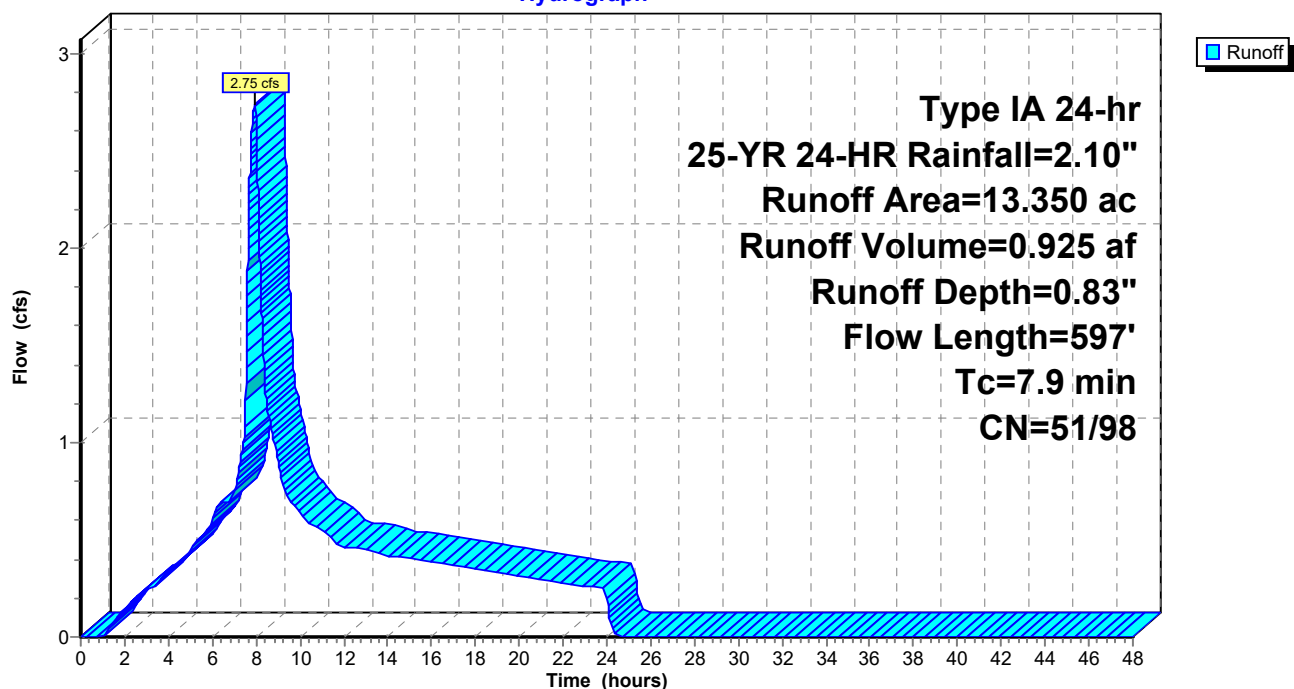
Type IA 24-hr 25-YR 24-HR Rainfall=2.10"

Area (ac)	CN	Description
7.196	49	50-75% Grass cover, Fair, HSG A
5.909	98	Paved parking, HSG A
0.245	96	Gravel surface, HSG A
13.350	72	Weighted Average
7.441	51	55.74% Pervious Area
5.909	98	44.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	145	0.0120	0.89		Sheet Flow, Sheet - Pavement Smooth surfaces n= 0.011 P2= 1.73"
1.0	144	0.0140	2.40		Shallow Concentrated Flow, Shallow - Pavement Paved Kv= 20.3 fps
4.2	308	0.0150	1.22		Shallow Concentrated Flow, Shallow - Infield Nearly Bare & Untilled Kv= 10.0 fps
7.9	597	Total			

Subcatchment PRP-2: PRP-2

Hydrograph



EAT Calculations - 100%*Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"*

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Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points

Runoff by SBUH method, Split Pervious/Imperv.

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentEX-1: EX-1

Runoff Area=6.309 ac 54.46% Impervious Runoff Depth=1.51"

Tc=5.0 min CN=68/98 Runoff=2.14 cfs 0.794 af

SubcatchmentEX-2: EX-2

Runoff Area=2.729 ac 8.02% Impervious Runoff Depth=0.19"

Flow Length=317' Tc=18.8 min CN=44/98 Runoff=0.11 cfs 0.044 af

SubcatchmentEX-3: EX-3

Runoff Area=13.350 ac 33.13% Impervious Runoff Depth=0.82"

Flow Length=595' Tc=7.9 min CN=50/98 Runoff=2.61 cfs 0.912 af

SubcatchmentPRP-1: PRP-1

Runoff Area=8.775 ac 62.63% Impervious Runoff Depth=1.70"

Tc=5.0 min CN=70/98 Runoff=3.47 cfs 1.241 af

SubcatchmentPRP-2: PRP-2

Runoff Area=13.350 ac 44.26% Impervious Runoff Depth=1.09"

Flow Length=597' Tc=7.9 min CN=51/98 Runoff=3.49 cfs 1.212 af

Total Runoff Area = 44.513 ac Runoff Volume = 4.203 af Average Runoff Depth = 1.13"**56.23% Pervious = 25.030 ac 43.77% Impervious = 19.483 ac**

EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Subcatchment EX-1: EX-1

Runoff = 2.14 cfs @ 7.92 hrs, Volume= 0.794 af, Depth= 1.51"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

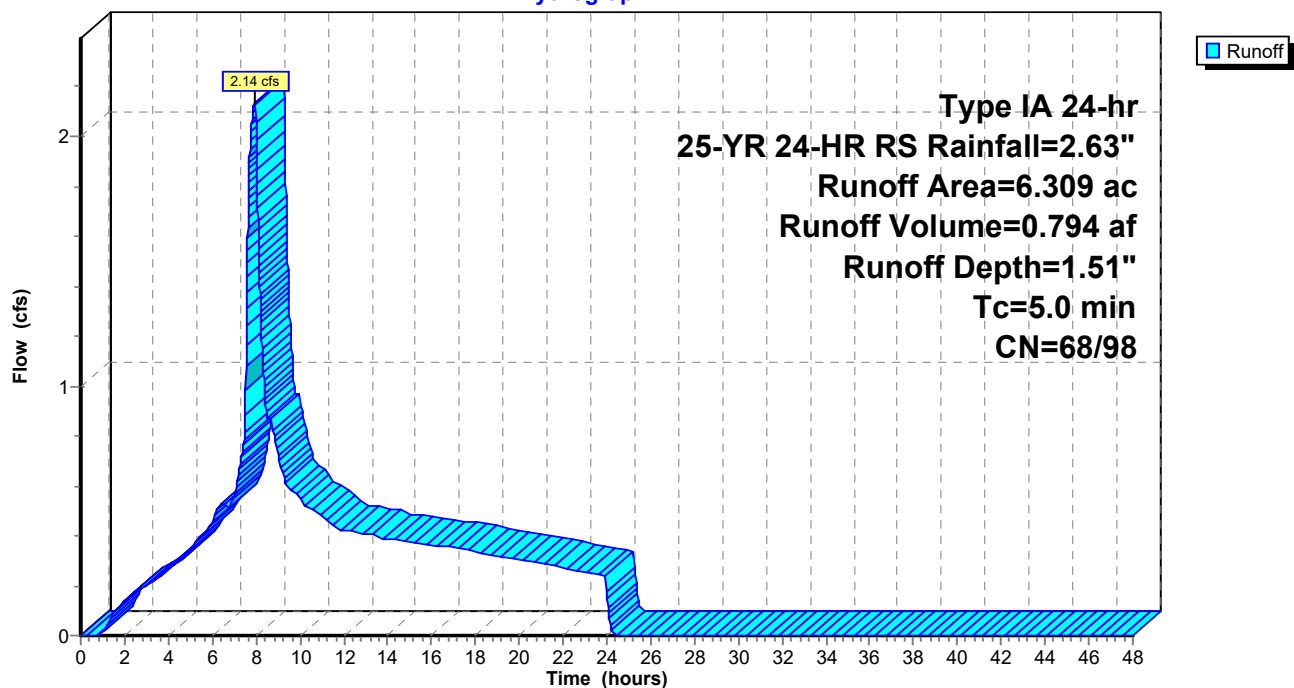
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
2.822	68	<50% Grass cover, Poor, HSG A
3.171	98	Paved parking, HSG A
0.051	96	Gravel surface, HSG A
0.265	98	Unconnected roofs, HSG A
6.309	85	Weighted Average
2.873	68	45.54% Pervious Area
3.436	98	54.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment EX-1: EX-1

Hydrograph



EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Subcatchment EX-2: EX-2

Runoff = 0.11 cfs @ 8.00 hrs, Volume= 0.044 af, Depth= 0.19"

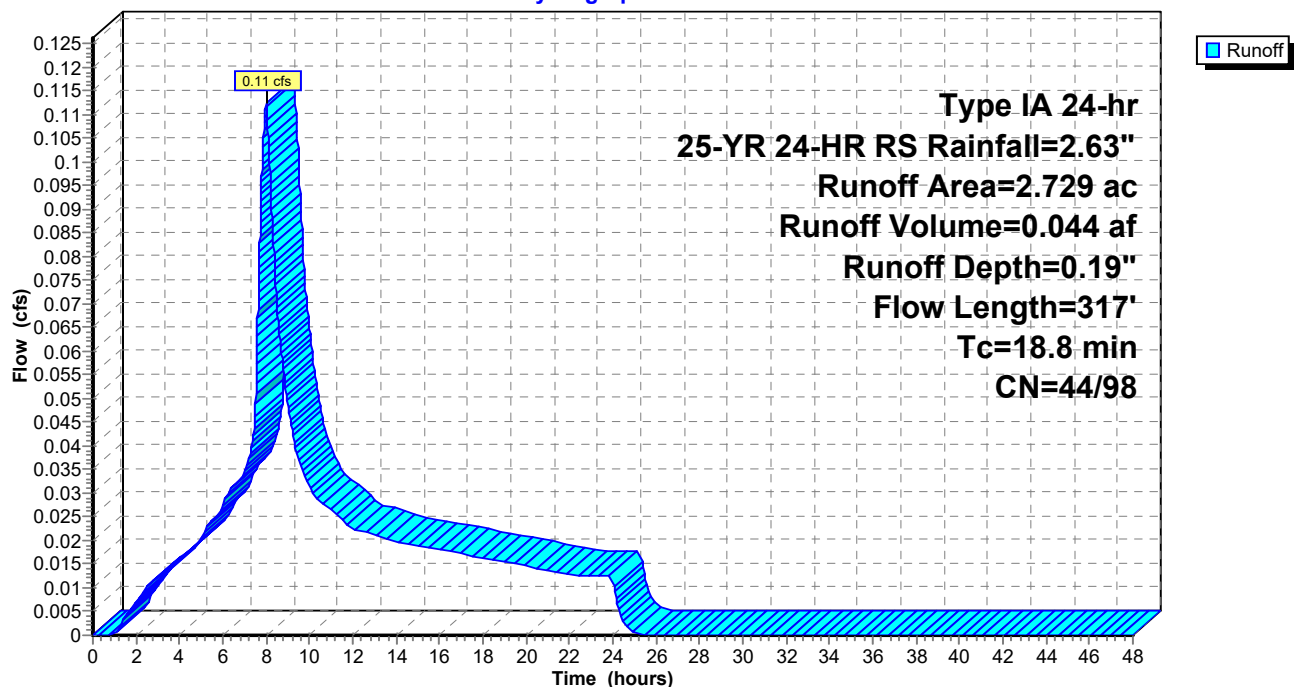
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
2.294	39	>75% Grass cover, Good, HSG A
0.219	98	Paved parking, HSG A
0.216	96	Gravel surface, HSG A
2.729	48	Weighted Average
2.510	44	91.98% Pervious Area
0.219	98	8.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.6	142	0.0200	0.13		Sheet Flow, Sheet
					Grass: Short n= 0.150 P2= 1.73"
1.2	175	0.0230	2.44		Shallow Concentrated Flow, Shallow
					Unpaved Kv= 16.1 fps
18.8	317	Total			

Subcatchment EX-2: EX-2

Hydrograph



EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Subcatchment EX-3: EX-3

Runoff = 2.61 cfs @ 7.93 hrs, Volume= 0.912 af, Depth= 0.82"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

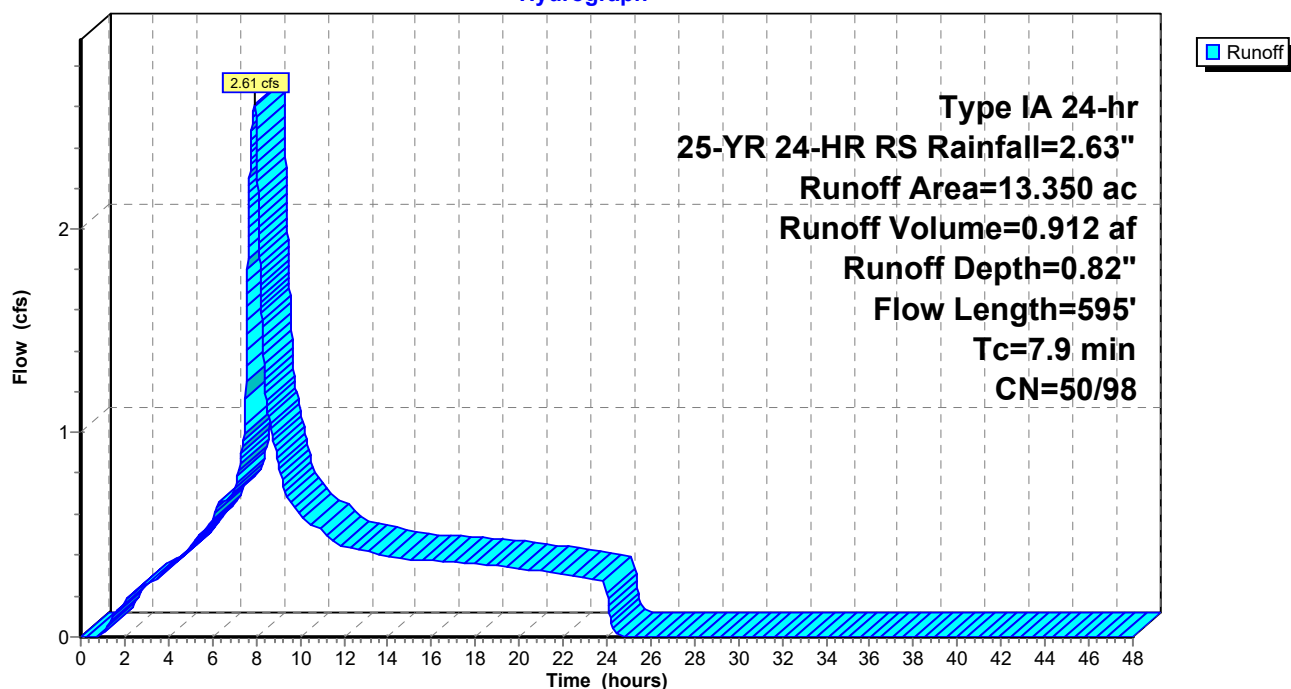
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
8.682	49	50-75% Grass cover, Fair, HSG A
4.423	98	Paved parking, HSG A
0.245	96	Gravel surface, HSG A
13.350	66	Weighted Average
8.927	50	66.87% Pervious Area
4.423	98	33.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	145	0.0120	0.89		Sheet Flow, Sheet - Pavement
					Smooth surfaces n= 0.011 P2= 1.73"
1.0	143	0.0140	2.40		Shallow Concentrated Flow, Shallow - Pavement
					Paved Kv= 20.3 fps
4.2	307	0.0150	1.22		Shallow Concentrated Flow, Shallow - Grass Infield
					Nearly Bare & Untilled Kv= 10.0 fps
7.9	595	Total			

Subcatchment EX-3: EX-3

Hydrograph



EAT Calculations - 100%

Prepared by Mead & Hunt, Inc.

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Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Subcatchment PRP-1: PRP-1

Runoff = 3.47 cfs @ 7.91 hrs, Volume= 1.241 af, Depth= 1.70"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

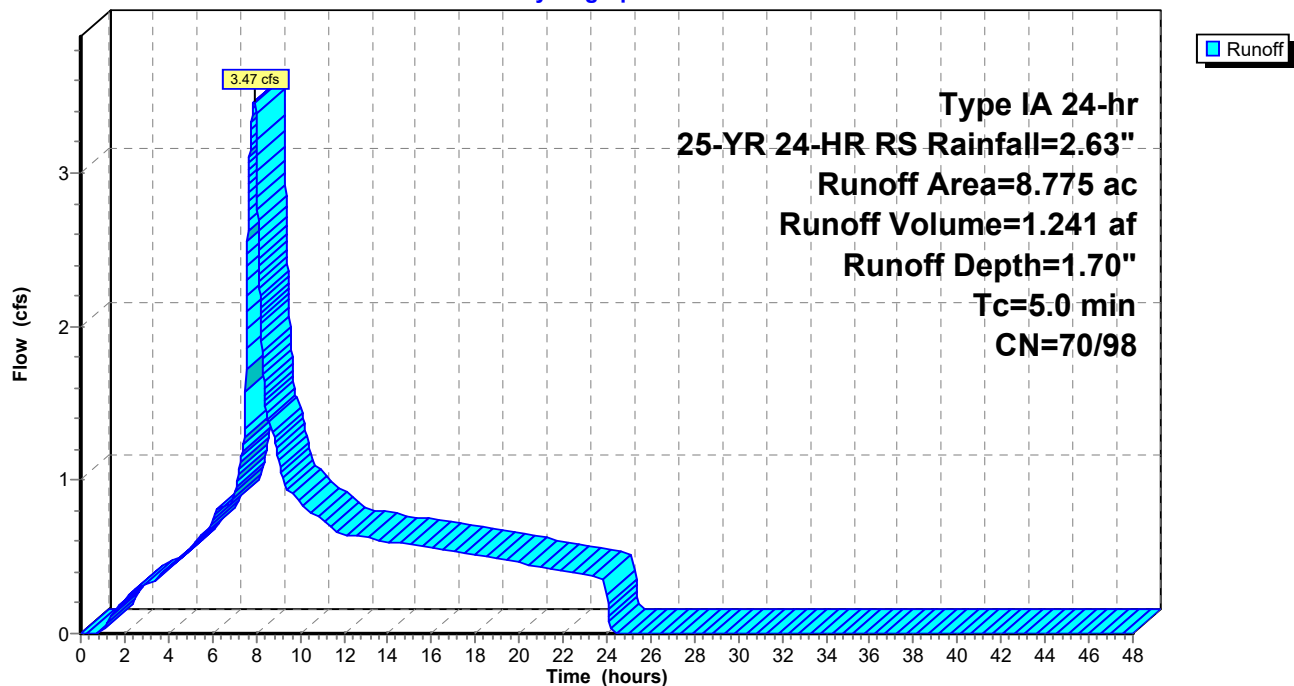
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
2.988	68	<50% Grass cover, Poor, HSG A
5.231	98	Paved parking, HSG A
0.291	96	Gravel surface, HSG A
0.265	98	Unconnected roofs, HSG A
8.775	88	Weighted Average
3.279	70	37.37% Pervious Area
5.496	98	62.63% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment PRP-1: PRP-1

Hydrograph



EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Subcatchment PRP-2: PRP-2

Runoff = 3.49 cfs @ 7.93 hrs, Volume= 1.212 af, Depth= 1.09"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

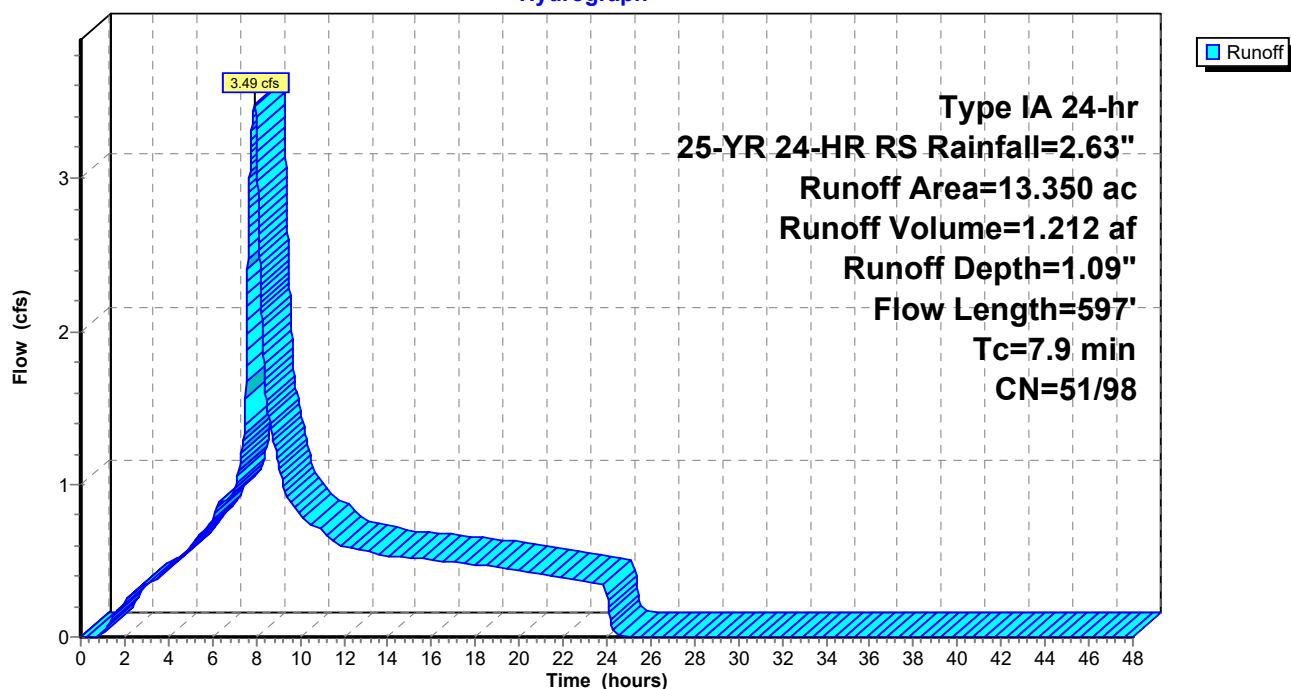
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
7.196	49	50-75% Grass cover, Fair, HSG A
5.909	98	Paved parking, HSG A
0.245	96	Gravel surface, HSG A
13.350	72	Weighted Average
7.441	51	55.74% Pervious Area
5.909	98	44.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	145	0.0120	0.89		Sheet Flow, Sheet - Pavement Smooth surfaces n= 0.011 P2= 1.73"
1.0	144	0.0140	2.40		Shallow Concentrated Flow, Shallow - Pavement Paved Kv= 20.3 fps
4.2	308	0.0150	1.22		Shallow Concentrated Flow, Shallow - Infield Nearly Bare & Untilled Kv= 10.0 fps
7.9	597	Total			

Subcatchment PRP-2: PRP-2

Hydrograph



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Appendix D. Aircraft Deicing Runoff Management Report



Appendix D: Final - Aircraft Deicing Runoff Management Report

Pangborn Memorial Airport
Terminal Apron Reconstruction

May 18, 2021



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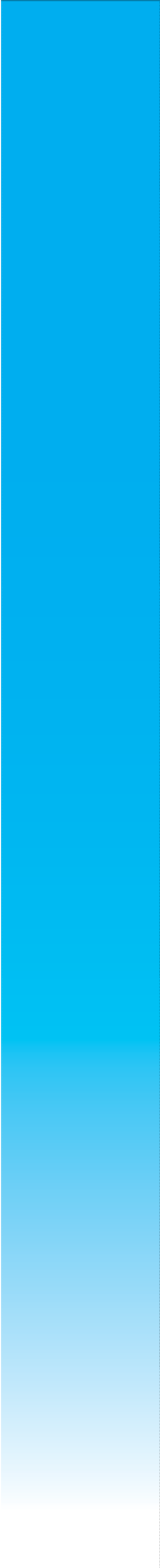
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APPENDICES

- Appendix A - Options for Disposal of Aircraft Deicing Runoff
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1. PROJECT DESCRIPTION

The Pangborn Memorial Airport (EAT, Airport) is a commercial airport in Douglas County, Washington located southeast of Wenatchee and East Wenatchee with primary roadway access via Grant Road. The Airport is owned and operated by the Chelan Douglas Regional Port Authority (CDRPA).

The Project includes reconstruction and expansion of the terminal apron which is considered a redevelopment project. The terminal apron will be used for aircraft loading and unloading of passengers at the terminal. Fueling of the aircraft will occur on the terminal ramp. An extension to the apron to the northwest is included for dedicated aircraft deicing activities. The project vicinity is shown in **Figure 1** and the project location is in **Figure 2**.



FIGURE 1. VICINITY MAP

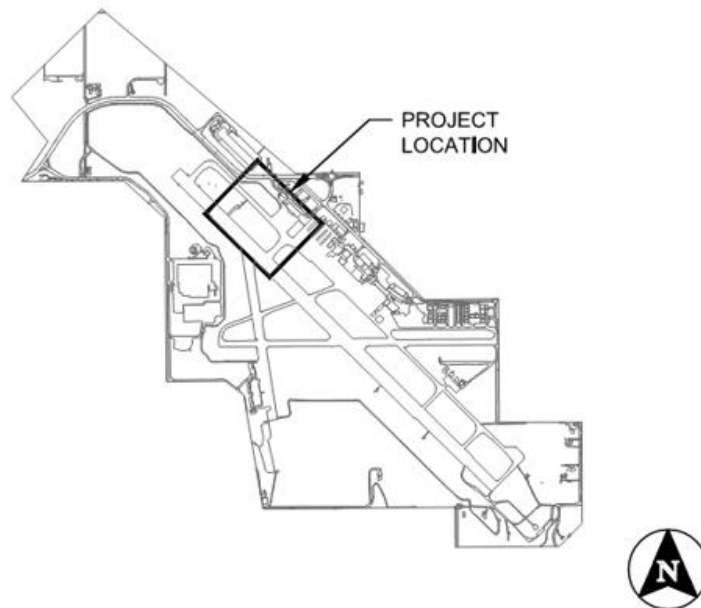


FIGURE 2. PROJECT LOCATION

Operators use deicing and/or anti-icing compounds on aircraft to control ice and snow. Typically, ethylene glycol and propylene glycol are the deicing chemicals used on aircraft. The deicing and anti-icing compounds have environmental impacts when conveyed to storm drains or to receiving water after application. Leaks and spills of these chemicals can also occur during their handling and storage. Only propylene glycol is utilized for deicing at EAT. No pavement deicers are utilized.

A Deicing Runoff Management Concept was developed as part of the project's Environmental Assessment and Preliminary Engineering Report in 2020. The project will include recommendations from that assessment for controlling runoff from aircraft deicing. All commercial aircraft deicing will be conducted on the reconstructed terminal apron. At present, spent aircraft deicing fluids (ADF) are not contained, captured, or treated.

The plan is intended to satisfy federal, state, and local regulations, with consideration of meeting increasingly more stringent requirements in the future. This document provides a general planning-level analysis to identify options associated with airline deicing activities, as part of planning for future airline apron pavement improvements and expansion considerations.

2. REGULATORY REQUIREMENTS

Deicing activities are subject to regulatory requirements intended to maintain operational safety and environmental protection. The following are federal and state statutory regulations pertaining to aircraft deicing and runoff management practices.

2.1 Federal

The Federal Aviation Administration (FAA) sets standards and establishes requirements to ensure that aircraft are maintained free of snow, ice, and other frozen contamination during wintertime conditions. FAA requires that aircraft deicers and anti-icers be certified as meeting Society of Automotive Engineers (SAE) International specifications. The protocols used by individual aircraft operators are described in FAA approved snow and ice control plans. Following are specific FAA Advisories which address deicing management:

- Airport Drainage Design, FAA Advisory Circular 150/5320-5D, April 2020
- Design of Aircraft Deicing Facilities, FAA Advisory Circular 150/5300-14D, March 2020

Discharges of stormwater containing aircraft to surface waterbody or to a storm sewer system that drains to a surface water are regulated under the National Pollutant Discharge Elimination System (NPDES) permit system. At the national level, minimum technology-based requirements for managing spent aircraft deicing runoff (SADR) are defined in Effluent Limitations Guidelines and New Source Performance Standards for the Airport Deicing Category (Federal Register, 77 (95): 29168 – 29205, May 2012). U.S. Environmental Protection Agency (U.S. EPA) 40 CFR Part 449 addresses the guidelines and new source performance standards to control discharges of pollutants from airport deicing operations.

2.2 State of Washington

The Washington State Department of Ecology (Ecology) administers the NPDES permitting process in the state. Discharges of stormwater associated with industrial activities at airports, including deicing of aircraft and airfield pavements, to a surface waterbody or storm sewer system that drains to a surface water are

authorized under the NPDES Industrial Stormwater General Permit (ISGP). Ecology developed the 2019 Stormwater Management Manual for Eastern Washington (SWMMEW) to provide guidance in stormwater design and management for eastern Washington associated with new development and redevelopment projects. As indicated in Chapter 8, Section S405E, “Spent glycol discharges in aircraft application areas are **process wastewaters** that are regulated under Ecology’s industrial stormwater general permit.” Facilities that discharge stormwater to the ground via infiltration facilities may be regulated by State Ground Water Quality Standards (Chapter 173-200 Washington Administrative Code). The Underground Injection Well Program (UIC) protects groundwater by regulating discharges to manmade structures, including drywells.

The Airport currently drains to a variety of infiltration facilities around the Airport with no direct discharge to surface waters of the State. As such, the Airport is exempt from coverage under the NPDES Permit for industrial and construction activities.

Several meetings were coordinated with Ecology during the winter of 2020-2021. In February of 2021, Ecology confirmed their position on discharging SADR to a drywell or infiltration trench. Discharge of SADR to groundwater (treated or untreated) is prohibited by Ecology and was ruled out as a disposal option.

2.2.1 Best Management Practices

The 2019 SWMMEW identifies the following Best Management Practices (BMPs) applicable to aircraft deicing operations:

Applicable BMPs for Aircraft:

- Conduct aircraft deicing or anti-icing applications in impervious containment areas.
- Collect spent aircraft deicing or anti-icing chemicals, such as glycol, draining from aircraft in deicing or anti-icing application areas and convey them to a sanitary sewer, treatment, or other approved disposal or recovery method. Divert SADR from paved gate areas to appropriate collection areas or conveyances for proper treatment or disposal.
- Do not discharge spent deicing or anti-icing chemicals or stormwater contaminated with aircraft deicing or anti-icing chemicals from application areas, including gate areas, into storm drains. **No discharge to receiving water, or ground water, directly or indirectly should occur.**
- Transfer deicing and anti-icing chemicals on an impervious containment pad, or equivalent spill/leak containment area, and store in secondary containment areas. See S428E: BMPs for Storage of Liquids in Permanent Aboveground Tanks.

