Phase 1 - Preliminary Design Report

City of Arlington
Prairie Creek Drainage Improvements

November 2, 2012

Murray, Smith & Associates, Inc.

PHASE 1
PRELIMINARY DESIGN REPORT

FOR

CITY OF ARLINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS

NOVEMBER 2012

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SECTION 1

INTRODUCTION

AUTHORIZATION

The City of Arlington (City) has authorized Murray, Smith and Associates, Inc. (MSA) to provide engineering services for a two phase work program to reduce the risk of local flooding impacts and improve the function of Prairie Creek under the Professional Services Agreement dated July 31, 2012.

BACKGROUND AND PURPOSE

Prairie Creek has a history of frequent flooding within the Jensen Business Park and nearby vicinity. The Prairie Creek watershed is currently collected by two stream channels, which converge upstream of the project area. The west fork of Prairie Creek was artificially realigned to its current location in the 1980's, and had originally been a separate stream. Combining the two stream channels has substantially increased the tributary watershed area, resulting in much larger surface runoff rates than originally existed in the project area. In addition, the Prairie Creek watershed has seen a significant amount of land development activity over the past several years, which may have increased surface runoff rates within the watershed. The increased runoff rates, in conjunction with ongoing sediment migration within Prairie Creek, has resulted in periodic flooding impacts to important and growing businesses within the City.

The City's Comprehensive Stormwater Plan (Stormwater Plan), dated October 2010, identified the following undersized culverts in the Prairie Creek watershed:

- 67th Avenue Culvert (Problem 29): Culvert replacement design completed under a separate contract
- Burlington Northern Santa Fe (BNSF) Railroad (RR) and 69th Avenue Culverts (Problem 30): Two existing culverts
- 204th Street Culvert (Problem 31)
- 71st Avenue Culvert (Problem 33)
- 74th Avenue Culvert (Problem 35)

The primary purpose of this project is to undertake and complete preliminary design of improvements to the culverts to reduce the risk of local flooding impacts to the surrounding businesses.

SECTION 2

PROJECT SCOPE

PROJECT OVERVIEW

The project has been split into two distinct phases of work. The first (Phase 1) was defined as the preliminary design phase, with the objective of collecting data to define the current watershed boundary and stream characteristics contributing to the flooding events. Information relating to the existing conditions was obtained through research of public records, topographic survey, site investigations, and information provided by the City. Hydrologic and hydraulic models were developed for the analysis of several design and implementation alternatives of drainage improvements for Prairie Creek. This document presents our findings from the analysis, discusses the stream characteristics and hydraulic response of various alternatives, and recommends potential options for the final design phase.

The final design phase (Phase 2) will begin immediately following the preliminary design. This phase includes all permitting and environmental reviews, as well as final engineering design to develop construction documents. The final construction documents will incorporate comments from the City and other review jurisdictions.

PROJECT APPROACH

The following describes, in more detail, the approach and specific tasks that were completed in Phase 1 and will be completed in Phase 2 for the Prairie Creek Drainage Improvements project.

Phase 1 – Preliminary Design

Site Investigations – Site visits, surveying and geotechnical investigations were performed to develop the basic information necessary to guide the final design. Detailed topographic survey information was obtained at each culvert crossing for replacement design, and basic topographic survey of the stream alignment and cross sections was performed for hydraulic modeling purposes. The geotechnical investigation included borings near the existing culverts to determine the anticipated subsurface conditions for construction.

Hydrologic and Hydraulic Modeling – Hydrologic modeling was performed to verify the City's existing hydrologic model, and develop peak flows tributary to Prairie Creek for use in the hydraulic model. Hydraulic modeling was performed to help identify potential interim drainage improvements, appropriately size the future culvert replacements, and identify the impacts to Prairie Creek from implementing interim drainage improvements as well as replacing some or all of the culverts in the identified problem areas.

Alternatives Analysis and Preliminary Design – Alternatives analysis and preliminary design conclusions and recommendations developed during the previously mentioned tasks will be summarized and presented within this document. This document will be a stand-alone document that will define the project and provide sufficient information and detail to proceed with the second phase, Final Design and Permitting.

Phase 2 – Final Design (Not included in this contract)

Final Design – The final design and construction documents will be advanced with opportunities for review by the City and other agency requirements at 50% and 95% submittal milestones. The specific project elements that will be included in the final design phase will be better defined at the completion of Phase 1. The design for all improvements is expected to be completed concurrently while the implementation (construction) will likely occur under two separate construction contracts in two construction seasons due to funding and permitting timeline constraints.

Permits and Environmental Reviews – Applications will be prepared for the necessary permits and environmental reviews. The City will submit all materials to the appropriate agencies and respond to agency inquiries.

Bidding and Award – MSA will assist the City with the bidding and award process by preparing a draft advertisement, assisting with bidder inquiries, preparing any necessary addenda, attending a pre-bid briefing, and assisting with the bid opening and award.

Construction Phase Services

If requested by the City, engineering services will be provided during the construction of the project. Typical construction phase services include:

- Shop Drawings and Submittals Review
- Monthly Pay Request Processing
- Requests for Information Clarifications
- Process Change Orders
- Monthly Project Status Reports and Project Meetings
- On-Site Construction Observation
- Testing and Start-Up Assistance
- Final Inspection
- Project Close-Out
- Record Drawings Preparation
- Warranty Inspection

SECTION 3

EXISTING SITE CONDITIONS

GENERAL

This section provides a summary of the existing site conditions within the Prairie Creek watershed as it relates to the drainage improvements project. The existing conditions are based on field investigations completed by the design team.

INFORMATION GATHERING

To understand the conditions of Prairie Creek, data was collected through field investigations and public record information for the project area and vicinity. Metron and Associates, Inc. performed field survey to develop base mapping and hydraulic modeling conditions for the project area. MSA also analyzed available construction documents, stormwater modeling data, GIS information, and existing studies and reports pertaining to the project area. Discussions were also held with City staff to better understand the history of the Prairie Creek drainage issues.

PRAIRIE CREEK WATERSHED

Watershed Description

The Prairie Creek watershed occupies an area of approximately 1,200 acres, in the southeast corner of Arlington and unincorporated Snohomish County. The watershed limits are presented in Figure 3-1 of this report.

The Prairie Creek Watershed originates east of SR-9, near 160th Street NE, and extends northwesterly. Surface runoff is collected into two well defined stream channels. The west fork of Prairie Creek collects runoff from the upper end of the watershed, as well as an area between SR-9 and the Gleneagle golf course. The east fork of Prairie Creek originates south of Arlington High School, and receives runoff from an area east of SR-9 which includes much of the High School property and Crown Ridge subdivision north of the school. The watershed extends northerly to 204th Street NE, which is the primary northern watershed boundary. Prairie Creek crosses beneath 204th Street NE just east of 67th Avenue, and receives surface runoff from a small corridor between 204th Street NE and its terminus at Portage Creek.

The upstream portion of the watershed, occupying roughly one-third of the total area, can generally be described as rural, sparsely developed area. Much of this area lies in unincorporated Snohomish County. The middle portion, occupying roughly half of the total area, is primarily comprised of single-family residential areas, and two public school sites. The remainder of the watershed is occupied mainly by the industrial and commercial properties near 204th Street NE.

In addition to stormwater runoff, the watershed also receives irrigation runoff from the Gleneagle golf course, which is derived from a groundwater source. Pumping records from the golf course were inconsistent, but the quantity of runoff appears to represent a small, if not negligible contribution to the total runoff in the project area. Irrigation runoff is also confined to the dry summer months, and not likely to be coincident with a significant storm event. With this in mind, irrigation runoff has not been considered as part of the basin runoff modeling contained within this report.

Study Area Description

The primary study area for this report is that portion of Prairie Creek which extends through the commercial zone near 204th Street NE, west of SR-9. This area is presented in Figure 3-2. Several of the properties south of 204th Street NE, and adjacent to the stream channel have experienced periodic flooding, which is expected to be a result of undersized culverts within the study area. This report has focused on five specific culvert crossings, as outlined in the Table 3-1 below:

Table 3-1
Existing Culvert Descriptions

Culvert Location	*Culvert Description*	*Culvert Conditions*
74th Ave NE	57”x38” Pipe Arch (per as-built drawing)	Culvert is inundated with sediment, with only 18” (approx.) of culvert remaining exposed. Downstream end of culvert is submerged.
71st Ave NE	58”x36” Pipe Arch (per as-built drawing)	Culvert is inundated with sediment, with only 24” (approx.) of culvert remaining exposed. A large sandbar has accumulated immediately downstream of the culvert.
204th St NE	71”x47” Pipe Arch (per as-built drawing)	Some sediment accumulation at downstream end of pipe. Most of the pipe barrel is exposed.
BNSF RR	60” Steel Pipe (per topo survey)	Some sediment accumulation in pipe. Most of the pipe barrel is exposed.
69th Ave NE	71”x47” Pipe Arch (per as-built drawing)	Sediment accumulation noted at downstream end of the pipe, and in the downstream channel. Most of the pipe barrel is exposed.

History of Drainage Problems

The two forks of Prairie Creek are historically documented as two separate stream channels. The west fork was realigned to the existing convergence point in the 1980’s. The resulting combined watershed is two-to-three times larger than the watershed that was initially tributary to the project area. The energy generated from the additional flow has resulted in significant streambank and streambed erosion downstream of the convergence point. This has caused the stream to become disconnected from a wetland area, and has also resulted in significant sediment accretion throughout the project area, and further downstream.

City staff has indicated that the project area has a history of flooding every couple of years. The primary flooding location identified in our discussions was at the 74th Avenue culvert crossing. The stream is known to overtop the roadway at this location, resulting in flooding to the adjacent Haggen's property to the north, as well as the AMT property to the west. Previously completed soils reports have also indicated that soils in the area are hydric, which suggests a history of inundation. The area was thought to have been a wetland area prior to initial settlement and agricultural use.

Through field observation and topographic survey information, it is clear that sediment accumulation has occurred at the 74th Avenue culvert location, and throughout the rest of the stream channel within the project area. Much of the 74th Avenue culvert is blocked with accumulated sediment, and the capacity of the culvert is expected to be substantially reduced from its intended function.

Significant sediment accumulations have also been documented at the 71st Avenue culvert crossing during field investigation and in the topographic survey. It is likely that periodic flooding also occurs at this location.

City staff has indicated that periodic flooding has not been reported further downstream at the 204th, BNSF, or 69th Avenue culvert.

Figure 3-1

Prairie Creek Drainage Improvements

Prairie Creek Watershed Map

November 2012

MSA Murray, Smith & Associates, Inc. Engineers/Planners

12-1347.104

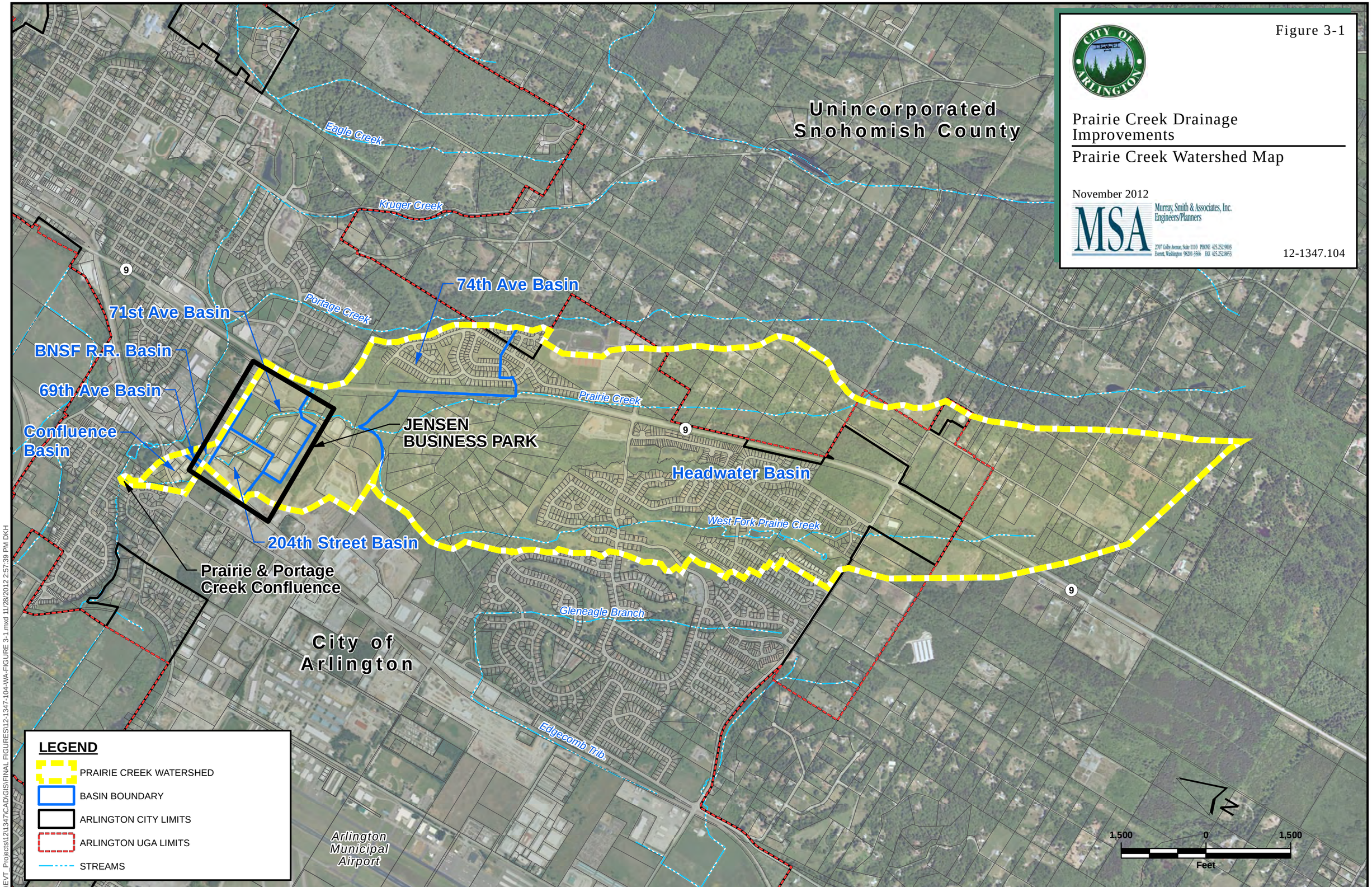

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Figure 3-2

Prairie Creek Drainage Improvements

Project Vicinity Map

November 2012

Murray, Smith & Associates, Inc.
Engineers/Planners

12-1347.104

204TH ST CULVERT

BNSF RR CULVERT

69TH AVE CULVERT

71ST AVE CULVERT

74TH AVE CULVERT

204TH ST NE

201ST ST NE

71ST AVE

74TH AVE NE

BNSF R.R.

SR 9

Prairie Creek

15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+00 34+00 35+00 36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00

NEWELL JEFFERY

WATERMARK DEVELOPMENT LLC

TRIPLE CREEK INVESTMENTS LLC

JENSEN BUSINESS PARKS LLC

BRIAR DEVELOPMENT COMPANY LLP

WATERMARK DEVELOPMENT LLC

CITY OF ARLINGTON

JNA PROPERTIES LLC

RHINO VENTURES

AEROSPACE MANUFACTURING TECHNOLOGIES

CAMA INVESTMENTS

AEROSPACE MANUFACTURING TECHNOLOGIES

JENSEN BUSINESS PARKS LLC

TRIPLE CREEK INVESTMENTS LLC

N

150 0 150

SCALE IN FEET

LEGEND

- PRAIRIE CREEK STATIONS
- PRAIRIE CREEK CULVERTS
- PRAIRIE CREEK ALIGNMENT

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GEOTECHNICAL CONDITIONS

A geotechnical investigation near each culvert location was performed by GeoEngineers. The following is a brief summary of the existing site subsurface soil conditions. For further details regarding the geotechnical conditions refer to the Geotechnical Engineering Services Report dated December 2012 in Appendix A.

- The soil descriptions in the boring logs are mainly sands; however, it is likely that layers of gravels are also present within these recessional outwash deposits. Large cobbles and boulders were not encountered in the borings except at 69th Avenue, but it should be noted that large cobbles and boulders are known to occur in recessional outwash soils.
- The culverts may be supported on shallow foundations bearing on the medium dense to dense recessional sand and gravel deposits. It is anticipated that the bottom of the culvert crossing under the BNSF tracks will likely be below the level of soft alluvial deposits encountered in boring B-2. An allowable soil bearing pressure of 4,000 pounds per square foot (psf) is recommended for footings supported by native medium dense soil or structural fill placed over native medium dense to dense soil.
- Difficulties in excavating and installing shoring will likely be encountered for the culvert crossing 69th Avenue due to the presence of rubble and/or large boulders present in the upper 5 feet of the fill.
- Provided the creek water is diverted from the excavations, it is anticipated that dewatering can typically be accomplished by open pumping using sump pumps. A higher level of pumping/dewatering may be required for the culvert excavation crossing 74th Avenue, where groundwater was encountered at a depth of about 9 feet during drilling and where relatively free-draining sand is present.
- It is anticipated that the soils at the site can be excavated using conventional construction equipment. However, the contractor should be prepared to deal with cobbles and boulders in the outwash soils, and with rubble or large boulders in the vicinity of 69th Avenue. Ideally, earthwork should be undertaken during extended periods of dry weather (generally July through September) when the soils will be less susceptible to disturbance and provide better support for construction equipment. Dry weather construction will help reduce earthwork costs.