Recommended BMPs for Aircraft

- Establish a centralized aircraft deicing/anti-icing facility, if practicable, or in designated areas of the tarmac equipped with separate collection drains for SADR.
- Consider installing an aircraft deicing/anti-icing chemical recovery system, or contract with a chemical recycler.

2.3 Airport Cooperative Research Program (ACRP)

The Airport Cooperative Research Program (ACRP) is an industry-driven, applied research program that develops practical solutions to problems faced by airport operators. Funding more than 20 projects a year, ACRP focuses on issues that other Federal research programs do not address. So far, ACRP has produced more than 400 practical resources and tools for airport practitioners and makes them available for free. The following documents were consulted during preparation of this manual:

- ACRP Report 14 2nd Edition Deicing Planning Guidelines and Practices for Stormwater Management System, 2020
- ACRP Project 02-71 Decision Support Tool, V. 3.0, (accompanies ACRP Research Report 14, 2nd edition), 2020
- ACRP Report 99 Guidance for Treatment of Airport Stormwater Containing Deicers, 2013

3. EXISTING AIRLINE APRON DEICING OPERATIONS

Horizon Airlines conducts deicing activities at the apron using both Type I (Propylene-Based; 88% propylene glycol) and Type IV (Propylene-Based; 50% propylene glycol) ADF, typically applied between October and April. Type I deicing fluids are thin-bodied fluids that are applied hot to remove frozen build-up and are diluted 50/50 with water prior to application. Type IV anti-icing fluids are more viscous and are used to prevent frozen material from adhering to the aircraft prior to takeoff. Type IV is not diluted before application. Average annual usage of undiluted Type I and Type IV is estimated in Table 1. Monthly data was not available.

TABLE 1: DEICING FLUID APPLIED SEASONALLY

	Type I	Type IV	Total
Volume (gal) for 2016-17	2500	825	3325
Volume (gal) for 2017-18	2250	550	2800
Volume (gal) for 2018-19	6500	1,100	7600
Volume (gal) for 2019-20	1500	530	2030
Volume (gal) for 2020-21	2855	363	3218
Average Annual Use (gal)	3121	674	3795

Airline deicing is performed exclusively on the airline apron and involves one aircraft deicing operation at a time. It is assumed Horizon's deicing practices will remain consistent, with deicing at the gate. General aviation deicing events do not occur on the airline apron and are not considered as part of the airline apron deicing discharge. General aviation deicing is typically applied with small portable sprayers and the volumes involved are considered negligible for this analysis.

Figure 3 identifies current deicing activities, along with factors associated with current and future deicing operations on the airline apron. SADR is generated and conveyed by the apron trench drainage system. The Airport removes snow from the airline apron, with the primary snow dump located to the southeast of the apron edge, and a secondary location to the northwest of the apron. The Airport does not transport snow beyond the existing snow dump areas along the periphery of the apron.

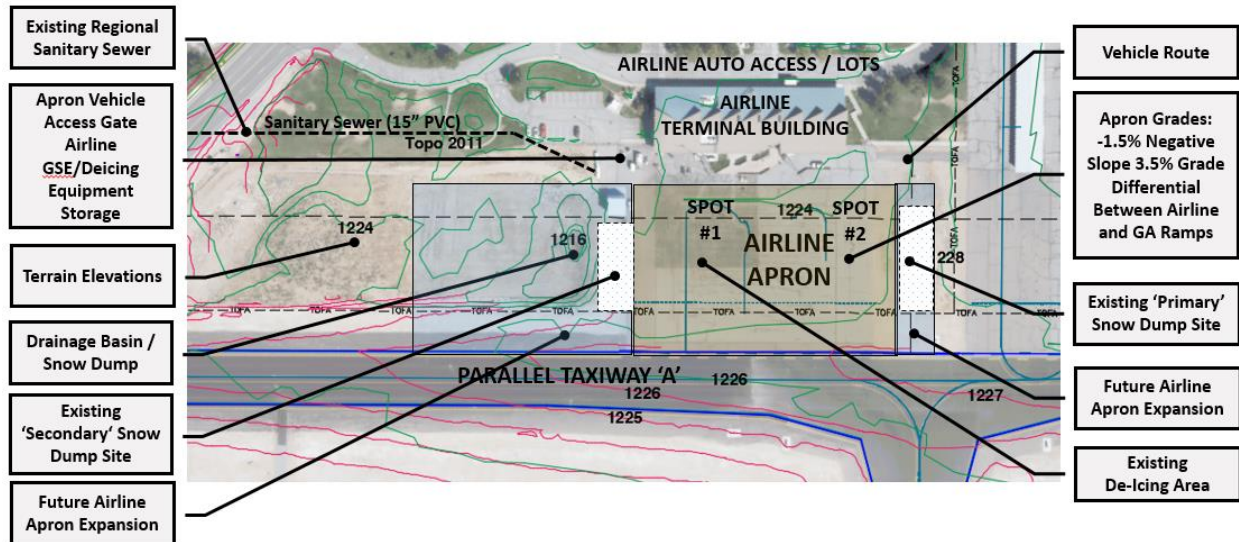


FIGURE 3. FACTORS RELEVANT TO AIRLINE APRON DEICING OPERATIONS

Stormwater from the existing apron and roof drains flow into an existing depression to the northwest of the existing apron (**Figure 3**). Runoff is diverted to this depression through an 8" PVC pipe from the apron, and a 8" PVC pipe from the roof drains. There are no drawings on record, nor any visible evidence of subsurface infrastructure in place within the depression. Additionally, there is no record indicating the depression is a permitted Underground Injection Control (UIC). As such, there will be no UIC decommissioning applications submitted as part of this project. This depression will be backfilled entirely during construction of the expanded apron.



FIGURE 4. STORMWATER AND ROOF DRAIN RUNOFF INFILTRATION DEPRESSION

4. DEICING ANALYSIS

4.1 Deicing System Components and Considerations

This functional category represents the infrastructure and operational practices that isolate and contain runoff from aircraft deicing operations, then convey to storage and ultimate disposal. SADR management systems consist of collection, storage, and disposal components that work in combination. For small commercial service airports with limited deicing operations, such as Pangborn Memorial Airport, preference is given to simple and cost-effective approaches that rely on passive collection of SADR, gravity flow, and manual operation of any structural features that may be required.

4.1.1 Deicing Containment and Collection

The first consideration in containment is identifying designated deicing areas where the drainage system provides isolation and containment. These consist of one or more paved areas with isolated and contained drainage designed to accommodate single or multiple aircraft undergoing deicing operations at a time. At gate deicing is operationally convenient and allows multiple aircraft to be deiced simultaneously. Once an aircraft is deiced at the gate, it can move immediately to taxiing and take-off. The disadvantages of at gate deicing include increased ground support equipment (GSE) traffic around the terminal ramp, GSE and personnel operating on pavement that can be wet and slippery from the spent deicers, larger drainage areas and volumes of runoff to be managed, and typically lower collection efficiencies (i.e., fraction of applied deicers captured).

In this case, a deicing pad is proposed on the southwest of the existing terminal ramp. However, this will only be used for general aviation. Horizon deicing operations will continue to occur exclusively at the gate, as the Airline does not have available equipment and manpower to move planes to a dedicated deicing pad. As such, SADR will be captured from both the deicing pad and apron. **Figure 5** shows the proposed deicing pad (blue) and apron (purple).

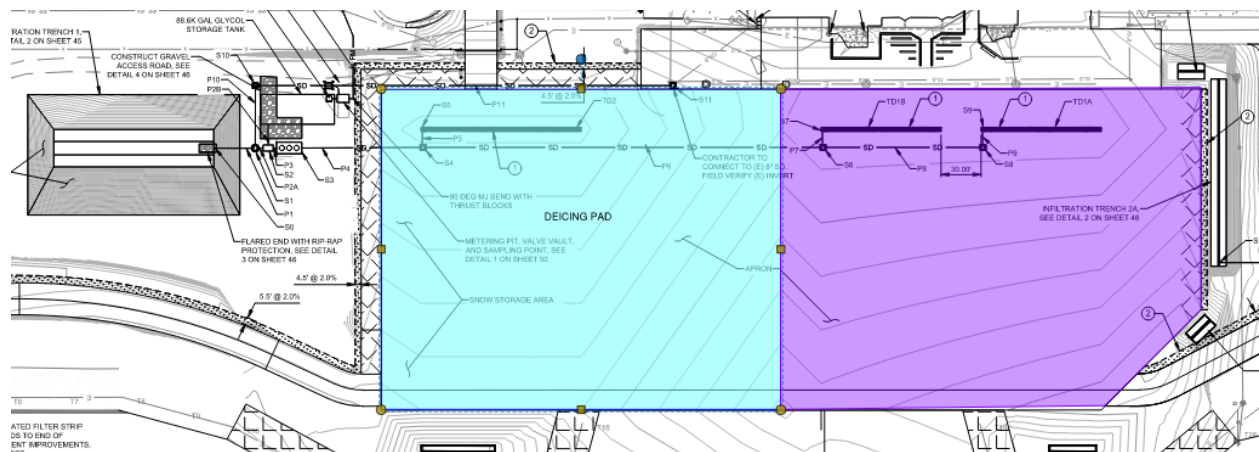


FIGURE 5: PROPOSED DEICING PAD

4.1.2 Collection

Ecology recommends that runoff from the apron during the non-deicing season does not discharge to UICs. UICs are defined and regulated by Chapter 173-218 WAC. Infiltration ponds, dispersion systems, or infiltration trenches that do not contain a perforated pipe are exempt from UIC well status per WAC 173-

218-050.

The recommended approach involves removal of the existing trench drain system from the apron to a configuration that allows interception of the SADR from the deicing pad and apron and diversion to a dedicated underground storage tank, while allowing stormwater runoff that is not associated with aircraft deicing to flow to an infiltration trench to the west of the apron.

A trench drain will collect runoff from both the deicing pad and apron. The trench drain will be connected to a manhole with a three-way plug diversion valve. During deicing season, the valve will be set to discharge SADR to a collection tank. During non-deicing season, the valve will be set to discharge stormwater runoff to the infiltration trench.

4.1.3 Deicer-Impacted Snow Removal

Snow removal from areas where aircraft are deiced can entrain low concentrations of SADR. The resulting impacted melt water would need to be managed. This could be accomplished by designating a paved “snow-dump” area for impacted snow where the melt water sheet flows into the glycol collection tank. The proposed containment area for improvements to the EAT apron is identified in **Figure 6**.

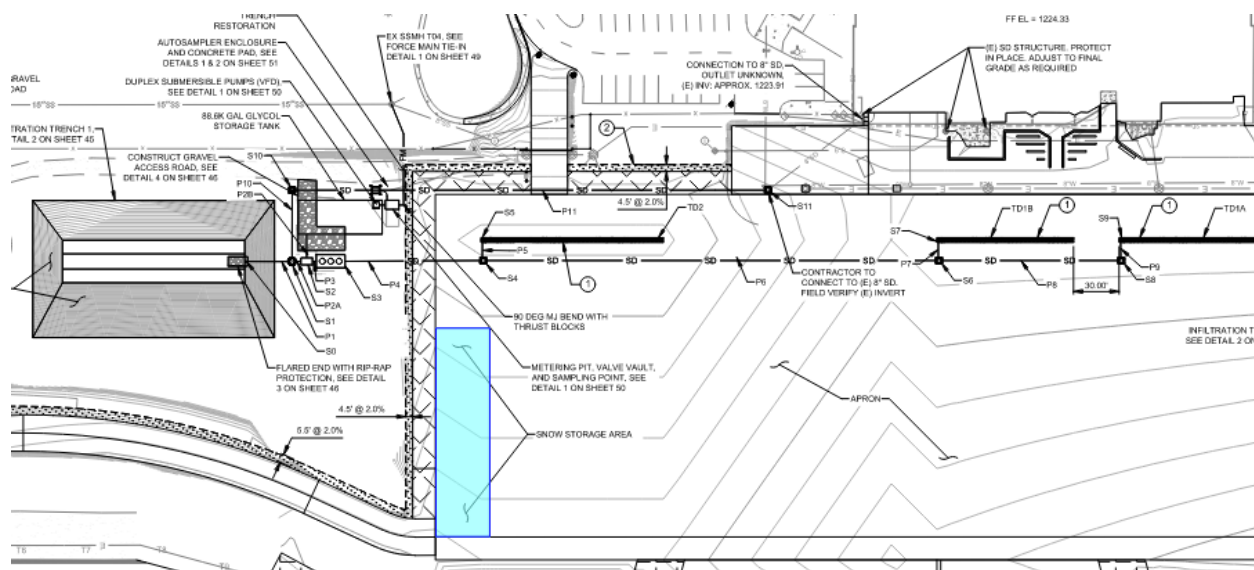


FIGURE 6: SNOW CONTAINMENT AREA

4.1.4 Diversion Valves

For the designated deicing area, runoff collection will be provided using gravity flow and structural diversions in the storm sewer network. A valve will be used to divert the flows to the appropriate destination as a function of deicing operations.

The diversion valve will have three possible positions:

- 1) Deicing mode, where flows are directed to a storage tank
- 2) Non-deicing mode, where flows are conveyed to the airport's stormwater system
- 3) Closed, to be used for containment in the event of a spill on the apron

The valve is to be located inside a vault. The valve will be operated with a portable electric actuator

from above grade. Based on the analysis for climate data discussed later in this report, it is anticipated this valve will be operated at the beginning and end of the deicing season, and intermittently as needed if precipitation events occur when deicing is not occurring. Consideration will need to be given to operational guidelines for flushing residual SADR from the surface and from collection infrastructure (e.g. possibly allow one day of flushing before manipulating the valve).

4.1.5 Storage

A storage tank is required to balance SADR flows from the collection system with treatment/disposal. A manual in-line diversion valve will direct the apron runoff to the appropriate destination based on the status of deicing operations on the apron. Considerations in locating and sizing the underground tank include minimizing pipeline lengths, proximity to the point of discharge or transfer to disposal, and accommodation of potential disruptions in availability of disposal. Sizing of storage tanks depends on the ultimate disposal method, which is discussed in greater detail in Section 4.3.

4.2 Deicing Discharge Quantities

An analysis of the estimated volumes and SADR concentrations were performed to provide a basis for evaluating disposal options. A spreadsheet-based model was used to estimate the optimum volume necessary to store SADR generated at Pangborn Memorial Airport (EAT). This model used precipitation and snowfall data from nearby Wenatchee, WA as snowfall data is not collected at EAT.

Two factors are considered in the basis of design; annual ADF use; and annual SADR collected. The model utilizes the weather parameters to estimate the SADR captured in the collection system. ADF usage data at EAT for the corresponding winter was used to estimate BOD loading.

The model assumes rainfall occurring on days when the temperature is greater than or equal to 35 degrees F is not collected and only the first 0.5" of rainfall occurring on cold days (<35 degrees F) is collected. 75% of snow falling on the apron is assumed to be impacted with deicing chemicals and collected, with the balance being plowed and stored in a designated area. The model also assumes 40% of applied ADF is collectable with the remainder being lost as overspray, remaining on the aircraft, or degraded by other means (photo-decay, volatilization, etc.). The model also assumes that 75% of the snow that falls on the apron is considered SADR impacted and collected (as melt water) for disposal.

Freezing rain and snowfall are key drivers in the use of ADF. The model assumed that deicing occurs on all days where snowfall over 1" occurs and on days when snowfall is less than 1" but precipitation occurs and the minimum temperature is less than 35 degrees F (indicator of freezing rain). The SADR distribution load over the winter is estimated by allocating ADF use based on the quantity of runoff collected on deicing days relative to the quantity collected annually.

The deicing seasons from 2016-2017 through 2020-2021 were analyzed. Annual SADR volumes collected range between 233,129 gallons (2019-2020) and 483,736 gallons (2016-2017).

Runoff volumes were estimated by multiplying the SADR collected by the size of the apron. For the deicing apron area of 162,929 square feet, **Table 2** presents the 2016-2017 seasonal average SADR captured in terms of volume and total BOD loading.

TABLE 2: 2016-2017 SEASONAL SADR STATISTICS

Seasonal Statistics - Spent Aircraft Deicing Runoff	
Impervious Area Captured (SF)	162,929
SADR Captured (Gal)	483,736

The same spreadsheet-based model estimated the Biochemical Oxygen Demand (BOD) loading associated with the collected runoff with ADF volumes from available data, ranging from 2030 gallons/year (2019-2020) to 7,600 gallons/year (2018-2019). Based on industry standard capture rates shown in **Table 3**, the seasonal BOD load is estimated at 25,080 pounds, for the October 2018 – March 2019 deicing season.

TABLE 3: BOD COLLECTED IN DEICING RUNOFF 2018-2019

DEICER TYPES AND CHARACTERISTICS		
	Type I	Type IV
Assumed Propylene Glycol concentration (%)	88%	50%
BOD Adjusted for Specific Gravity (mg/L)	1,149,200	1,171,300
Annual Use (gals)	6,500	1,100
% capture	40%	10%
BOD ₅ Captured (lbs.) Total/Season	25,080	
BOD ₅ (mg/L) Avg Concentration	9,401	

4.3 Options for Disposal of Aircraft Deicing Runoff

Various options are available to airports for the disposal of collected SADR, ranging from discharging into a sanitary sewer system to on-site treatment. The possible SADR disposal options for Pangborn Memorial Airport are described in the following discussions. An alternatives summary for disposal of SADR can be found in **Appendix A**, including capital costs, annual operating costs, and a 20-year present worth analysis based on discount rates in OMB Circular No. A-94, November 220. Real interest rates are used for discounting constant-dollar flows, as is often required in cost-effectiveness analysis.

4.3.1 Wastewater Treatment Plant Direct Discharge (Preferred Alternative)

The most common method for the disposal of collected SADR is discharge to a municipal wastewater treatment plant (WWTP), either by direct discharge to a sanitary sewer, hauling via a tanker truck to an access point in the WWTP collection network or directly to the WWTP facility. SADR is not harmful to the sanitary sewer system, is readily biodegradable, and can be completely removed by conventional WWTP technology. However, the strength of SADR, expressed as BOD, can be significantly greater than domestic sanitary sewerage, so controlled discharge into the sewer system is typically required in consideration of plant capacity and to avoid shock loading. The advantages of WWTP disposal include potential low disposal costs and operational simplicity.

The Douglas County Sewer District #1 (DCSD) provides sanitary/wastewater sewer service to the Airport. A 15" PVC gravity main supports the airline passenger terminal building, connecting to the gravity main in Grant Road. The DCSD wastewater treatment plant is located along the Columbia River, east of Sunset

Highway and just north of Highway 285.

The spreadsheet-based model was used to estimate the optimum volume necessary to store SADR generated at EAT prior to discharge to a the local WWTP. The daily estimates of runoff volume and BOD load generated were evaluated by the model to estimate the storage volume required to contain SADR under various daily BOD discharge rate scenarios. A plot of the results is shown in **Figure 7**.

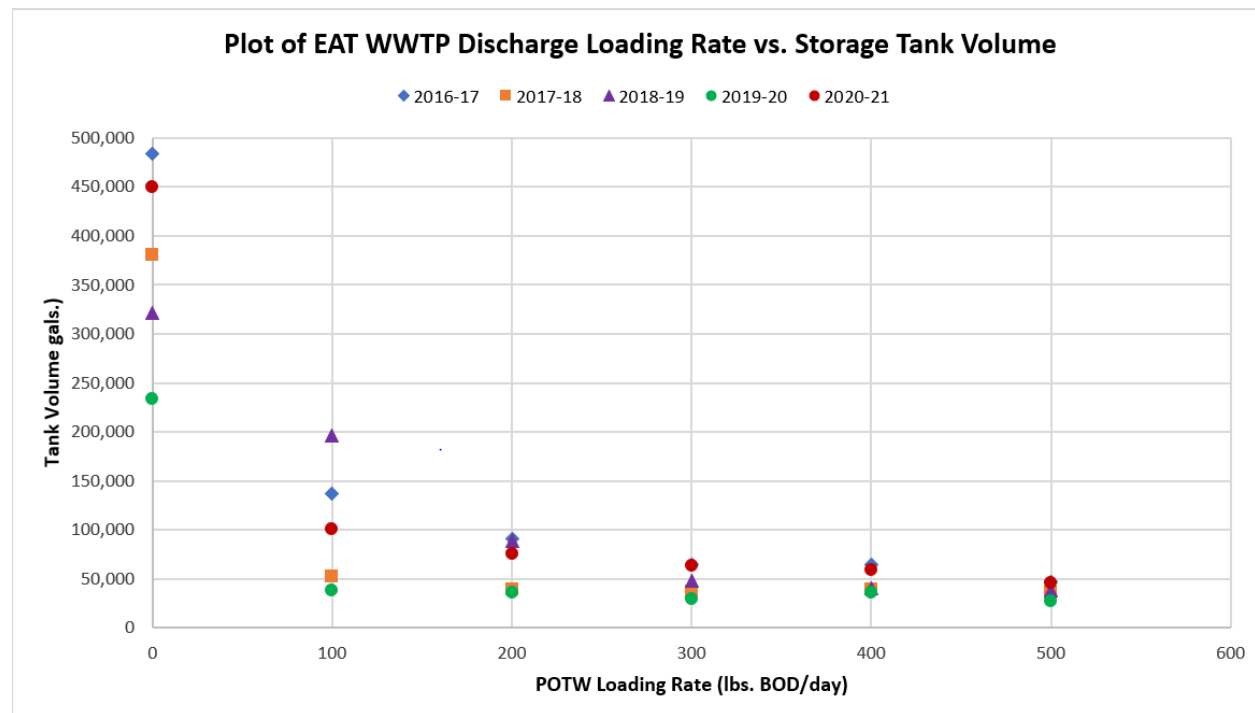


FIGURE 7. DISCHARGE LOADING VERSUS STORAGE TANK VOLUME

TABLE 4: LOADING AND STORAGE TANK VOLUMES

POTW Discharge Load (lbs. BOD/day)	Storage Tank Size (gals.)				
	2016-17	2017-18	2018-19	2019-20	2020-21
0	483736	380951	321682	233129	449799
100	137191	52894	196665	37831	100907
200	91266	39559	88806	36090	75574
300	64964	36497	47994	29170	62907
400	64964	39559	40342	36090	58685
500	47430	35460	37609	27451	46018

As shown, an optimum storage tank useable volume of 64,964 gallons is achieved at a 300 lbs./day BOD loading rate to the WWTP. A factor of safety of 1.4 was applied to account for seasonal variation, bringing the usable volume for design to 88,600. A nominal tank volume of 100,700 gallons is required after accounting for freeboard in the tank above the maximum operating water surface.

Permitting for this discharge was discussed with Washington State Department of Ecology (Ecology). The following three key thresholds are utilized in the Ecology Permit Writer's Manual to define a Potential Significant industrial User (See below and **Figure 8**). Dischargers not triggering any of these thresholds would not require a permit.

- Flow threshold <25,000 gal/day
- Loading Threshold < 0.5% of treatment plant (DCSD plant design is 7500 lbs BOD/day (ie 0.5% is 37.5 lb./day)
- Potential of the discharge negatively impact the receiving plant operations

Ecology confirmed they would consider CDRPA a Significant Industrial User and will require a State Waste Discharge Permit to a POTW.

Significant Industrial User (SIU):

- 1) All industrial users subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; and;
- 2) Any other industrial user that: discharges an average of 25,000 gallons per day or more of process wastewater to the POTW (excluding sanitary, noncontact cooling, and boiler blow-down wastewater); contributes a process wastestream that makes up five percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the Control Authority on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement (in accordance with 40 CFR 403.8(f)(6)).

Upon finding that the industrial user meeting the criteria in paragraph 2, above, has no reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement, the Control Authority may at any time, on its own initiative or in response to a petition received from an industrial user or POTW, and in accordance with 40 CFR 403.8(f)(6), determine that such industrial user is not a significant industrial user.

Potential Significant Industrial User: A potential significant industrial user is defined as an Industrial User which does not meet the criteria for a Significant Industrial User, but which discharges wastewater meeting one or more of the following criteria:

- a. Exceeds 0.5 % of treatment plant design capacity criteria and discharges <25,000 gallons per day *or*;
- b. Is a member of a group of similar industrial users which, taken together, have the potential to cause pass through or interference at the POTW (e.g., facilities which develop photographic film or paper, and car washes).

Ecology may determine that a discharger initially classified as a potential significant industrial user should be managed as a significant industrial user.

FIGURE 8. Excerpt from WA DOE, Water Quality Program, Permit Writer's Manual

Ecology would require the following submittals for review and approval, per the Washington Administrative Code (WAC):

- WAC 173-240-110 Submission of plans and reports.
- WAC 173-240-130: Engineering Report
- WAC 173-240-150: Operations and Maintenance Manual

During a 4/22/21 planning session with DCSD, the following discharges were proposed:

- 300-500 lbs. BOD desired per day to POTW (during deicing season Oct – March)
- 2000 – 20,000 mg/l BOD anticipated concentration
- 300,000 gallons total volume SADR

DCSD generally felt it would be feasible to accept the waste but did voice some operational concerns:

- Dissolved Oxygen (DO) sags; blowers in their aeration basins are not automatically controlled by DO levels in the basins; fluctuations of influent BOD could cause sags in DO which effects treatment levels
- Fluctuation of influent BOD loading by up to 20%
- Load on secondary portion of system
- Microbial growth in deicing tank; note this has not been an issue with other systems due to high BOD concentration.
- Other contaminants from the apron entering the collection system; BMPs will be in place for fueling etc.

RH2 Engineering has prepared an analysis of potential impacts of this industrial waste stream on the DCSD treatment facility, and potential changes in plant operations (**Appendix B**).

To date, DCSD has not served customers with significantly high strength wastewater and has not needed to develop a rate structure specifically for this customer category. Currently, DCSD is providing this high-level estimate of the billing rate in order to assist the discharger in weighing discharge alternatives. To accurately calculate the BOD billing portion of equation below, DCSD would need to analyze O&M costs that are largely driven by BOD, such as energy consumption and O&M related to the aeration system, autothermal thermophilic aerobic digestion (ATAD), solids handling equipment, solids disposal, etc. For the purposes of a high-level estimate, DCSD believes the monthly rate equation shown below is a good approximation.

Connection charge – calculated based on \$5,500 per ERU at 224 gpd/ERU as follows:

- Seasonal average discharge volume (average discharge Nov-Apr): ~300,000 gallons total or ~1,650 gpd average
- 1,650 gpd / 224 gpd per ERU = ~7.5 ERUs
- 7.5 x \$5,500 = \$41,250

Monthly rate – calculated based on metered flow and routinely measured BOD (or chemical oxygen demand (COD) converted to BOD):

$$ERUs = \frac{[flow(gpd)]}{224gpd} + 0.5 * \frac{[BOD(ppd)]}{0.47ppd}$$

- Flow will be totalized monthly and converted to an average daily flow for each month. The flow value in the equation will not be lower than 224 gpd.

- Average BOD will be based on the routinely measured COD values, which will be converted to BOD based on a factor established through sampling. The BOD value in the equation will not be lower than 0.47 ppd.
- The monthly charge shall not be less than \$1,000 per month, which constitutes a continual “ready-to-serve” charge
- Example annual calculation assuming ~15,000 mg/L BOD and \$43/ERU per month (**Table 5**); Total \$64,800 per year.

TABLE 5: EXAMPLE ANNUAL RATE CALCULATION

Annual Rate Calculation Example								
Waste Stream ID#	Months							
	JAN	FEB	MAR	APRIL	MAR - SEPT	OCT	NOV	DEC
SADR	85,000	81,250	37,000	<10000	0/mo.	<10000	11,000	77,500
Monthly Rate	\$16,300	\$17,300	\$7,100	\$1,000	\$1,000/mo.	\$1,000	\$2,200	\$14,900

The monthly rate calculation method would be identified in a user agreement between DCSD and CDRPA. In the future, DCSD may develop a policy for high strength dischargers. The individual user agreement with the customer may be updated at that time to be consistent with the policy, though we would not intend for that change to significantly alter the billing rate defined above.

DCSD acceptance of all or part of the applicant’s discharge of SADR would be contingent upon the implementation of all agreed-upon operational mitigation measures (e.g. flow regulation/coordination and reporting), current and future requirements and limitations of DCSD’s National Pollutant Discharge Elimination System (NPDES) permit with WDOE, and all other operational, environmental, or regulatory constraints or considerations that may arise in the future.

The advantages and disadvantages of disposal of SADR to DCSD are as follows:

Advantages:

- Widely used and proven approach
- Relatively low capital cost
- Moderately simple to operate and maintain
- Lowest annual O&M cost and 20-year present worth

Disadvantages:

- Reliance on continued availability of treatment capacity into the future
- Requires monitoring of discharge flows and concentrations
- Requires routine communication and coordination with WWTP to avoid operational problems
- Airport’s discharge could be temporarily halted if the WWTP is experiencing process problems
- Operational costs and surcharges

Design of this preferred alternative is discussed in Section 5 of this report.

Estimate capital cost of the system is \$540,524; annual O&M of \$69,800, with an estimated 20-year present worth of \$2,012,580.

4.3.2 Disposal – Off-Site Vehicle Transport and Treatment.

This option involves contracting with a company to pick-up and transport the collected SADR for off-site treatment. The company could process SADR through a municipal wastewater treatment plant system, a privately-operated industrial wastewater treatment facility, or a privately-operated land application site. This option is easy to manage but hauling and disposal costs can be significant.

Waste Management operates a landfill 1.5 miles from EAT and may be looking for liquid waste to foster bio decay and enhance the anaerobic activity in their landfill. Coordination with Waste Management is underway to learn more about the application process, acceptance parameters, and cost. Hauling costs from EAT were obtained from Clean Harbors for a single truck load (5000 gallon). This single truck hauling cost was used to estimate total hauling cost for an entire deicing season.

A 100,700 gallon below-grade storage tank (88,600 useable volume) would be required and configured with a transfer station for filling tanker trucks. The transfer station would be located for ease of truck access. Optimally, the tank and transfer station configuration should be designed with minimum piping distances. The tanker trucks would be notified on-demand for hauling, depending on precipitation events and volume of SADR remaining in the tank. Generally, the tank would be designed to contain the greatest amount of collected SADR as estimated in the model for the deicing seasons analyzed and pump-down would occur between storm events.

Advantages:

- No reliance on WWTP capacity and associated sanitary sewer infrastructure
- Relatively simple operation and maintenance requirements
- Discharge rates can be increased by arranging for more frequent tanker pick-ups
- Waste Management disposal site is in close proximity to EAT

Disadvantages:

- Availability of transport/processing companies
- Collection contract costs are significant
- Off-site transfer rates can be negatively impacted by outside factors
- Increased carbon emissions from truck hauling activities

Estimate capital cost of the system is \$292,441; annual O&M of \$286,837, with an estimated 20-year present worth of \$6,447,181.

4.3.3 Disposal - On-Site Deicing Treatment.

A variety of on-site options are available for treating captured SADR, including stabilization ponds, aerobic activated sludge plants, anaerobic fluidized bed reactors, gravel bed filters, engineered wetlands, and land application. Highly engineered industrial wastewater treatment systems are generally costly and operationally complex. However, simpler technologies, specifically land application, can be cost effective and relatively uncomplicated to operate and maintain. For the scale of operations at the Pangborn Memorial Airport, land application presents the greatest likelihood of feasible on-site treatment.