Trenchless Technologies

The geotechnical report also provided a discussion of trenchless techniques that could be used to construct a culvert beneath the BNSF RR tracks. Pipe ramming is expected to be the preferred trenchless technique. Conventional tunneling and auger boring were two other potential options, but based on previous experience, tunneling is typically not allowed by BNSF and auger boring requires a receiving pit, which is probably not feasible due to topographic constraints.

EXISTING UTILITIES

The project covers a relatively large area, and includes a number of roadway crossings that are also expected to be utility corridors. Overhead power and communication utilities are visible in the area, and underground utilities were also located in a recent field survey. The following is a summary of known underground utilities in the vicinity, based on recent utility locator markings, field survey, and information provided by utility providers for the project area.

Water

Water service in the project vicinity is provided by the City. The City's utility mapping and survey base mapping indicates there is a water main beneath the 204th St NE traveled way and based on as-built drawings, it is in conflict with the existing culvert. Notches were cut into the bottom of the pipe to accommodate the conflicting utilities, then covered with streambed gravel. There is a water main beneath the 71st Ave NE traveled way crossing the culvert. Also, there is a water main beneath the 74th Ave NE traveled way crossing the culvert and a connecting line within the vicinity beneath 201st St NE. There are several commercial businesses in the project vicinity which may have water service lines near potential construction areas as well. Water utilities are typically constructed with a cover depth of approximately 3-ft and may conflict with proposed culvert improvements at 74th and 71st Ave NE locations. Since the actual depth of the existing water utility is unknown, it is recommended to pothole to verify the horizontal and vertical depth information as part of the final design.

Sanitary Sewer

Sanitary sewer service in the project area is provided by the City. The City's utility mapping depicts a force main within the 69th Ave NE right-of-way crossing the existing culvert as well as a gravity sewer main and force main within the 204th St NE right-of-way in the vicinity of the existing culvert. There also appears to be two additional gravity sewer lines nearby, serving the commercial properties south of 204th St NE. The survey base mapping and the City's utility mapping shows a gravity sanitary sewer main beneath the 71st Ave NE traveled way crossing the existing culvert as well as a manhole near the 74th Ave NE culvert. There are several commercial businesses in the project vicinity which may have side sewer service lines near the potential construction areas as well. Sanitary sewer is located below all existing culverts and not expected to conflict with proposed culvert improvements.

Stormwater

Stormwater utilities in the project vicinity are administered by the City. The City's utility mapping depicts stormwater collection structures in the 204th St NE traveled way, within less than 5-feet of the existing culvert. Discussions with City staff indicate that a perforated infiltration pipe exists in this location, with an overflow pipe discharging to Prairie Creek near the downstream end of the culvert. Stormwater utilities in 204th St NE are located above the existing culvert and may conflict with proposed culvert improvements. This will be closely considered during final design.

Electric

Electrical power for the vicinity is supplied by Snohomish County PUD. Mapping of underground power utilities is not generally available, but may extend through the anticipated work areas. The utility locator and surveyor mapped underground power within the 71st Ave NE and 74th Ave NE rights-of-way, crossing the existing culverts. The 67th Ave Phase III Reconstruction Project which is slated to be constructed in 2013, will install an electrical conduit within the 69th Ave NE right-of-way, crossing the existing culvert. Underground electrical utility depths are unknown, but are generally fairly shallow, and are expected to be a direct conflict with proposed culvert improvements.

Natural Gas

Natural gas service in the vicinity is provided by Cascade Natural Gas. An overall project map with the existing gas lines in the area was provided by Cascade Natural Gas. The utility locator and surveyor also provided the location of the gas lines on the base mapping. According to Cascade Natural Gas and the survey base map, there is a gas main within the 69th Ave NE right-of-way and beneath the 204th St NE traveled way, crossing the existing culverts. The Cascade Natural Gas map shows a gas main within the 71st Ave NE right-of-way, crossing the existing culvert. Both the Cascade Natural Gas and base map show a gas main along the 74th Ave NE right-of-way, crossing the existing culvert. Cascade personnel have indicated that the typical minimum cover depth for their natural gas utilities is 3-ft and may conflict with proposed culvert improvements at 74th Ave NE. Since the actual depth of the natural gas utility is unknown, it is recommended to pothole to verify the horizontal and vertical depth information as part of the final design.

Telephone

Telephone service is provided in the project vicinity by Frontier Communications, who provided an overall project map with the existing communication lines in the area. These utilities were also identified by the utility locator, and are shown on the project's topographic survey mapping. According to the information gathered, there is a communication line within the 204th St NE, 71st Ave NE, and 74th Ave NE rights-of-way, crossing the existing culverts. Underground telephone utility depths are unknown, but an as-built drawing for the 204th St NE culvert shows the telephone conduit, as well as the water main described previously, to be in conflict with the existing culvert. Notches were cut into the bottom of the pipe to accommodate the conflicting utilities, then covered with streambed gravel. Telephone utilities are generally installed at fairly shallow depths, and could be in direct conflict with proposed culvert improvements.

Fiber Optic

No fiber optic utilities were located within the project area.

SECTION 4

HYDROLOGIC AND HYDRAULIC MODELING

GENERAL

This section discusses the hydrologic and hydraulic modeling that was performed for the project. A brief discussion of the modeling methods is provided below, followed by a general summary of the modeling results.

HYDROLOGIC AND HYDRAULIC MODELING METHODS

The following is a brief discussion of the modeling methods that were established for this project. Specific modeling criteria and assumptions were outlined in the Modeling Methodology Technical Memorandum previously submitted to the City, which is included in Appendix B of this report.

Hydrologic Model

MSA has developed a hydrologic model of the Prairie Creek Watershed in order to evaluate the runoff tributary to Prairie Creek. This analysis began by evaluating and verifying the watershed limits that were previously defined for the City's current stormwater comprehensive plan. The basin limits were updated, using GIS-based topographic information, and Water Resource Inventory Area (WRIA) boundaries defined by the State of Washington.

The next step in building the hydrologic model was to determine the existing soil and land cover conditions. Soil conditions were determined from NRCS soil survey information, and land cover assumptions were based on current zoning regulations. The watershed was evaluated for both the existing land cover condition, and the anticipated full build-out condition. The full build-out condition was evaluated because the watershed has been, and continues to be, subject to land development activity, which is expected to increase future runoff rates within the study area.

Full build-out coverage was estimated by assuming the maximum allowable impervious coverage allowed by current zoning regulations. The existing build-out conditions were estimated in the same fashion, but aerial photos were also evaluated to determine which parcels have not yet been developed. Land cover assumptions for these parcels were adjusted according to what was observed in the aerial photographs.

The final step in the hydrologic model was to use the parameters described above to calculate peak flowrates within the watershed. This was done using Santa Barbara Urban Hydrograph methodology. Detailed hydrologic calculations and results have been provided in Appendix C of this report.

Hydraulic Model

MSA has developed a hydraulic model of Prairie Creek using the Hydrologic Engineering Center River Analysis System (HEC-RAS), developed by the U.S. Army Corps of Engineers. The hydraulic model was developed to measure the response of the culverts and stream channel during various design storm events. The hydraulic model defines stream channel and culvert geometrics using detailed topographic data provided by the project surveyor. The hydraulic analysis utilized design flowrates that were derived from the hydrologic model described above. Detailed hydraulic calculation results have been provided in Appendix C of this report.

HYDROLOGIC AND HYDRAULIC MODELING RESULTS

Hydrologic Model

During evaluation of the Prairie Creek watershed limits, overall area was determined to be approximately 100 acres larger than what appears in the comprehensive plan. The comprehensive plan also estimated less impervious coverage than is allowed in the underlying zones. Due to the increase in overall basin area, and the higher impervious coverage estimate, the current model is expected to generate higher peak flowrates than the comprehensive plan. The following table summarizes the peak flowrate estimates for the full watershed, in both the existing and full build-out conditions, and compares them with the flowrates given in the current comprehensive plan:

Table 4-1
Hydrologic Modeling Results

Storm Event	*Comprehensive Plan*	*Existing Condition*	*Full Build-out Condition*
2-year	*[not calculated]*	90.0 cfs	111.8 cfs
10-year	146.3 cfs	180.1 cfs	212.6 cfs
100-year	231.3 cfs	257.7 cfs	296.0 cfs

In order to mitigate future potential risk to properties in the project area, the drainage improvement alternatives presented in this document reflect the anticipated full build-out condition.

Hydraulic Model

The hydraulic model was used to analyze the existing stream and culvert conditions. The results indicate that the stream is slightly above flood stage at the 74th Avenue and 71st Avenue crossings during the 2-yr storm event. Overtopping of the roadway at these locations will result in flooding of the Haggens parcel immediately north of the 74th Avenue culvert, and in the Jensen Business Park near both culverts. This is generally consistent with observations from City staff, who have indicated the presence of flooding in these areas every couple of years.

Further downstream, there appears to be sufficient capacity for the 2-year design storm event, but the model indicates that during the 10-year and 100-year storm events, the culverts at 204th Street, BNSF, and 69th Avenue are constricted, and will create a tailwater condition which propagates upstream. This is expected to result in bank-full flooding upstream, beginning with the vacant parcel north of the 204th Street culvert, and potentially flooding the parcels immediately south of 204th Street as well.

Table 4-2
Hydraulic Modeling Results (Existing Condition)

Storm Event	*Apparent Flooding Conditions*
2-year	Roadway overtopping at 71st Ave & 74th Ave culverts
10-year	Roadway overtopping at 71st Ave & 74th Ave culverts Bank-full flooding possible south of the 204th Street culvert
100-year	Roadway overtopping at 71st Ave & 74th Ave culverts Bank-full flooding north of the 204th Street culvert Bank-full flooding likely south of the 204th Street culvert

The hydraulic model was also used to analyze a number of permanent drainage improvements alternatives. These improvements are discussed in the following section.

SECTION 5

PRAIRIE CREEK DRAINAGE IMPROVEMENT ALTERNATIVES

The first step in developing drainage improvement solutions was to look at interim options that can be implemented for the upcoming wet season, while permanent options are under design.

INTERIM DRAINAGE IMPROVEMENTS

The City requested that MSA evaluate potential options for interim drainage improvements to Prairie Creek that could be implemented in the fall of 2012. These options could potentially reduce (not eliminate) the risk of local flooding impacts to key businesses within the City prior to the implementation of future culvert replacements which will occur no earlier than the summer of 2013.

MSA prepared a memorandum summarizing potential interim drainage improvement options and presented them to the City during a workshop in October 2012 (Appendix D). A summary of the potential options that were evaluated is presented below followed by a description of the preferred alternative selected that for implementation.

Interim Drainage Improvement Options

The potential interim options evaluated consisted of the following:

- Option 1: Drainage ditch improvements between Portage and Prairie Creeks adjacent to BNSF and 69th Ave NE.
- Option 2: Raising the berms adjacent to Prairie Creek, between 204th St NE and 74th Ave NE.
- Option 3: Installing a temporary headwall on the 74th Ave NE culvert inlet and raising the surrounding berm elevation to provide additional backwater storage.

Preferred Interim Drainage Improvement Options

After some additional investigation, it was determined that Option 1 would not provide a significant amount of storage volume to significantly impact the stream behavior, and would not benefit the locations most prone to frequent flooding. Option 2 was also ruled out, because it would require a significant amount of earthwork to complete, and would likely require removal of a number of trees and other vegetation. This option also could not be achieved without blocking a bridge which currently provides access to one of the local businesses. Option 3 was determined to be the preferred interim option, as discussed in Appendix D, and is expected to provide approximately 92,000 cubic feet of storage capacity immediately upstream of the 74th Avenue culvert. While this is not sufficient to contain a large scale storm event, it is expected to provide some attenuation of small storm events, and reduce the likelihood of a flooding event until a more permanent solution can be constructed. Refer to Figure 2 within Appendix D for a graphical representation of the improvements and an estimate of the potential inundation area for backwater storage.

The work required to implement the preferred interim drainage improvement may be conducted by the City staff as part of the maintenance program. Federal and state permitting are not required since the work avoids wetlands and any direct impacts to the stream channel within the ordinary high water mark.

PERMANENT DRAINAGE IMPROVEMENTS

The next step in the preliminary design process was to identify permanent drainage improvement alternatives. This began with a hydraulic analysis of Prairie Creek in the existing stream and culvert conditions and assuming full build-out of the tributary area (Scenario #1). This demonstrated the performance of the current stream channel to help identify the critical problem areas. Through series of modeling scenarios that were completed, it was determined that all five culverts would require replacement to improve the drainage so that the 100-year event could be passed through the project area without flooding impacts.

Initial sizing calculations were performed for each culvert, by first determining the width which would be required to meet fish passage requirements. Based on the required fish passage widths, and topographic constraints, it was determined that round culverts or squash pipe arches would probably not be feasible at any of the culvert locations. With this in mind, a simple Manning's analysis was performed to determine the required height of a rectangular culvert section above the streambed, given the minimum required width for fish passage. The preliminary sizes were further refined in the hydraulic model, resulting in the culvert dimensions shown in the table below. The table indicates the required width, and vertical height above the streambed.

Table 5-1
Preliminary Culvert Replacement Dimensions

Location	*Existing Culvert Dimensions*	*Preliminary Culvert Dimensions*
74th Ave	*57"x38" Pipe Arch* *(per as-built drawing)*	19' x 2.7'
71st Ave	*58"x36" Pipe Arch* *(per as-built drawing)*	16' x 3.0'
204th St	*71"x47" Pipe Arch* *(per as-built drawing)*	16' x 4.0'
BNSF RR	*60" Steel Pipe* *(per topo survey)*	16' x 3.3'
69th Ave	*71"x47" Pipe Arch* *(per as-built drawing)*	16' x 3.3'

Figure 5-1 presents the recommended culvert improvements within the project area. A more complete description of the proposed improvements at each location is provided below.

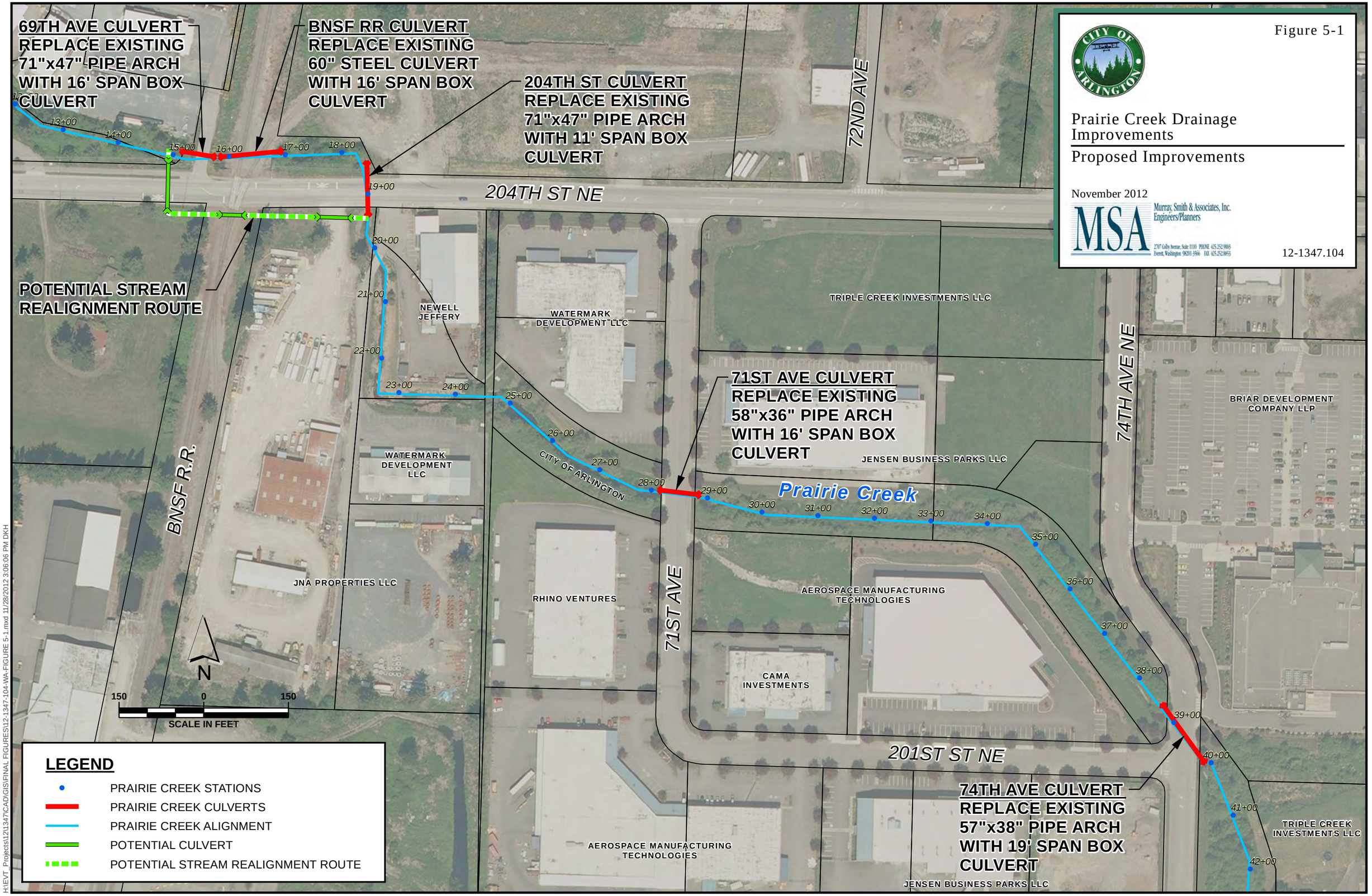
Figure 5-1
Prairie Creek Drainage Improvements
Proposed Improvements
November 2012
Murray, Smith & Associates, Inc. Engineers/Planners
12-1347.104
69TH AVE CULVERT
REPLACE EXISTING
71"x47" PIPE ARCH
WITH 16' SPAN BOX
CULVERT
BNSF RR CULVERT
REPLACE EXISTING
60" STEEL CULVERT
WITH 16' SPAN BOX
CULVERT
204TH ST CULVERT
REPLACE EXISTING
71"x47" PIPE ARCH
WITH 11' SPAN BOX
CULVERT
POTENTIAL STREAM
REALIGNMENT ROUTE
71ST AVE CULVERT
REPLACE EXISTING
58"x36" PIPE ARCH
WITH 16' SPAN BOX
CULVERT
74TH AVE CULVERT
REPLACE EXISTING
57"x38" PIPE ARCH
WITH 19' SPAN BOX
CULVERT
Prairie Creek
204TH ST NE
201ST ST NE
72ND AVE
71ST AVE
74TH AVE NE
BNSF R.R.
CITY OF ARLINGTON
NEWELL JEFFERY
WATERMARK DEVELOPMENT LLC
WATERMARK DEVELOPMENT LLC
TRIPLE CREEK INVESTMENTS LLC
JENSEN BUSINESS PARKS LLC
BRIAR DEVELOPMENT COMPANY LLP
JNA PROPERTIES LLC
RHINO VENTURES
AEROSPACE MANUFACTURING TECHNOLOGIES
CAMA INVESTMENTS
AEROSPACE MANUFACTURING TECHNOLOGIES
JENSEN BUSINESS PARKS LLC
TRIPLE CREEK INVESTMENTS LLC
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SCALE IN FEET
LEGEND
PRAIRIE CREEK STATIONS
PRAIRIE CREEK CULVERTS
PRAIRIE CREEK ALIGNMENT
POTENTIAL CULVERT
POTENTIAL STREAM REALIGNMENT ROUTE
H:\EVT_Projects\12\1347\CAD\GIS\FINAL FIGURES\12-1347-104-WA-FIGURE 5-1.mxd 11/28/2012 3:06:06 PM DKH