A land application facility consists of a vegetated parcel of land upon which wastewater is applied by an irrigation system at or below a maximum permitted rate. The application rate is determined by factors that include defined maximum BOD loading rates, evapotranspiration rates, soils, and type of vegetation. Typically, the vegetation is a crop, such as pasture grass. For treating SADR, a lined storage basin is required because runoff is typically collected faster than the allowable land application rate. A critical

consideration in siting and design of a facility near an airport is avoiding wildlife hazard risks.

Numerous WA State and EPA references to Land Application/Treatment of Industrial Effluent are available and include:

- WA Department of Ecology 1993 – Guidelines for the Preparation for Engineering Reports for Industrial Wastewater Land Application Systems (report requirements Chapter 173-240 WAC)
- WA Department of Ecology 2005 - Implementation Guidance for the Ground Water Quality Standards
- WA Department of Ecology 2004 – Guidance on Land Treatment of Nutrients in Wastewater, with Emphasis on Nitrogen
- WA Department of Ecology Orange Book – Criteria for Sewage Works Design, Section E3-2.1
- WA Department of Ecology Green Book – Pending Publication
- WA Department of Ecology 2012 – Application for a State Waste Discharge Permit to Discharge Industrial Wastewater to Groundwater by Land Treatment or Application
- WA Department of Health 1994 – Design Criteria for Municipal Wastewater Land Treatment Systems for Public Health Protection
- EPA 2006- Process Design Manual, Land Treatment of Municipal Wastewater Effluents (also applies to Industrial Land Treatment)
- Land Treatment Systems for Municipal and Industrial Wastes, McGraw Hill Professional Engineering; 1st edition

Other applicable references to consider for Land Application include:

- FAA Advisory Circular 150/5200-33C Hazardous Wildlife Attractants on or near Airports

The general approach for site planning and selection for a land application/treatment site is presented below (EPA 2006). This memorandum covers the first three steps in the process on a conceptual basis: wastewater characterization, land treatment suitability, and estimate of land requirements.

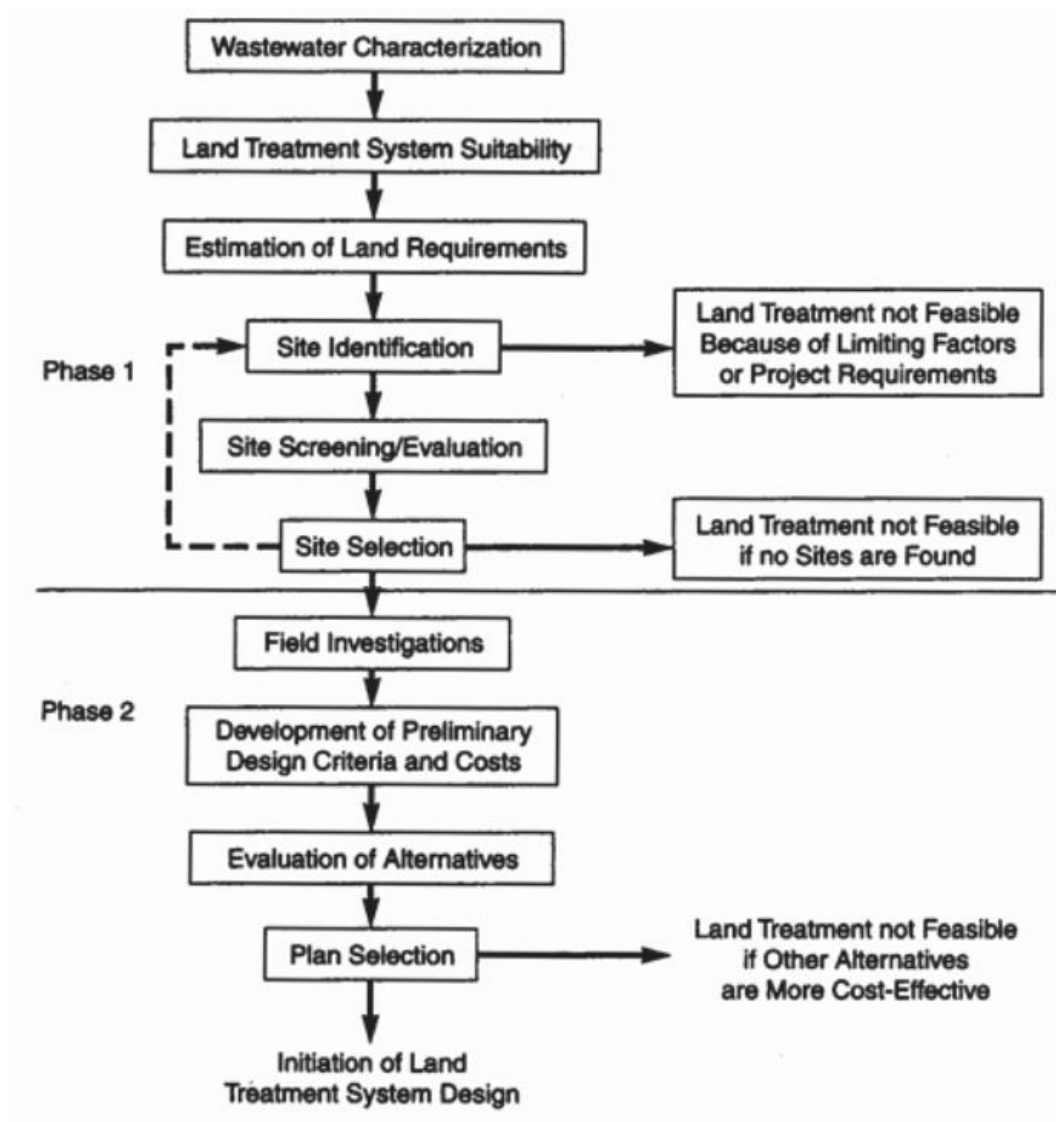


FIGURE 9. LAND APPLICATION DECISION PROCESS

4.3.4 Land Treatment System Suitability

There are numerous references in EPA 2006 that indicate slow rate (SR) sprinkler land application systems are most suitable to industrial wastewater due to the high BOD concentration. For conceptual land requirement sizing, this is the method of application assumed. For reference, the general Slow Rate Land Application Design Procedure is shown below (EPA 2006):

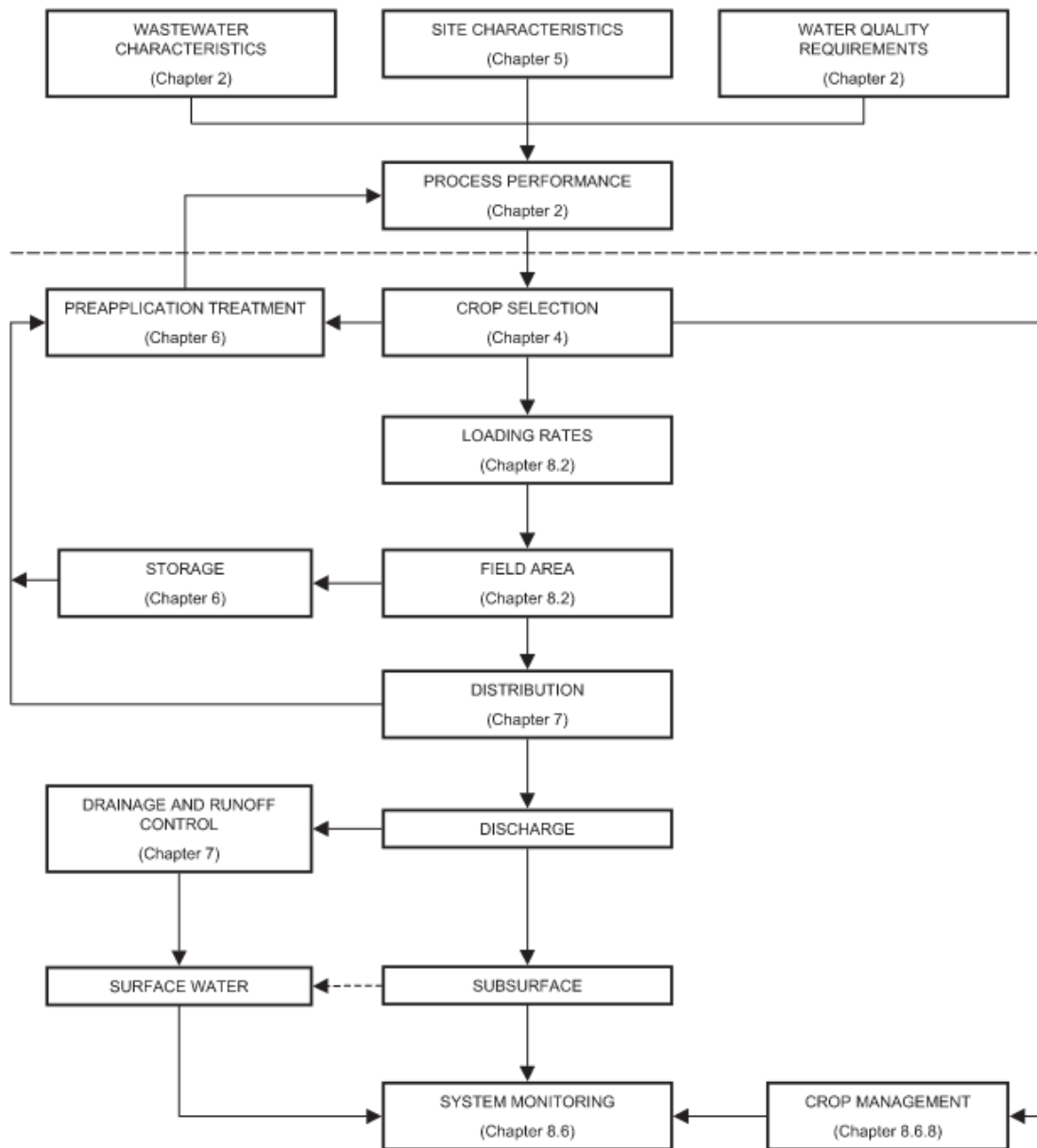


FIGURE 10. SLOW RATE LAND APPLICATION DESIGN PROCEDURE

One component of site selection is to minimize wildlife attractants. FAA Advisory Circular 150/5200-33C provides a summary of possible wildlife attractants and the suggested distances for each. Wildlife attractants include waste disposal operations, wetlands, dredge spoil containment area, agricultural activities, aquaculture, golf courses, landscaping structures, and other land-use considerations. The recommended separation distances from these attractants are as follows: 5,000 feet from airports serving piston-powered aircraft, 10,000 feet from airports serving turbine-powered aircraft, 5-miles for all airports to protect approach, departure, and circling airspace.

4.3.5 Estimation of Land Requirement

The BOD loading rate for land application is defined below (EPA 2006):

To establish a basis for the amount of degradable organic matter that can be land applied, the BOD loading rate is calculated. The BOD loading rate is defined as follows:

$$L_{\text{BOD}} = (\text{kg of BOD applied/day}) / (\text{area loaded per day}) (\text{cycle time})$$

(2-1)

Where

L_{BOD} = kg/ha-d
 Kg of BOD applied per day = concentration, mg/L x flow, m³/d x 1000 L/1 m³ x 0.001 kg/g x 1 g/1000 mg
 Area loaded = total wetted area receiving wastewater per day, ha
 Cycle time = time between subsequent applications to a given subplot (days of application plus days of drying), days

FIGURE 11. BOD LOADING RATE FOR LAND APPLICATION

Based on the Slow Rate (SR) application loading from the table below, the applicable loading rate is 275 kgBOD/ha-day; or 245 lb. BOD/ac-day.

Process	BOD loading (kg BOD ₅ /ha•d) ^{a,b}
Slow Rate (SR)	50 – 500
Soil Aquifer Treatment (SAT)	145 – 1000
Overland Flow (OF)	40 – 110

^akg/ha•d x 0.89 = lb BOD₅/ac•d
^bLower end of range is typical of municipal systems and upper end is typical of industrial strength wastewater.

FIGURE 12: TYPICAL LOADING RATES FOR LAND TREATMENT (REED ET AL, 1995)

Table 6 estimates a land requirement of 0.25- acres for SR application, utilizing an average SR loading rate of 245 lb. BOD/ac-day. Total irrigation depth is 72 inches per season of applied water.

TABLE 6: ESTIMATED LAND REQUIREMENT – BOD BASIS

ESTIMATE OF LAND REQUIREMENT BASED ON ALLOWABLE BOD LOADING		
Total Volume to Apply	483,736	Gallons
Estimated irrigation season	180	Days
Average volume per day	2,687	gpd
Average BOD/day	61	Lbs. BOD/day
Acres based on allowable loading	0.25	Acres
Resulting irrigation rate	0.40	in/day
	72	in/season

The Natural Resources Conservation Service soil survey maps identify the soil within the project area as Pogue fine sandy loam, which is classified as a Hydrologic Soil Group A. Based on the Geotechnical report and investigations associated with the project completed in March 2021, site soils encountered in the subgrade were identified as sand and silty sand. The short-term infiltration rate for the sandy soils was determined to be 6 inches/hour based on field tests.

The application and uptake rates associated with land application are more dependent on the evapotranspiration rate of the crop, which are more of a bell curve during the growing season. See sample Kc-Apple bell curve below in **Figure 14**.

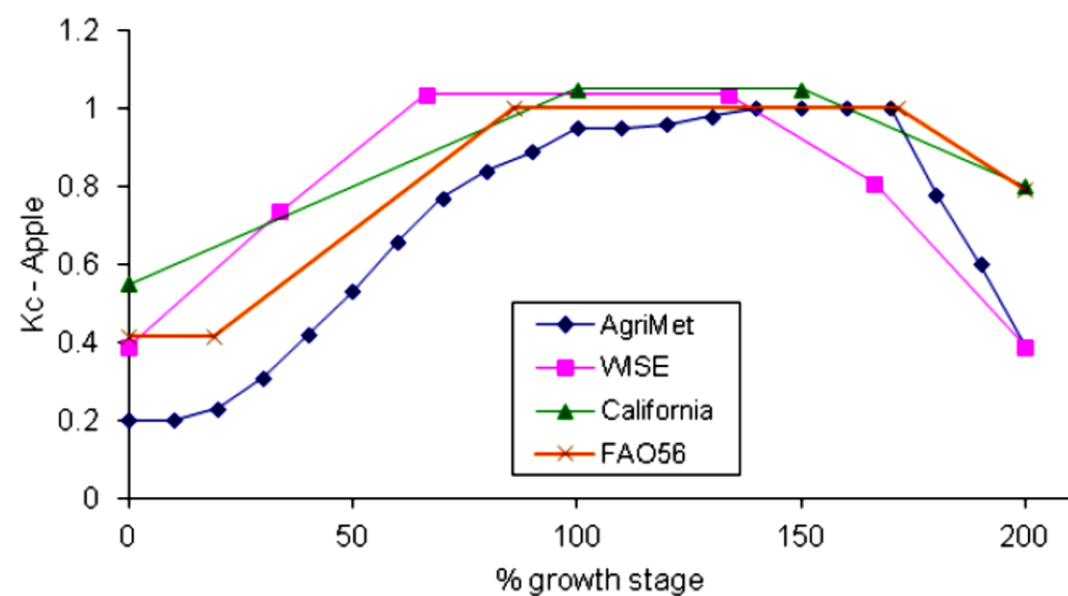


FIGURE 13. TYPICAL GROWING SEASON

The actual irrigation requirement is driven by cropping pattern, irrigation efficiency, pan evaporation and cropping coefficients. In the crop coefficient approach, the crop evapotranspiration, ET_c , is calculated by multiplying the reference crop evapotranspiration, ET_o , by a crop coefficient, K_c :

$$[ET_c = K_c ET_o]$$

where

ET_c crop evapotranspiration [mm d⁻¹],

K_c crop coefficient [dimensionless],

ET_o reference crop evapotranspiration [mm d⁻¹].

Crop water use requirements were calculated for the 2020 growing season using the AgWeatherNET weather station, and for the pasture grass. This crop water use calculator can be found on the WSU website: <http://weather.wsu.edu>. Total water use for pasture grass for the 2020 growing season was 29 inches. With an annual total of 1.48 acre-feet captured SADR, the required area of for land application of pasture grass would be 0.7 acres. The acreage requirement on a crop water basis is greater than the acreage requirement based on BOD application. The crop water requirement would be the controlling factor for land application design, with an acreage of 0.70.

TABLE 7: ESTIMATED LAND REQUIREMENT – CROP WATER REQUIREMENT BASIS

ESTIMATE OF LAND REQUIREMENT BASED ON CROP WATER REQUIREMENT		
ET of pasture grass	29	in/year
Precipitation in growing season	0.2	ft/year
Net crop water requirement	2.2	ft/year
Total annual volume SADR	1.48	acre- feet
Acres of pasture grass required	0.70	acres

Infrastructure requirements for this option include an oil water separator, 588,000 gallons (494,000 useable gallons) underground concrete tank, a three-way plug valve for flow diversion, submersible pumps, flow meter, sampler, irrigation sprinkler equipment, equipment for tilling the field and broadcasting seed each spring.

In the case of land application, the deicing season (October – April) may slightly overlap with the irrigation season (April-September). During the winter months in non-freezing temperatures, land application may be viable as the possibility exists for biodegradation. If this is the case, a smaller storage volume would be required for captured SADR as it could be land applied during available days. Future analysis and information would have to be conducted to identify this as a possibility. If it is discovered that the seasons are to stay isolated, storage must be provided for the full volume of captured SADR, or roughly 588,000 gallons (494,000 useable gallons) below-ground storage tank.

Permitting requirements for this system may require an Application for a State Waste Discharge Permit to Discharge Industrial Wastewater to Ground Water by Land Treatment or Application (Ecology form ECY-040-179). To determine ultimate permitting requirements, Ecology would require the following submittals for review and approval, per the Washington Administrative Code (WAC):

- WAC 173-240-110 Submission of plans and reports.
- WAC 173-240-130: Engineering Report
- WAC 173-240-150: Operations and Maintenance Manual
- State Waste Discharge Permit to Discharge Industrial Wastewater to Ground Water by Land Treatment or Application (Ecology form ECY-040-179); unsigned.

Ecology would require groundwater monitoring wells, preliminarily it could include one (1) upstream and three (3) downstream of the site. Samples from these wells would be collected on a monthly basis for a given amount of time and dependent on results, the frequency of sampling could be reduced. Background groundwater quality, before construction begins, would be used to compare and monitor the effectiveness of the land application system. In addition, soils and influent water quality testing would be required. An effective system would be capable of demonstrating the required biodegradation of the BOD and other components in the deicing fluids.

A surface mounted sprinkler irrigation system for a 0.7-acre application area would be assumed for the conceptual design. Annual tilling and seeding of the plot would be required each spring. This tilling would require removal of the sprinkler system and reinstallation at the beginning of each season. Conceptually, a pasture type grass is assumed, requiring mowing at the end of each season.

Land application is a suitable alternative for airports across the country. Below is information provided in the August 2000 EPA Document titled, "*Preliminary Data Summary Airport Deicing Operations (Revised)*" land applications processes at other airports.

Albany International Airport (ALB) – ALB utilizes an anaerobic biological treatment system. A portion of this effluent is disposed of via airfield spray irrigation. They have determined spray irrigation as a cost-effective alternative to discharging to the POTW. The spray irrigation is performed at a rate of 150 gallons per minute a day with BOD loading of less than 10 lb. BOD/ac*d. Their discharge permit allows irrigation discharge of up to 500 lb. BOD/ac*d when soil temperatures are above 50 degrees. The effluent is continuously monitored via a 24-hour composite sample to verify compliance with the permit.

Anchorage International Airport (ANC) – ANC maintains oversized open drainage swales that allow natural biodegradation, filtration, settling, and evaporation of storm water runoff. An existing wetland also received a limited amount of SADR for natural degradation.

Duluth International Airport (DLH) – DLH also utilizes natural degradation. At this airport some SADR is conveyed to retention areas where the stormwater is allowed to evaporate and infiltrate into the ground.

Baltimore/Washington International Airport (BWI) – BWI's infiltration facilities have been designed and constructed to temporarily store and infiltrate run off from the first 1/2" rain event into the underlying soils. This infiltration systems consists of gravel filled trenches installed parallel to the runways and taxiways. Any overflow of water is directed to stormwater retention areas or specially designed overland flow through grass meadow strips and a shrub bed prior to discharge.

Other airports not captured in the EPA document also utilize land applications. Two (2) of those include Spokane International Airport (SIA) and Austin Bergstrom International Airport (AUS). Additional information regarding their land application processes is provided below.

Spokane International Airport (SIA) – SIA existing configuration of the terminal apron does not provide drainage to a common location. Due to this, glycol recovery vehicles (vacuum trucks) must be used to remove deicing fluids from the apron. The vacuum trucks then take the fluid to an above-ground 300,000-gallon lined modular tank with a floating cover. Replacement of the liner is an additional expense that occurs as part of the land application process. The collected SADR is stored in the tank for the entire duration of the deicing season. A 100-acre site, away from the airport, is tilled up in the spring, seeded, and regularly sprayed with deicing fluid via water trucks/trailers. The land is mowed and maintained periodically, as necessary. In addition to maintenance items, seven (7) groundwater monitoring wells are in place to identify effects of the discharge on the groundwater quality. Soil samples are also collected to verify nitrogen is not increasing the soil profile in the treatment site.

In 2018, a contract was awarded to Inland Technologies International, Ltd. to provide SADR maintenance for one-year with four optional one-year terms. The scope of work was developed by airport staff and includes the provision for all labor to perform aircraft deicing fluid collection activities, testing and storage of collected material, and land application in accordance with the Airport's permit from the Department of Ecology. The initial term of the contract included the purchase and installation of a replacement collection tank liner. Inland Technologies was the only bid received on the project for an amount of \$419,830.10 (including Washington State Sales Tax). The tank liner replacement amounted to \$109,345.27. An additional \$42,000 was awarded for contract contingencies for an overall authorization of \$461,830.10.

Austin Bergstrom International Airport (AUS) – AUS primarily disposes of their SADR to the local POTW. However, in instances where the POTW is unavailable, or if the airport cannot meet the agreed parameter of the POTW, a secondary land application area is used. AUS utilizes storage ponds for storing SADR prior to the land application. Typically, the storage period is greater than 48 hours. Due to this, AUS had to provide wildlife deterrents in the design of the pond system. These deterrents include a 10' high fence with three (3) strands of barbed wire to prevent deer and other wildlife from getting over the fence as well as a buried fence fabric to keep animals from digging and undermining the fence. Additionally, water sprayers both as a deterrent to prevent birds from landing on the pond and to aide in recirculation/aeration of the water. Propane cannons are also located around the pond to deter birds. It is important to note that if the deterrent listed above proved unsatisfactory at deterring wildlife, additional measures would be required. The location of the pond is distanced from the airfield which helps with potential wildlife attractants but incurs additional costs as vehicles must be used to truck the SADR to the pond. The land application site itself is a large, fenced, naturally vegetated field sited in an area mostly out of public view.

This option is the second preferred alternative for disposal of SADR at EAT. If discharge to DCSD WWTP does not prove to be viable, the following steps are recommended to advance this option:

- 1) Identify possible sites for the land application and determine approach for screening.
- 2) Further research FAA criteria and required buffers between land application site and active runways/taxiways.
- 3) Refine crop and seed selection
- 4) Refine type of irrigation system
- 5) Continue to refine the required area by determining the Limiting Design Parameter (LDP). This is achieved by completing a series of computations related to the following balances:
 - Water Balance
 - Organic loading
 - Nutrient Balance
- 6) Further develop operating costs
- 7) Prepare an alternative for combining this land application approach with partial discharge DCSD
- 8) Coordinate with Inland Technologies for a scope and fee for potential contract operations of the land application system

Following are advantages and disadvantages of the Land Application Option:

Advantages:

- Entirely within the airport's control
- May be eligible for FAA funds
- Proven treatment technology

Disadvantages:

- Part-time operator required; or contract operations
- Operation would require close monitoring of weather, water quality, and soils
- Requires Land Application Permit (Ecology, 1993)
- Requires suitable and adequate parcel of land that does not conflict with FAA guidelines; may require a lease off airport property
- Piping and other infrastructure required for application system
- Requires significant on-site storage (588,000-gallon tank; 494,000-gallons useable)
- Odors can be problematic for holding runoff for whole deicing season, especially when spray applied

Estimate capital cost of the system is \$3,051,336; annual O&M of \$78,000, with an estimated 20-year present worth of \$4,696,328.

4.3.6 Disposal - Glycol Recycling (Dismissed)

The feasibility of recycling propylene glycol from SADR is determined by the following considerations:

- Only propylene glycol-based ADF is used in the collection area
- Propylene glycol concentrations in collected runoff is greater than 10 percent to be cost-effectively recycled
- The airport is in relatively close proximity to a glycol recycling facility minimize transportation costs.

SADR collected by the recommended apron system is not anticipated to have propylene glycol concentrations at or above 10 percent. For that reason, recycling has a diminished potential.

5. PREFERRED ALTERNATIVE – Disposal to Douglas County Sewer District

The recommended alternative includes that the collected SADR would be released into the regional sanitary/wastewater sewer line, based on an agreement with the DCSD, for treatment at the WWTP.

DCSD is in the process of reviewing the following proposed parameters:

- Proposed BOD loading rate: up to 400 lbs./day
- Proposed flow rate: this depends on the BOD concentrations but is estimated at 2,600 gpd
- Estimated BOD concentration: this is a weather dependent variable, but a range of 2,000 to 20,000 mg/L is likely

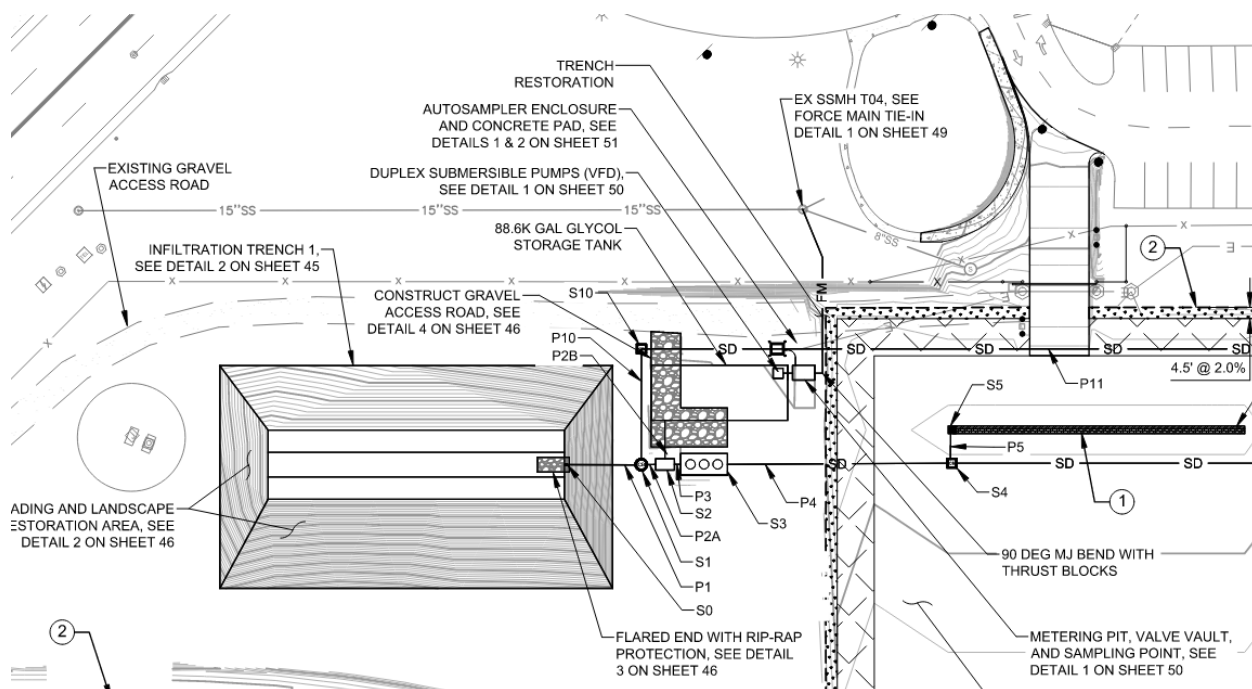


FIGURE 14: SITE PLAN FOR DISCHARGE TO DCSD

To address the SADR, a trench drain will collect runoff from the deicing pad and apron. The trench drain will be connected to a manhole with a valve system. The diversion valve will have three possible positions:

- 1) Deicing mode, flows are directed to a storage tank
- 2) Non-deicing mode, where flows are conveyed to the airport's stormwater system
- 3) Closed, to be used for containment in the event of a spill on the apron

A 100,700-gallon storage tank (88,600 useable volume) was sized such that a maximum BOD loading of 300 lb./day will be discharged to DCSD. This discharge limit is awaiting feedback from DCSD. The tank will store and allow equalizing of runoff which exceeds the maximum daily load that can be discharged to DCSD.

The buried concrete tank will be equipped with duplex 20 gpm submersible pumps at the northeast corner. This is an assumed discharge rate and will require confirmation with DCSD. The pumps will be controlled by a variable speed drive so that operations can control the flowrate and associated BOD loading discharged. DCSD would prefer off peak discharges, as compared to the standard diurnal municipal curve. A buried concrete vault will sit just east of the tank and will house a mag meter, check valves, plug valves and a sampling tap. The pump will convey water through the vault and into DCSD's 15-inch gravity sewer main which runs east/west, serving the terminal. An autosampler will be housed in a small weatherproof enclosure near the tank hatch and create composite samples to support the reporting requirements of a potential future discharge permit. Ecology would require the following submittals for review and approval, per the Washington Administrative Code (WAC):

- WAC 173-240-110 Submission of plans and reports.
- WAC 173-240-130: Engineering Report (this Glycol Management Report)
- WAC 173-240-150: Operations and Maintenance Manual
- Application for a State Waste Discharge Permit to Discharge Industrial Wastewater to a Publicly - Owned Treatment Works (POTW) – (Form ECY 040-177) - unsigned copy in initial submittal

The following are recommended next steps for refining this alternative:

- 1) Continue discussions/negotiations with DCSD for industrial discharge rates
- 2) Finalize State Waste Discharge Permit to Discharge Industrial Wastewater to a Publicly - Owned Treatment Works

Estimate capital cost of the system is \$540,524; annual O&M of \$69,800, with an estimated 20-year present worth of \$2,012,580.

APPENDIX A

5/18/2021

Spent Aircraft Deicing Fluid Runoff Disposal Alternatives - EAT

	Discharge to POTW	Land Application	Hauling
Description	Divert spent aircraft deicing fluid runoff from new apron area during deicing season to an underground concrete tank to discharge (either in batches or continuously - TBD) to POTW (Douglas County Sewer District facility)	Divert spent aircraft deicing fluid runoff from new apron area during deicing season to an underground tank to be stored until irrigation season and conditions permit land application	Divert spent aircraft deicing fluid runoff from new apron area during deicing season to an underground tank. Schedule approved hauling companies on an as-needed basis to pump out tank and take to Waste Management site 1.5 miles away
Equipment Requirements	Oil water separator, 100,700 gal (88,600 useable gal) underground concrete tank, 3-way plug valve for flow diversion, submersible pump, flow meter, sampler	Oil water separator, 588,000-gallon tank(494,000-gallons useable vol) underground concrete tank, 3-way plug valve for flow diversion, submersible pump, flow meter, sampler; irrigation sprinkler equipment, land tilling equpent, seed broadcasting equipment.	Oil water separator, 100,700 gal (88,600 useable gal) underground concrete tank, 3-way plug valve for flow diversion; (hauler would pump out of tank)
Permitting Requirement	Washington Department of Ecology State Waste Discharge Permit to Discharge Industrial Wastewater to a Publicly-Owned	State Waste Discharge Permit to Discharge Domestic Wastewater To Ground Water by Land Treatment or Application	None known
Staff Requirements	Management of diversion valve, regular sampling	Management of diversion valve, monthly sampling, significant operational requirements for irrigation requirement and climate tracking	Management of diversion valve; significant coordination with hauling company during deicing season
Advantages	Ecology's preferred option; widely used and proven approach; relatively low capital cost; moderately simple to operate and maintain; lowest O&M cost; operationally straightforward	Entirely within the airport's control; May be eligible for FAA funds	No reliance on WWTP capacity and associated sanitary sewer infrastructure; Relatively simple operation and maintenance requirements; Discharge rates can be increased by arranging for more frequent tanker pick-ups
Disadvantages	Reliance on continued availability of treatment capacity into the future; Requires monitoring of discharge flows and concentrations; Requires routine communication and coordination with WWTP to avoid operational problems; Airport's discharge could be temporarily halted if the WWTP is experiencing process problems; Operational costs and potentially surcharges	Part time operations staff required during growing season; close monitoring of weather, water quality, and soils; Requires Land Application Permit; Requires suitable and adequate parcel of land; Piping and other infrastructure required for application system; Requires significant on-site storage; Odors can be problematic for holding runoff for whole season; airport may not have suitable land and may have to lease which increases costs; may need to apply potable water to meet crop water requirement since BOD application is limiting factor; monthly groundwater monitoring required; physical working of the land required each season (tilling and seeding)	Availability of transport/processing companies; Collection contract costs can be significant if haul distances are great; Off-site transfer rates can be negatively impacted by outside factors; Increased carbon emissions from truck hauling activities
Capital Cost	\$540,524	\$3,051,336	\$292,441
Estimated Annual Operating Cost	\$69,800	\$78,000	\$286,837
20-Year Project Present Worth	\$2,012,580	\$4,696,328	\$6,447,181

Location: Pangborn Memorial Airport
Program: Terminal Apron Reconstruction - Glycol System
Project No:
Status: 100% Design Submittal



DISCHARGE TO POTW					
		ENGINEER'S COST ESTIMATE			
Item No.	ITEM DESCRIPTION	BUDGET QUANTITIES	UNITS	UNIT PRICE	BUDGET COST
1	12-inch PVC, C-900	94	LF	\$ 75	\$ 7,050
2	Submersible Pumps, rails, panels etc	1	LS	\$ 87,161	\$ 87,161
3	Fiberglass Shelter with pad	1	LS	\$ 8,157	\$ 8,157
4	Autosampler	1	LS	\$ 13,184	\$ 13,184
5	Precast Tank (100,700 gal)	1	LS	\$ 242,567	\$ 242,567
6	Valve Vault with internals	1	EA	\$ 25,000	\$ 25,000
7	Vault for 3 way plug valve	1	EA	\$ 4,000	\$ 4,000
8	3- way plug valve	1	EA	\$ 16,696	\$ 16,696
9	3" force main	50	LF	\$ 45	\$ 2,250
10	Force Main tie in at ex MH	1	LS	\$ 8,000	\$ 8,000
11	Bilco hatch's	3	EA	\$ 4,000	\$ 12,000
12	3" mag meter	1	EA	\$ 2,600	\$ 2,600
13	Electrical	1	EA	\$ 10,000	\$ 10,000
14	I&C, ultrasonic sensor, meter readout, etc	1	EA	\$ 8,000	\$ 8,000
15	Portable Operator for plug valve	1	EA	\$ 3,470.00	\$ 3,470
16	Douglas County Connection Fee	1	LS	\$ 41,250.00	\$ 41,250
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
		Subtotal Construction Costs			\$ 491,385
		Contingency		10.0%	\$ 49,139
		Total Construction Costs			\$ 540,524
OPERATING COSTS					
Annual Disposal Fee to Douglas County		1.00	LS	\$ 64,800.00	\$ 64,800
Water Quality Sampling		1.00	LS	\$ 5,000.00	\$ 5,000
			LS		\$ -
		Subtotal O&M Costs			\$ 69,800
		20 yr Present Value - Operating Costs			\$ 1,472,056
		20 year Present Worth - TOTAL PROJECT			\$ 2,012,580
OMB- 94 Real Discount Rate					
-0.5%					

ENGINEER'S COST ESTIMATE

Location: **Pangborn Memorial Airport**
 Program: **Terminal Apron Reconstruction - Glycol System**
 Project No:
 Status: **100% Design Submittal**

**LAND APPLICATION OPTION****ENGINEER'S COST ESTIMATE**

Item No.	ITEM DESCRIPTION	BUDGET QUANTITIES	UNITS	UNIT PRICE	BUDGET COST
1	12-inch PVC, C-900	94	LF	\$ 75	\$ 7,050
2	Submersible Pumps, rails, panels etc	1	LS	\$ 124,337	\$ 124,337
3	Fiberglass Shelter with pad	1	LS	\$ 7,806	\$ 7,806
4	Autosampler	1	LS	\$ 12,578	\$ 12,578
5	Precast Tank (588,000-gallon tank)	1	LS	\$ 2,339,394	\$ 2,339,394
6	Valve Vault with internals	1	EA	\$ 25,000	\$ 25,000
7	Vault for 3 way plug valve	1	EA	\$ 4,000	\$ 4,000
8	3- way plug valve	1	EA	\$ 15,878	\$ 15,878
9	Bilco hatch's	3	EA	\$ 4,000	\$ 12,000
10	3" mag meter	1	EA	\$ 2,600	\$ 2,600
11	Electrical	1	EA	\$ 10,000	\$ 10,000
12	I&C, ultrasonic sensor, meter readout, etc	1	EA	\$ 8,000	\$ 8,000
13	Irrigation Equipment	1	LS	\$ 100,000.00	\$ 100,000
14	Force main	1,200	LF	\$ 60.00	\$ 72,000
15	Portable Operator for plug valve	1	EA	\$ 3,300.00	\$ 3,300
16	Monitoring Wells	3	EA	\$ 10,000.00	\$ 30,000
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
Subtotal Construction Costs					\$ 2,773,942
Contingency		10%			\$ 277,394
Total Construction Costs					\$ 3,051,336
OPERATING COSTS					
	Part time operator	1.00	LS	\$ 35,000.00	\$ 35,000
	Seed for spring planting	1.00	LS	\$ 10,000.00	\$ 10,000
	Land Lease?	1.00	LS	\$ 10,000.00	\$ 10,000
	Increased Electrical Usage	1.00	LS	\$ 1,000.00	\$ 1,000
	Purchased water to meet crop ET	1.00	LS	\$ 1,000.00	\$ 1,000
	Tilling of land + broadcasting seed (hired/rented)	1.00	LS	\$ 10,000.00	\$ 10,000
	Fall mowing	1.00	LS	\$ 1,000.00	\$ 1,000
	Water Quality Sampling; Possibly Soil sampling	1.00	LS	\$ 10,000.00	\$ 10,000
Subtotal O&M Costs					\$ 78,000
20 yr Present Value - Operating Costs					\$ 1,644,991
20 year Present Worth - TOTAL PROJECT					\$ 4,696,328
OMB- 94 Real Discount Rate					
-0.5%					

Location: **Pangborn Memorial Airport**
 Program: **Terminal Apron Reconstruction - Glycol System**
 Project No:
 Status: **100% Design Submittal**



		ENGINEER'S COST ESTIMATE			
Item No.	ITEM DESCRIPTION	BUDGET QUANTITIES	UNITS	UNIT PRICE	BUDGET COST
1	12-inch PVC, C-900	94	LF	\$ 75	\$ 7,050
2	Precast Tank (100,700 gal)	1	LS	\$ 230,928	\$ 230,928
3	Vault for 3 way plug valve	1	EA	\$ 4,000	\$ 4,000
4	3- way plug valve	1	EA	\$ 15,878	\$ 15,878
5	Bilco hatch's	2	EA	\$ 4,000	\$ 8,000
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
			EA		\$ -
		Subtotal Construction Costs			\$ 265,856
		Contingency	10.0%		\$ 26,586
		Total Construction Costs			\$ 292,441
OPERATING COSTS					
	Annual Hauling Costs	60.00	loads	\$ 4,780.62	\$ 286,837
	Water Quality Sampling	1.00	LS	\$ 5,000.00	\$ 5,000
		Subtotal O&M Costs			\$ 291,837
		20 yr Present Value - Operating Costs			\$ 6,154,740
		20 year Present Worth - TOTAL PROJECT			\$ 6,447,181
OMB- 94 Real Discount Rate					
-0.5%					

APPENDIX B

RH2 TECHNICAL MEMORANDUM

Client: Douglas County Sewer District No. 1

Project: Developer Reviews – Proposed Aircraft Deicer Fluid Discharge from Pangborn Airport

Project File: DCS 21.0006.03 Project Manager: Jeremy Stumetz, PE

Composed by: Eric Smith, PE

Reviewed by: Richard Ballard, PE

Subject: Review of Potential Discharge of Aircraft Deicer Fluid to the Douglas County Sewer District System

Date: May 11, 2021



Signed:
5/11/2021



Signed:
5/11/2021

Background

Pangborn Airport (Airport) is owned and operated by Chelan Douglas Regional Port Authority (CDRPA). As part of winter operations, aircraft deicer fluid (ADF) is routinely applied to aircraft at the terminal. Overspray of ADF accumulates on the impervious surfacing near the terminal, from which stormwater runoff carries it to the existing drainage system at the Airport. The ADF utilized is believed to consist largely of propylene glycol with minor additives. As part of an upcoming project, CDRPA is evaluating alternatives for treatment and disposal of this runoff and has requested the review of discharging in a controlled manner to Douglas County Sewer District No. 1 (District). Monthly discharge volumes are approximated in **Table 1**, as provided by CDRPA's consultant.

Table 1
Monthly Discharge Volumes

Month	Jan	Feb	Mar	Apr	May to Sep	Oct	Nov	Dec
Monthly Discharge (gallons/month)	85,000	81,250	37,000	<10,000	0	<10,000	11,000	77,500

It is expected the concentration of the discharge will vary based on deicing operations and precipitation, but it is expected to generally be in the range of 10,000 to 20,000 milligrams per liter (mg/L). Based on initial discussions, CDRPA intends to provide storage tankage for use in equalizing ADF runoff as well as a monitoring and pumping system that will discharge to the District's system at approximately 300 to 500 pounds per day (ppd) of 5-Day Biochemical Oxygen Demand (BOD) during the highest months of ADF usage. The system will discharge uniformly across 24 hours each day to the District's system.

This technical memorandum is intended to provide a review of the technical aspects of receiving this discharge for CDRPA's use in comparing this disposal option to other alternatives. Exact requirements for this discharge, including the billing structure, would be detailed in a user contract between the District and the discharger.

Potential Impacts of ADF on the District WWTP

Propylene glycol is biodegradable and ADF has been discharged to wastewater treatment facilities in various locations. However, ADF can impact the operation and treatment efficacy of such facilities primarily through shock loading, inadequate biomass acclimation to ADF, and nutrient imbalance. Mitigatory measures may be required on a site-specific basis for the discharge of ADF. The following analysis includes the primary considerations for ADF discharge to the District's wastewater treatment plant (WWTP), as well as initial suggestions of potential mitigatory measures.

WWTP Organic Treatment Capacity

The WWTP has a rated capacity at the maximum month as shown in **Table 2**.

Table 2
WWTP Rated Capacity at Maximum Month

Parameter	Value
Flow Rate	3.0 MGD
5-Day Biochemical Oxygen Demand (BOD)	7,500 ppd
Chemical Oxygen Demand (COD)	10,630 ppd
Total Suspended Solids	7,500 ppd
Total Kjeldahl Nitrogen	1,200 ppd

MGD – million gallons per day

ADF represents primarily organic loading due to the high concentration of propylene glycol, and as such, the BOD and COD associated with this discharge is of primary importance related to WWTP capacity. BOD and COD are directly related, and for the purposes of this technical memorandum, BOD will be the term used for discussion of the organic loading and capacity. The aeration system, which supports the activated sludge biomass necessary to provide treatment by reducing influent BOD loading, as well as the solids handling system, which is used to process sludge produced by the WWTP, are the two systems that will be most impacted by the increased organic loading. Both systems were analyzed recently to verify that they afford the capacity in **Table 2**.

It should be noted that the BOD associated with influent ADF will not be substantially reduced by the WWTP primary clarifiers. Primary clarifiers typically remove approximately 25 percent of the BOD in normal municipal influent through gravity separation. Without this removal, all BOD associated with influent ADF will reach the WWTP aeration system.

Historical influent BOD loading to the WWTP over the last 3 years is summarized in **Table 3**.

Table 3
Three Years of Historical Influent BOD Loading to WWTP during Proposed Deicer Discharge Months

Month	BOD (ppd)	Month	BOD (ppd)	Month	BOD (ppd)
Jan-18	3,611	Jan-19	3,865	Jan-20	4,332
Feb-18	3,760	Feb-19	3,477	Feb-20	4,179
Mar-18	3,841	Mar-19	3,716	Mar-20	4,062
Nov-18	4,231	Nov-19	4,277	Nov-20	4,416
Dec-18	3,591	Dec-19	4,084	Dec-20	4,148

During the peak months of the proposed discharge, influent BOD loading has averaged 40 to 60 percent of the rated influent loading of 7,500 ppd BOD. An ADF discharge of 500 ppd BOD will equate to a nominal increase of approximately 6 to 7 percent of influent BOD loading. Since the primary clarifiers will not substantially reduce BOD associated with ADF, 500 ppd BOD from ADF will equate to a nominal increase of 9 percent influent BOD loading as it relates to the aeration system. Based on the current loading and design criteria, the WWTP has sufficient capacity to accept this discharge in an equalized manner.

Biomass Acclimation

The activated sludge biomass in the WWTP does not normally receive propylene glycol and may need to be acclimated prior to receiving this waste stream. This may naturally occur based on the normal usage pattern of ADF at the Airport but will need to be verified. Alternatively, ADF could be discharged to the District before and after the normally high ADF months to acclimate the biomass to this substrate in late fall and taper the biomass off each spring.

High Organic Shock Loading

Concentrated ADF is high in BOD and could represent high organic shock loading if the proposed discharge of 300 to 500 ppd BOD is not equalized and discharged to the WWTP uniformly over 24 hours each day. CDRPA will provide a system that equalizes the discharge in a manner that maintains BOD loading in a range of 300 to 500 ppd. This should generally alleviate concerns of shock loading.

Nutrient Deficiency

ADF is largely propylene glycol and does not contain nutrients in sufficient quantities. The WWTP activated sludge biomass requires a specific ratio of micro- and macronutrients relative to carbon to support microbial growth. If deemed necessary, the discharger could supplement micro- or macronutrients, such as phosphoric acid in the case of a phosphorus deficiency, into the equalization system to mitigate the nutrient deficiency.

Micro-Contaminants in Apron Runoff

The stormwater runoff that contains ADF also may contain other contaminants. The potential effect of these contaminants are not reasonably quantifiable at this time. The system will include an oil-water separator, which should remove floating hydrocarbons as well as allow some constituents to settle. Other contaminants that pass through to the equalization system are unlikely to be in sufficient concentration to cause noticeable impact to the WWTP, but this should be monitored and verified.

Growth of Non-Desirable Organisms in the ADF Equalization System

Based on CDRPA consultant's work at other airports utilizing similar systems, this issue appears to be of low likelihood. The equalization tank will not be aerated and will completely drain between major hydrologic events, limiting the opportunity for organism growth. If additional mitigation was necessitated, low level chlorination may be one option that could be provided by the discharger.

Recommendations

While each of the potential impacts listed likely can be mitigated by the discharger, it is recommended that the discharge be accepted for a trial period of potentially one or multiple seasons. All potential effects of this discharge cannot be reasonably quantified at this time without substantial effort. Initial mitigation of the discharge through equalization, monitoring, and uniform pumping likely will reduce any substantial risk associated with the discharge, and a trial period can be used to determine or refine mitigatory efforts required on the part of the discharger. At a minimum, the following is recommended for the proposed discharge:

- Install an equalization, monitoring and pumping system capable of limiting the discharge to 300 to 500 ppd BOD, which will discharge the load uniformly through 24 hours each day.
- Monitor COD (and correlate the COD to BOD) in the equalization system for use in adjusting the daily discharge rate.

- Install a connection between the District's telemetry system and the discharger's equalization system for the purposes of remote monitoring of the discharge by the District.
- Complete a trial period with the intent of demonstrating the ability of the WWTP to accept this discharge while identifying any necessary mitigatory measures necessary for the discharger to implement.

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Appendix E. Vegetated Filter Strip Design



EAT Calculations - 100%

Prepared by Mead & Hunt, Inc.

HydroCAD® 10.10-5a s/n 00568 © 2020 HydroCAD Software Solutions LLC

E-WA Short 3-hr 6MO. 3HR RS Rainfall=0.36"

Printed 5/18/2021

Page 1

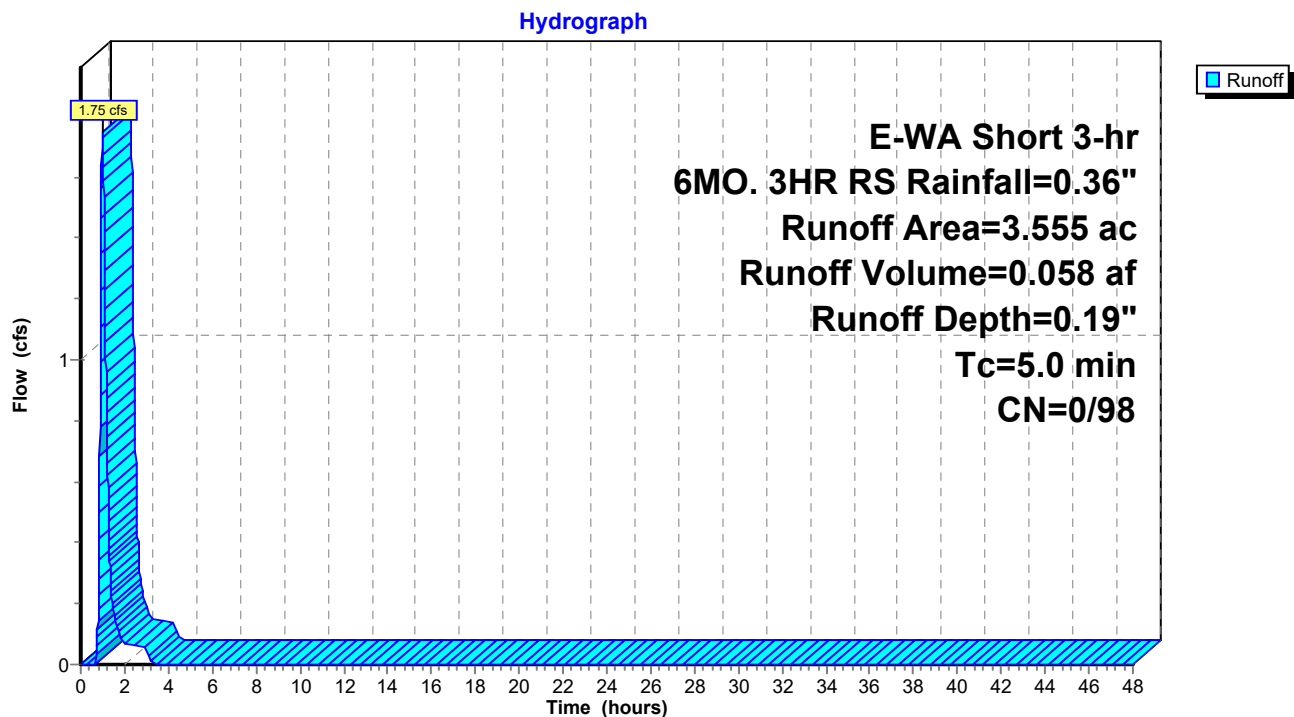
Summary for Subcatchment VFSI: VFS Area

Runoff = 1.75 cfs @ 0.99 hrs, Volume= 0.058 af, Depth= 0.19"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
E-WA Short 3-hr 6MO. 3HR RS Rainfall=0.36"

Area (ac)	CN	Description
0.000	68	<50% Grass cover, Poor, HSG A
3.555	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
3.555	98	Weighted Average
3.555	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment VFSI: VFS Area

Vegetated Filter Strip Design Worksheet

Mead&Hunt

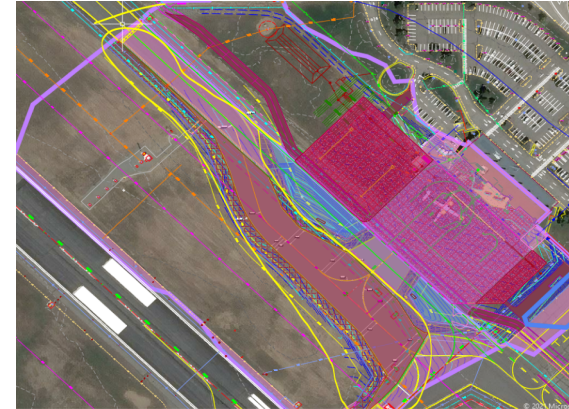
WSDOT Aviation SW Design Manual
AR.12 - Vegetated Filter Strip

Project No.: 1622900-210084.01
Project Name: EAT
Date: May 17, 2021
Facility Data: Taxiway VFS I

DESIGN DATA

Discharge values from HydroCAD Model for impervious areas only

VFS I



Rounded VFS Width
Area

35	FT
26635	SF

Flow
Geometry

User-Supplied Data

Variable	Symbol	Data	Notes
Hydrologic Method		SBUH	
Storm Type		E-WA Short	
Recurrence Interval, year		0.5	
Event Duration, hour		3	
Runoff Treatment Design Flow	Qwq	1.75	
Vegetated Filter Strip Design Flow	Qvfs	1.75	
<i>Eastern Washington does not require a flow rate adjustment</i>			
Manning's roughness coefficient	n	0.35	Table AR.12.1
Length of vegetated filter strip parallel to the pavement edge, ft	L	761	
Slope of vegetated filter strip parallel to direction of flow (ft/ft)	s	0.02	10-ft at 5% then slope flattens

Computed Data

Variable	Symbol	Data	
Design Flow Depth, ft	y	0.035	Equation AR. 12.4
Design Flow Depth, in	y	0.425	
<i>If depth>1 inch, adjust geometry or select other runoff treatment BMP</i>			
Design Flow Velocity, ft/s	Vwq	0.065	Equation AR. 12.5
Residence Time, s	t	540	
<i>A 9-min residence time is used to calculate vegetated filter strip width</i>			
Vegetated Filter Strip Width, ft	W	35.1	Equation AR. 12.6

Flow depth<1 inch, OK to proceed

EAT Drainage Design

Purpose:	Vegetated filter strip width determination for vehicle service roads	Date	5/17/2021
References:	WSDOT Aviation Stormwater Manual 2009	Designed By:	Andrea Boyd
Notes:	Calculated using the narrow area VFS design (for flowpaths<30')	Checked By:	

Vehicle Service Road West

Blue on chart			
Width of paved surface parallel to flow path		24	ft
Length of VFS		483	ft
Average lateral slope of VFS		2.0%	
Required VFS width	5.25	ft	AREA
Bumped up to	5.5	ft	2656.5 SF

Vehicle Service Road East

Blue on graph			
Width of paved surface parallel to flow path		24	ft
Length of VFS		156	ft
Average lateral slope of VFS		2.0%	
Required VFS width	5.25	ft	AREA
Bumped up to	5.5	ft	858 SF

Taxiway Shoulder - Narrow

Red on chart			
Width of paved surface parallel to flow path		30	ft
Length of VFS		461	ft
Average lateral slope of VFS		2.0%	
			AREA
Required VFS width	5.5	ft	2535.5 SF

Apron Shoulders

Green on chart			
Width of paved surface parallel to flow path		15	ft
Length of VFS	East side	165	ft
	West side	308	ft
	Northwest side	108	ft
	TOTAL:	596	ft
Average lateral slope of VFS		2.0%	
	AREA	2682	SF
Required VFS width	4.5	ft	

QUANTITIES

Total Topsoil	35367	SF
	1309.9	SY

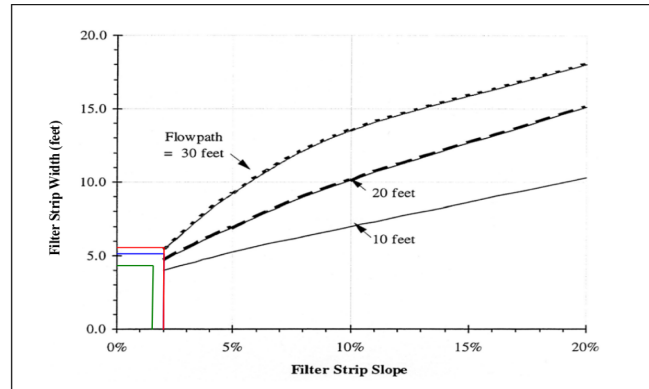


Figure AR.12.2. Narrow area vegetated filter strip design graph.

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Appendix F. Infiltration Trench Design



EAT Infiltration Trench Design

Purpose:	Infiltration facility sizing	Date:	2/3/2022
References:	Ecology, Stormwater Management Manual for Eastern Washington (SWMMIEW) (2019), WSDOT Airport Stormwater Manual	Designed By:	Andrea Boyd
Notes:	Must drain fully within 48 hours. Sized partially based on required surface area but primarily what geometry works in HydroCAD model. WSDOT (pg 141-143) Geometric Parameters of Infiltration Pond/Trench: 2H:1V side slopes or steeper, Depth 3 ft. min 6 feet max, 1 ft freeboard above the 25 year water service, width no greater than 30 feet, if longer than 30 feet in length, wildlife deterrents must be in place	Checked By:	
Design Update Log:	Revised 12/1/2021 RFI #4 - updated Infiltration Trench 2 geometry. Modeled as one trench. Originally was split into trenches 2A, B, and C but was updated to Trench 2A and B. Printed 2/3/2022 for inclusion with Revised Stormwater Site Plan per Douglas County Comments		

Depth to Water Table		Infiltration Rate		*infiltration rate and depth to groundwater as provided in preliminary geotech report from Strata	2.5
Shallow	100	Infiltration Rate (short term)*	6 in/hr		
Deep	392				
Design Volume Estimate for INF-1		FOS	0.4	Table 6.4 SWMME	
Snowmelt volume	4149.66 cf	Infiltration Rate (long term)	2.4 in/hr		
25-yr, 24-hr rain on snow volume	54057.96 cf	Required drain period	48 hrs		
Required surface area	5631.04 ft2	Total depth drained in period	115.2 in		
			9.6 ft		

INFILTRATION TRENCH 1 Geometry				Trench Inverts	
Length	120 ft	Top width	28 ft	Grade at beginning of trench	1216.4
Base width, b	10 ft	Vert	6 ft	Invert at inlet to trench	1210.4
Depth, d	6 ft	Z length	9 ft	Invert at end of trench	1210.4
Side slope (horizontal value), z	1.5 ft/ft	Hyp length	10.82 ft	Grade at end of trench	1216.4
End slope, m	0 ft/ft	Surface area of base	1200.00 ft2		
Cross sectional area, A	114.00 ft2	SA	3796.00 ft2		
Volume	13680 ft3	Perimeter	31.6 ft		
		US end slope length	0 ft		
Longitudinal slope	0.00%	DS end slope length	0 ft	GW ELEV	1110.4
Delta Z	0 ft	Top length	120 ft		

Infiltration Trench 1 - Landscaping Geometry				Trench Inverts	
Upper Trapezoidal Area - 100-yr Overflow Area. 4:1 side slopes for mowing					
base Length	120 ft	Top width	80 ft		
Base width, b	28 ft	Depth, d	6.5 ft	Surface Elev at inlet to trench	1222.9
Depth, d	6.5 ft			invert elevation	1216.4
Side slope (horizontal value), z	4 ft/ft			end invert	1216.4
End slope, m	3 ft/ft				
Cross sectional area, A	351.00 ft2	Surface area of base	3360 ft2	Grade at end	1222.9
Volume	42120 ft3				
		US end slope length	19.5 ft		
Longitudinal slope	0.0%	DS end slope length	19.5 ft		
Delta Z	0 ft	Top length	159		

Design Volume Estimate for INF-2	
25-yr, 24-hr rain on snow volume	6142 cf
Required surface area	640 ft2

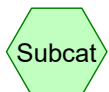
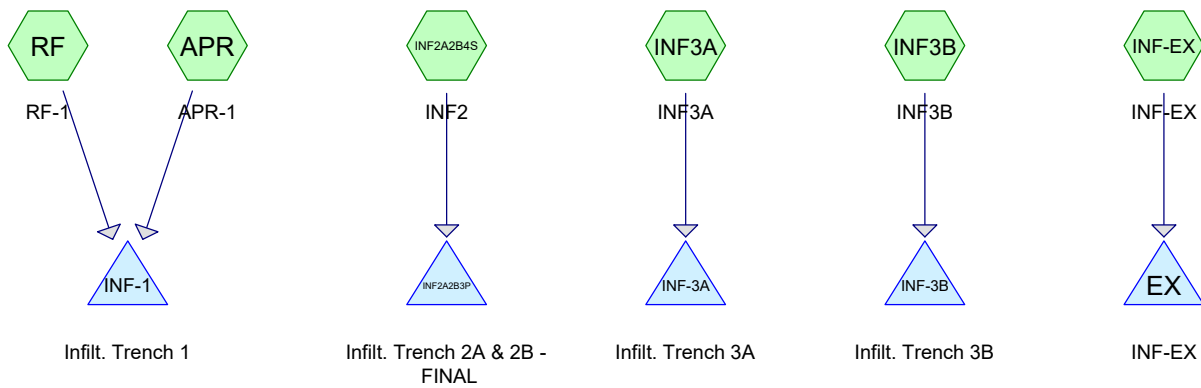
INFILTRATION TRENCH 2A+B Geometry				Trench Inverts	
Length	189 ft	Top width	11 ft	Estimated Grade at Top of Trench	1223.27
Base width, b	2 ft	Vert	3 ft	Elevation of bottom of inlet side of trench	1220.27
Depth, d	3 ft	Z length	4.5 ft	Invert at end of trench	1220.27
Side slope (horizontal value), z	1.5 ft/ft	Hyp length	5.41 ft	Grade at end of trench	1223.27
End slope, m	0 ft/ft	Surface area of base	378.00 ft2		
Cross sectional area, A	19.50 ft2	SA	2422.35		
Volume	3685.5 ft3	Perimeter	12.82		
		US end slope length	0 ft		
Longitudinal slope	0.0%	DS end slope length	0 ft	GW ELEV	
Delta Z	0 ft	Top length	189 ft		