74th Avenue NE

The existing culvert beneath 74th Avenue is undersized, and is significantly inundated with sediment. Periodic overtopping of the roadway occurs at this location, resulting in flooding of the nearby grocery store and business park. Replacement of this culvert would include sediment removal within the stream channel for a distance of 200 feet upstream and downstream to enhance culvert performance. Construction should also include installation of a permanent sediment trap upstream of the culvert, to provide a maintenance point for accumulated sediment to be removed. This feature should be in-place and maintained until permanent upstream streambank erosion solutions are implemented. The existing Hydraulic Project Approval (HPA) permit for stream maintenance should be updated to accommodate this sediment removal.

The culvert structure could be replaced with open-cut methods. A detour can be provided around the proposed construction zone, while still maintaining access to the surrounding roads and businesses. Utility mapping indicates that water, natural gas, electric, and telephone utility crossings exist at this location. As mentioned previously, additional investigation of the water and gas utilities in this area will be required in order to minimize conflicts with the proposed improvements.

71st Avenue NE

The existing culvert beneath 71st Avenue is undersized, and is significantly inundated with sediment. Periodic overtopping of the roadway occurs at this location, resulting in flooding of the nearby business park. Replacement of this culvert would include sediment removal within the stream channel for a distance of 200 feet upstream and downstream to enhance culvert performance. This culvert could be constructed with open-cut methods. A detour can be provided around the proposed construction zone, while still maintaining access to the surrounding roads and businesses. Utility mapping indicates that water, sewer, natural gas, electric, and telephone utility crossings exist at this location. As previously mentioned, additional investigation of the water utilities in this area will be required in order to minimize conflicts with the proposed improvements.

204th Street NE

Recurring flooding has not been observed at this location, however preliminary hydraulic modeling indicates that this culvert is undersized for large-scale storm events. Frequent flooding could also become more likely at this location if upstream culverts are replaced. As part of the culvert replacement, excess sediment would be removed from the upstream channel for a distance of approximately 200 feet, and downstream to the inlet of the BNSF RR culvert. 204th Street is classified as a 'Collector Arterial' roadway, and will likely need to remain open during replacement of the culvert. The existing roadway provides one travel lane in each direction, a turning lane in the middle, and paved shoulders on each side. An open-cut replacement of the culvert appears to be feasible in two phases, closing half of the roadway in each phase. Maintenance of traffic would be achieved by routing vehicles to two reduced-width lanes on either the north or south sides of the road through the construction zone, while maintaining access to the surrounding businesses. Water, gravity sewer, sewer force main, natural gas, telephone, adjacent stormwater, and overhead power utilities are all present at this crossing.

BNSF Railroad Culvert

Recurring flooding has not been observed at this location, but preliminary hydraulic modeling indicates that the culvert at this location is undersized for large-scale storm events. Constriction at this location could create a tailwater condition, resulting in bank-full flooding further upstream. Replacement of this culvert will require an agreement with BNSF, which will likely require a trenchless installation method, such as pipe jacking, pipe ramming, or conventional tunneling. The existing culvert crossing is a steel pipe, which will be a barrier to trenchless installation methods. A new culvert will probably need to be installed just north of the existing culvert, requiring a realignment of the stream channel. Installation options at this location may be further limited by the railroad's close proximity to 69th Avenue, which may not accommodate a receiving pit, or tunneling equipment. The chosen trenchless installation method for this culvert would likely need to be performed from the east side of the railroad. Overhead power is the only existing utility that appears to be present at this location. There would be no impacts to the surrounding businesses during the replacement of this culvert. During installation of this culvert, excess sediment would be removed from the upstream channel to the outfall of the 204th Street culvert, and downstream to the inlet of the 69th Avenue culvert.

69th Avenue NE

Recurring flooding has not been observed at this location, but preliminary hydraulic modeling of Prairie Creek indicates a condition at this culvert similar to that at the BNSF RR culvert. The culvert itself is undersized for large scale storm events, and the constriction appears to create a tailwater condition which could result in bank-full flooding further upstream. Replacement of this culvert would include removal of excess sediment from the upstream channel to the outfall of the BNSF RR culvert, and downstream for a distance of approximately 200 feet. Replacement of the culvert would likely require a full closure of 69th Avenue, which provides access to a single business. However, it appears that temporary access to this business may be achievable from an adjacent parcel. Utility mapping and survey information indicate that sewer force main, natural gas, and overhead power utilities are present at the culvert site. Depending on the timing of the culvert installation there could be underground electricity from the 67th Avenue Phase III Reconstruction Project which is scheduled for construction in 2013.

Summary of Options

The options listed above could be implemented individually, or combined to meet various design goals. Table 5-2 below provides a brief summary of the anticipated hydraulic improvements and specific considerations related to the replacement of each structure. A more detailed discussion of drainage improvement scenarios follows Table 5-2.

Table 5-2
Summary of Culvert Replacement Options

Culvert Location	Anticipated Improvement	Considerations
74th Avenue	Frequent flooding mitigated at Haggens property and on east side of Jensen business park.	Additional flow would be routed to undersized culverts further downstream.
71st Avenue	Frequent flooding reduced at west side of Jensen business park.	Additional flow would be routed to undersized culverts further downstream. 74th Avenue culvert would also need to be replaced to fully mitigate flooding at west side of Jensen business park.
204th Street	Improved capacity for large storm events	Constrictions at all three culverts create a tailwater condition which inundates the upstream channel during large events. All three structures would need to be replaced to resolve this issue.
BNSF RR	Improved capacity for large storm events	
69th Avenue	Improved capacity for large storm events	

DRAINAGE IMPROVEMENT SCENARIOS

Funding and permitting constraints could potentially limit the work that can be completed within the next construction season. With that in mind, a number of potential drainage improvement scenarios were developed to evaluate the impacts of replacing different culvert combinations.

Based on the hydraulic modeling results, the greatest hydraulic restrictions were determined to be at the 74th Avenue and 71st Avenue culvert crossing locations. These locations appear to have the least conveyance capacity, and highest likelihood for frequent flooding events. The three culverts further downstream have sufficient capacity to convey the smaller, more frequent flooding events, but appear to be constricted at larger events. This constriction creates a tailwater condition that propagates up the stream channel, resulting in bank-full flooding between the 71st Avenue and 204th Street culverts. With this in mind, prioritizing the replacement of the upstream culverts at 74th and 71st Avenues seems to have the greatest impact to resolving frequent flooding events.

The following is a brief summary of the existing stream conditions, and potential drainage improvement scenarios:

Existing Condition:

Scenario #1 – Existing Condition (No Culvert Replacement)

Hydraulic modeling of Prairie Creek suggests that the most frequent flooding is due to the overtopping of the culverts at 74th Avenue and 71st Avenue. As a result of upstream land development activity and sediment migration in the stream channel, these two culverts no longer provide sufficient hydraulic capacity to convey stream flows, even during relatively frequent storm events. The downstream culverts, at 204th Street, BNSF RR, and 69th Avenue, are under capacity during larger, less frequent storm events. During times of high flow, the restriction at these culverts can be expected to create a tailwater condition, resulting in a surcharge of the streambanks between the 71st Avenue and 204th Street culverts. This would likely occur in addition to the overtopping of the 74th Avenue and 71st Avenue culverts.

Streambed Maintenance Scenarios:

Scenario #2 – Maintenance Dredging of Existing Culverts

Periodic flooding in the project area is due, in part, to sediment accretion in the stream channel and culvert barrels. This option proposes dredging and removal of excess sediment within the existing culverts and within 200 feet upstream and downstream of the culverts. The hydraulic model still indicates overtopping at the 74th Avenue culvert during the 2-year design storm event, but at a slightly lower stage elevation. Frequent flooding was mitigated at the 71st Avenue culvert, and further downstream, but large event flooding is still present. This scenario would likely be suitable as a temporary measure or in conjunction with one of the other options discussed below. More comprehensive modeling of the stream channel itself can be provided in the future design phase. Continued sediment accretion in the culvert barrels could present a future barrier to fish passage. Removal of accumulated sediment within the existing culverts and within 200 feet upstream and downstream of the culvert is expected to be beneficial to fish mobility.

Scenario #3 – Accumulated Sediment Removal within Stream Channel

Periodic flooding in the project area is due, in part, to sediment accretion in the stream channel and culvert barrels. This option proposes dredging and removal of accumulated sediment within the existing culverts, and in the stream channel between culverts, to restore it the originally intended function, as shown in Figure 5-2. The hydraulic model still indicates overtopping at the 74th Avenue culvert during the 2-year design storm event, but at a slightly lower stage elevation. Frequent flooding was mitigated at the 71st Avenue culvert, and further downstream, but large event flooding is still present. This scenario would likely be best suited in conjunction with one of the other options discussed below. Removing the accumulated sediment would also restore natural stream velocities, allowing future sediment to migrate through the stream channel more efficiently.

Erosion of the streambank and streambed upstream of the project area is expected to continue indefinitely. Removal of accumulated sediment through the project area will improve stream function, and assist in passing sediment through the project site in the short term, but long term accretion through the project area is expected to remain problematic. In order to ensure long term performance of improvements through the project area, streambank stabilization and sediment removal measures should also be implemented upstream.

Figure 5-2

Prairie Creek Drainage Improvements

Accumulated Sediment Removal

November 2012

Murray, Smith & Associates, Inc.
Engineers/Planners

12-1347.104

69TH AVE CULVERT MAINTENANCE DREDGING

BNSF RR CULVERT MAINTENANCE DREDGING

204TH ST CULVERT MAINTENANCE DREDGING

POTENTIAL STREAM REALIGNMENT ROUTE

71ST AVE CULVERT MAINTENANCE DREDGING

74TH AVE CULVERT MAINTENANCE DREDGING

CHANNEL REGRADE (TYPICAL)

Prairie Creek

12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00 28+00 29+00 30+00 31+00 32+00 33+00 34+00 35+00 36+00 37+00 38+00 39+00 40+00 41+00 42+00

204TH ST NE

72ND AVE

71ST AVE

74TH AVE NE

201ST ST NE

BNSF R.R.

CITY OF ARLINGTON

NEWELL JEFFERY

WATERMARK DEVELOPMENT LLC

TRIPLE CREEK INVESTMENTS LLC

JENSEN BUSINESS PARKS LLC

BRIAR DEVELOPMENT COMPANY LLP

WATERMARK DEVELOPMENT LLC

JNA PROPERTIES LLC

RHINO VENTURES

AEROSPACE MANUFACTURING TECHNOLOGIES

CAMA INVESTMENTS

AEROSPACE MANUFACTURING TECHNOLOGIES

JENSEN BUSINESS PARKS LLC

TRIPLE CREEK INVESTMENTS LLC

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SCALE IN FEET

LEGEND

- PRAIRIE CREEK STATIONS
- PRAIRIE CREEK CULVERTS
- PRAIRIE CREEK ALIGNMENT
- POTENTIAL CULVERT
- POTENTIAL STREAM REALIGNMENT ROUTE
- CHANNEL REGRADE

H:\EVT_Projects\12\1347\CAD\GIS\FINAL FIGURES\12-1347-104-WA-FIGURE 5-2.mxd 11/28/2012 3:09:44 PM DKH

Culvert Replacement Scenarios:

Scenario #4A – Replace 74th Ave Culvert

Replacement of the 74th Avenue culvert is expected to mitigate flooding to the north of the culvert, up to the 100-year design storm event. While this improvement will benefit properties to the north and west of the culvert crossing, periodic surcharge of the 71st Avenue culvert will continue, impacting parcels on the west side of the business park. A new culvert will provide a substantially wider streambed at the crossing which will be less prone to sediment plugging and high velocities, which are potential barriers to fish passage.

Scenario #4B – Replace 74th Ave Culvert & Remove Stream Sediment

Replacement of the 74th Avenue culvert, as described above, could be further enhanced by removing accumulated sediment within the nearby stream channel and restoring the historic streambed, as outlined in Scenario #3. Removal of the sediment will provide more constant velocity through this portion of the stream channel, reducing the potential for new sediment accumulations and increasing the long-term performance of the culvert replacement.

Scenario #5A – Replace 74th Ave & 71st Ave Culvert

Replacement of both culverts is expected to mitigate the frequent flooding that is occurring in the vicinity of the business park. The improvements are also expected to reduce the flooding impacts to much of the business park during larger, less frequent storm events. However, a tailwater constriction further downstream could result in occasional overtopping of the streambanks between the 204th Street and 71st Avenue culverts during larger storm events. New culverts in these locations will provide a wider streambed, which will be less prone to sediment plugging and high velocities, which are potential barriers to fish passage.

Scenario #5B – Replace 74th Ave & 71st Ave Culvert, and Remove Stream Sediment

Replacement of the 74th and 71st Avenue culverts, as described above, could be further enhanced by removing accumulated sediment within the nearby stream channel and restoring the historic streambed, as outlined in Scenario #3. Removal of the sediment will provide more constant velocity through this portion of the stream channel, reducing the potential for new sediment accumulations and increasing the long-term performance of these two culvert replacement.

Scenario #6A – Replace All Culverts

The hydraulic model for Prairie Creek indicates that flooding can be fully mitigated to the 100-year design event if all five culverts are replaced. The entire reach of Prairie Creek that extends through the project site has been determined to be fish-bearing, so all five culverts will be constructed to meet fish passage criteria, and improve fish habitat.

Scenario #6B – Replace All Culverts and Remove Stream Sediment

Overall performance of the stream channel would be most improved by replacing all five culverts, and removing excess sediment accumulations through the stream channel, as outlined in Scenario #3. In addition to improving the culvert capacity, this would restore the streambed elevation to the historic location, increasing the capacity of the channel, and reducing the amount of sediment accumulation throughout the project area.

CONSTRUCTION COST ESTIMATE

A preliminary Engineer's Estimate of Probable Construction Costs was developed as part of the preliminary design phase. The estimate presented includes provisions for estimated construction costs plus an aggregate 30 percent allowance for contingencies. These cost estimates are based upon recent experience with construction costs for similar work in the area and anticipate improvements will be accomplished by private contractors. Cost estimates represent opinions of cost only, acknowledging that final costs of the project will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule and other factors. The estimates are preliminary, and are based on the level and detail of planning presented in this report. As the project proceeds through the final design phase, this estimate will be revised and updated with each design submittal.

Table 5-3 presents the estimated range of costs of the proposed improvements. These estimates are for construction costs only and do not include final design engineering costs, engineering services during construction, permitting costs, or City's administrative, legal or inspection services. Detailed cost estimates for each scenario is included in Appendix E.

Table 5-3
Estimated Construction Costs

Scenario	*Description*	*Estimated Cost*
1	Existing Condition	N/A
Streambed Maintenance Scenarios		
2	Maintenance dredging (remove sediment 200' upstream & downstream and within existing culverts)	$120,000
3	Remove accumulated sediment within culverts and stream channel	$400,000
Culvert Replacement Scenarios		
4A	Replace 74th Ave culvert	$500,000
4B	Replace 74th Ave culvert and remove accumulated stream channel sediment	$900,000
5A	Replace 74th Ave & 71st Ave culverts	$900,000
5B	Replace 74th Ave & 71st Ave culverts and remove accumulated stream channel sediment	$1,300,000
6A	Replace all five culverts	$3,000,000
6B	Replace all five culverts & remove accumulated stream channel sediments	$3,400,000

PERMITTING CONSIDERATIONS

Replacing one or two culverts would likely require a Section 404 Nationwide Permit from the U.S. Army Corps of Engineers (Corps). Replacement of several culverts and/or removing accumulated sediment beyond maintenance dredging could trigger an individual Corps permit, requiring significant additional time and complexity for permitting and approval.