Design Volume Estimate for INF-3A	
25-yr, 24-hr rain on snow volume	2047 cf
Required surface area	213.2625 ft2

INFILTRATION TRENCH 3A Geometry				Trench Inverts	
Length	50 ft	Top width	13 ft	Top depth at trench start	1222.00
Base width, b	4 ft	Vert	3 ft	Elevation of bottom of inlet side of trench	1219.00
Depth, d	3 ft	Z length	4.5 ft	Invert at end of trench	1219.00
Side slope (horizontal value), z	1.5 ft/ft	Hyp length	5.41 ft	Grade at end of trench	1222.00
End slope, m	0 ft/ft	Surface area of base	200 ft2	Stage invert at end of sloped section	1219.00
Cross sectional area, A	25.50 ft2	SA TOTAL	740.83 ft2	Top depth at trench end	1222.00
Volume	1275 ft3	Perimeter	14.81665383		
		US end slope length	0 ft		
Longitudinal slope	0.0%	DS end slope length	0 ft	GW ELEV	
Delta Z	0 ft	Top length	50 ft		

Design Volume Estimate for INF-3A	
25-yr, 24-hr rain on snow volume	1873 cf
Required surface area	195.1125 ft2

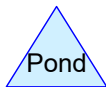
INFILTRATION TRENCH 3B Geometry				Trench Inverts	
Length	34 ft	Top width	13 ft	Top depth at trench start	1224.00
Base width, b	4 ft	Vert	3 ft	Elevation of bottom of inlet side of trench	1221.00
Depth, d	3 ft	Z length	4.5 ft	Invert at end of trench	1221.00
Side slope (horizontal value), z	1.5 ft/ft	Hyp length	5.41 ft	Grade at end of trench	1224.00
End slope, m	0 ft/ft	Surface area of base	136 ft2	Stage invert at end of sloped section	1221.00
Cross sectional area, A	25.50 ft2	SA TOTAL	503.77 ft2	Top depth at trench end	1224.00
Volume	867 ft3				
		US end slope length	0 ft		
Longitudinal slope	0.0%	DS end slope length	0 ft	GW ELEV	
Delta Z	0 ft	Top length	34 ft		



Subcat



Reach



Pond



Link

Routing Diagram for EAT Calculations - 100% - RFI #4 - DCC Review

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Page 2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.236	49	50-75% Grass cover, Fair, HSG A (INF3A)
2.758	68	<50% Grass cover, Poor, HSG A (INF-EX, INF2A2B4S, INF3B)
8.148	98	Paved parking, HSG A (APR, INF-EX, INF2A2B4S, INF3A, INF3B)
0.265	98	Unconnected roofs, HSG A (RF)
11.407	90	TOTAL AREA

EAT Calculations - 100% - RFI #4 - DCC Review

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Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
11.407	HSG A	APR, INF-EX, INF2A2B4S, INF3A, INF3B, RF
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
11.407		TOTAL AREA

EAT Calculations - 100% - RFI #4 - DCC Review

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Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.236	0.000	0.000	0.000	0.000	0.236	50-75% Grass cover, Fair	INF3A
2.758	0.000	0.000	0.000	0.000	2.758	<50% Grass cover, Poor	INF-EX, INF2A2B 4S, INF3B
8.148	0.000	0.000	0.000	0.000	8.148	Paved parking	APR, INF-EX, INF2A2B 4S, INF3A, INF3B
0.265	0.000	0.000	0.000	0.000	0.265	Unconnected roofs	RF
11.407	0.000	0.000	0.000	0.000	11.407	TOTAL AREA	

Summary for Subcatchment APR: APR-1

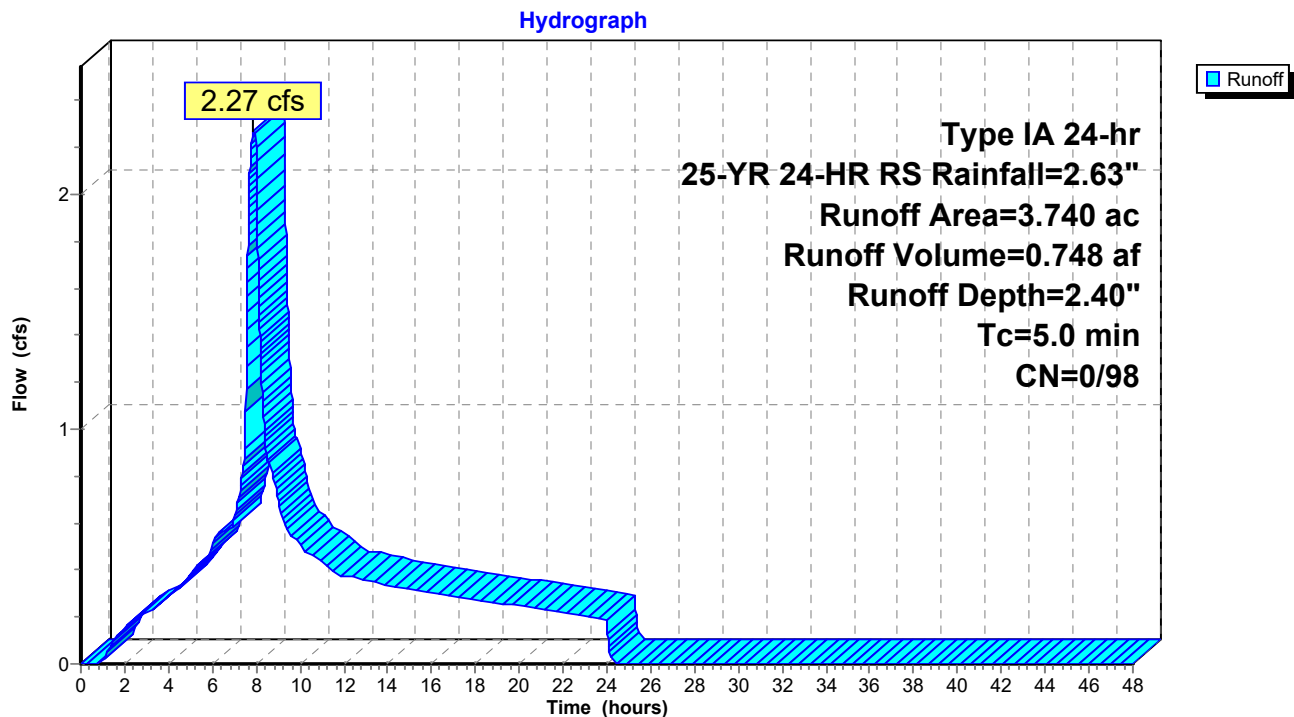
Runoff = 2.27 cfs @ 7.88 hrs, Volume= 0.748 af, Depth= 2.40"
 Routed to Pond INF-1 : Infilt. Trench 1

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
0.000	68	<50% Grass cover, Poor, HSG A
3.740	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
3.740	98	Weighted Average
3.740	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment APR: APR-1



Summary for Subcatchment INF-EX: INF-EX

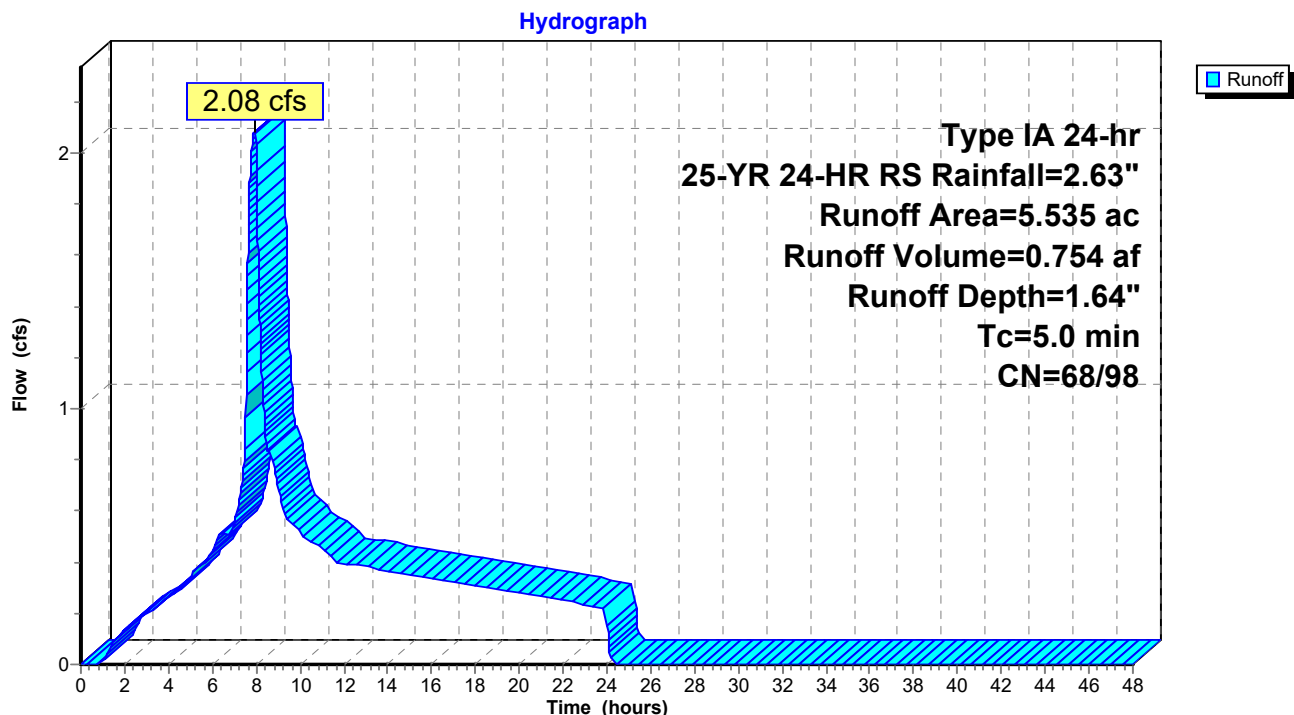
Runoff = 2.08 cfs @ 7.91 hrs, Volume= 0.754 af, Depth= 1.64"
 Routed to Pond EX : INF-EX

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
2.167	68	<50% Grass cover, Poor, HSG A
3.368	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
5.535	86	Weighted Average
2.167	68	39.15% Pervious Area
3.368	98	60.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment INF-EX: INF-EX



Summary for Subcatchment INF2A2B4S: INF2

Runoff = 0.39 cfs @ 7.91 hrs, Volume= 0.141 af, Depth= 1.61"
 Routed to Pond INF2A2B3P : Infilt. Trench 2A & 2B - FINAL

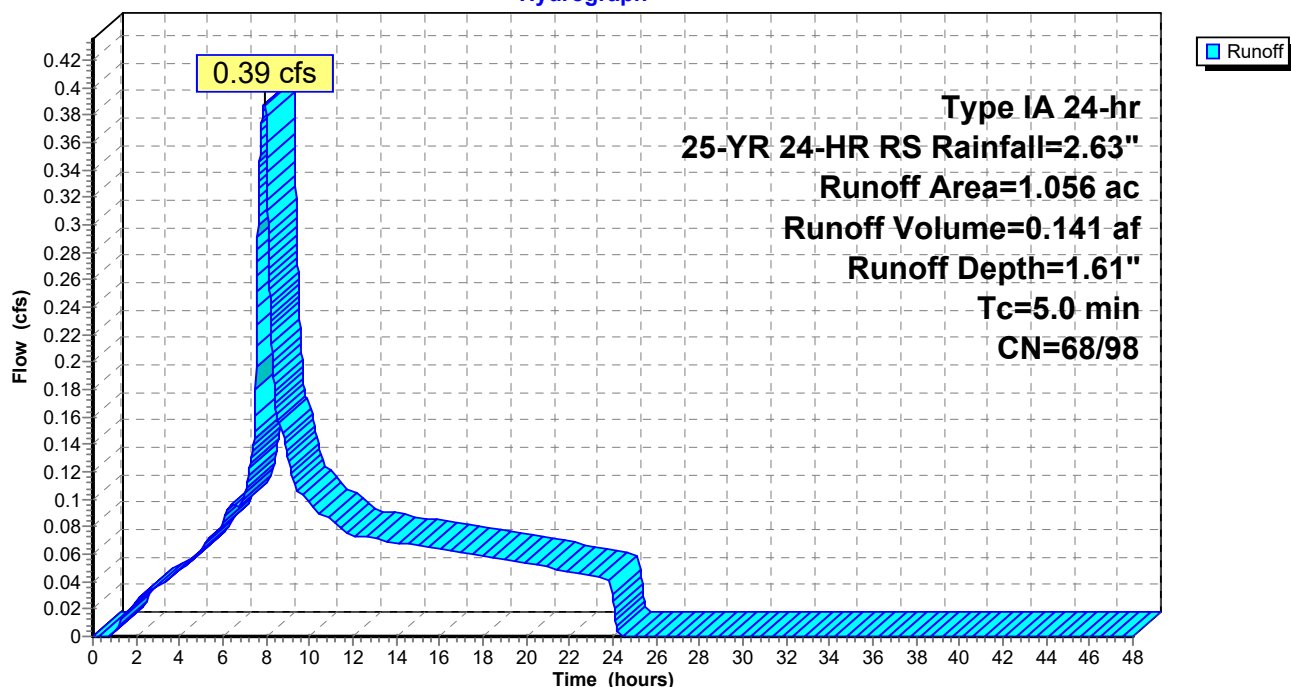
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
0.429	68	<50% Grass cover, Poor, HSG A
0.627	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
1.056	86	Weighted Average
0.429	68	40.63% Pervious Area
0.627	98	59.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment INF2A2B4S: INF2

Hydrograph



Summary for Subcatchment INF3A: INF3A

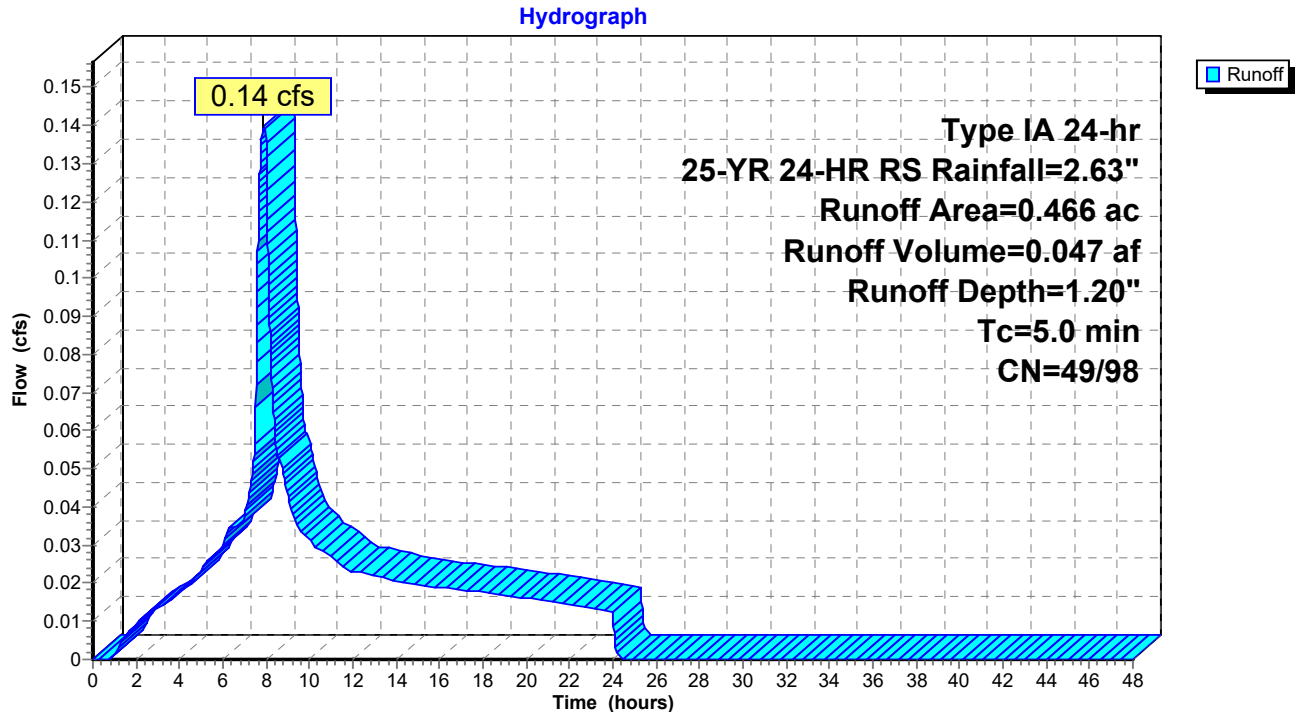
Runoff = 0.14 cfs @ 7.88 hrs, Volume= 0.047 af, Depth= 1.20"
 Routed to Pond INF-3A : Infiltr. Trench 3A

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
0.236	49	50-75% Grass cover, Fair, HSG A
0.230	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
0.466	73	Weighted Average
0.236	49	50.64% Pervious Area
0.230	98	49.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Minimum Tc

Subcatchment INF3A: INF3A



Summary for Subcatchment INF3B: INF3B

Runoff = 0.11 cfs @ 7.92 hrs, Volume= 0.043 af, Depth= 1.48"
 Routed to Pond INF-3B : Infiltr. Trench 3B

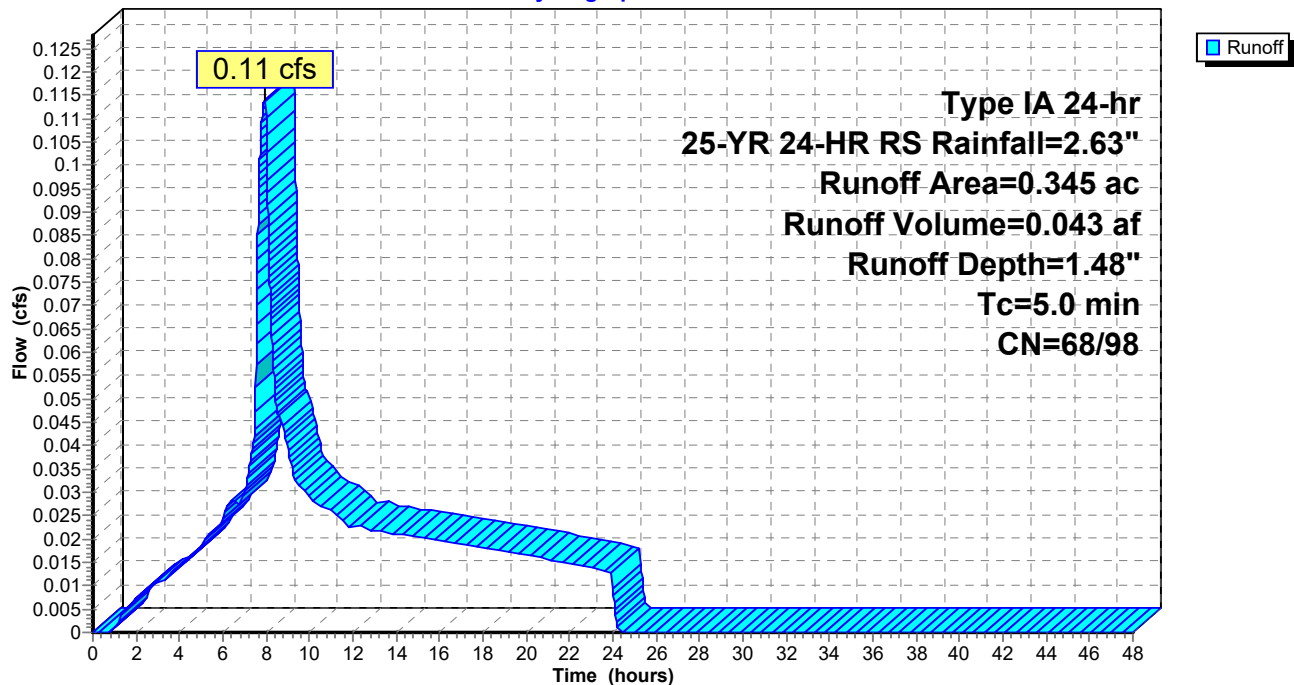
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
0.162	68	<50% Grass cover, Poor, HSG A
0.183	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
0.345	84	Weighted Average
0.162	68	46.96% Pervious Area
0.183	98	53.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Minimum Tc

Subcatchment INF3B: INF3B

Hydrograph



Summary for Subcatchment RF: RF-1

Runoff = 0.16 cfs @ 7.88 hrs, Volume= 0.053 af, Depth= 2.40"
 Routed to Pond INF-1 : Infilt. Trench 1

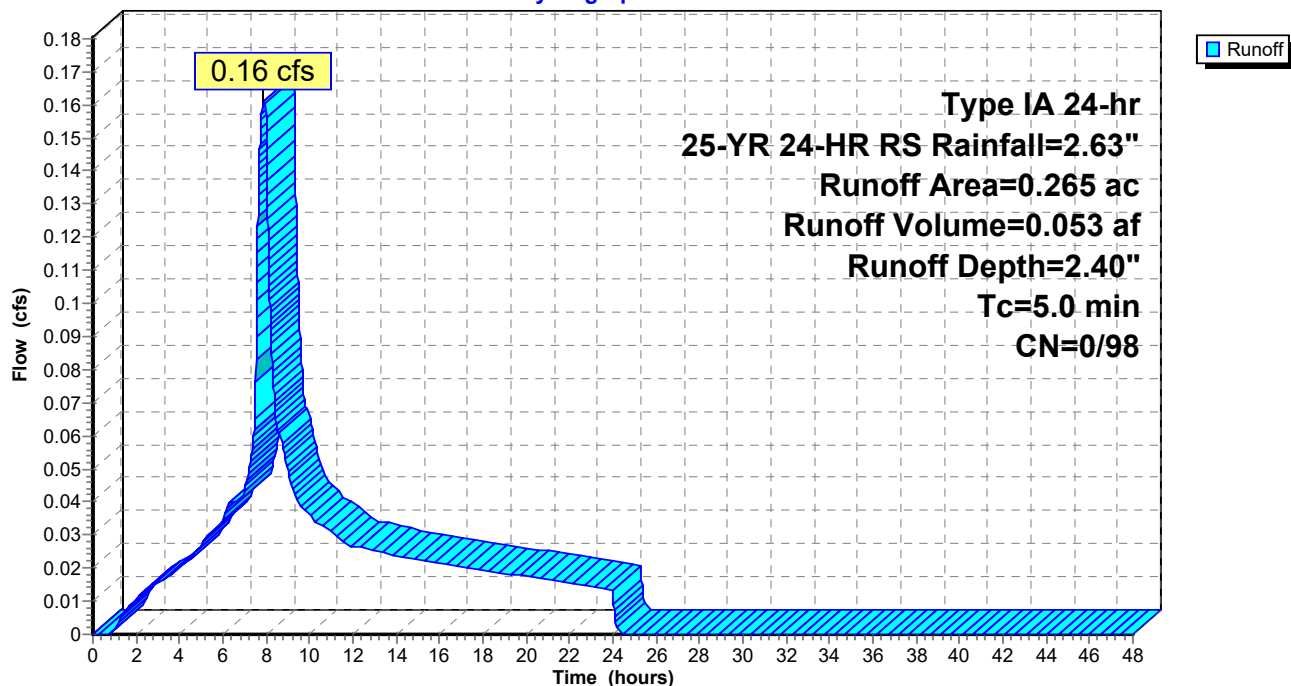
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
0.265	98	Unconnected roofs, HSG A
0.265	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment RF: RF-1

Hydrograph



EAT Calculations - 100% - RFI #4 - DCC ReviType IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Pond EX: INF-EX

Inflow Area = 5.535 ac, 60.85% Impervious, Inflow Depth = 1.64" for 25-YR 24-HR RS event
 Inflow = 2.08 cfs @ 7.91 hrs, Volume= 0.754 af
 Outflow = 0.85 cfs @ 8.47 hrs, Volume= 0.754 af, Atten= 59%, Lag= 33.9 min
 Discarded = 0.85 cfs @ 8.47 hrs, Volume= 0.754 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 1,219.66' @ 8.47 hrs Surf.Area= 15,322 sf Storage= 4,735 cf

Plug-Flow detention time= 63.6 min calculated for 0.754 af (100% of inflow)
 Center-of-Mass det. time= 63.7 min (764.3 - 700.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,215.00'	96 cf	4.00'W x 20.00'L x 4.00'H Existing Infiltration Gallery 320 cf Overall x 30.0% Voids
#2	1,219.00'	27,318 cf	SURFACE STORAGE (Prismatic) Listed below (Recalc)
		27,414 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,219.00	80	0	0
1,219.50	10,118	2,550	2,550
1,220.00	25,662	8,945	11,495
1,220.47	41,674	15,824	27,318

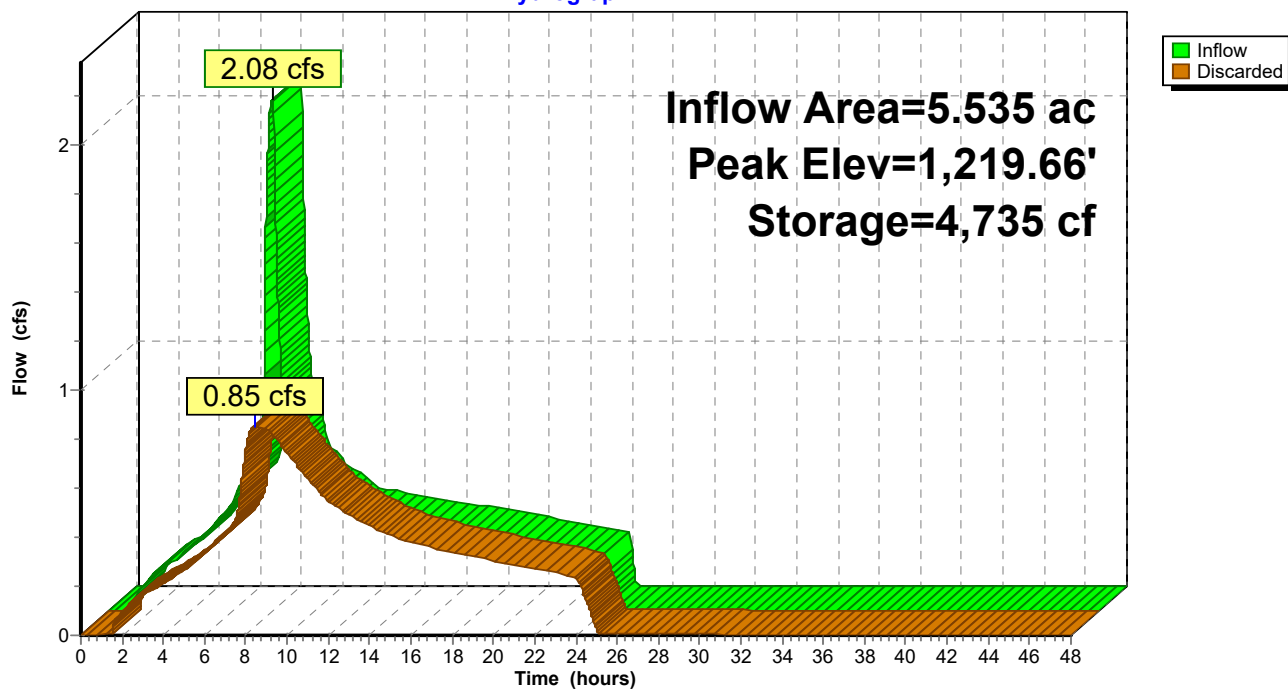
Device	Routing	Invert	Outlet Devices
#1	Discarded	1,215.00'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=0.85 cfs @ 8.47 hrs HW=1,219.66' (Free Discharge)

↑**1=Exfiltration** (Controls 0.85 cfs)

Pond EX: INF-EX

Hydrograph



EAT Calculations - 100% - RFI #4 - DCC ReviType IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Pond INF-1: Infilt. Trench 1

Inflow Area = 4.005 ac, 100.00% Impervious, Inflow Depth = 2.40" for 25-YR 24-HR RS event
Inflow = 2.44 cfs @ 7.88 hrs, Volume= 0.801 af
Outflow = 0.46 cfs @ 11.12 hrs, Volume= 0.801 af, Atten= 81%, Lag= 194.5 min
Discarded = 0.46 cfs @ 11.12 hrs, Volume= 0.801 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 1,218.23' @ 11.12 hrs Surf.Area= 8,065 sf Storage= 11,356 cf

Plug-Flow detention time= 310.3 min calculated for 0.801 af (100% of inflow)
Center-of-Mass det. time= 310.4 min (981.4 - 671.0)

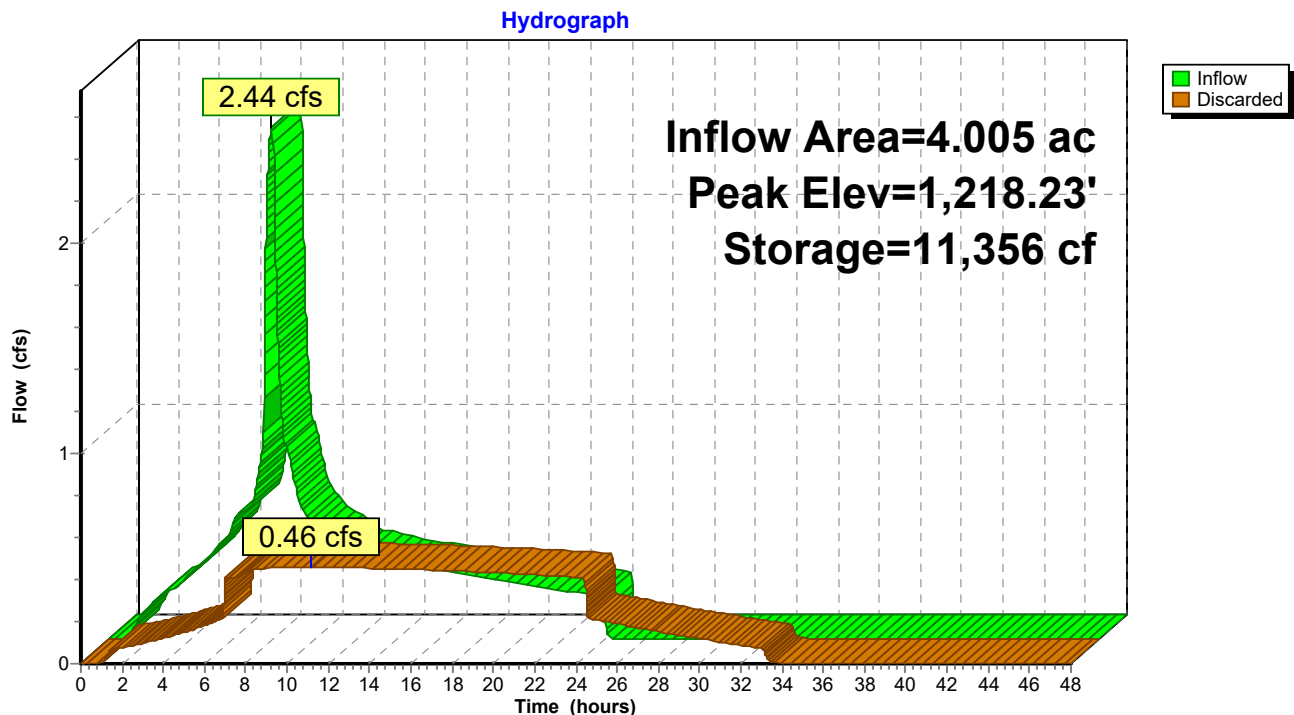
Volume	Invert	Avail.Storage	Storage Description
#1	1,210.40'	4,460 cf	10.00'W x 120.00'L x 6.00'H Trench Z=1.5 14,868 cf Overall x 30.0% Voids
#2	1,216.40'	32,043 cf	28.00'W x 120.00'L x 6.50'H Landscaping Z=1.5
		36,504 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,210.40'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,061.90' Phase-In= 0.01'

Discarded OutFlow Max=0.46 cfs @ 11.12 hrs HW=1,218.23' (Free Discharge)

↑1=Exfiltration (Controls 0.46 cfs)

Pond INF-1: Infilt. Trench 1



EAT Calculations - 100% - RFI #4 - DCC ReviType 1A 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Pond INF-3A: Infilt. Trench 3A

Inflow Area = 0.466 ac, 49.36% Impervious, Inflow Depth = 1.20" for 25-YR 24-HR RS event
 Inflow = 0.14 cfs @ 7.88 hrs, Volume= 0.047 af
 Outflow = 0.04 cfs @ 9.04 hrs, Volume= 0.047 af, Atten= 70%, Lag= 69.8 min
 Discarded = 0.04 cfs @ 9.04 hrs, Volume= 0.047 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2

Peak Elev= 1,221.92' @ 9.04 hrs Surf.Area= 749 sf Storage= 404 cf

Plug-Flow detention time= 99.2 min calculated for 0.047 af (100% of inflow)

Center-of-Mass det. time= 99.2 min (776.9 - 677.8)

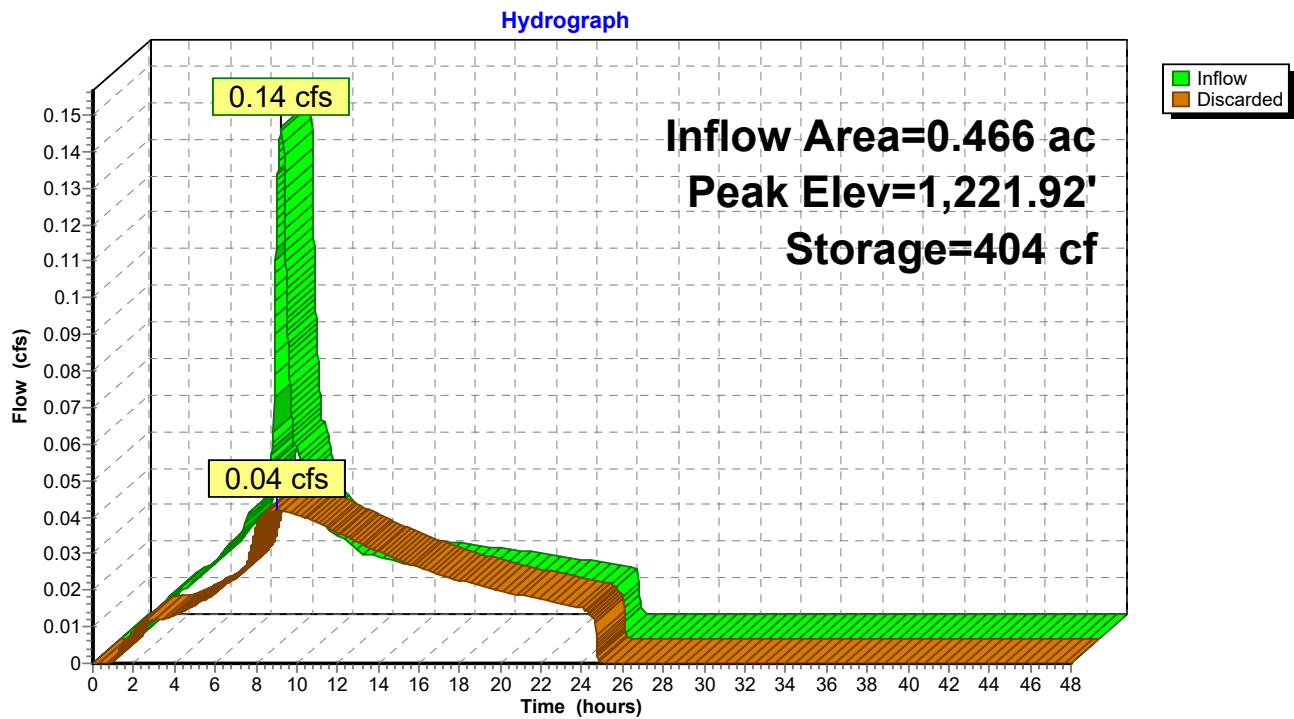
Volume	Invert	Avail.Storage	Storage Description
#1	1,219.01'	423 cf	4.00'W x 50.00'L x 3.00'H Trench 3A Z=1.5 1,410 cf Overall x 30.0% Voids
#2	1,222.00'	624 cf	Surface Storage (Prismatic) Listed below (Recalc)
		1,047 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,222.00	650	0	0
1,222.20	1,497	215	215
1,222.40	2,597	409	624

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,219.01'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=0.04 cfs @ 9.04 hrs HW=1,221.92' (Free Discharge)↑**1=Exfiltration** (Controls 0.04 cfs)

Pond INF-3A: Infiltr. Trench 3A



EAT Calculations - 100% - RFI #4 - DCC ReviType 1A 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Pond INF-3B: Infiltr. Trench 3B

Inflow Area = 0.345 ac, 53.04% Impervious, Inflow Depth = 1.48" for 25-YR 24-HR RS event
 Inflow = 0.11 cfs @ 7.92 hrs, Volume= 0.043 af
 Outflow = 0.04 cfs @ 9.01 hrs, Volume= 0.043 af, Atten= 66%, Lag= 65.3 min
 Discarded = 0.04 cfs @ 9.01 hrs, Volume= 0.043 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2

Peak Elev= 1,223.98' @ 9.01 hrs Surf.Area= 556 sf Storage= 298 cf

Plug-Flow detention time= 80.8 min calculated for 0.043 af (100% of inflow)

Center-of-Mass det. time= 80.8 min (791.0 - 710.2)

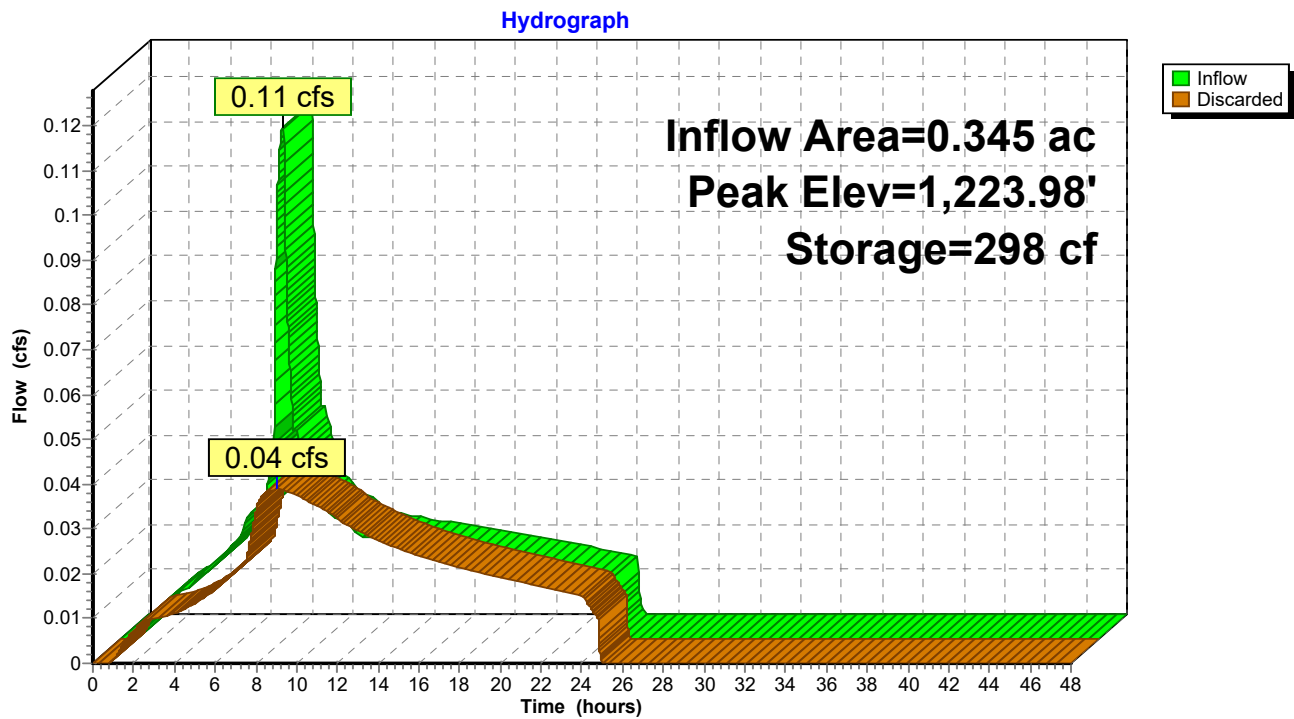
Volume	Invert	Avail.Storage	Storage Description
#1	1,221.00'	301 cf	4.00'W x 34.00'L x 3.00'H Trench 3B Z=1.5 1,002 cf Overall x 30.0% Voids
#2	1,224.00'	752 cf	Surface Storage (Prismatic) Listed below (Recalc)
		1,052 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,224.00	442	0	0
1,224.20	1,860	230	230
1,224.40	3,356	522	752

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,221.00'	3.000 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=0.04 cfs @ 9.01 hrs HW=1,223.98' (Free Discharge)↑**1=Exfiltration** (Controls 0.04 cfs)

Pond INF-3B: Infiltr. Trench 3B



EAT Calculations - 100% - RFI #4 - DCC ReviType 1A 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Pond INF2A2B3P: Infiltr. Trench 2A & 2B - FINAL

Inflow Area = 1.056 ac, 59.38% Impervious, Inflow Depth = 1.61" for 25-YR 24-HR RS event
 Inflow = 0.39 cfs @ 7.91 hrs, Volume= 0.141 af
 Outflow = 0.13 cfs @ 8.98 hrs, Volume= 0.141 af, Atten= 66%, Lag= 64.1 min
 Discarded = 0.13 cfs @ 8.98 hrs, Volume= 0.141 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 1,223.25' @ 8.98 hrs Surf.Area= 2,163 sf Storage= 1,122 cf

Plug-Flow detention time= 102.6 min calculated for 0.141 af (100% of inflow)
 Center-of-Mass det. time= 102.6 min (804.9 - 702.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,220.27'	1,138 cf	2.00'W x 189.00'L x 3.00'H Infiltration Trench 2 Z=1.5 3,794 cf Overall x 30.0% Voids
#2	1,223.27'	1,579 cf	Surface Storage (Prismatic) Listed below (Recalc)
		2,717 cf	Total Available Storage

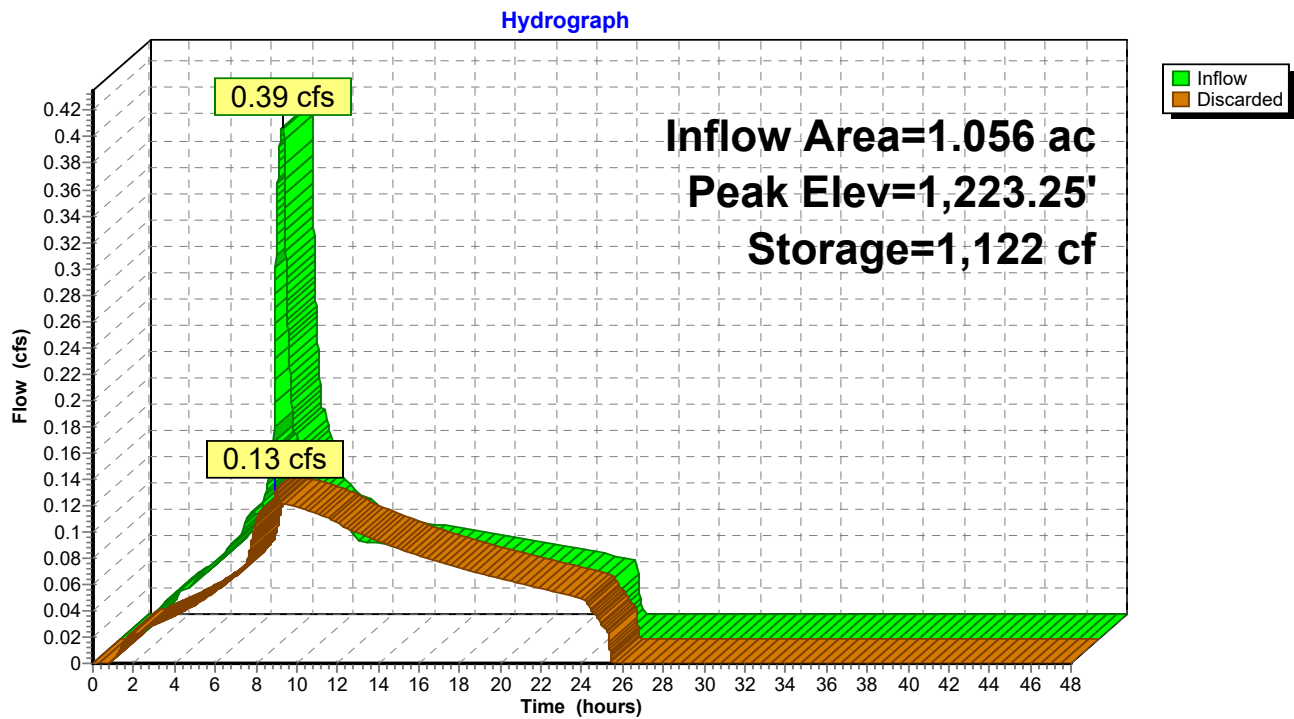
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,223.27	2,079	0	0
1,223.81	3,769	1,579	1,579

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,220.27'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=0.12 cfs @ 8.98 hrs HW=1,223.25' (Free Discharge)

↑**1=Exfiltration** (Controls 0.12 cfs)

Pond INF2A2B3P: Infiltr. Trench 2A & 2B - FINAL



Summary for Subcatchment APR: APR-1

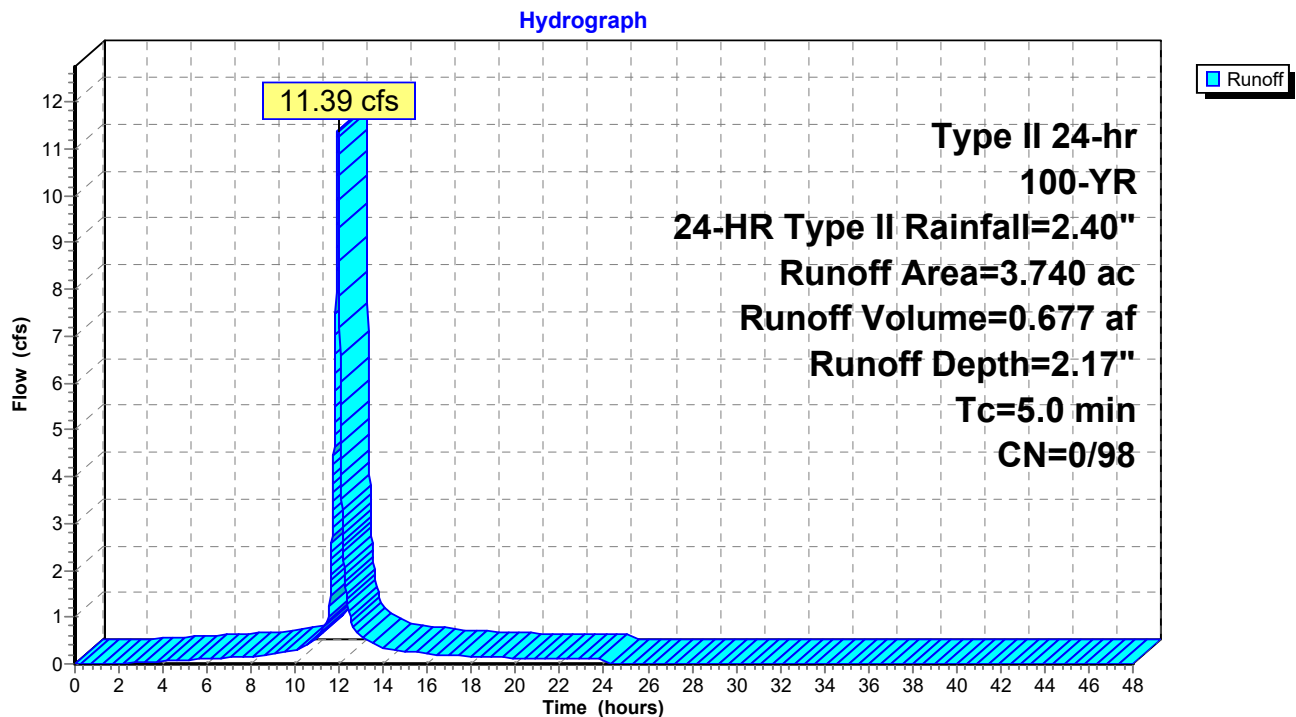
Runoff = 11.39 cfs @ 11.93 hrs, Volume= 0.677 af, Depth= 2.17"
 Routed to Pond INF-1 : Infilt. Trench 1

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

Area (ac)	CN	Description
0.000	68	<50% Grass cover, Poor, HSG A
3.740	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
3.740	98	Weighted Average
3.740	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment APR: APR-1



Summary for Subcatchment INF-EX: INF-EX

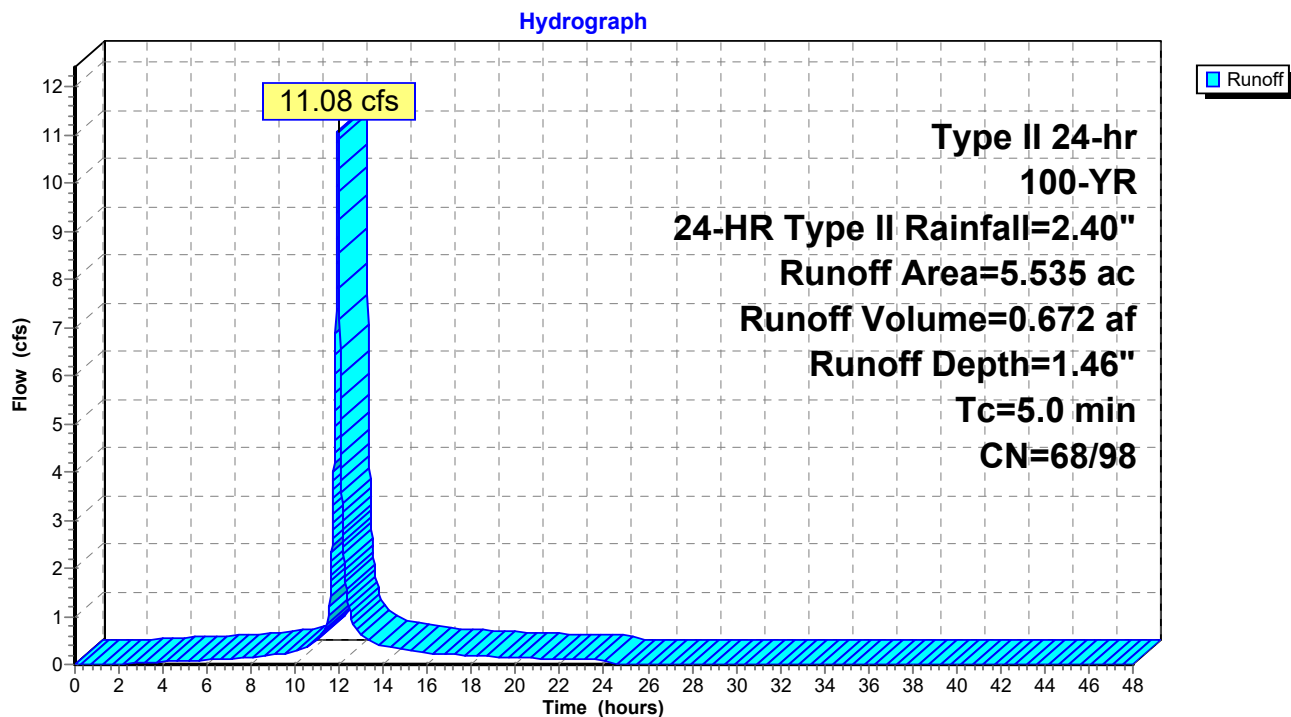
Runoff = 11.08 cfs @ 11.94 hrs, Volume= 0.672 af, Depth= 1.46"
 Routed to Pond EX : INF-EX

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

Area (ac)	CN	Description
2.167	68	<50% Grass cover, Poor, HSG A
3.368	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
5.535	86	Weighted Average
2.167	68	39.15% Pervious Area
3.368	98	60.85% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment INF-EX: INF-EX



Summary for Subcatchment INF2A2B4S: INF2

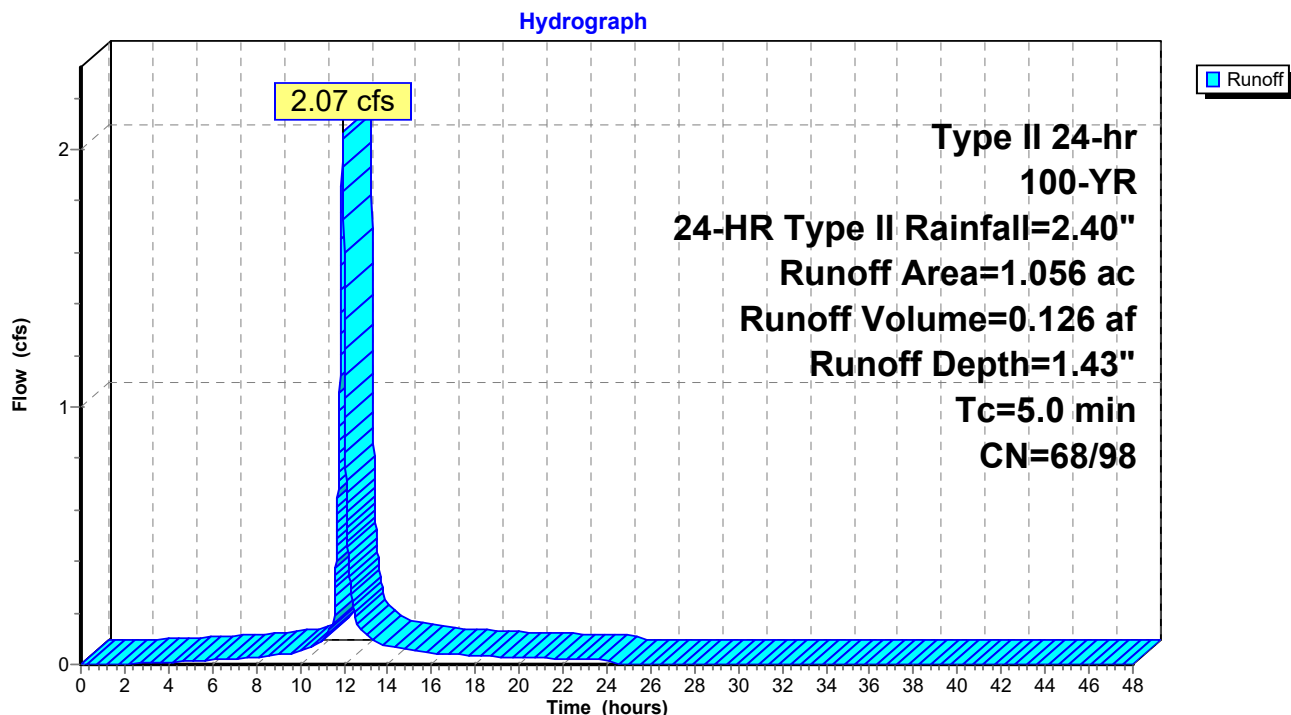
Runoff = 2.07 cfs @ 11.94 hrs, Volume= 0.126 af, Depth= 1.43"
 Routed to Pond INF2A2B3P : Infilt. Trench 2A & 2B - FINAL

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

Area (ac)	CN	Description
0.429	68	<50% Grass cover, Poor, HSG A
0.627	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
1.056	86	Weighted Average
0.429	68	40.63% Pervious Area
0.627	98	59.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment INF2A2B4S: INF2



Summary for Subcatchment INF3A: INF3A

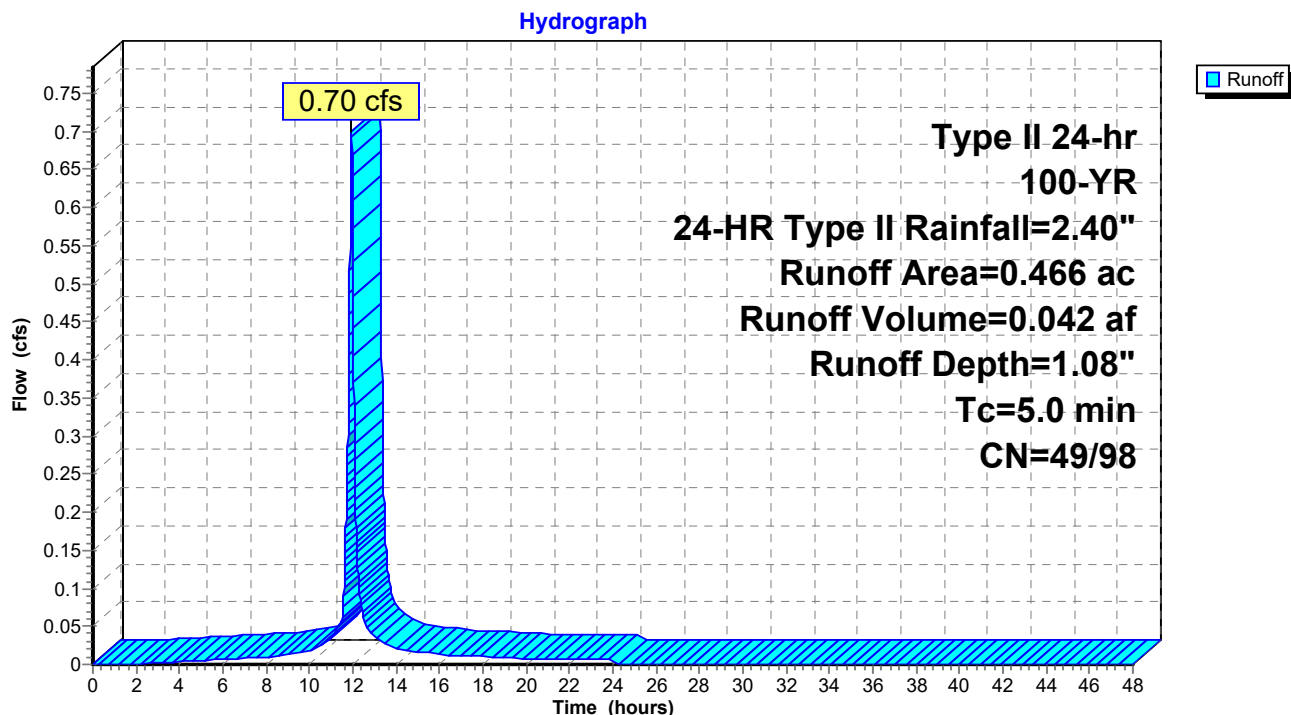
Runoff = 0.70 cfs @ 11.93 hrs, Volume= 0.042 af, Depth= 1.08"
 Routed to Pond INF-3A : Infilt. Trench 3A

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

Area (ac)	CN	Description
0.236	49	50-75% Grass cover, Fair, HSG A
0.230	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
0.466	73	Weighted Average
0.236	49	50.64% Pervious Area
0.230	98	49.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Minimum Tc

Subcatchment INF3A: INF3A



Summary for Subcatchment INF3B: INF3B

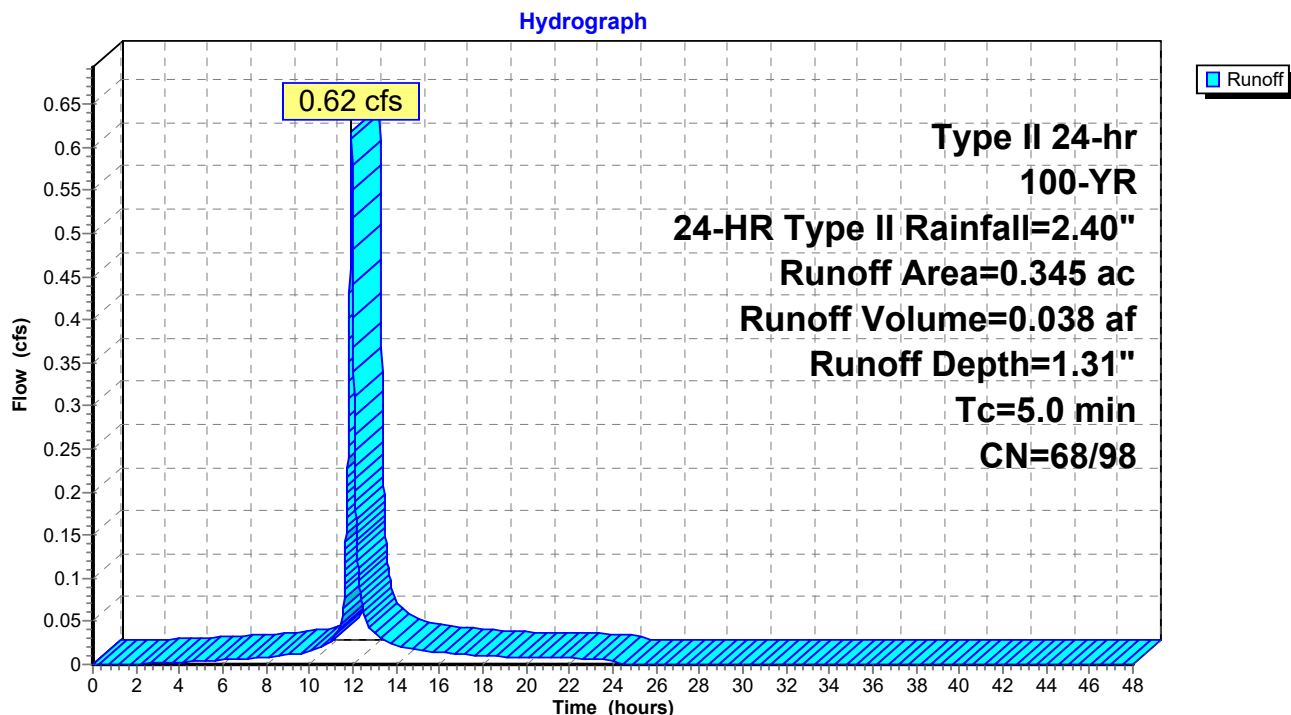
Runoff = 0.62 cfs @ 11.94 hrs, Volume= 0.038 af, Depth= 1.31"
 Routed to Pond INF-3B : Infilt. Trench 3B