There is potential for a streamlined permitting process for some of the project elements, but to determine that potential, a completed Joint Aquatic Resource Project Application (JARPA) and approximately 30% design level information must be submitted to the Corps.

Any proposed gravel removal and other work associated with the final design should be included with the initial JARPA submittal for the Corps to review and determine whether a Nationwide Permit or Individual Permit is appropriate for the project. If additional gravel removal or other work would trigger a more involved permitting process that work could be performed separately from the culvert work as to not impact the schedule.

Replacement of any culverts would also require a Section 401 Water Quality Certification from the Washington State Department of Ecology (DOE), Hydraulic Project Approval from the Washington State Department of Fish and Wildlife (DFW), and SEPA/Critical Areas review from the City of Arlington.

Any options causing more than 1 acre of combined ground disturbance will require a Construction Stormwater General Permit from DOE.

Replacement of the culvert within the BNSF right-of-way will require a BNSF license agreement.

ADDITIONAL CONSIDERATIONS

Fish Passage

According to the City's Final Comprehensive Stormwater Plan, the Prairie Creek watershed contains at least 2.5 miles of fish-bearing streams, and supports populations of Coho salmon and native cutthroat trout. Due to Prairie Creek being a fish bearing stream, the Washington Department of Fish and Wildlife (WDFW)'s *Design of Road Culverts for Fish Passage, 2003* was used to design the replacement culverts. WDFW has three design options for fish passable culverts: No-Slope, Hydraulic and Stream-Simulation. The Stream-Simulation method will be used on this project as it is the most widely accepted method and is consistent with the methods used for the design of the fish passable culverts located within the 67th Ave Phase III Reconstruction Project located directly downstream. The Stream-Simulation method drives the designed culvert widths which are typically greater than the existing channel width to create or maintain natural stream characteristics within a culvert.

Roadway Restoration

The restoration design for the areas impacted during construction, such as the streets and sidewalks, will reference the City of Arlington's *Design and Construction Standards and Specifications, 2008* as well as the WSDOT/APWA *Standards and Specifications for Road, Bridge and Municipal Construction*. The design will include restoring all disturbed roadways, sidewalks and landscaping features to match existing conditions.

Stream Realignment

Replacement of the culvert within the BNSF RR right-of-way is expected to be relatively difficult due to the trenchless installation requirement and close proximity of the 69th Avenue culvert. As an alternative, it may be practical to realign a portion of Prairie Creek, beginning immediately upstream of the existing 204th culvert. From this point, the stream would extend westerly for approximately 350 feet, along the south side of 204th Street. The stream would then turn northerly and cross beneath 204th Street, and connect to the existing stream channel, just west of the existing 69th Avenue culvert.

There are several advantages to this option. First, much of the work could be done without impacting the existing stream channel, and without having to divert water around the work area. Second, the required culvert crossing beneath the BNSF RR would be shorter on the south side of 204th Street, and would not have the physical constraints with 69th Avenue that exist at the existing culvert location. Third, this option would avoid potential conflicts and service disruptions with the sewer force main that exists beneath 69th Avenue and 204th Street. Finally, this option would allow the existing culverts to be abandoned in-place, rather than having to remove them.

Water, natural gas, telephone, stormwater, and overhead power utilities would be present at this crossing. Also, this option would require the City to acquire property interest across two parcels on the south side of 204th Street. A new culvert would need to be constructed beneath a commercial driveway accessing the 'JNA Properties' Parcel (Sno. Co. Parcel #31051400200400). Temporary access to this parcel during construction of the culvert may be available via the adjacent parcel to the east. Discussions with the surrounding businesses would be necessary to determine site accessibility options.

Sediment Control Measures

Several streambank stabilization measures upstream of the project could provide additional long-term viability for the entire area. First, significant streambank and streambed incision has been observed in the east fork of Prairie Creek, in the vicinity of the existing SR-9 culvert crossing. The erosion in this area is thought to be a significant contributor of sediment through the project area. Streambank armoring and energy dissipation measures should be explored in this area. Second, the realignment of the west fork or Prairie Creek has resulted in a significant increase in energy immediately downstream of the convergence point with the main fork of Prairie Creek. This portion of Prairie Creek should be explored to determine if additional stabilization is warranted. Finally, it is recommended that the City continue implementing a previously planned improvement project upstream of the 74th Avenue culvert, which would reconnect an upstream wetland to Prairie Creek. Reconnecting

the existing wetland would promote any remaining sedimentation over a large wetland area rather than in the primary stream channel. These projects could be beneficial for fish and wetland restoration values, and could add potential diversity in funding sources.

Adjacent Construction Coordination

As part of 67th Ave Phase III Reconstruction Project, the existing headwall on the upstream side of the 69th Ave NE culvert will be extended up to the road/path surface. MSA will work with the City to ensure the coordination and implementation of the design in this overlapping area is efficient and effective.

SUMMARY AND RECOMMENDATIONS

A summary of the potential permanent drainage improvement scenarios is presented in Table 5-4 below. The table includes a description of each scenario with the associated estimated construction cost, permitting considerations and flooding risk, including overflow storm event and location, to be expected with the improvement.

We recommend that the City implement the most beneficial improvements based on the available funding and permitting timeline constraints. The improvements with the most meaningful effect to reduce frequent, recurring flooding in the project area should be constructed first.

Given the timelines associated with the federal permits required for this project and funding limitations, it is recommended that the improvements be constructed in two phases over two separate construction seasons. The first phase of improvements will include the 71st and 74th Avenue culvert replacements and a portion of sediment removal approximately 200 feet upstream and downstream of the 71st and 74th Avenue culverts. This first phase can likely be permitted and constructed in summer 2013.

The second phase of improvements will include the replacement of the 204th Street, BNSF RR, and 69th Avenue culverts and sediment removal between each of these culverts and any additional areas that was not completed in the first phase. The second phase can likely be permitted and constructed in summer 2014.

Table 5-4
Prairie Creek Drainage Improvement Scenarios

Scenario		Overflow Storm Event	Flooding Frequency by Area					Overflow Location / Notes	Estimated Construction Costs	Permitting Considerations
			74th Ave	71st Ave	204th St	BNSF	69th Ave			
1	Existing Conditions (No Improvements)	< 2 year event	High	High	Moderate	Low	Low	- Roadway overflow @ 74th Ave (~2-yr event) - Roadway overflow @ 71st Ave (~2-yr event)	N/A	N/A
Streambed Maintenance Scenarios										
2	Maintenance Dredging (Remove sediment 200' upstream & downstream and within existing culverts)	< 2 year event	High	Moderate	Moderate	Low	Low	- Roadway overflow @ 74th Ave (~2-yr event) - Left/Right bank overflows between 71st Ave & 204th Ave during larger storm events	$120,000	Likely approval in 2013 - no Corps review.
3	Maintenance Dredging and Additional Accumulated Sediment Removal Between Culverts	~2 year event	High	Moderate	Moderate	Low	Low	- Roadway overflow @ 74st Ave (2yr event) - Left bank overflow downstream of 204th Street during larger storm events - Left/Right bank overflows upstream of 204th Street during larger storm events	$400,000	Possible approval in 2013, but may trigger individual Corps permit requiring longer review.
Culvert Replacement Scenarios										
4A	Replace 74th Ave Culvert	< 2 year event	Moderate	High	Moderate	Low	Low	- Roadway overflow @ 71st Ave (~2-yr event) - Left/Right bank overflows between 71st Ave & 204th Ave during larger storm events	$500,000	Possible approval in 2013.
4B	Replace 74th Ave Culvert and Remove Accumulated Sediment Between Culverts	Btwn 2 year and 10 year event	Moderate	Moderate	Moderate	Low	Low	- Left bank overflow downstream of 204th Street during larger storm events - Left/Right bank overflows upstream of 204th Street during larger storm events	$900,000	Possible approval in 2013, but may trigger individual Corps permit requiring longer review. Likely approval in 2014.
5A	Replace 74th & 71st Ave Culverts	Btwn 2 year and 10 year event	Moderate	Moderate	Moderate	Low	Low	- Left bank overflow downstream of 204th Street during larger storm events - Left/Right bank overflows upstream of 204th Street during larger storm events	$900,000	Possible approval in 2013.
5B	Replace 74th & 71st Ave Culverts and Remove Accumulated Sediment Between Culverts	Btwn 2 year and 10 year event	Moderate	Moderate	Moderate	Low	Low	- Same as previous option, but less frequent overflow	$1,300,000	Possible approval in 2013, but may trigger individual Corps permit requiring longer review. Likely approval in 2014.
6A	Replace All 5 Culverts	>100 year event	Low	Low	Low	Low	Low	- No expected flooding to 100-yr event	$3,000,000	Possible approval in 2013, but may trigger individual Corps permit requiring longer review. Likely approval in 2014.
6B	Replace All 5 Culverts and Remove Accumulated Sediment Between Culverts	>100 year event	Low	Low	Low	Low	Low	- No expected flooding to 100-yr event - Greater storage capacity within the stream channel	$3,400,000	Possible approval in 2013, but may trigger individual Corps permit requiring longer review. Likely approval in 2014.

Flooding Frequency Legend
High: < 2 year event.
Moderate: Between 2 year and 100 year event.
Low: > 100 year event.

SECTION 6

PROJECT IMPLEMENTATION

GENERAL

This section provides a summary of the preliminary design phase and details the next steps required to implement the final design phase and construction of the drainage improvements along Prairie Creek.

PRELIMINARY PLANS

A preliminary plan set was developed that shows the preliminary design concepts of the Prairie Creek culvert replacements. The plans present the completed project basemap with project cover sheet and plan and profile views of the proposed improvements. The plans are included in Appendix F.

FINAL DESIGN (PHASE 2)

Based on the design criteria identified in this Preliminary Design Report, final plans and specifications for the Prairie Creek Drainage Improvement project will be prepared in a manner suitable for public bidding. This work will consist of preparing project contract documents and developing a construction plan set.

The first task to be completed during the final design will be selection of which improvements will be implemented in 2013. The decision will be made by the City in consideration of permitting timelines and the availability of funding for the project. At this time, it is anticipated that the design for all the proposed improvements will occur concurrently, but may be constructed as separate construction contracts in two or more construction seasons due to permitting constraints described previously.

A second high priority task will be to determine the feasibility for realigning a portion of Prairie Creek to the south side of 204th Street. MSA will work closely with the City, businesses in the vicinity, and regulatory agencies to determine if this is a viable alternative to consider and advance into final design.

UTILITY COORDINATION

As described in Section 3, the project corridor was examined for utility obstructions and potential conflicts. Due to the close proximity to the culvert replacements and limited vertical clearances, there are several utilities that should be physically located, ideally by potholing, as part of the final design process. MSA will develop a recommended list of utilities to pothole and submit this separately to the City.

EASEMENT REQUIREMENTS

Temporary construction easements will be required for construction areas and access needs outside of the City's property and public right-of way. Temporary construction easements will likely be necessary for the 69th Avenue, BNSF RR and 204th Street culvert replacements and the work within the stream south of 204th Street. Permanent easements are not anticipated to be necessary for this project; unless it is determined that pursuing the alternative stream alignment south of 204th Street is determined to be feasible.

PROPOSED DESIGN, PERMITTING & CONSTRUCTION SCHEDULE

The schedule outlined below represents the necessary timeframes for implementing drainage improvements for the 2013 construction season. Since the segment of Prairie Creek involved with this project is considered fish bearing all in-water work must be performed during the 2013 fish window for construction.

- Final Design: December 2012 through March 2013
- Permitting and Environmental Reviews: December 2012 through June 2013
- Bidding and Award: April 2013 through May 2013
- Construction Phase: June 2013 through October 2013
- Approximate 2013 Fish Construction Window: Mid-July 2013 to Mid-October 2013

APPENDIX A

GEOTECHNICAL INVESTIGATION REPORT (GeoEngineers)

Geotechnical Engineering Services

Prairie Creek Drainage Improvement Project
Arlington, Washington

for
Murray, Smith & Associates, Inc.

December 3, 2012

GeoEngineers
Earth Science + Technology

Geotechnical Engineering Services

Prairie Creek Drainage Improvement Project
Arlington, Washington

for
Murray, Smith & Associates, Inc.

December 3, 2012

GeoEngineers

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Geotechnical Engineering Services

Prairie Creek Drainage Improvement Project
Arlington, Washington

File No. 5430-007-00

December 3, 2012

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GeoEngineers

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INTRODUCTION

This report presents the results of our geotechnical engineering services for evaluation of the soil and groundwater conditions and provides recommendations for the design and construction of the proposed five new culvert crossings for the Prairie Creek Drainage Improvement project located in Arlington, Washington. The creek crossings will be at Haskens Road, the BNSF Railroad corridor, 204th Street NE just east of BNSF, 71st Avenue NE at about the 202nd Block NE and at 74th Avenue NE near 201st Street NE. The site is shown relative to surrounding physical features on the Vicinity Map (Figure 1) the Site Plan Location Map (Figure 2) and the Site Plans (Figures 3, 4, and 5).

PROJECT DESCRIPTION

GeoEngineers understanding of the project is based on discussions with Nathan Hardy and Jenna Thelen with Murray, Smith & Associates, Inc. We understand that the City of Arlington proposes drainage improvements along Prairie Creek from north of Haskens Road to south of 74th Avenue NE. This report only focuses on the planned replacement of the existing five culverts situated at Haskens Road, under the BNSF Railroad corridor immediately east of Haskens Road, 204th Street NE about 150 feet east of BNSF, 71st Avenue NE at about the 202nd Block NE and at 74th Avenue NE near 201st Street NE.

This report was prepared in support of the preliminary design phase. We understand that agencies are requesting that the new culverts have a width of 16 feet for fish passage considerations. At this time, most of the existing culverts are planned to be replaced with box culverts with a typical width of 16 to 19 feet and lengths ranging from 68 to 130 feet. The crossing of 204th Street NE will have to be accomplished in two phases to maintain traffic on 204th Street NE. The bottom of the new culverts will be about 2 to 3 feet below the existing stream bed grade, and will require excavations on the order of about 10 to 18 feet in depth. New abutment walls may be necessary for some of the new culverts.

The crossing under the BNSF right of way is currently planned to be accomplished using trenchless technologies. However, other options for the Haskens Road and BNSF crossings are being considered including skewing the Haskens Road culvert to the north and moving the BNSF culvert north of the existing culvert, or possibly realigning the creek to the south side of 204th Street NE.

SCOPE OF SERVICES

The purpose of this study is to complete subsurface explorations at the project site and to provide geotechnical engineering conclusions and recommendations for the design and construction of the proposed improvements. GeoEngineers' geotechnical engineering services were completed in general accordance with our task order agreement executed on August 8, 2012. Our specific scope of services for this phase of the project includes the following tasks:

1. Review geologic maps and subsurface information in our files for the site vicinity.

2. Explore subsurface soil and groundwater conditions by completing five geotechnical borings. The original scope was for six borings but we were unable to complete one of the borings due to utility and right-of-way restrictions.
3. Complete laboratory testing on selected soil samples obtained from the explorations.
4. Classify the soils encountered in the explorations and evaluate pertinent engineering and physical characteristics.
5. Provide recommendations for temporary excavations, including geotechnical considerations for allowable temporary cut slopes, temporary shoring and dewatering.
6. Provide recommendations for the design of the new culverts including foundation support and lateral soil pressures. Comment on any anticipated construction difficulties identified from the results of our site studies and from our experience on projects at similar sites.
7. Assess seismic hazards at the site, including ground liquefaction and lateral spreading potential. If liquefaction is a concern, recommendations will be presented for methods to mitigate the effects of liquefaction.
8. Discuss trenchless pipeline installation issues and alternatives (pipe jacking and boring, microtunneling, HDD, etc.). Preliminary considerations for trenchless construction will be provided.
9. Provide recommendations for earthwork and site preparation including suitability of on-site soils for reuse in trench backfill, placement and compaction of trench backfill, and mitigation of unsuitable soil conditions. This will include an evaluation of the effects of weather and/or construction equipment on site soils.
10. Comment on any anticipated construction difficulties identified from the results of site studies and from experience on projects at similar sites.
11. Discuss geotechnical considerations related to groundwater conditions including anticipated seasonal fluctuations.
12. Address City of Arlington sensitive areas ordinance issues as they pertain to geotechnical and geological considerations.
13. Present our findings and recommendations in a written report with supporting site plan, boring logs, and other applicable figures.

FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

Subsurface soil and groundwater conditions at the site were evaluated by completing five geotechnical borings (B-1 through B-5). The borings were completed to depths ranging from 4 to 24 feet below the existing ground surface. The approximate locations of these borings are shown on the Site Plans, Figures 3, 4 and 5. Details of the field exploration program and logs of the explorations are presented in Appendix A.

Laboratory Testing

Soil samples were obtained during drilling and taken to our laboratory for further evaluation. Selected samples were tested for the determination of moisture content, fines content, and particle size distribution. A description of the laboratory testing and the test results are presented in Appendix B.

SITE DESCRIPTION

Site Geology

The site is located along the eastern side of the Stillaguamish River Valley. According to the Geologic Map of the Arlington West Quadrangle (Minard 1985), the project site is located on an outcropping of Recessional Outwash, specifically the Marysville Sand Member. The Arlington Gravel Member is present north of the project site.

The recessional outwash was deposited by meltwater flowing south from the stagnating and receding Vashon Glacier. The Marysville Sand Member is characterized by well draining stratified outwash sand, with some gravel and areas of silt and clay. This deposit is up to 65 feet thick and is generally underlain by glacial till. The Arlington gravel member consists of well drained stratified sand and gravel deposits; oxidation and iron oxide cementation are common in this unit. The deposit may be up to 85 feet thick, and is also generally underlain by glacial till.

Surface Conditions

As described previously, the focus of this report is on the five culvert crossings at Haskens Road, under the BNSF Railroad corridor immediately east of Haskens Road, 204th Street NE about 150 feet east of BNSF, 71st Avenue NE at about the 202nd Block NE and at 74th Avenue NE near 201st Street NE. The project alignment is shown on the attached Site Plans, Figures 2, 3, 4 and 5.

Haskens Road north of 204th Street NE has a commercial development north and west of the road and creek, and a ditch vegetated with blackberry bushes between the east end of the culvert and the railroad embankment. East of the railroad embankment, the creek drainage is bordered by 204th Street NE to the south and a level undeveloped parcel to the north. The undeveloped parcel has some trees and shrubs near the creek, and is vegetated with blackberry bushes and grass across the remainder of the parcel. The railroad has a spur line veering to the northeast. It does not appear that this spur line is in active use based on the vegetation present in the railroad bed. For the culvert crossing under 204th Street NE, the undeveloped parcel is present to the north, and south of 204th Street NE the creek is in a channel bordered by commercial developments to the east and a gravel access driveway to the west. The creek channel in this area is about 6 to 8 feet below the surrounding areas.

The creek channel and culvert under 71st Avenue NE cut across commercial developments with landscaping present along the road. The creek channel is vegetated with tall grass and some shrubs and trees. A low levee is present along the channel east of 71st Avenue NE with the creek channel about 3 to 5 feet below the road and levee. Where the creek crosses under 74th Avenue NE, commercial developments with landscaping are present on the west side of the street. Undeveloped property vegetated with tall grass, brush, blackberry bushes and trees is

present on the east side of 74th Avenue NE in the vicinity of the creek. The creek is about 3 to 4 feet below the road and surrounding area. The road, culvert and creek elevations are as follows:

Area	Culvert Type and Size	Elevation[1] (feet)		
		Roadway	Top of Culvert	Creek Water Level[2]
Haskens Road	60-inch CMP	122 to 124	114 to 115	113 to 114
BNSF RR	60-inch Steel	124	114 to 116	114 to 115
204th Street NE	60-inch CMP	121	116 to 117	114
71st Avenue NE	60-inch CMP	119	118	117
74th Avenue NE	48-inch CMP	127	124-125	124

Notes:

[1] Elevations are approximate and based off of a survey provided by Murray, Smith & Associates.

[2] Creek water levels as measured by the surveyors late August 2012.

Existing utilities within or near the project areas include overhead power, business signs and communication lines and buried gas, fiber optic, storm sewer, sanitary sewer, and water.

City of Arlington Critical Areas

As part of our services for the project, we reviewed available City of Arlington information regarding critical areas for the site and surrounding area. Based on information provided by the City, we note the following:

- The liquefaction susceptibility is mapped as low to moderate by the Washington State Department of Natural Resources.
- Very small steep slope hazard areas are mapped along the south side of the creek channel south of 204th Street NE and west of Haskens Road.
- A 150-foot stream buffer is present along the Prairie Creek alignment.

SUBSURFACE EXPLORATIONS

Soil Conditions

We evaluated the subsurface conditions at the site by drilling five geotechnical borings (B-1C through B-5) to depths ranging from 4 to 24 feet below the ground surface (bgs). A detailed description of our field exploration procedures and logs of the explorations are presented in Appendix A.

With the exception of the boring B-1 completed on Haskens Road, the remaining borings were completed in unpaved areas. Borings B-1, B-1B and B-1C encountered 3 inches of asphaltic concrete underlain by 8 to 10 inches of crushed rock base course. Boring 1 was attempted at three locations as the first two attempts (borings B-1 and B-1B on the west side of the road) encountered refusal on rocks or rubble at a depth of 4 to 5.25 feet, respectively. Boring B-1C was able to penetrate this rubble/boulder zone on the east side of the road. We understand from a

City of Arlington employee that fill with large boulders was placed in this area during development of the road and surrounding area.

The subsurface conditions encountered in the remaining borings generally include 3 to 6 inches of grass/sod and root zone underlain by fill. The fill typically consists of medium dense silty sand with varying amounts of gravel. As discussed above, large boulders and possibly rubble is present in the upper portion of the fill underlying Haskens Road. The thickness of the fill layer ranges from about 6 to 10 feet and is likely associated with previous development and grading activities adjacent to the creek channel.

Recessional outwash deposits and possibly alluvial deposits from the creek or the Stillaguamish River were encountered below the fill and extended to the maximum depth explored in each boring. These deposits generally consist of medium dense to very dense sand and gravel with varying amounts of silt and cobble content. Boring B-2 encountered a soft and loose alluvial layer of silt and silty sand from a depth of about 11 to 15 feet. It should be noted that the sampler used in collecting soil samples from each boring has an internal diameter of about 1.5 inches. Therefore, the size of the sampler restricts the size of gravel we are able to sample. In most borings, the driller noted the presence of gravels by the drilling action. Notations are present on the boring logs where rough drilling occurred or where gravels were felt by the driller. Therefore, although the soil descriptions in the boring logs are mainly sands, we believe that layers of gravels are also present within these recessional outwash deposits. Large cobbles and boulders were not encountered in the borings we completed with the exception of B-1; however, large cobbles and boulders are known to occur in recessional outwash soils.

Groundwater Conditions

Groundwater was observed in some of the borings. Groundwater was observed at a depth of about 19 feet in boring B-3, at a depth of about 9 feet in boring B-4, and at a depth of about 23 feet in boring B-5. Static groundwater was not observed in borings B-1 and B-2 at the time of exploration. Groundwater observations represent conditions observed during drilling and may not represent the groundwater conditions throughout the year. Groundwater conditions are expected to fluctuate as a result of season, precipitation and other factors.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our subsurface exploration program and our geotechnical evaluation, it is our opinion that the proposed drainage improvements (i.e. culvert replacements) can be successfully completed from a geotechnical perspective provided the considerations presented in this report are incorporated in the project planning and design. The key geotechnical issues for the project are summarized below:

- The culverts may be supported on shallow foundations bearing on the medium dense to dense recessional sand and gravel deposits. We anticipate that the bottom of the culvert crossing under the BNSF tracks will likely be below the level of soft alluvial deposits encountered in boring B-2. We recommend an allowable soil bearing pressure of 4,000 pounds per square

foot (psf) be used for footings supported by native medium dense soil or structural fill placed over native medium dense to dense soil.

- We anticipate that pipe ramming will be the preferred trenchless technique to construct a new culvert under the BNSF tracks. However, pipe ramming would require installing two 8-footdiameter culverts as 8 feet is the maximum size for this method. Pregrouting of the embankment fill soils above the culvert would likely be required by BNSF.
- We did not complete a specific scour analyses for this project. The proposed culvert foundations should be placed deep enough to protect them from potential scour impacts.
- Shoring will likely be used to complete the excavations for the remaining culverts to minimize the impacts to the adjacent roadways.
- Difficulties in excavating and installing shoring will likely be encountered for the culvert crossing Haskens Road due to the presence of rubble and/or large boulders present in the upper 5 feet of the fill.
- Provided the creek water is diverted from the excavations, we anticipate that dewatering can typically be accomplished by open pumping using sump pumps. A higher level of pumping/dewatering may be required for the culvert excavation crossing 74th Avenue NE, where groundwater was encountered at a depth of about 9 feet during drilling and where relatively free-draining sand is present.
- We anticipate that the soils at the site can be excavated using conventional construction equipment. However, the contractor should be prepared to deal with cobbles and boulders in the outwash soils, and with rubble or large boulders in the vicinity of Haskens Road. Ideally, earthwork should be undertaken during extended periods of dry weather when the soils will be less susceptible to disturbance and provide better support for construction equipment. Dry weather construction will help reduce earthwork costs.
- Effective erosion and sedimentation control must be implemented during construction so that potential impacts to the adjacent sensitive areas are reduced. The erosion potential of the on-site soils is moderate to high. The erosion and sedimentation control measures used for this project should be in accordance with applicable regulatory standards.

The following sections of this report present our conclusions and recommendations for site development, foundation support and performance estimates for the associated site developments.

Site Preparation and Earthwork

General

We recommend that site preparation and earthwork be completed during the normally dry season of the year (generally July through September) if practical, as the workability of the soil becomes difficult and the erosion potential of the on-site soils is increased during extended periods of wet weather.

Earthwork Considerations

Asphalt, grass/sod, fill, and outwash deposits were observed in the explorations. In addition, excavations will require removal of adjacent concrete sidewalks. We anticipate that these materials can be excavated with conventional excavation equipment, such as trackhoes or dozers. Cobbles were not encountered in these explorations, with the possible exception of borings B-1 and B-1B, but were encountered in borings completed for a nearby project and boulders are known to occur in glacial outwash deposits. Therefore, the contractor should be prepared to deal with cobbles and boulders in the fill and outwash.

Clearing and Grubbing

The work area should be cleared of all surface and subsurface deleterious matter, including debris, trees, shrubs and associated stumps and root wads, and should be stripped of the sod and organic soil. The woody debris should be removed from the project site for disposal. Based on our experience, we anticipate that stripping depths will generally be less than 8 inches. The stripped vegetative material and organic soil can be stockpiled and later reused in landscaping if desirable.

Removal and demolition of existing structures should include removal of below-grade elements. Existing voids or new depressions created during site preparation should be cleaned of loose soil or debris and backfilled with structural fill.

Creek Diversion

The creek should be diverted into a tight line going around each excavation such that creek water does not enter each excavation.

Sedimentation and Erosion Control

In our opinion, the erosion potential of the undisturbed on-site soils is low to moderate as most of the adjacent areas are relatively flat and landscaped or well vegetated.

The amount and potential impacts of erosion are in part a function of the time of year construction occurs. Wet weather construction will increase the amount and extent of erosion. We expect that exposed soils will have moderate erosion potential during wet weather. It will therefore be necessary to put in place effective erosion controls during and after construction. These should include proper control of surface water runoff to prevent uncontrolled, concentrated surface water runoff over slope areas and minimizing the time of exposure in the areas stripped during construction through prompt re-vegetation.

Effective erosion and sedimentation control during construction may consist of interceptor swales and silt fences to prevent water from flowing off site. Because the runoff is likely to be silty, we recommend that the collected water be passed through a temporary desilting facility prior to discharging the water into the stormwater collection system. Completion of initial clearing and grading activities during the drier months and limiting the disturbance of the existing ground surface and vegetation where possible will also reduce the risks of erosion. Material stockpiles should be covered during wet weather to prevent erosion and soil loss. All areas disturbed during construction should be seeded and planted as soon as practical to reduce the potential for erosion.

Erosion and sedimentation control measures should be installed and maintained in accordance with applicable regulatory standards.

Subgrade Preparation

We recommend that all subgrade soils for each culvert foundation be evaluated by a representative of GeoEngineers before construction of the foundation or structural fill to identify any soft or unsuitable subgrade soils. Any soft or unsuitable subgrade soils that are observed during this evaluation should be removed and replaced with compacted structural fill. Where subgrade soils have high fines content, construction during the wet season can result in significant disturbance. In areas where high fines content are observed in the subgrade soils, we recommend 2 to 4 inches of crushed rock be placed on the prepared foundation subgrade to protect it and avoid softening the silty subgrade soils during wet weather construction. Haul roads and laydown areas should also include crushed rock surfacing to protect them during wet weather construction.

Structural Fill

All fill, whether on-site or imported soil, that will support pavement areas or foundations, or in utility trenches should meet the criteria for structural fill presented below. The suitability of soil for use as structural fill depends on its gradation and moisture content.

MATERIALS

Structural fill material quality varies depending upon its use, as described below:

1. Structural fill placed to construct embankments, to backfill utility trenches, to support culvert or wall foundations and to provide subgrade for pavement should consist of common borrow as described in Section 9-03.14(3) of the 2012 Washington State Department of Transportation (WSDOT) Standard Specifications. If structural fill is placed during wet weather, it should consist of gravel borrow as described in Section 9-03.14(1) of the 2012 WSDOT Standard Specifications.
2. Structural fill placed adjacent to below-grade and retaining walls (drainage zone) should consist of gravel backfill for walls in conformance with Section 9-03.12(2) of the 2012 WSDOT Standard Specifications.
3. Structural fill placed as crushed surfacing base course below pavements should conform to Section 9-03.9(3) of the 2012 WSDOT Standard Specifications.

USE OF ON-SITE SOILS

Most of the near-surface soils observed in the explorations generally contain a high percentage of fines (silt/clay) and are moisture-sensitive. Some of the existing fill that meet the requirements for common borrow may be suitable for use as common borrow during dry weather, provided it can be properly moisture-conditioned prior to placement. These soils will likely be limited to the sand, sand with silt, and gravel encountered in the borings.

The on-site soils that meet the requirements for common borrow are expected to be suitable for structural fill in areas requiring compaction to at least 95 percent of the maximum dry density (MDD) estimated in general accordance with American Society for Testing and Materials (ASTM) D 1557, provided the work is completed during the normally dry season (June through September) and that the soil can be properly moisture-conditioned. It may be necessary to

import sand and gravel with a low fines content to achieve adequate compaction for support of pavement areas for wet weather construction. Imported structural fill consisting of sand and gravel (WSDOT gravel borrow) should be planned if construction occurs during wet weather.

The use of on-site soils that meet the requirements for common borrow as structural fill during wet weather should be planned only for areas requiring compaction to 90 percent of the MDD or less, as long as the soils are properly protected from wet weather and not placed during periods of precipitation. The contractor should plan to cover and maintain all fill stockpiles with plastic sheeting if the soil will be used as structural fill. The reuse of on-site soils is highly dependent on the skill of the contractor and the schedule, and we will work with the design team and contractor to maximize the reuse of on-site soils during the wet and dry seasons.

STRUCTURAL FILL PLACEMENT

Structural fill should generally be placed in loose lifts not exceeding about 8 to 10 inches in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. If structure fill is placed adjacent to existing slopes, the existing slope should be benched prior to the fill placement and compaction to avoid an unstable interface zone. Structural fill placed in areas used to support footings or retaining walls should be compacted to at least 95 percent of MDD as determined by the ASTM D-1557 test method. Pavement area fill, including utility trench backfill, should be compacted to at least 90 percent of MDD, except for the upper 2 feet below finished subgrade surface, which should be compacted to at least 95 percent of MDD. Structural fill to support sidewalks should be placed after the subgrade is evaluated and be compacted to at least 90 percent of MDD.

We recommend that a representative from GeoEngineers, Inc. be present during structural fill placement to observe the work and perform in-place density tests to evaluate whether or not the specified compaction is being achieved.

Culvert Excavations

General

Culvert excavation depths will range from about 10 to 20 feet, with most of the culvert replacements requiring excavations on the order of about 10 feet deep, with the exception of the two culverts under Haskens Road and the BNSF tracks. We anticipate that medium dense to dense recessional deposits will be exposed in the base of these excavations. All temporary cut slopes and shoring must comply with the provisions of Title 296 Washington Administrative Code (WAC), Part N, “Excavation, Trenching and Shoring.” The contractor performing the work has the primary responsibility for the protection of workers and adjacent improvements.

Because the soils at the project consist mostly of sand and gravel with variable amounts of silt, we recommend that all excavations extending below groundwater depth be fully dewatered. Otherwise, excessive groundwater flow into excavations could cause lateral movement of the granular soils into the excavations, possibly destabilizing the excavations or causing excessive ground settlement adjacent to the excavations. Dewatering is discussed further below in the “Construction Dewatering” section of this report.

Temporary and Permanent Slopes

We anticipate that shored excavations will be required for most of the culvert replacements. However, where sloped excavations are possible, we recommend that temporary cut slopes be inclined no steeper than 1½H:1V (horizontal to vertical). Flatter slopes may be necessary if seepage is present on the face of the cut slopes or if localized sloughing occurs.

Some sloughing and raveling of the cut slopes should be expected. Temporary covering, such as heavy plastic sheeting, should be used to protect these slopes during periods of rainfall. Surface water runoff from above cut slopes should be prevented from flowing over the slope face by using curbs, berms, drainage ditches, swales or other appropriate methods.

If temporary cut slopes experience excessive sloughing or raveling during construction, it may become necessary to modify the cut slopes to maintain safe working conditions and protect adjacent facilities or structures. Slopes experiencing excessive sloughing or raveling can be flattened, they can be regraded to add intermediate slope benches, or additional dewatering can be provided if the poor slope performance is related to groundwater seepage.

Because the contractor has control of the construction operations, the contractor should be made responsible for the stability of cut slopes, as well as the safety of the excavations. Shoring and temporary slopes must conform to applicable local, state and federal safety regulations. The final configuration for temporary excavation slopes should be evaluated during construction, as it is a function of the soil and groundwater conditions encountered and the contractor's approach to excavation.

Permanent creek banks should be inclined no steeper than 3H:1V. Permanent slopes should be planted or hydroseeded as soon as practicable after grading. We recommend that all fill be placed as structural fill, as described above.

Shored Excavations

We anticipate that the excavations for the culvert replacements, plus the jacking and recovery pit for trenchless construction, will be completed using shored excavations to minimize the limits of the excavations. The jacking pit might be completed using temporary cut slopes or using shoring, depending on the existing ground surface slope in the vicinity of the receiving pit and right-of-way limitations.