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

Area (ac)	CN	Description
0.162	68	<50% Grass cover, Poor, HSG A
0.183	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
0.345	84	Weighted Average
0.162	68	46.96% Pervious Area
0.183	98	53.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Minimum Tc

Subcatchment INF3B: INF3B



Summary for Subcatchment RF: RF-1

Runoff = 0.81 cfs @ 11.93 hrs, Volume= 0.048 af, Depth= 2.17"
 Routed to Pond INF-1 : Infilt. Trench 1

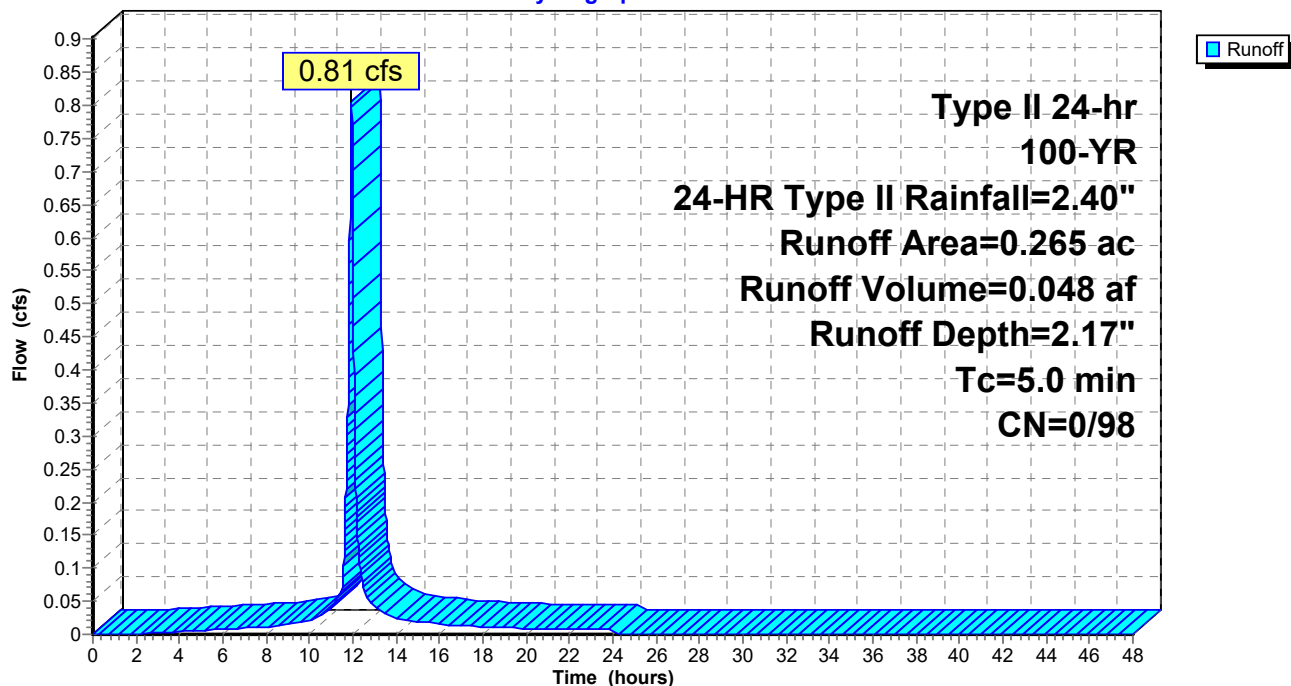
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

Area (ac)	CN	Description
0.265	98	Unconnected roofs, HSG A
0.265	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment RF: RF-1

Hydrograph



EAT Calculations - 100% - RFI #4 - DCC Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

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Summary for Pond EX: INF-EX

Inflow Area = 5.535 ac, 60.85% Impervious, Inflow Depth = 1.46" for 100-YR, 24-HR Type II event
 Inflow = 11.08 cfs @ 11.94 hrs, Volume= 0.672 af
 Outflow = 1.43 cfs @ 12.35 hrs, Volume= 0.672 af, Atten= 87%, Lag= 24.7 min
 Discarded = 1.43 cfs @ 12.35 hrs, Volume= 0.672 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2

Peak Elev= 1,220.00' @ 12.35 hrs Surf.Area= 25,751 sf Storage= 11,597 cf

Plug-Flow detention time= 86.5 min calculated for 0.672 af (100% of inflow)

Center-of-Mass det. time= 86.5 min (859.4 - 772.9)

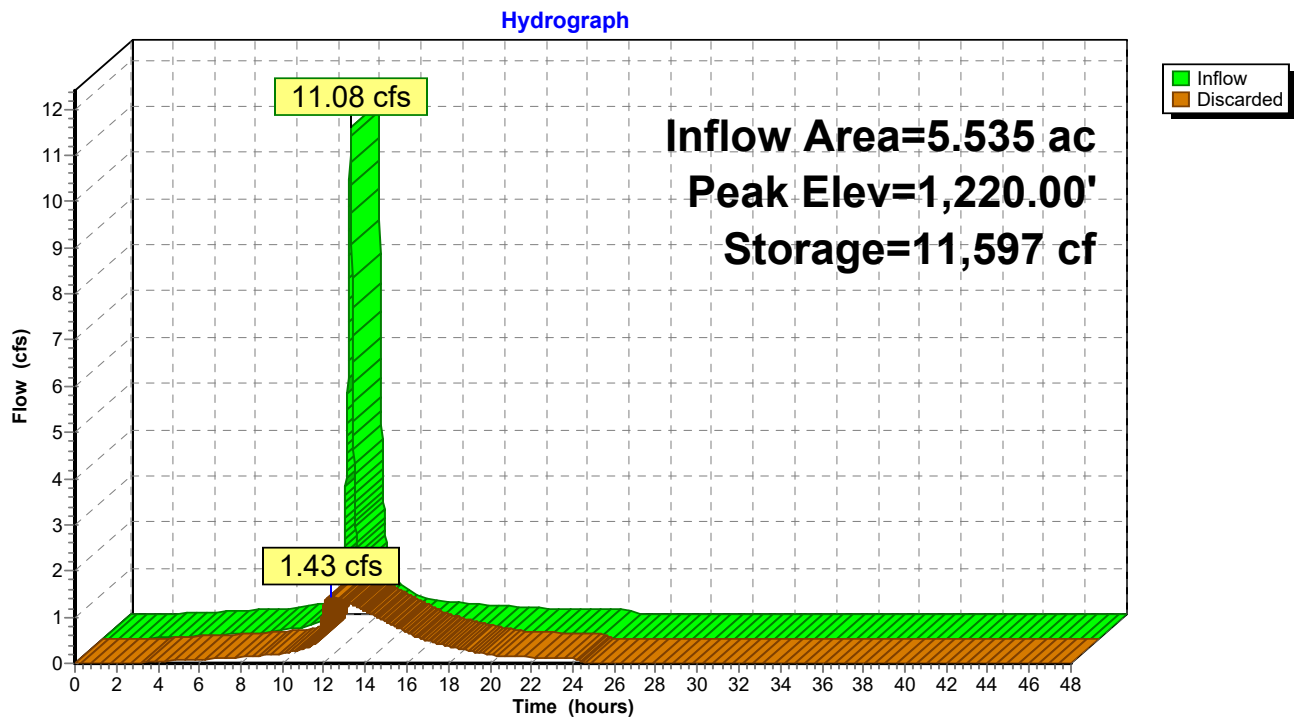
Volume	Invert	Avail.Storage	Storage Description
#1	1,215.00'	96 cf	4.00'W x 20.00'L x 4.00'H Existing Infiltration Gallery 320 cf Overall x 30.0% Voids
#2	1,219.00'	27,318 cf	SURFACE STORAGE (Prismatic) Listed below (Recalc)
		27,414 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,219.00	80	0	0
1,219.50	10,118	2,550	2,550
1,220.00	25,662	8,945	11,495
1,220.47	41,674	15,824	27,318

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,215.00'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=1.43 cfs @ 12.35 hrs HW=1,220.00' (Free Discharge)↑**1=Exfiltration** (Controls 1.43 cfs)

Pond EX: INF-EX



Summary for Pond INF-1: Infilt. Trench 1

Inflow Area = 4.005 ac, 100.00% Impervious, Inflow Depth = 2.17" for 100-YR, 24-HR Type II event
 Inflow = 12.20 cfs @ 11.93 hrs, Volume= 0.725 af
 Outflow = 0.50 cfs @ 13.39 hrs, Volume= 0.725 af, Atten= 96%, Lag= 87.7 min
 Discarded = 0.50 cfs @ 13.39 hrs, Volume= 0.725 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 1,219.70' @ 13.39 hrs Surf.Area= 8,787 sf Storage= 18,076 cf

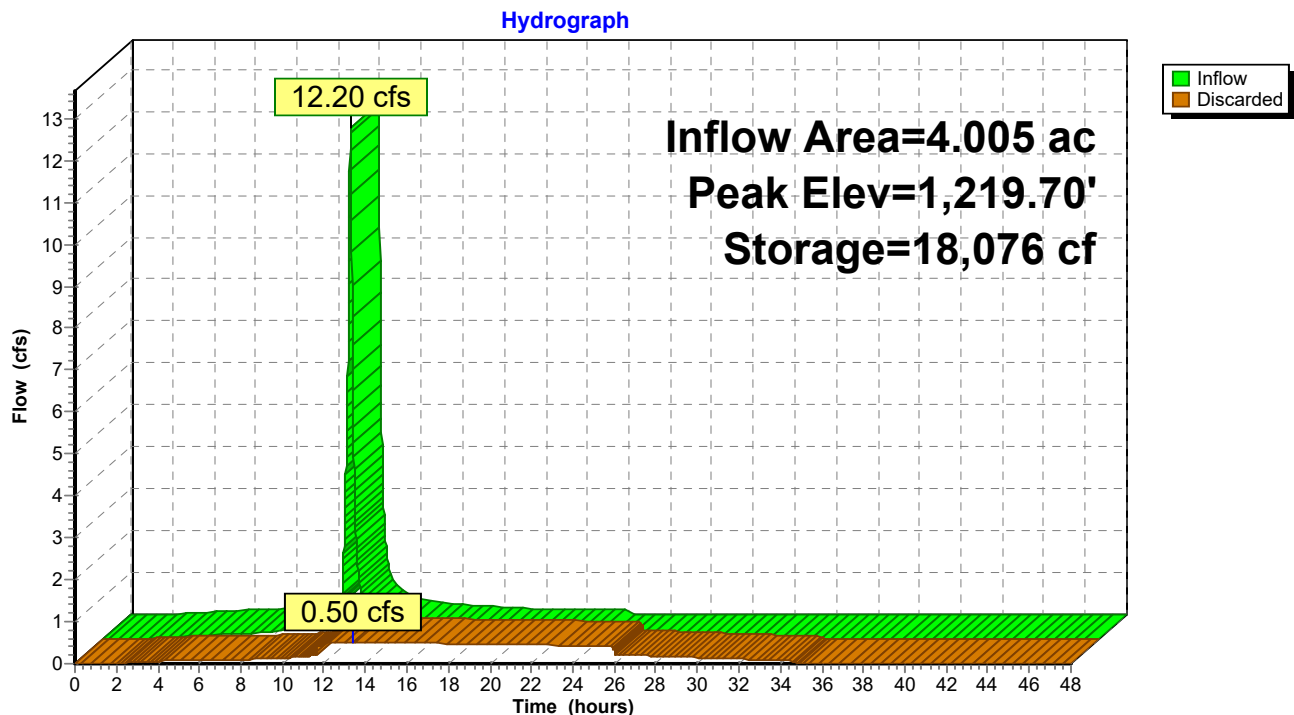
Plug-Flow detention time= 385.4 min calculated for 0.725 af (100% of inflow)
 Center-of-Mass det. time= 385.5 min (1,144.3 - 758.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,210.40'	4,460 cf	10.00'W x 120.00'L x 6.00'H Trench Z=1.5 14,868 cf Overall x 30.0% Voids
#2	1,216.40'	32,043 cf	28.00'W x 120.00'L x 6.50'H Landscaping Z=1.5
		36,504 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,210.40'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,061.90' Phase-In= 0.01'

Discarded OutFlow Max=0.50 cfs @ 13.39 hrs HW=1,219.70' (Free Discharge)
 ↑1=Exfiltration (Controls 0.50 cfs)

Pond INF-1: Infilt. Trench 1



EAT Calculations - 100% - RFI #4 - DCC Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

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Summary for Pond INF-3A: Infiltr. Trench 3A

Inflow Area = 0.466 ac, 49.36% Impervious, Inflow Depth = 1.08" for 100-YR, 24-HR Type II event
 Inflow = 0.70 cfs @ 11.93 hrs, Volume= 0.042 af
 Outflow = 0.14 cfs @ 12.19 hrs, Volume= 0.042 af, Atten= 80%, Lag= 15.4 min
 Discarded = 0.14 cfs @ 12.19 hrs, Volume= 0.042 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 1,222.24' @ 12.19 hrs Surf.Area= 2,511 sf Storage= 711 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 81.9 min (842.8 - 761.0)

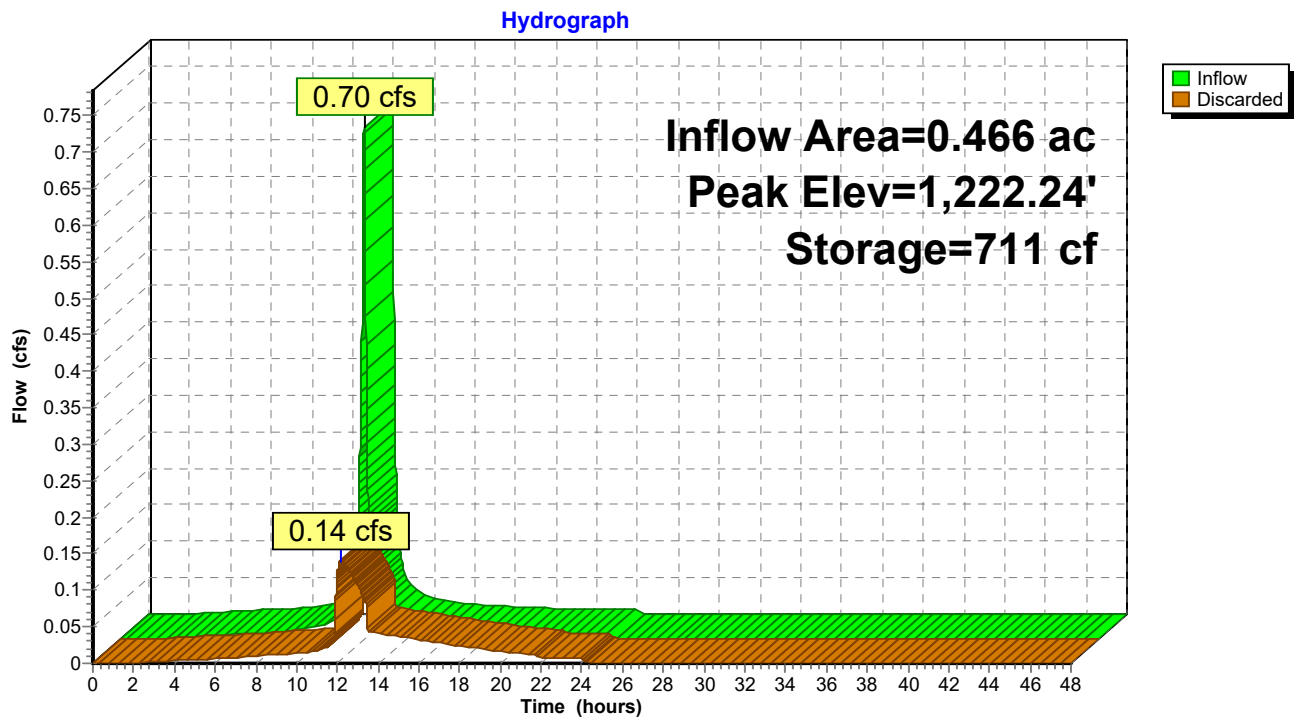
Volume	Invert	Avail.Storage	Storage Description
#1	1,219.01'	423 cf	4.00'W x 50.00'L x 3.00'H Trench 3A Z=1.5 1,410 cf Overall x 30.0% Voids
#2	1,222.00'	624 cf	Surface Storage (Prismatic) Listed below (Recalc)
		1,047 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,222.00	650	0	0
1,222.20	1,497	215	215
1,222.40	2,597	409	624

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,219.01'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=0.14 cfs @ 12.19 hrs HW=1,222.24' (Free Discharge)
 ↑**1=Exfiltration** (Controls 0.14 cfs)

Pond INF-3A: Infiltr. Trench 3A



EAT Calculations - 100% - RFI #4 - DCC Type II 24-hr 100-YR, 24-HR Type II Rainfall=2.40"

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Summary for Pond INF-3B: Infiltr. Trench 3B

Inflow Area = 0.345 ac, 53.04% Impervious, Inflow Depth = 1.31" for 100-YR, 24-HR Type II event
 Inflow = 0.62 cfs @ 11.94 hrs, Volume= 0.038 af
 Outflow = 0.17 cfs @ 12.14 hrs, Volume= 0.038 af, Atten= 72%, Lag= 11.9 min
 Discarded = 0.17 cfs @ 12.14 hrs, Volume= 0.038 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 1,224.21' @ 12.14 hrs Surf.Area= 2,480 sf Storage= 546 cf

Plug-Flow detention time= 60.7 min calculated for 0.038 af (100% of inflow)
 Center-of-Mass det. time= 60.6 min (838.2 - 777.6)

Volume	Invert	Avail.Storage	Storage Description
#1	1,221.00'	301 cf	4.00'W x 34.00'L x 3.00'H Trench 3B Z=1.5 1,002 cf Overall x 30.0% Voids
#2	1,224.00'	752 cf	Surface Storage (Prismatic) Listed below (Recalc)
		1,052 cf	Total Available Storage

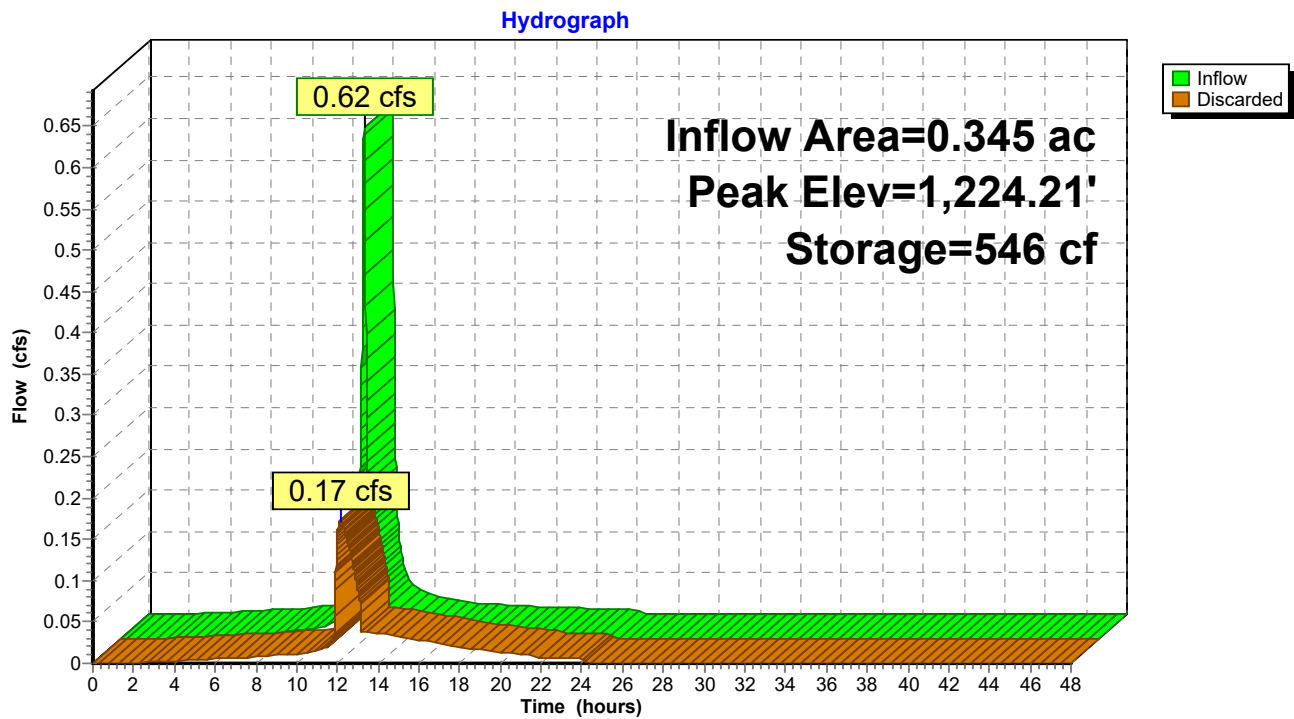
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,224.00	442	0	0
1,224.20	1,860	230	230
1,224.40	3,356	522	752

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,221.00'	3.000 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=0.17 cfs @ 12.14 hrs HW=1,224.21' (Free Discharge)

↑**1=Exfiltration** (Controls 0.17 cfs)

Pond INF-3B: Infiltr. Trench 3B



Summary for Pond INF2A2B3P: Infiltr. Trench 2A & 2B - FINAL

Inflow Area = 1.056 ac, 59.38% Impervious, Inflow Depth = 1.43" for 100-YR, 24-HR Type II event
 Inflow = 2.07 cfs @ 11.94 hrs, Volume= 0.126 af
 Outflow = 0.30 cfs @ 12.30 hrs, Volume= 0.126 af, Atten= 85%, Lag= 21.6 min
 Discarded = 0.30 cfs @ 12.30 hrs, Volume= 0.126 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 1,223.65' @ 12.30 hrs Surf.Area= 5,456 sf Storage= 2,164 cf

Plug-Flow detention time= 90.1 min calculated for 0.126 af (100% of inflow)
 Center-of-Mass det. time= 90.0 min (863.7 - 773.7)

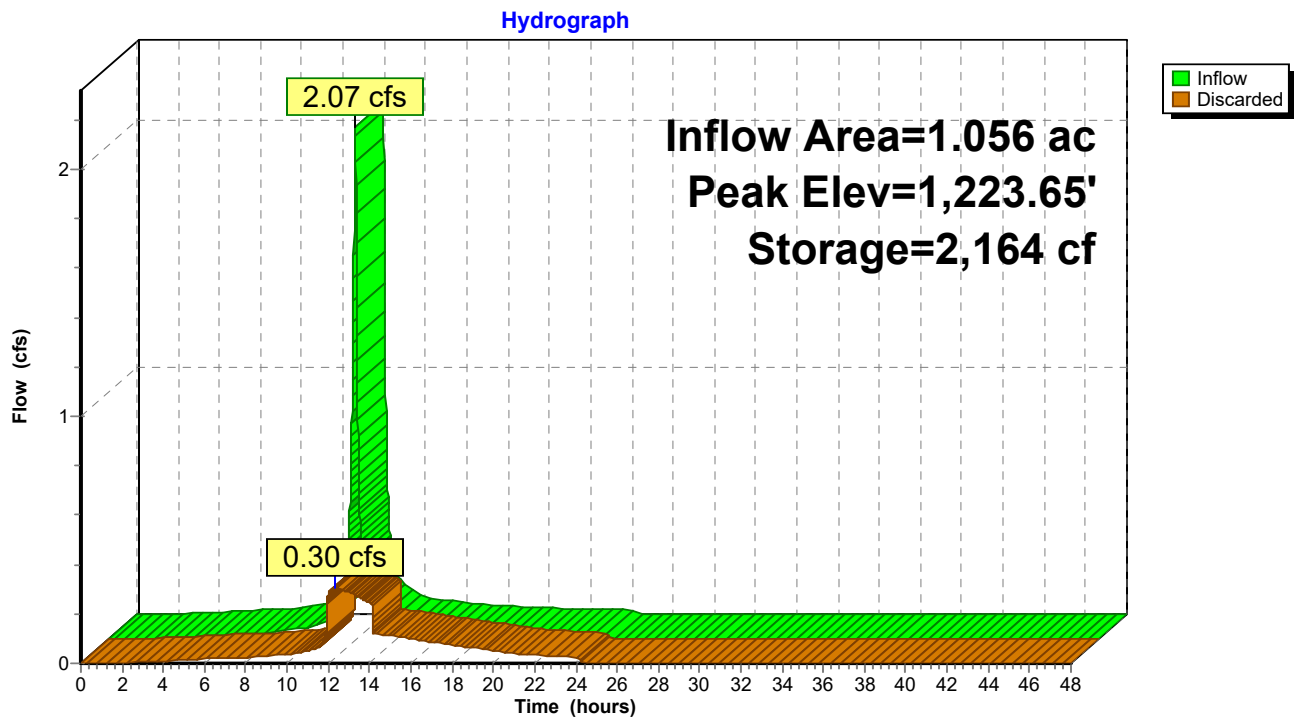
Volume	Invert	Avail.Storage	Storage Description
#1	1,220.27'	1,138 cf	2.00'W x 189.00'L x 3.00'H Infiltration Trench 2 Z=1.5 3,794 cf Overall x 30.0% Voids
#2	1,223.27'	1,579 cf	Surface Storage (Prismatic) Listed below (Recalc)
		2,717 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,223.27	2,079	0	0
1,223.81	3,769	1,579	1,579

Device	Routing	Invert	Outlet Devices
#1	Discarded	1,220.27'	2.400 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 1,026.50' Phase-In= 0.01'

Discarded OutFlow Max=0.30 cfs @ 12.30 hrs HW=1,223.65' (Free Discharge)
 ↑**1=Exfiltration** (Controls 0.30 cfs)

Pond INF2A2B3P: Infiltr. Trench 2A & 2B - FINAL



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Appendix G. Conveyance Calculations



Main Apron only

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.012
Channel Slope	0.005 ft/ft
Diameter	12.0 in
Discharge	1.23 cfs
Results	
Normal Depth	5.6 in
Flow Area	0.4 ft ²
Wetted Perimeter	1.5 ft
Hydraulic Radius	2.9 in
Top Width	1.00 ft
Critical Depth	5.6 in
Percent Full	47.1 %
Critical Slope	0.005 ft/ft
Velocity	3.38 ft/s
Velocity Head	0.18 ft
Specific Energy	0.65 ft
Froude Number	0.989
Maximum Discharge	2.94 cfs
Discharge Full	2.73 cfs
Slope Full	0.001 ft/ft
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	0.0 %
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	5.6 in
Critical Depth	5.6 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Apron Expansion only

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.012
Channel Slope	0.005 ft/ft
Diameter	12.0 in
Discharge	1.00 cfs
Results	
Normal Depth	5.0 in
Flow Area	0.3 ft ²
Wetted Perimeter	1.4 ft
Hydraulic Radius	2.7 in
Top Width	0.99 ft
Critical Depth	5.0 in
Percent Full	41.9 %
Critical Slope	0.005 ft/ft
Velocity	3.21 ft/s
Velocity Head	0.16 ft
Specific Energy	0.58 ft
Froude Number	1.006
Maximum Discharge	2.94 cfs
Discharge Full	2.73 cfs
Slope Full	0.001 ft/ft
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	41.9 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.0 in
Critical Depth	5.0 in
Channel Slope	0.005 ft/ft
Critical Slope	0.005 ft/ft

Apron + Expansion PVC

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.010
Channel Slope	0.005 ft/ft
Diameter	12.0 in
Discharge	2.23 cfs
Results	
Normal Depth	7.3 in
Flow Area	0.5 ft ²
Wetted Perimeter	1.8 ft
Hydraulic Radius	3.3 in
Top Width	0.98 ft
Critical Depth	7.7 in
Percent Full	60.5 %
Critical Slope	0.004 ft/ft
Velocity	4.48 ft/s
Velocity Head	0.31 ft
Specific Energy	0.92 ft
Froude Number	1.109
Maximum Discharge	3.52 cfs
Discharge Full	3.27 cfs
Slope Full	0.002 ft/ft
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	60.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.3 in
Critical Depth	7.7 in
Channel Slope	0.005 ft/ft
Critical Slope	0.004 ft/ft

Apron + Expansion RCP

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.012
Channel Slope	0.005 ft/ft
Diameter	12.0 in
Discharge	2.23 cfs
Results	
Normal Depth	8.2 in
Flow Area	0.6 ft ²
Wetted Perimeter	2.0 ft
Hydraulic Radius	3.5 in
Top Width	0.93 ft
Critical Depth	7.7 in
Percent Full	68.7 %
Critical Slope	0.006 ft/ft
Velocity	3.88 ft/s
Velocity Head	0.23 ft
Specific Energy	0.92 ft
Froude Number	0.868
Maximum Discharge	2.94 cfs
Discharge Full	2.73 cfs
Slope Full	0.003 ft/ft
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	60.5 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	8.2 in
Critical Depth	7.7 in
Channel Slope	0.005 ft/ft
Critical Slope	0.006 ft/ft

Apron + Expansion + Roof

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Roughness Coefficient	0.010
Channel Slope	0.005 ft/ft
Diameter	12.0 in
Discharge	2.39 cfs
Results	
Normal Depth	7.6 in
Flow Area	0.5 ft ²
Wetted Perimeter	1.8 ft
Hydraulic Radius	3.4 in
Top Width	0.96 ft
Critical Depth	7.9 in
Percent Full	63.4 %
Critical Slope	0.004 ft/ft
Velocity	4.55 ft/s
Velocity Head	0.32 ft
Specific Energy	0.96 ft
Froude Number	1.086
Maximum Discharge	3.52 cfs
Discharge Full	3.27 cfs
Slope Full	0.003 ft/ft
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	63.4 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.6 in
Critical Depth	7.9 in
Channel Slope	0.005 ft/ft
Critical Slope	0.004 ft/ft

EAT Trench Drain Design

Purpose:	Calculate capacity for trench drain system to ensure adequate for main apron and expanded apron runoff	Date	5/17/2021
		Designed By:	Andrea Boyd
Notes:	Used Zurn Z882 model and ACO Powerdrain S200K 8" to estimate capacity at upstream and downstream ends of trench drain runs. Used the DWG files to measure cross sectional areas and wetted perimeter. The DWG shows the upstream cross sectional area. Drew an approximate down stream cross sectional area with the known depth to invert.	Checked By:	

Trench Drain 1 (TD1)

Two segments of 87 feet of trench drain, based on 8 ft sections

Capacity required for full apron1.20 cfs

Estimated req'd capacity per TD0.6 cfs

Manning's n0.013for concrete, most conservative, since material is unknown

ACO S200K 8" Powerdrain

Capacity at upstream end of trench drain

Dimensions measured in CAD

X-Section Area, A0.344767ft2

Wetted Perimeter, P1.576389ft

Hydraulic Radius, R (A/P)0.218707

Trench drain slope0.0050

Manning's n0.013

Discharge, Q1.01cfs

Depth to invert upstream9.8750.82inft

Depth to invert downstream15.0951.26inft

Capacity at downstream end of trench drain

Dimensions estimated in CAD

X-Section Area, A0.54ft2

Wetted Perimeter, P2.47ft

Hydraulic Radius, R (A/P)0.22

Trench drain slope0.01

Manning's n0.013

Discharge, Q1.61cfs

CAPACITY CHECK:GOOD

of Runs2

Length per run87ft

Zurn Z882

Segment length8ft

#Segments10.875

Length of last segment7ft

Capacity at upstream end of trench drain

Dimensions measured in CAD

X-Section Area, A28.69880.20in2ft2

Wetted Perimeter, P13.27231.11inft

Hydraulic Radius, R (A/P)0.18019233

Trench drain slope0.0085

Manning's n0.013(provided by mfr.)