Because of the diversity of available shoring systems and construction techniques, the design of temporary shoring is most appropriately left up to the contractor proposing to complete the installation. However, we recommend that the shoring be designed by an engineer licensed in Washington, and that the PE-stamped shoring plans and calculations be submitted to the City of Arlington and the Engineer for review prior to construction. The following paragraphs present general recommendations for the type of shoring system and design parameters that we conclude are appropriate for the subsurface conditions at the project.

The site soils can be retained using conventional trench shoring systems such as trench boxes, slide rail system, or sheet piles with lateral restraint. The design of temporary shoring should allow for lateral pressures exerted by the adjacent soil, and for surcharge loads resulting from structures,

traffic, construction equipment, temporary stockpiles adjacent to the excavation, etc. Lateral load resistance can be mobilized through the use of braces, tiebacks, anchor blocks and passive pressures on members that extend below the bottom of the excavation. Temporary shoring used to support trench excavations typically uses internal bracing such as hydraulic shoring or trench boxes.

The lateral soil pressures acting on shoring walls will depend on the nature and density of the soil behind the wall and the inclination of the backfill surface. For walls that are free to yield at the top at least one thousandth of the height of the wall (i.e., wall height times 0.001), soil pressures will be less than if movement is restrained. We recommend that yielding walls retaining medium dense to dense fill and native soils be designed using an equivalent fluid density of 35 and 60 pounds per cubic foot (pcf), for horizontal ground surfaces and ground surfaces inclined at 1½ H:1V above the horizontal, respectively. For non-yielding (i.e., braced) systems, we recommend that the shoring be designed for a uniform lateral pressure of 26*H in psf, where H is the depth of the planned excavation in feet below a level ground surface. Similarly, for a ground surface inclined at 1½H:1V above partial shoring, we recommend that shoring be designed for a uniform lateral pressure of 46*H.

These lateral soil pressures do not include traffic, structure or construction surcharges that should be added separately, if appropriate. Shoring should be designed for a traffic influence equal to a uniform lateral pressure of 100 psf acting over the depth of the trench. If shoring is within 15 feet of active BNSF tracks, additional surcharge loading may be necessary. More conservative pressure values should be used if the designer deems them appropriate. These soil pressure recommendations are predicated upon the construction being essentially dewatered; if effective dewatering methods are used to lower the groundwater level below the bottom of the excavation, hydrostatic pressures need not be added to the soil pressures within the exposed height of shoring.

If portions of the shoring use passive elements such as anchor or reaction blocks, available soil resistance can be estimated using passive soil pressures assuming an equivalent fluid density of 350 pcf above the water table and 200 pcf below the water table.

Dewatering

The purpose of this report section is to present geotechnical and hydrogeological data that will influence temporary construction dewatering and to describe in general terms various types of dewatering techniques that may be feasible at the site. Detailed dewatering designs for construction are not within our scope of services.

As discussed above, static groundwater was observed in some of the borings at the time of exploration. Where observed, the depth to static groundwater varied from about 9 to 23 feet. We recommend the groundwater level be maintained a minimum of 2 feet below the bottom of the excavation during construction or that level necessary to stabilize the shoring. The level will depend upon the dewatering method, the size of the excavation and other factors.

Based on the soil conditions and our experience in the area, we expect that groundwater in excavations less than about 2 to 4 feet below the static groundwater level can be controlled by open pumping using sump pumps. For excavations deeper than 4 feet below the water table, or

where free-draining sands and gravels are present at the base of the excavation, dewatering using well points or deep wells might be necessary. We recommend that the contractor be required to submit a proposed dewatering system design and plan layout to the City of Arlington and the Engineer for review and comment prior to beginning construction.

The level of effort required for dewatering will depend to a great extent on the time of year during which construction is accomplished and the extent to which all of the creek flow is successfully diverted around each excavation. Less seepage into the work areas should be expected if construction is accomplished in the late summer or early fall months, and correspondingly, more seepage should be expected during the wetter periods of the year. We recommend that construction be completed in the late summer or early fall months when the creek flows are typically at their lowest. In our opinion, this will result in significant cost savings for the dewatering.

A general discussion of the dewatering methods anticipated for the project is presented below.

Open Pumping

This dewatering method involves removing water that has seeped into the excavation by pumping from a sump that has been excavated at one end of the excavation or trench. Drainage ditches that are connected to the sump are typically excavated along the sidewalls at the base of the excavation or trench. The excavation for the sump and the drainage ditches should be backfilled with gravel or crushed rock to reduce the amount of erosion and associated sediment in the water pumped from the sump. In our experience, a slotted casing or perforated 55-gallon drum that is installed in the sump backfill provides a suitable housing for a submersible pump.

The amount of water removed from the excavation by open pumping should be minimized because of high turbidity levels. Temporary storage of dewatering effluent from the sumps in a settlement tank or basin may be required to meet discharge permit requirements and reduce sediment content prior to discharging the water to surface water courses.

Pumped Wells

Individually pumped wells may be considered for dewatering the construction areas. Pumped wells that have been properly installed and developed are capable of producing the high discharge rates that are necessary to dewater highly permeable sand deposits. Pumped wells are generally the most effective dewatering method in areas where dewatering to deeper than about 20 feet below the ground surface is necessary.

We recommend that all dewatering wells installed for this project be properly developed to remove fine sediment from the immediate vicinity of the well screens. Proper development is essential for producing efficient wells and greatly reduces the turbidity of the water discharged from the well. Filter packs consisting of graded sand, or sand and fine gravel should be installed around the well screens in areas where the aquifer contains a high percentage of fine sand and silt.

Well Points

Well points are effective for dewatering all types of soils, whether pumping small amounts of water from silt or large quantities of water from coarse sand and gravel. The volume of water generated by a well point system is typically less than the volume generated by a corresponding system of

pumped wells because the well points are generally completed at a shallower depth. Because of the shallower completion depth, the volume of aquifer that contributes water to a well point system is less than for a comparable deep well system.

Well point systems are most suitable for dewatering shallow excavations where the water table must be lowered no more than about 20 feet bgs. Multiple well point stages are generally required beyond that depth because of the physical limitations of suction lift. Dewatering can be accomplished at depths greater than 20 feet where the excavation can be open cut to permit installation of the well point system below original grade. This technique increases the depth to which the water table can be lowered with well points.

Earthquake Engineering

Design Earthquake Parameters

The seismic design of the proposed improvements can be completed using the design criteria presented in the American Association of State Highway and Transportation Officials (AASHTO) seismic design information. The AASHTO Guide Specifications recommend a 7 percent probability of exceedance in 75 years (nominal 1,000-year earthquake) design event for development of a design spectrum. Based on these criteria, we recommend the parameters for site class, seismic zone, acceleration coefficient and spectral acceleration coefficients presented in the following table.

AASHTO SEISMIC PARAMETERS

AASHTO Seismic Parameter	Recommended Value
Site Class	D
Seismic Zone for $0.30 < S_{D1} \leq 0.50$	3
Effective Peak Ground Acceleration Coefficient $A_S = F_{pga}PGA = (1.17)(0.333)$	0.39
Design Spectral Acceleration Coefficient at 0.2 Second period $S_{DS} = F_aS_s = (1.20)(0.753)$	0.904
Design Spectral Acceleration Coefficient at 1.0 Second period $S_{D1} = F_vS_1 = (1.89)(0.255)$	0.482

Seismic Hazards

We evaluated the site conditions for seismic hazards including liquefaction, lateral spreading and seismically induced landsliding. Our evaluation indicates the site has low risk of liquefaction because of the relatively low groundwater and presence of medium dense to very dense outwash deposits below the site. Because there is a low risk of liquefaction, the site has a low risk of liquefaction-induced ground disturbance including lateral spreading. Our evaluation of seismically induced landsliding indicates that there is also a low risk for seismically induced landsliding.

Shallow Foundations

General

Based on soils observed in our explorations located near the proposed culverts, we anticipate that medium dense or denser sand and gravel soils (recessional outwash) will be present at the anticipated foundation grades, assumed to be about 12 to 17 feet below existing grades, with the exception of the 71st Street culvert which may be slightly higher. Overexcavation and replacement with structural fill may be necessary in the vicinity of the crossing under the BNSF tracks, as Boring B-2 encountered a zone of loose silty sand to soft silt from a depth of about 12 to 15 feet. We recommend that the proposed culverts be supported on conventional spread footings bearing on the native medium dense to dense sand and gravel soils observed in the borings at and below the anticipated base of the new culverts, or on properly placed and compacted structural fill that extends down to the competent native soils.

Foundation Design Parameters

Footings may be designed using an allowable soil bearing value of 4 kips per square foot (ksf) on properly compacted structural fill or native medium dense or denser sand and gravel soils. The allowable soil bearing values apply to the total of dead and long-term live loads and may be increased by up to one-third for wind or seismic loads. Footings should be at least 2-foot-wide, and should be founded a minimum of 2 feet below the level of the creek channel bottom.

Settlement

Provided all loose soil is removed and the subgrade is prepared as recommended under "Construction Considerations" below, we estimate the total settlement of shallow foundations will be on the order of ½ to 1 inch. The settlements will occur rapidly, essentially as loads are applied. Differential settlement between the bridge abutments is expected to be less than 1 inch.

Lateral Resistance

Lateral foundation loads may be resisted by passive resistance on the sides of footings and by friction on the base of the footings. For footings supported on native soils or on structural fill placed and compacted in accordance with our recommendations, the allowable frictional resistance may be computed using a coefficient of friction of 0.4 applied to vertical dead-load forces.

The allowable passive resistance of soils may be computed using an equivalent fluid density of 200 pcf (triangular distribution) if these elements are poured directly against undisturbed native soils or surrounded by structural fill. This value assumes that the hydrostatic groundwater level may at times be as high as the culvert footings. No passive resistance should be allowed for soils located on the creek-side of the culvert within 2 feet of the creek bed. The above coefficient of friction and passive equivalent fluid density values incorporate a factor of safety of about 1.5.

Construction Considerations

Subgrade disturbance may occur if footing excavations are completed during wet weather. A working mat of lean concrete or compacted crushed rock should be placed over the footing

subgrade immediately following excavation to prevent softening and disturbance of the footing subgrade if construction occurs during wet weather.

If soft areas are present at the footing subgrade elevation, the soft areas should be removed and replaced with structural fill at the direction of the Geotechnical Engineer. In such instances, the zone of structural fill should extend laterally beyond the footing edges a horizontal distance at least equal to the thickness of the fill.

Given the relatively high allowable bearing pressures presented above, the condition of all footing excavations must be observed by the Geotechnical Engineer or their representative to evaluate if the work is completed in accordance with our recommendations and that the subsurface conditions are as anticipated.

Retaining/Abutment Walls

General

At this time, we do not know if the proposed culverts will require abutment walls. Abutment walls could consist of conventional concrete cantilever walls or possibly a block/keystone type of wall. bearing on shallow foundations. The following paragraphs present our recommendations for retaining walls.

For retaining walls with horizontal backslopes that are allowed to deflect about 0.002H under loading, we recommend that the walls be designed for the active earth pressure taken as an equivalent fluid density of 35 pcf for well-draining gravel backfill for walls. If the ground within 5 feet of the retaining wall rises at an inclination of 2H:1V or steeper, the retaining wall should be designed using an equivalent fluid density of 50 pcf. For adjacent slopes flatter than 2H:1V, soil pressures can be interpolated between this range of values. Other conditions should be evaluated on a case-by-case basis.

If the retaining walls are restrained against rotation, we recommend that the walls with horizontal backslopes be designed for an at-rest earth pressure taken as an equivalent fluid density of 55 pcf. If the ground within 5 feet of the retaining wall rises at an inclination of 2H:1V or steeper, the rigid retaining wall should be designed using an equivalent fluid density of 78 pcf. For adjacent slopes flatter than 2H:1V, soil pressures can be interpolated between this range of values. Rigid walls are walls that deflect less than about 0.002H under the at-rest pressure loading, where H is the height of the retaining wall. Once the wall moves approximately 0.002H, the active pressure state is achieved.

Typically, retaining walls are designed for a surcharge pressure for traffic loading. For traffic loading, we recommend that retaining walls be designed for a uniform surcharge pressure determined by increasing the height of the wall by 2 feet. Other surcharge loads should be included as appropriate.

If seismic earth pressure are considered in design we recommend that a rectangular seismic earth pressure distribution equal to 8H in psf be added to the static lateral earth pressures presented above for the rigid wall or active earth pressure condition, whichever is appropriate.

Drainage

The above lateral earth pressures assume that the backfill behind the retaining walls is drained. Drainage consisting of either a perforated drain pipe installed near the base of the retaining walls or installation of weepholes near the base of the retaining wall should be incorporated in the design. If a drain pipe is used, the drains should consist of a perforated pipe a minimum of 4 inches in diameter enveloped within a minimum thickness of 6 inches of gravel backfill for drains, WSDOT Standard Specification 9-03.12(4). Clean-outs for the collector pipe should be installed as appropriate. Alternatively, the walls can be provided with weepholes designed in accordance with WSDOT Standard Plans.

Construction Considerations

Backfill placed within 5 feet of below grade walls should be compacted to densities of at least 90 percent of the MDD obtained in accordance with the ASTM D-1557 procedure to reduce the potential for development of excess pressure on the walls. If sidewalks or pavement will be placed adjacent to the wall, we recommend that the upper 2 feet of fill be compacted to 95 percent of the MDD. Measures should be taken to prevent the buildup of excess lateral soil pressures due to over-compaction of the backfill behind the wall; for example, by using hand-operated mechanical vibrators.

Drainage Considerations

General

We recommend that all surfaces be sloped to drain away from the existing and proposed structures and improvements. Pavement surfaces and open space areas should be sloped such that the surface water is collected and routed to suitable discharge points.

We anticipate that shallow groundwater seepage may enter excavations depending on the time of year construction takes place, especially in the winter months. However, we expect that this seepage water can be handled by digging interceptor trenches in the excavations and pumping from sumps. If not intercepted and removed from the excavations, the seepage water will make it difficult to place and compact structural fill and may destabilize cut slopes.

Trenchless Crossing Considerations

General

We understand that the culvert replacement under the BNSF tracks will likely be completed using trenchless technology. Difficulties in completing trenchless in this area include the close proximity to Haskens Road which may limit the area available for the jacking or receiving pits, and the presence of rubble or large boulders in the fill underlying Haskens Road which precludes installing a longer continuous culvert using trenchless techniques under both Haskens road and the BNSF tracks.

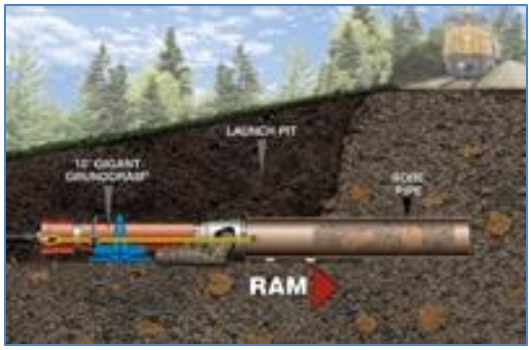
In general, we anticipate that recessional sands and gravels will be encountered along most of the alignment. Some softer silt and loose sand may also be encountered. No groundwater was observed in borings B-1C or B-2, however, based on the groundwater conditions encountered in other borings, groundwater may be present along the trenchless alignment.

Large rocks and/or rubble were encountered in the upper 5 feet of fill along the west side of Haskens Road. If the trenchless portion extends under Haskens Road, the presence of large rocks or rubble could present extreme difficulties for completing the trenchless bore. Therefore, at this time, we recommend that the trenchless section extend only under the railroad tracks and not under Haskens Road.

Due to the desired large width of the new culvert, it is our opinion that the trenchless techniques best suited for this project include pipe ramming, box culvert jacking, and tunneling using arch canopy methods. Based on our experience with completing trenchless projects under railroad embankments, we anticipate that the railroad will require the City to pregrout the embankment soils prior to initiating the trenchless project. The following sections provide a general discussion of possible trenchless techniques for this project.

Twin Pipe Ramming

Pipe ramming is a trenchless construction method that uses a large pneumatic ramming tool to drive steel pipe through a variety of soil types (see the graphic to the right). A cutting shoe can be welded to the front of the lead pipe to provide a small over cut and help reduce friction along the pipe, and to cut through the soil. Bentonite or polymer lubrication can also be used to help reduce friction during long ramming drives. The soil inside the pipe remains in place during ramming and is removed after the pipe reaches the far side of the embankment. With pipe ramming, the maximum possible size is about 8 feet in diameter.



Pipe Ramming (graphic courtesy of TT Technologies)

Therefore, if a spring line diameter of 16 feet is required, a twin barrel approach would be necessary using this method. The combined width at the spring line of the two pipes would be about 16 feet.

For railroad and embankment crossings, the steel pipe is often driven in one continuous section. Once the full length of the pipe casing has been installed, the spoils inside the casing are removed. Depending on the length of the installation, spoil from inside the casing can be removed with compressed air, jetting or augering.

One of the benefits of pipe ramming is that the spoils from inside the casing are not removed during installation (like auger boring). This results in formation of a soil plug within the casing. In soils which may have perched layers of groundwater, or in soils that are a few feet below the groundwater table, this soil plug can reduce or stop the inflow of groundwater. Additionally, the soil plug in the casing eliminates the possibility of over excavation at the face of the casing.

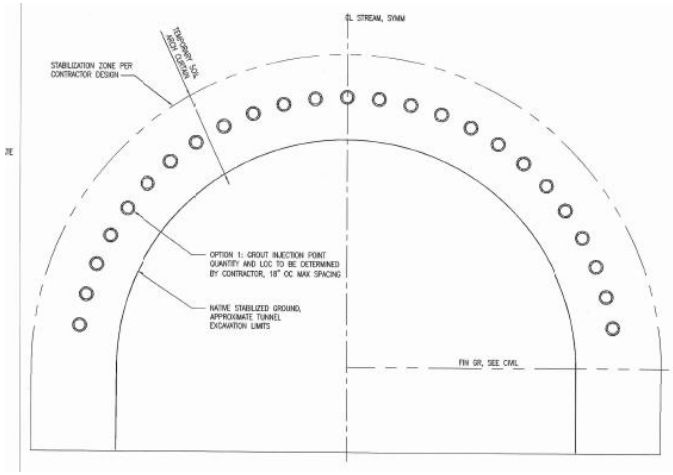
Pipe ramming is the preferred method by many railroads as no soil is removed until the casing is completely installed, lessening the risk of piping or disturbance of the railroad embankment fill soils. Pipe ramming also has the benefit of not requiring a receiving pit and the ramming pit could be placed on the east side of the railroad where there is adequate room.

Box Culvert Jacking

Jacking a box culvert uses the same approach as jacking a pipe. A steering shield is placed in front of the first section of reinforced box culvert. Large rams are placed behind the box culvert to provide thrust. Lubrication is provided along the top and sides of the box culvert to reduce friction. As the first section of box culvert is pushed into place, the soil from the interior of the culvert is excavated. The length of box culvert that can be pushed depends on the weight of the culvert, the soils and the available sizes of rams. **This technology is not common in the PNW and to our knowledge no local contractors have rammed large box culverts**. Challenges include preventing the culvert from sinking below the desired alignment due to the weight of the box. Also, a special order box culvert would be required to have rails built in on the bottom of the culvert.

Conventional Tunneling Using Arch Canopy Methods

Conventional tunneling is typically not allowed by railroads, however, installation of a pre-grouted (or pre-frozen) arch would construct a canopy of improved ground (also known as "barrel vaulting") by drilling horizontal bores from either side of the embankment and might be allowed by the railroad. This is a method commonly used in large diameter tunneling applications. For either grout or freeze pipes, the canopy usually has a single or a double row of freeze tubes or perforated grout tubes placed in 8-inch-diameter bores, with bores spaced at 12 to 18 inches on center. For a grout canopy, the grout is pumped through the steel grout tubes and is directed to discrete areas along the tube by using packers. The result is closely spaced and possibly overlapping grouted beams with the grout tube left in place as reinforcing. For both a grout-arch and a frozen-ground arch, the beams act as support for the overlying soil mass and as soil improvement to reduce over-excavation of the tunnel. Once the arch is in place, the tunnel is excavated and a final liner is installed.



LIMITATIONS

We have prepared this report for the exclusive use by Murray, Smith & Associates, and their authorized agents for the geotechnical elements of the proposed Prairie Creek Drainage Improvements project to be located in Arlington, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, expressed or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to the attachment titled Report Limitations and Guidelines for Use for additional information pertaining to use of this report.

REFERENCES

Minard, "Geologic Map of the Arlington West 75 Minute Quad, Snohomish County, Washington," 1985.

Palmer, Stephen P., et al, Liquefaction Susceptibility Map of Snohomish County, Washington, Washington State Department of Natural Resources, OFR 2004-20, September, 2004.

Washington State Department of Transportation, "Standard Specifications for Road, Bridge and Municipal Construction," 2012.

FIGURES

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Type Date of Report Here

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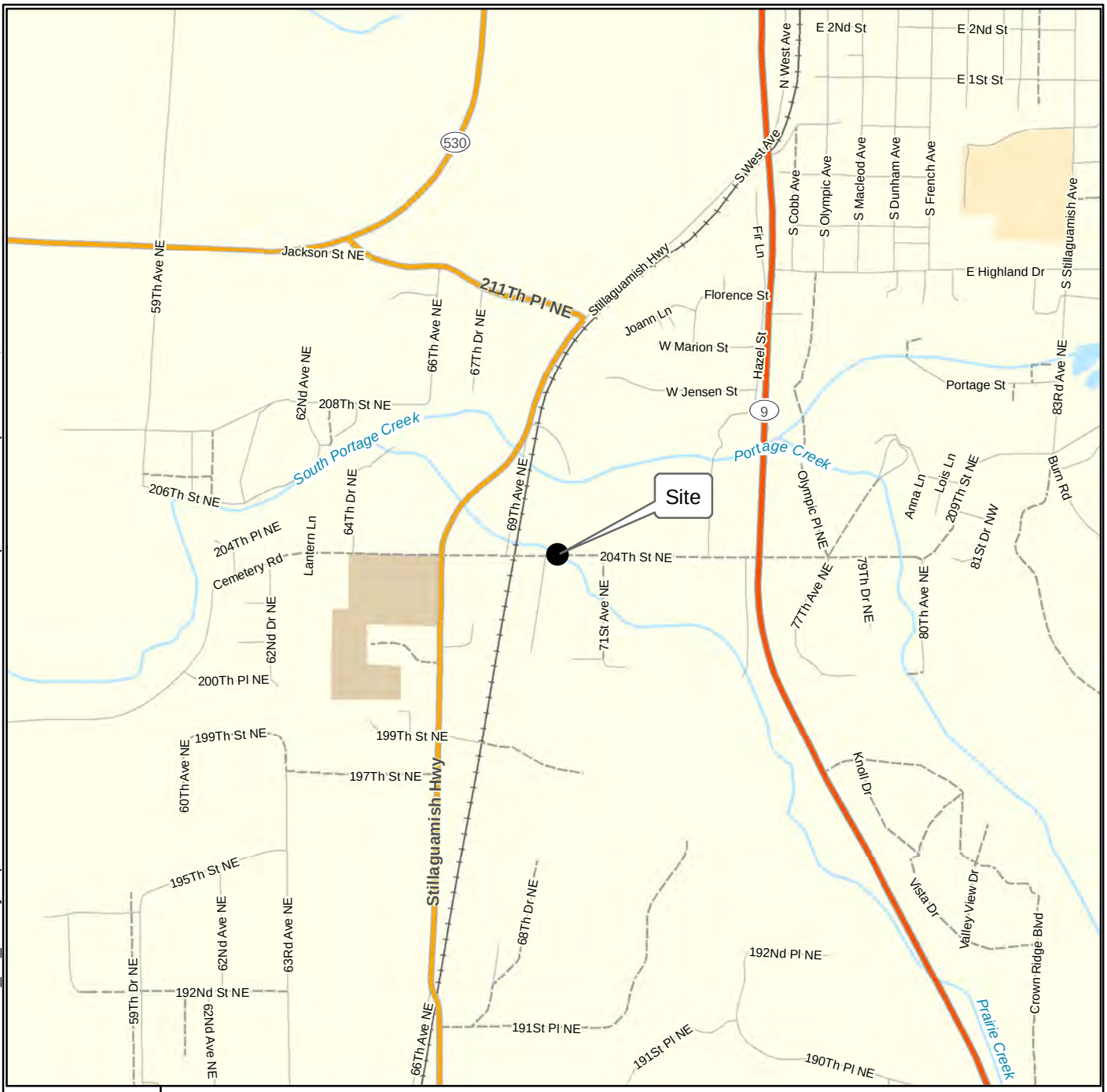

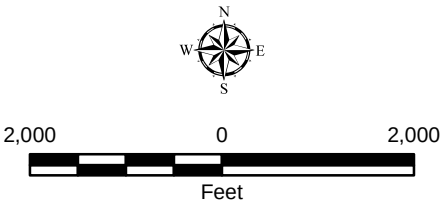

Notes:
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Data Sources: ESRI Data & Maps, Street Maps 2005

Transverse Mercator, Zone 10 N North, North American Datum 1983
North arrow oriented to grid north

Vicinity Map

City of Arlington
Prairie Creek Drainage Improvements
Arlington, Washington

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Figure 1

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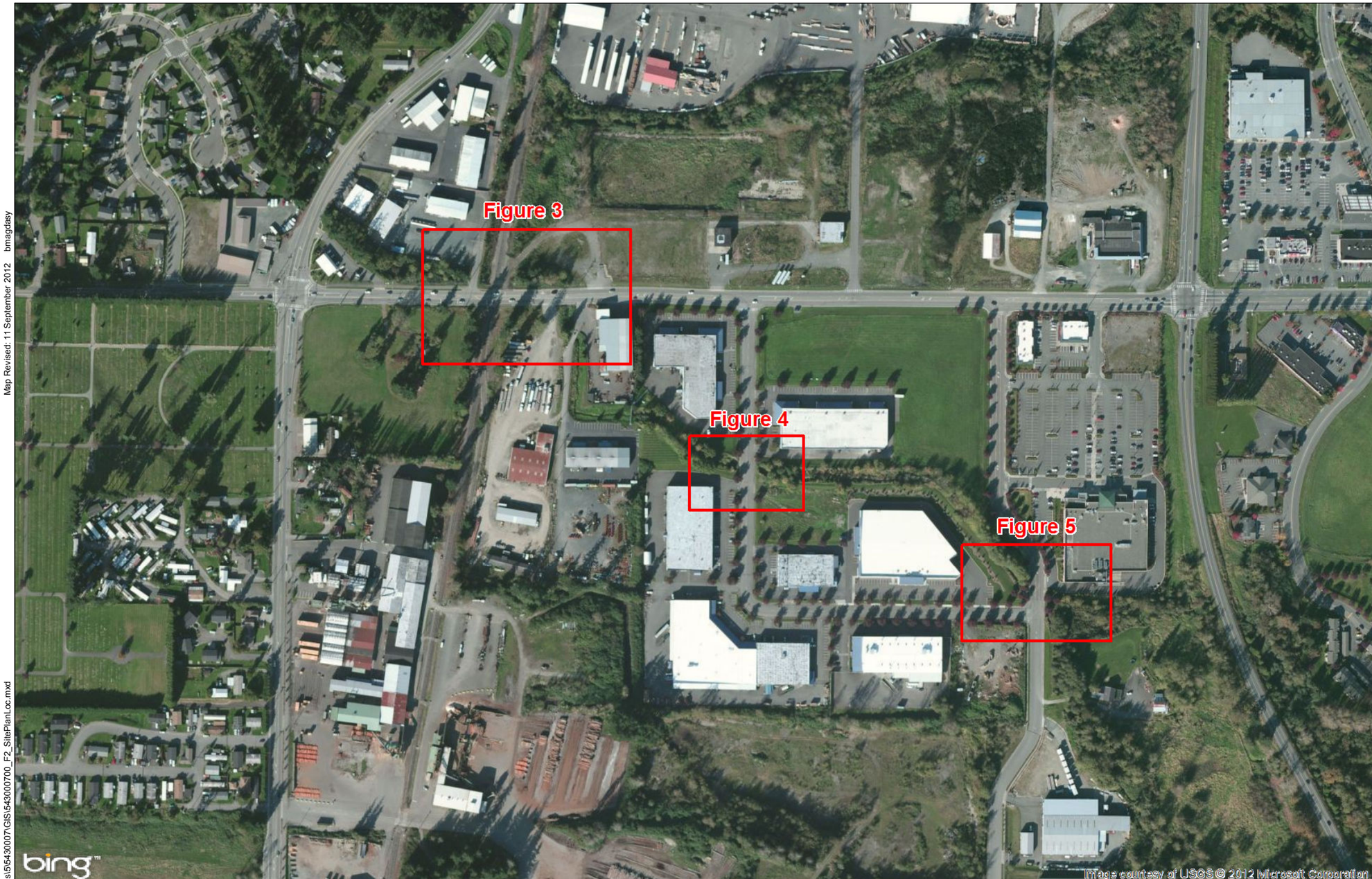

Legend

Site plan extent

N
W E
S

250 0 250
Feet

Data Source:

Projection: WGS 1984 Web Mercator Auxiliary Sphere

Notes:
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Site Plan Locations

Prairie Creek Drainage Improvements
Arlington, WA

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Figure 2

Map Revised: 11 September 2012 bmagdasy

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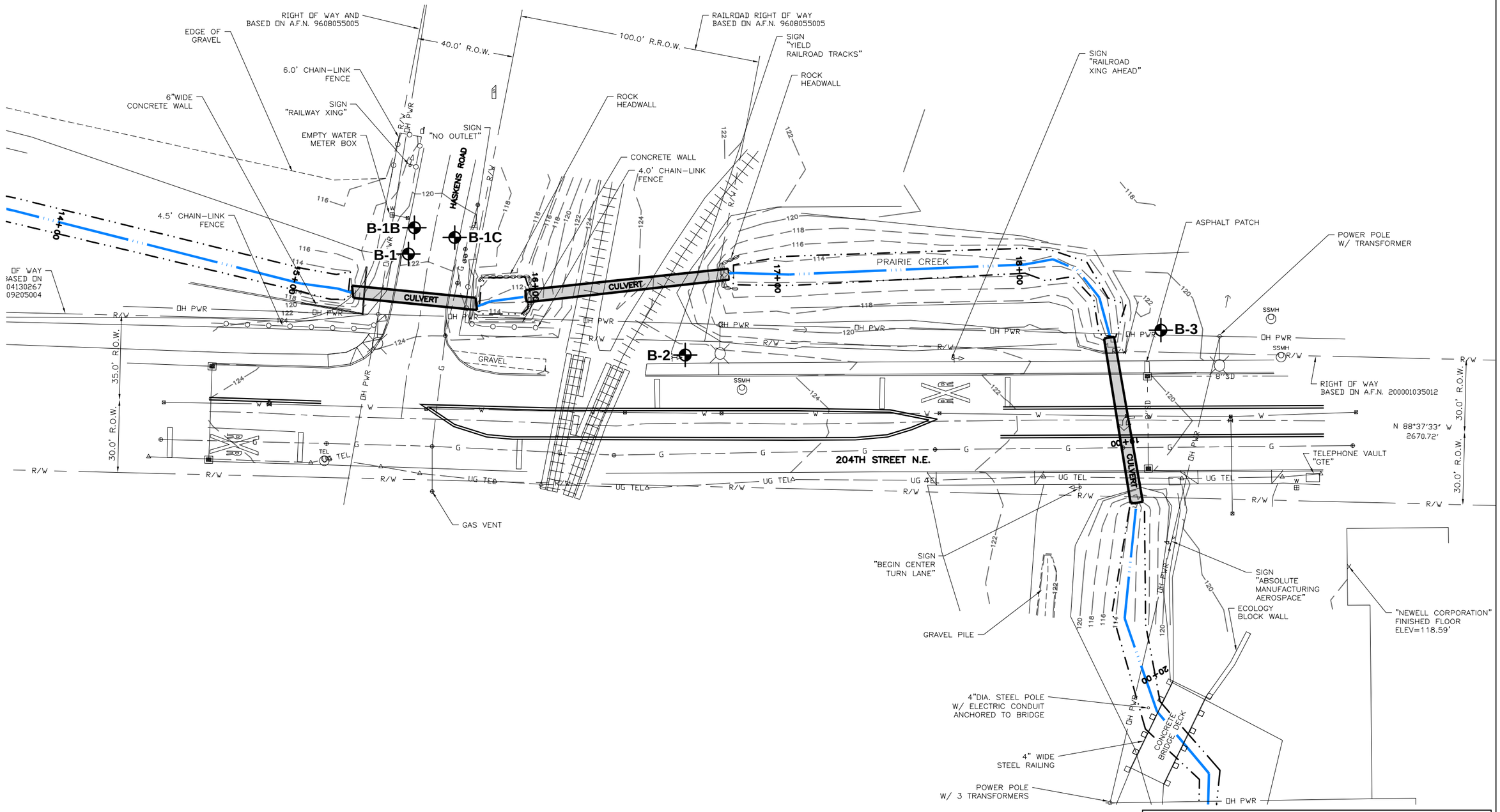

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Reference: Base survey by Metron and Associates, Inc. dated August 2012.