Discharge, Q0.67cfs

Depth to invert upstream6.258201 segment shallow invertin

Depth to deep downstream15.258209 segment deep invertin

Slope of segment0.125

Adjustment0.125

Depth to invert downstream15.125

Capacity at downstream end of trench drain

Dimensions estimated in CAD

X-Section Area, A91.710.64in2ft2

Wetted Perimeter, P29.552.46inft

Hydraulic Radius, R (A/P)0.26

Trench drain slope0.01

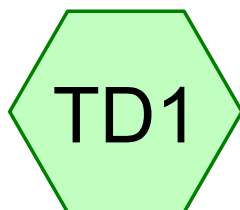
Manning's n0.013

Discharge, Q2.10cfs

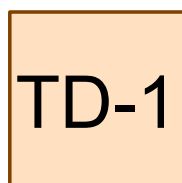
CAPACITY CHECK:GOOD

Trench Drain 2 (TD2)

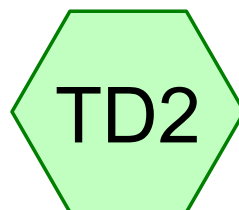
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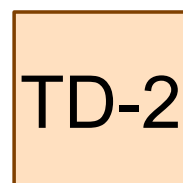
Trench Drain 1



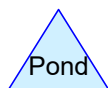
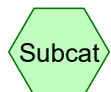
Trench Drain 1



Trench Drain 2



Trench Drain 2



EAT Calculations - 100%

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Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.741	98	Paved parking, HSG A (TD1, TD2)
3.741	98	TOTAL AREA

EAT Calculations - 100%

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Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
3.741	HSG A	TD1, TD2
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
3.741		TOTAL AREA

EAT Calculations - 100%

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Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
3.741	0.000	0.000	0.000	0.000	3.741	Paved parking	TD1, TD2
3.741	0.000	0.000	0.000	0.000	3.741	TOTAL AREA	

EAT Calculations - 100%*Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"*

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Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points

Runoff by SBUH method, Split Pervious/Imperv.

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentTD1: Trench Drain 1

Runoff Area=1.974 ac 100.00% Impervious Runoff Depth=2.40"

Tc=5.0 min CN=0/98 Runoff=1.20 cfs 0.395 af

SubcatchmentTD2: Trench Drain 2

Runoff Area=1.767 ac 100.00% Impervious Runoff Depth=2.40"

Tc=5.0 min CN=0/98 Runoff=1.07 cfs 0.353 af

Reach TD-1: Trench Drain 1Avg. Flow Depth=0.55' Max Vel=3.46 fps Inflow=1.20 cfs 0.395 af
n=0.013 L=87.0' S=0.0068 '/' Capacity=1.86 cfs Outflow=1.20 cfs 0.395 af**Reach TD-2: Trench Drain 2**Avg. Flow Depth=0.53' Max Vel=3.24 fps Inflow=1.07 cfs 0.353 af
n=0.013 L=117.0' S=0.0061 '/' Capacity=1.76 cfs Outflow=1.07 cfs 0.353 af**Total Runoff Area = 3.741 ac Runoff Volume = 0.748 af Average Runoff Depth = 2.40"**
0.00% Pervious = 0.000 ac 100.00% Impervious = 3.741 ac

EAT Calculations - 100%

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Summary for Subcatchment TD1: Trench Drain 1

Runoff = 1.20 cfs @ 7.88 hrs, Volume= 0.395 af, Depth= 2.40"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

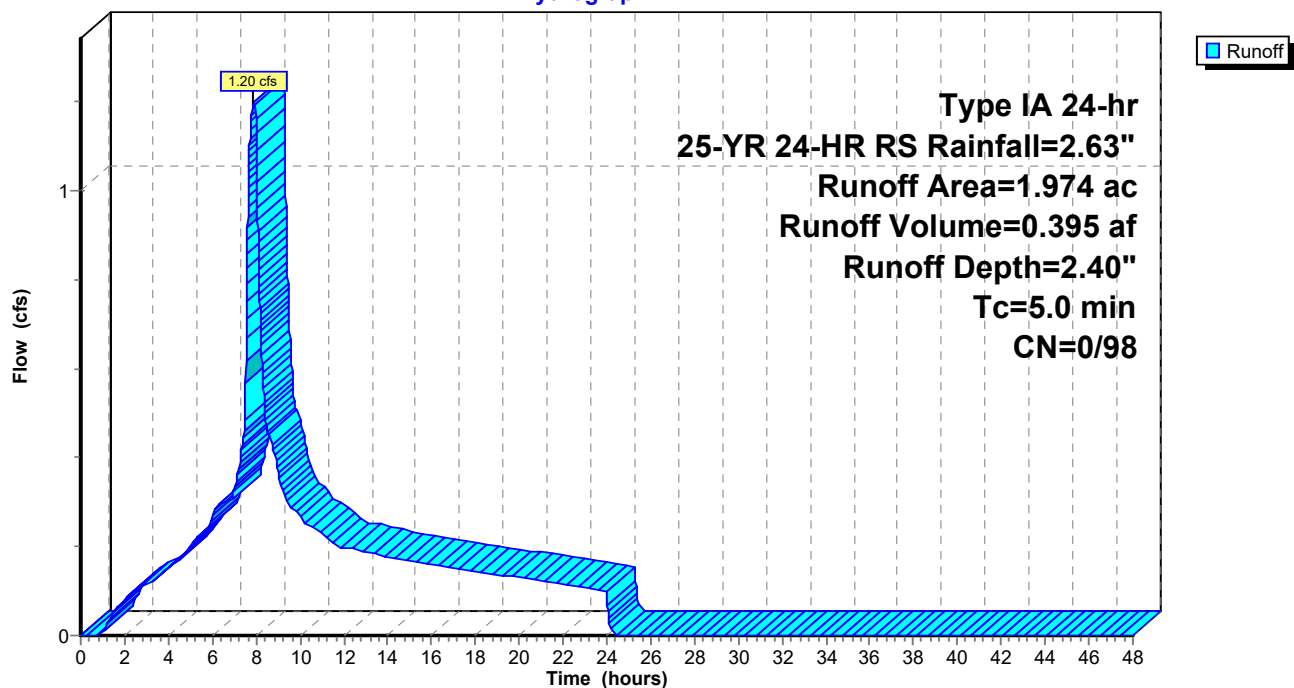
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
0.000	68	<50% Grass cover, Poor, HSG A
1.974	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
1.974	98	Weighted Average
1.974	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment TD1: Trench Drain 1

Hydrograph



EAT Calculations - 100%

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Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Subcatchment TD2: Trench Drain 2

Runoff = 1.07 cfs @ 7.88 hrs, Volume= 0.353 af, Depth= 2.40"

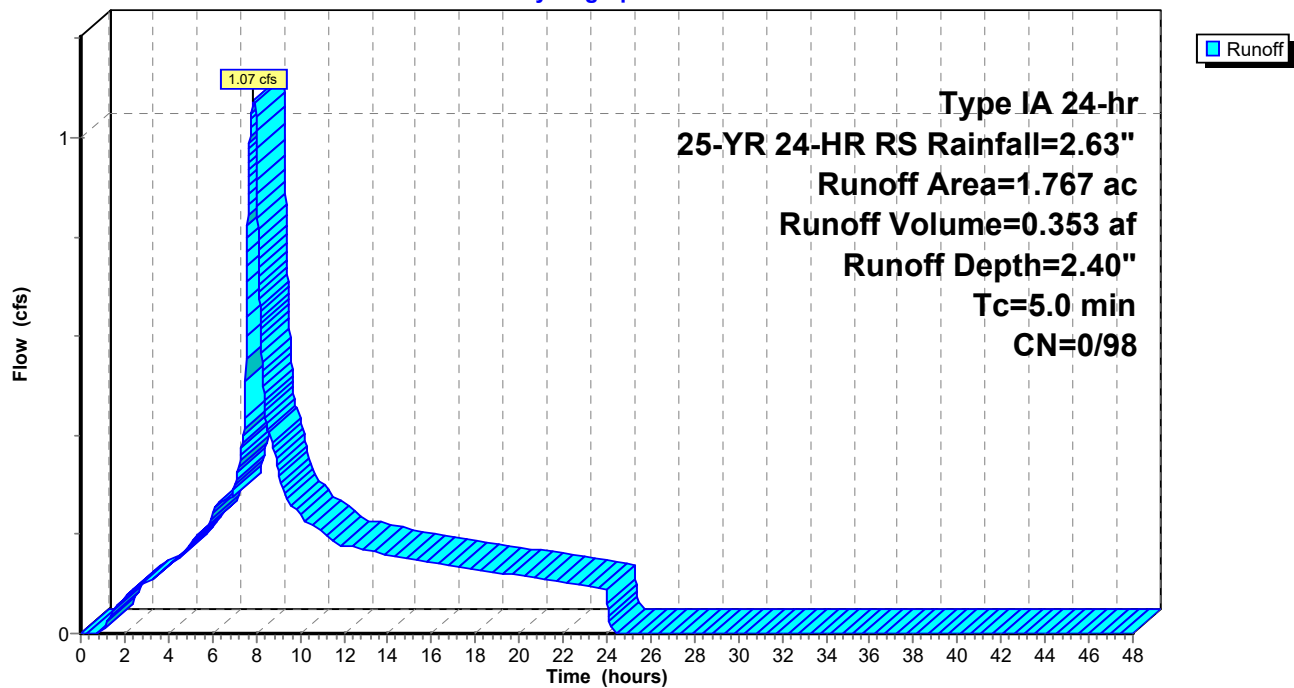
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

Area (ac)	CN	Description
0.000	68	<50% Grass cover, Poor, HSG A
1.767	98	Paved parking, HSG A
0.000	96	Gravel surface, HSG A
1.767	98	Weighted Average
1.767	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Min Tc

Subcatchment TD2: Trench Drain 2

Hydrograph



EAT Calculations - 100%

Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Reach TD-1: Trench Drain 1

Inflow Area = 1.974 ac, 100.00% Impervious, Inflow Depth = 2.40" for 25-YR 24-HR RS event
 Inflow = 1.20 cfs @ 7.88 hrs, Volume= 0.395 af
 Outflow = 1.20 cfs @ 7.89 hrs, Volume= 0.395 af, Atten= 0%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Max. Velocity= 3.46 fps, Min. Travel Time= 0.4 min

Avg. Velocity = 2.07 fps, Avg. Travel Time= 0.7 min

Peak Storage= 30 cf @ 7.89 hrs

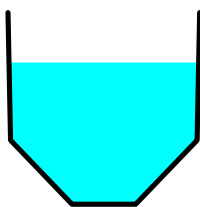
Average Depth at Peak Storage= 0.55' , Surface Width= 0.74'

Bank-Full Depth= 0.75' Flow Area= 0.5 sf, Capacity= 1.86 cfs

Custom cross-section, Length= 87.0' Slope= 0.0068 '/'

Constant n= 0.013 Concrete pipe, bends & connections

Inlet Invert= 1,221.98', Outlet Invert= 1,221.39'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	100.00	0.00
0.01	99.50	0.50
0.25	99.25	0.75
0.50	99.25	0.75
0.74	99.50	0.50
0.75	100.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.3	0.0	0	0.00
0.25	0.1	0.9	0.7	11	0.30
0.75	0.5	1.9	0.8	43	1.86

EAT Calculations - 100%

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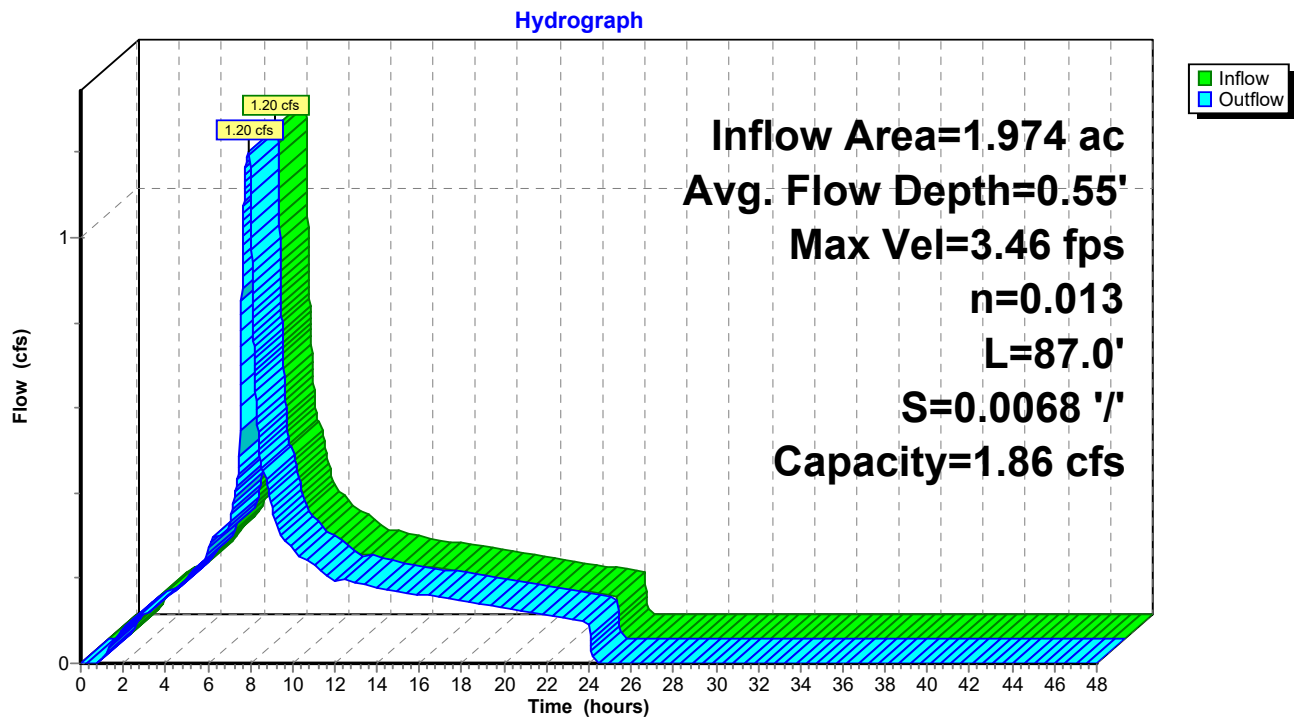
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Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Reach TD-1: Trench Drain 1



EAT Calculations - 100%

Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Summary for Reach TD-2: Trench Drain 2

Inflow Area = 1.767 ac, 100.00% Impervious, Inflow Depth = 2.40" for 25-YR 24-HR RS event
 Inflow = 1.07 cfs @ 7.88 hrs, Volume= 0.353 af
 Outflow = 1.07 cfs @ 7.90 hrs, Volume= 0.353 af, Atten= 0%, Lag= 1.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Max. Velocity= 3.24 fps, Min. Travel Time= 0.6 min

Avg. Velocity= 1.92 fps, Avg. Travel Time= 1.0 min

Peak Storage= 39 cf @ 7.89 hrs

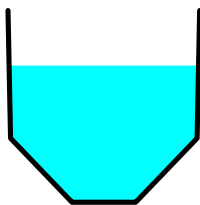
Average Depth at Peak Storage= 0.53' , Surface Width= 0.74'

Bank-Full Depth= 0.75' Flow Area= 0.5 sf, Capacity= 1.76 cfs

Custom cross-section, Length= 117.0' Slope= 0.0061 '/'

Constant n= 0.013 Concrete pipe, bends & connections

Inlet Invert= 1,222.08', Outlet Invert= 1,221.37'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	100.00	0.00
0.01	99.50	0.50
0.25	99.25	0.75
0.50	99.25	0.75
0.74	99.50	0.50
0.75	100.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	0.3	0.0	0	0.00
0.25	0.1	0.9	0.7	14	0.28
0.75	0.5	1.9	0.8	58	1.76

EAT Calculations - 100%

Prepared by Mead & Hunt, Inc.

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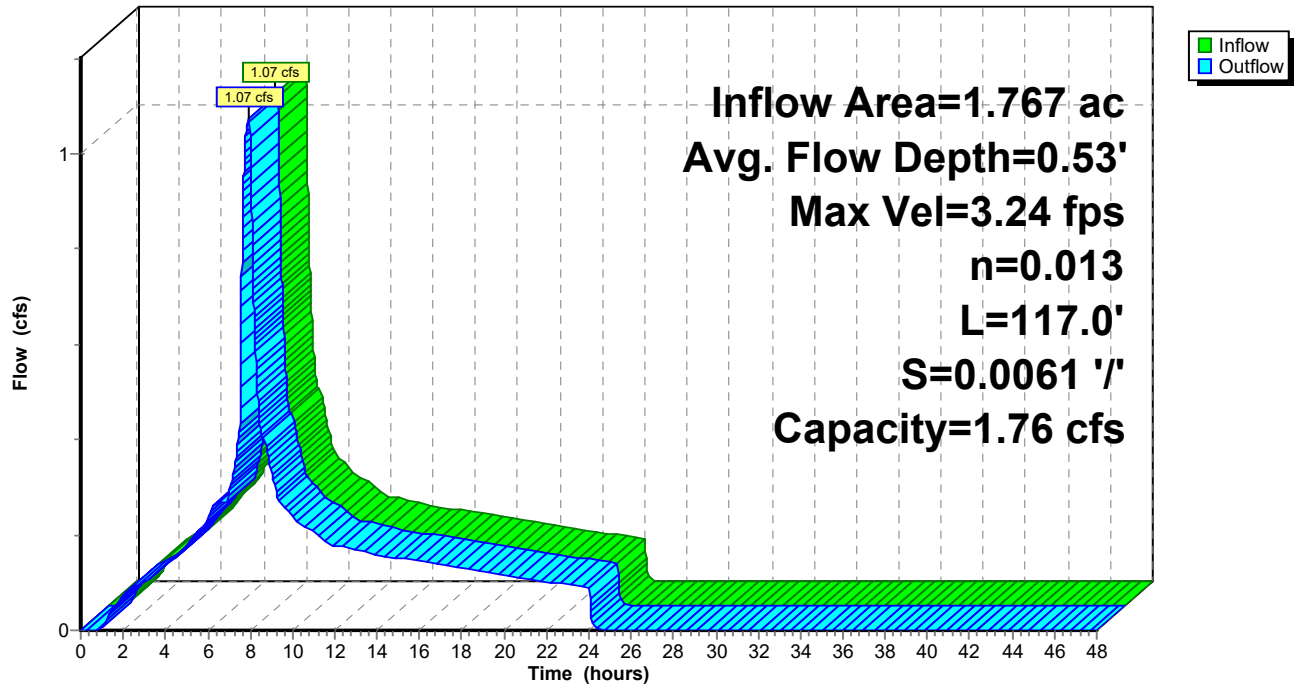
Type IA 24-hr 25-YR 24-HR RS Rainfall=2.63"

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Reach TD-2: Trench Drain 2

Hydrograph



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Appendix H. O&M Manual



1. System Operational Objectives

The operational objectives for the EAT system differ from a traditional wastewater treatment plant.

However, the following guidelines will be followed when operating the system:

- The EAT discharge will be maintained at the maximum BOD₅ loading rate authorized by the DCWTF when at least 2,500-gallons of SADR is present in the UST.
- Rainfall greater than 0.5"/day will be diverted from the UST if active deicing is not occurring. The system is intended to be monitored each day during the October 1 – April 15 period each deicing season. Stormwater will be allowed to flow to the EAT stormwater system, unmonitored, during the April 16 – September 30 period each season.
- The overall objective will be to maintain the UST in as empty a state as possible.

2. System Controls Description

This section contains information regarding the operation of each unit of the EAT system and a description of various controls, recommended settings, fail-safe features, etc.

- **Gate Valves for Directing Flow**
 - There are two gate valves, only one of which will be open at a time. The summer setting is "Flow-Through" which releases flow to the onsite and the winter setting is "Divert".
 - The diversion valve can be operated by using either a manual "Tee Handle" or a power actuator with a stub-extender.
 - The stub-extender is a solid piece of metal that should be stored with the power actuator.
- **Autosampler**
 - The autosampler is designed to "pull" an aliquot once an hour during periods that the pumps are operational.
 - The autosampler must be set prior to each day that a sample will be collected. Instructions on setting and maintaining the autosampler are contained in **Appendix D**.
- **Chemical Oxidation Demand (COD) Analyzer**
 - The COD analyzer is a small bench-scale unit that heats vials containing small quantities of SADR for approximately 90 minutes after which the COD of the sample can be "read" using a colorimeter that is part of the instrument.
 - A small number of basic laboratory items are required to accurately measure the SADR samples to be analyzed for COD.
 - "Spent" COD vials contain materials that should not be washed down the drain and should be disposed of properly with other hazardous waste generated at EAT.
- **Variable Flowrate Pump System (including flowmeter)**
 - The system pumps are designed to operate at a range of flowrates as described in Section 6 of this Manual.
 - The pumps are designed to operate for long periods of time with little maintenance but should be run at least once per month, including during the summer.
- **System Control and Data Acquisition (SCADA) System**
 - The SCADA system monitors the operational status of the pumps and flowmeter, and UST level-sensing equipment with this information displayed on a "dashboard" that is password protected. The dashboard can be configured to allow operation of the system by the owner or observation-only of the system status by others authorized by EAT.
 - The SCADA system can also be configured to send texts, e-mails, or cell-phone calls in the event a system alarm (pump/power failure, high- or low-level alarms, high-temperature, etc.). Typically, these alarms will continue to announce until they are addressed.

- The SCADA system maintains data “in the cloud” and many different types of reports can be generated to document current or historic operation of the system,

3. Laboratory Procedures

This section contains information on laboratory procedures including sampling techniques, monitoring requirements, and sample analysis.

A. COD Sample Collection Procedures

- (Discharge not occurring). Samples for COD analysis are collected when a discharge is not occurring opening the by lowering a clean bucket through the UST access hatch to at least three feet beneath the water surface and collecting at least one quart of water. Pour water from the bucket into a clean quart sample jar and place the jar in a cooler for transport to the bench COD lab. Run a COD analysis. Use this COD value to calculate the allowable flow rate to the DCWTF, following approval from that facility.
- (Discharge occurring). Open the sampling spigot on the line to the autosampler and obtain at least a one-quart sample in a clean jar. place the jar in a cooler for transport to the bench COD lab. Run a COD analysis. Use this COD value to calculate the allowable flow rate to continue the DCWTF discharge, based on approval from that facility.

B. BOD₅ Sample Collection and Pickup Procedures

- BOD₅ samples should be collected using the autosampler in accordance with procedures specified by the DCWTF and the analytical lab that processes the samples.
- BOD₅ samples need to be refrigerated following collection and typically must be submitted to the analytical laboratory within 48 hours of collection. A Chain-of-Custody document is usually required by the laboratory that performs the BOD₅ analysis.

4. Recordkeeping and Reporting Procedures

The EAT SADR pumps and flow meter are monitored by a Supervisory Control and Data Acquisition (SCADA) system. Numerous reports of current and historical reports are readily obtainable using this SCADA system.

Electronic copies of all analytical laboratory reports will be maintained by EAT for a period of three years and will be provided to authorized requesting agencies upon request.

5. BMPs for Mobile Fueling

Steps must be taken during mobile fueling operations to comply with the 2019 Stormwater Management Manual for Eastern Washington, section S419e.

- Ensure that the local fire department approves all mobile fueling operations. Comply with local and Washington State fire codes.
- In fueling locations that are in proximity to sensitive aquifers, designated wetlands, wetland buffers, or other waters of the state, approval by local jurisdictions is necessary to ensure compliance with additional local requirements.
- Ensure the compliance with all 49 CFR Part 178 requirements for a U.S. Department of Transportation (DOT) 406 cargo tanker. Documentation from a DOT-registered inspector provides proof of compliance.
- Ensure the presence and the constant observation/monitoring of the driver/operator at the fuel transfer location at all times during fuel transfer, and ensure implementation of

the following procedures at the fuel transfer locations:

- Locate the point of fueling ≥ 25 feet from the nearest storm drain or inside an impervious containment with a volumetric holding capacity $\geq 110\%$ of the fueling tank volume, or covering the storm drain to ensure no inflow of spilled or leaked fuel. Covers are not required for storm drains that convey the inflow to a spill control separator, approved by the local jurisdiction and the fire department. Potential spill/leak conveyance surfaces must be impervious and in good repair. Do not remove the drain cover if sheen is present. Properly collect and dispose of any contaminated material.
- Place a drip pan or an absorbent pad under each fueling location prior to and during all dispensing operations. The pan (must be liquid tight), and the absorbent pad must have a capacity of ≥ 5 gallons. There is no need to report spills retained in the drip pan or the pad.
- Manage the handling and operation of fuel transfer hoses and nozzle, drip pan(s), and absorbent pads as needed to prevent spills/leaks of fuel from reaching the ground, storm drains, and receiving waters.
- Avoid extending the fueling hoses across a traffic lane without fluorescent traffic cones, or equivalent devices, conspicuously placed to prevent all traffic from crossing the fuel hose.
- Remove the fill nozzle and cease filling the tank when the automatic shutoff valve engages. Do not lock automatic shutoff fueling nozzles in the open position.
- Do not “top off” the fuel receiving equipment.
- Provide the driver/operator of the fueling vehicle with the following:
 - Adequate flashlights or other mobile lighting to view fuel fill openings with poor accessibility. Consult with local fire department for additional lighting requirements.
 - Two-way communication with his/her home base.
- Train the driver/operator annually in spill prevention and cleanup measures and emergency procedures. Make all employees aware of the significant liability associated with fuel spills.
- The responsible manager shall properly sign and date the fueling operating procedures. Distribute procedures to the operators, retain them in the organization files, and make them available in the event an authorized government agency requests a review.
- Immediately notify the local fire department (911) and the appropriate regional office of the Washington State Department of Ecology in the event of any spill entering surface or ground waters. Establish a “call down list” to ensure the rapid and proper notification of management and government officials should any significant amount of product be lost off-site. Keep the list in a protected but readily accessible location in the mobile fueling truck. The “call down list” should also identify spill response contractors available in the area to ensure the rapid removal of significant product spillage into the environment.
- In all fueling vehicles, maintain a minimum of the following spill cleanup materials:
 - Non-water-absorbents capable of absorbing ≥ 15 gallons of fuel
 - A storm drain plug or cover kit
 - A non-water-absorbent containment boom of a minimum 10 feet in length with a 12-gallon minimum absorbent capacity

- A non-spark-generating shovel (a steel shovel could generate a spark and cause an explosion in the right environment around a spill)
 - Two 5-gallon buckets with lids
- Use automatic shutoff nozzles for dispensing the fuel. Replace automatic shutoff nozzles as recommended by the manufacturer.
- Maintain and replace equipment on fueling vehicles, particularly hoses and nozzles, at established intervals to prevent failures.
- Immediately remove and properly dispose of soils with visible surface contamination to prevent the spread of chemicals to ground water or receiving waters via stormwater runoff.
- Do not use dispersants to clean up spills or sheens.

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Appendix I. Letter from DOE





STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
1250 West Alder Street • Union Gap, Washington 98903-0009 • (509) 575-2490

April 1, 2020

Vince Barthels
Project Manager
121 W. Pacific Avenue, Suite 200
Spokane, WA 99201

Re: EA for Pangborn Memorial Airport

Dear Vince Barthels:

Thank you for the opportunity to comment on the scope of the Environmental Assessment for the Pangborn Memorial Airport proposed action. We have reviewed the application and have the following comment.

WATER QUALITY

Project with Potential to Discharge Off-Site

If the project anticipates disturbing ground with the potential for stormwater discharge off-site, the NPDES Construction Stormwater General Permit is recommended. This permit requires that the SEPA checklist fully disclose anticipated activities including building, road construction and utility placements. Obtaining a permit may take 38-60 days.

The permit requires that a Stormwater Pollution Prevention Plan (Erosion Sediment Control Plan) shall be prepared and implemented for all permitted construction sites. These control measures must be able to prevent soil from being carried into surface water and storm drains by stormwater runoff. Permit coverage and erosion control measures must be in place prior to any clearing, grading, or construction.

In the event that an unpermitted Stormwater discharge does occur off-site, it is a violation of Chapter 90.48 RCW, Water Pollution Control and is subject to enforcement action.

More information on the stormwater program may be found on Ecology's stormwater website at: <http://www.ecy.wa.gov/programs/wq/stormwater/construction/>. Please submit an application or contact **Wendy Neet** at the Dept. of Ecology, 509-454-7277 or wendy.neet@ecy.wa.gov, with questions about this permit.

Vince Barthels
April 1, 2020
Page 2

AIR QUALITY

Due to the dry conditions of our region, we are reminding people that extra efforts are needed to control blowing dust and dirt. The proponent should create a site-specific Fugitive Dust Control Plan (FDCP) before starting this project, and then follow the plan for construction of the project and duration of activity on property. The FDCP should include, but is not limited to, the following components:

- Identify all potential fugitive dust emission points.
- Assign dust control methods.
- Determine the frequency of application
- Record all dust control activities.
- Train personnel in the FDCP.
- Shut down during windy conditions.
- Follow the FDCP and monitor dust control efforts.

Washington Administrative Code (WAC) 173-400-040 requires that reasonable precautions be taken to prevent dust from leaving the site. Also, dust is prohibited from interfering unreasonably with the use and enjoyment of property, causing health impacts, or damaging property or business.

Sincerely,



Gwen Clear
Environmental Review Coordinator
Central Regional Office
509-575-2012
crosepa@ecy.wa.gov

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STORMWATER SITE PLAN

PREPARED BY



9600 NE Cascades Parkway, Ste. 100
Portland, Oregon 97220
503-548-1494
www.meadhunt.com