Legend

B-1 Boring by GeoEngineers

Site Plan

Prairie Creek Drainage Improvement Project
Arlington, Washington

GEOENGINEERS

Figure 3

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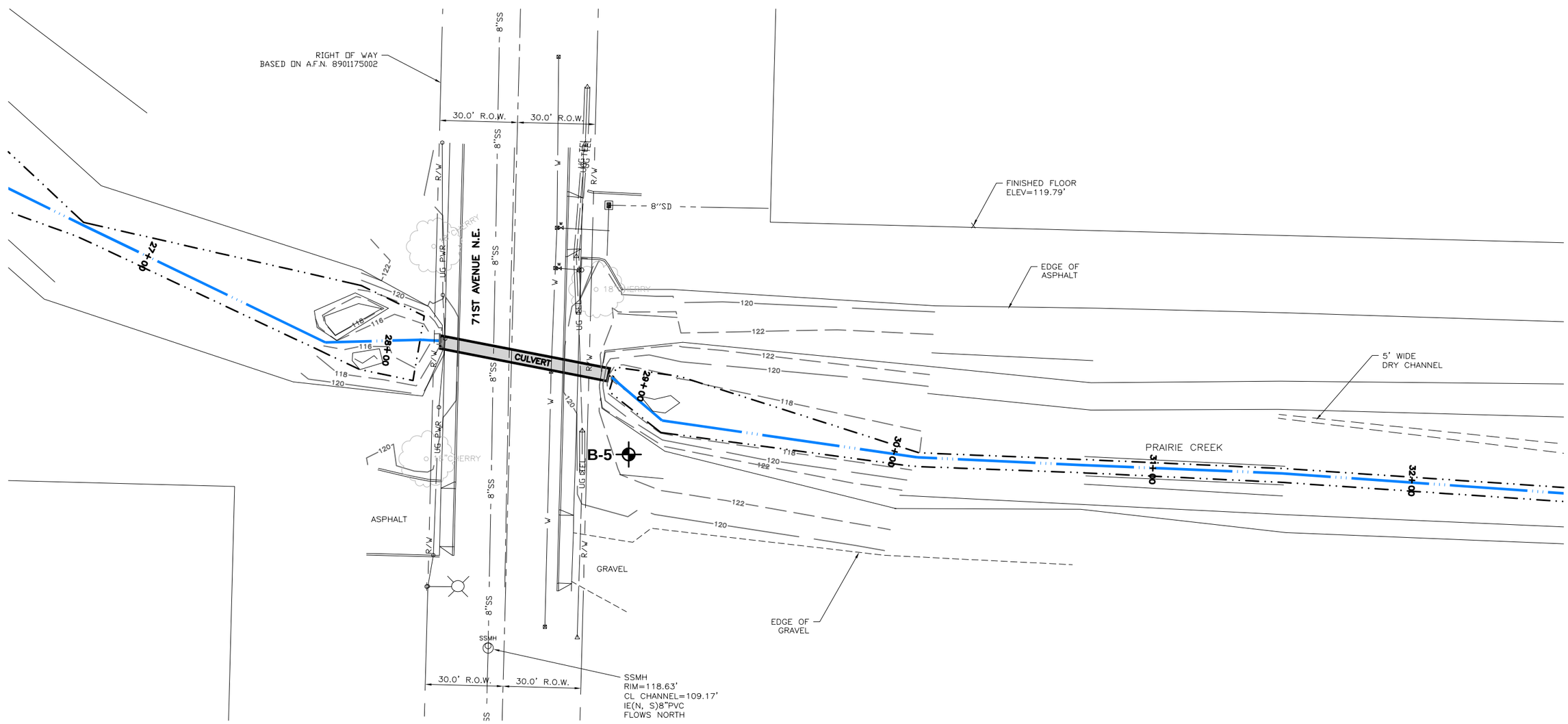

Notes

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Reference: Base survey by Metron and Associates, Inc. dated August 2012.

Legend

B-5 Boring by GeoEngineers

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FEET

Site Plan

Prairie Creek Drainage Improvement Project
Arlington, Washington

GEOENGINEERS

Figure 4

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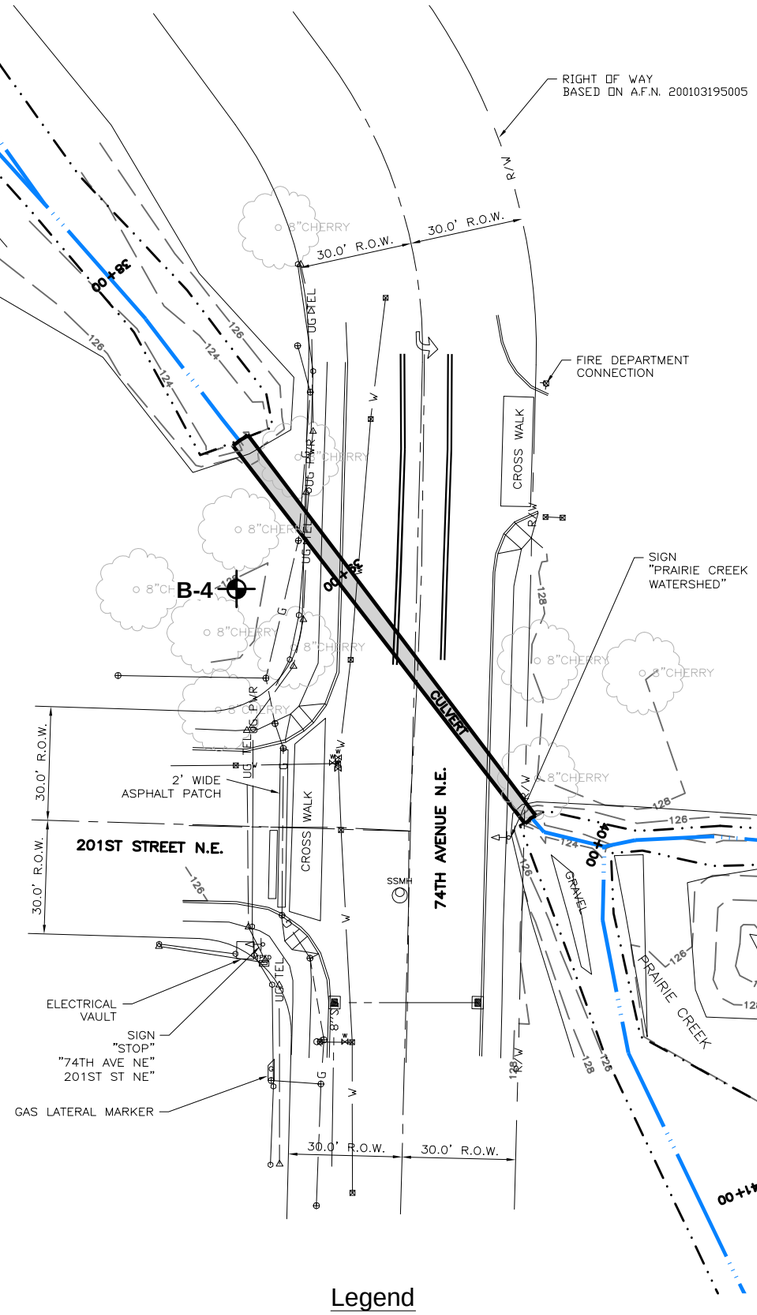

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Reference: Base survey by Metron and Associates, Inc. dated August 2012.

Legend

B-4 Boring by GeoEngineers

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Site Plan

Prairie Creek Drainage Improvement Project
Arlington, Washington

GEOENGINEERS

Figure 5

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APPENDICES

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Type Client Name Here

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APPENDIX A
Field Explorations

APPENDIX A
FIELD EXPLORATIONS

We explored subsurface conditions at the site of the proposed culvert locations by completing five borings (B-1C through B-5). Boring 1 was attempted at three locations as the first two attempts (borings B-1 and B-1B on the west side of the road) encountered refusal on rocks or rubble at a depth of 4 to 5.25 feet. The drilling was performed by Geologic Drill on August 29, 2012.

The locations of the explorations were estimated in the field by measuring distances from site features through taping/pacing in the field. The approximate exploration locations are shown on the Site Plans, Figures 3, 4, and 5. Boring elevations were estimated based on a survey drawing provided by Murray, Smith & Associates, Inc. dated August 2012.

The borings were completed using trailer-mounted, continuous-flight, hollow-stem auger drilling equipment. The borings were continuously monitored by a representative from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration.

The soils encountered in the borings were generally sampled at 2½- or 5-foot vertical intervals with a 2-inch-outside diameter split-barrel standard penetration test (SPT) sampler. The samples were obtained by driving the sampler 18 inches into the soil with an automatic 140-pound hammer falling approximately 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions precluded driving the full 18 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 through A-8. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may actually be gradual. If the change occurred between samples, it was interpreted. The densities noted on the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented on the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	TS	Topsoil/ Forest Duff/Sod

Groundwater Contact

- **Measured groundwater level in exploration, well, or piezometer**
- **Groundwater observed at time of exploration**
- **Perched water observed at time of exploration**
- **Measured free product in well or piezometer**

Graphic Log Contact

- **Distinct contact between soil strata or geologic units**
- **Approximate location of soil strata change within a geologic soil unit**

Material Description Contact

- **Distinct contact between soil strata or geologic units**
- **Approximate location of soil strata change within a geologic soil unit**

Sampler Symbol Descriptions

- **2.4-inch I.D. split barrel**
- **Standard Penetration Test (SPT)**
- **Shelby tube**
- **Piston**
- **Direct-Push**
- **Bulk or grab**

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
PPM	Parts per million
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

GEOENGINEERS

FIGURE A-1

Drilled	Start 8/29/2012	End 8/29/2012	Total Depth (ft) 4	Logged By JQS Checked By	Driller Geologic	Drilling Method

Surface Elevation (ft) Vertical Datum	121.0 (Approximate)	Hammer Data	Auto 140 (lbs) / 30 (in) Drop	Drilling Equipment	Deep Rock XL
Easting (X) Northing (Y)		System Datum		Groundwater Date Measured / Depth to Water (ft) / Elevation (ft)	

Notes: Auger Data: 3¼-inch I.D.

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								AC	3 inches asphalt concrete			
120									CR	8 to 10 inches base course, 5/8-inch minus crushed rock			
									SM	Brown silty fine to medium sand with gravel and rubble or boulders (dense, dry to moist) (fill)			
			8	50/6"		1							Slight hydrocarbon odor

Refusal at 4 feet on rock?

Note: Please see Figure A-1 for explanation of symbols

Log of Boring B-1

GEOENGINEERS

Project: City of Arlington
Project Location: Arlington, Washington
Project Number: 05430-007-00

Figure A-2
Sheet 1 of 1

Redmond: Date:9/12/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\54300700.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 8/29/2012	End 8/29/2012	Total Depth (ft) 5.25	Logged By JQS	Checked By	Driller Geologic	Drilling Method
Surface Elevation (ft) Vertical Datum	121.0 (Approximate)		Hammer Data	Auto 140 (lbs) / 30 (in) Drop		Drilling Equipment	Deep Rock XL
Easting (X) Northing (Y)			System Datum			Groundwater Date Measured	Depth to Water (ft) / Elevation (ft)

Notes: Auger Data: 3¼-inch I.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
120	0								AC	3 inches asphalt concrete			Boring 5 feet north of B-1
									CR	8 to 10 inches base course, 5/8-inch minus crushed rock			
									SM	Brown silty fine to medium sand with occasional gravel and rubble or boulders (medium dense, moist) (fill)			
			8	50/5"		1							Slight hydrocarbon odor
	5									Refusal at 5.25 feet on rock?			

Note: Please see Figure A-1 for explanation of symbols

Log of Boring B-1B

GeoEngineers

Project: City of Arlington
Project Location: Arlington, Washington
Project Number: 05430-007-00

Figure A-3
Sheet 1 of 1

Redmond: Date:9/12/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\54300700.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 8/29/2012	End 8/29/2012	Total Depth (ft) 24	Logged By JQS	Checked By	Driller Geologic	Drilling Method
Surface Elevation (ft) Vertical Datum	121.0 (Approximate)		Hammer Data	Auto 140 (lbs) / 30 (in) Drop		Drilling Equipment	Deep Rock XL
Easting (X) Northing (Y)			System Datum			Groundwater Date Measured	Depth to Water (ft) / Elevation (ft)

Notes: Auger Data: 3¼-inch I.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								AC	3 inches asphalt concrete			
120									CR	8 to 10 inches base course, 5/8-inch minus crushed rock			
									SM	Brown silty fine to medium sand with occasional gravel and rubble or boulders (medium dense to dense, moist) (fill)			
			12	50/6"		1							
	5												
115													
			12	25		2							
									SP-SM	Brown fine to medium sand with silt and gravel (dense, moist)			
	10												
110													
			10	61		3					4		%F = 8.6
	15												
105									SP-SM	Brown fine to medium sand with silt and occasional gravel (loose, moist) (recessional outwash)			
			16	33		4					17		SA; %F = 7
	20												
100													
			14	84		5							

Note: Please see Figure A-1 for explanation of symbols

Log of Boring B-1C

GEOENGINEERS

Project: City of Arlington
Project Location: Arlington, Washington
Project Number: 05430-007-00

Figure A-4
Sheet 1 of 1

Redmond: Date:9/12/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\54300700.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 8/29/2012	End 8/29/2012	Total Depth (ft) 24	Logged By JQS	Checked By	Driller Geologic	Drilling Method
Surface Elevation (ft) Vertical Datum	124.0 (Approximate)		Hammer Data	Auto 140 (lbs) / 30 (in) Drop		Drilling Equipment	Deep Rock XL
Easting (X) Northing (Y)			System Datum			Groundwater Date Measured	Depth to Water (ft) / Elevation (ft)

Notes: Auger Data: 3¼-inch I.D.

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								SM	Brown silty fine to medium sand with occasional gravel, organic matter and cobbles (medium dense, moist) (fill)			Drilling action indicates large gravels or cobbles
120			12	27		1							
	5												Rough drilling
									SW	Brown fine to coarse sand with trace silt and occasional gravel (medium dense, moist)	6		Rough drilling %F = 35
115			10	30		2							
	10								ML/SM	Dark brown silt with sand to silty fine to medium sand with occasional gravel (soft/loose, wet)			
110			10	4		3					28		
	15								SP-SM	Brown fine to coarse sand with silt and gravel (medium dense to dense, moist) (recessional outwash)			Driller notes larger gravels
105			13	43		4					6		SA; %F = 10
	20								SM	Brown silty fine to medium sand (medium dense, moist)			
100			5	30		5							Little recovery, with gravel?

Note: Please see Figure A-1 for explanation of symbols

Log of Boring B-2

GeoEngineers

Project: City of Arlington
Project Location: Arlington, Washington
Project Number: 05430-007-00

Figure A-5
Sheet 1 of 1

Redmond: Date:9/12/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\54300700.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 8/29/2012	End 8/29/2012	Total Depth (ft) 24	Logged By JQS	Checked By	Driller Geologic	Drilling Method
Surface Elevation (ft) Vertical Datum	121.0 (Approximate)		Hammer Data	Auto 140 (lbs) / 30 (in) Drop		Drilling Equipment	Deep Rock XL
Easting (X) Northing (Y)			System Datum			Groundwater Date Measured	Depth to Water (ft) / Elevation (ft)
Notes: Auger Data: 3¼-inch I.D.						8/29/2012	19.0 / 102.0

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0							SM	Brown silty fine to medium sand with occasional gravel (loose, moist) (fill?)			
120		12	13		1			SP-SM	Brown silty fine to medium sand with gravel (loose to medium dense, moist) (fill?)			Driller notes large gravels at approximately 2 to 2.5 feet
	5											
115		14	50/5"		2			SM	Brown silty fine to medium sand with gravel (medium dense to dense, moist) (fill?)	3.3		Driller notes gravels %F = 9
	10											
110		1	50		3			SM	Dark brown silty fine to medium sand (medium dense to dense, moist)			Little recovery
	15											
105		16	39		4			SM	Brown silty fine to medium sand with trace gravel (medium dense to dense, moist) (recessional outwash)	5.4		SA; %F = 13
	20											
100								SP	Gray-brown fine to medium sand with trace silt, occasional gravel and occasional lenses of silt (dense, moist to wet)			
		18	54		5							

Note: Please see Figure A-1 for explanation of symbols

Log of Boring B-3

GEOENGINEERS

Project: City of Arlington
Project Location: Arlington, Washington
Project Number: 05430-007-00

Figure A-6
Sheet 1 of 1

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Drilled	Start 8/29/2012	End 8/29/2012	Total Depth (ft) 24	Logged By JQS	Checked By	Driller Geologic	Drilling Method
Surface Elevation (ft) Vertical Datum	128.0 (Approximate)		Hammer Data	Auto 140 (lbs) / 30 (in) Drop		Drilling Equipment	Deep Rock XL
Easting (X) Northing (Y)			System Datum			Groundwater	
Notes: Auger Data: 3¼-inch I.D.						Date Measured 8/29/2012	Depth to Water (ft) 9.0 / Elevation (ft) 119.0

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0						SOD	3 inches sod			
							SM	Light brown silty fine to medium sand with gravel, cobbles and occasional organics (loose, moist) (fill)			
125		5	18	1				Grades to darker brown			
	5						SP-SM	Brown fine to medium sand with silt and gravel (medium dense, moist) (recessional outwash)			
120		12	20	2	▽				7.9		Driller notes gravel at 7.5 feet %F = 8
	10						SW-SM	Gray fine to coarse sand with silt and gravel (medium dense, wet)			
115		12	27	3					11		SA; %F = 8
	15						SM	Brown silty fine to coarse sand with gravel (medium dense to dense, wet)			
110		14	51	4							
	20										
105		12	34	5							

Note: Please see Figure A-1 for explanation of symbols

Log of Boring B-4

GEOENGINEERS

Project: City of Arlington
Project Location: Arlington, Washington
Project Number: 05430-007-00

Figure A-7
Sheet 1 of 1

Redmond: Date:9/12/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\54300700.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled	Start 8/29/2012	End 8/29/2012	Total Depth (ft) 24	Logged By JQS	Checked By	Driller Geologic	Drilling Method
Surface Elevation (ft) Vertical Datum	122.0 (Approximate)		Hammer Data	Auto 140 (lbs) / 30 (in) Drop		Drilling Equipment	Deep Rock XL
Easting (X) Northing (Y)			System Datum			Groundwater	
Notes: Auger Data: 3¼-inch I.D.						Date Measured 8/29/2012	Depth to Water (ft) 22.5 / Elevation (ft) 99.5

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0								SOD	4 inches sod			
									SM	Brown silty fine to medium sand with gravel and trace organics (medium dense, dry to moist) (fill)			
120			4	17		1							
	5												
									SP	Gray-brown fine to medium sand with trace silt and occasional gravel (medium dense, moist) (recessional outwash)			
115			10	19		2					5.5		%F = 4
	10												
110			10	35		3			SW-SM	Grayish brown fine to coarse sand with silt and gravel to sandy gravel with silt (medium dense, moist)	6.5		SA; %F = 7
	15												
105			12	35		4				Grades to brown in color			
	20												
100			17	15		5			SP-SM	Brown fine to medium sand with silt (medium dense, wet)			

Note: Please see Figure A-1 for explanation of symbols

Log of Boring B-5

GEOENGINEERS

Project: City of Arlington
Project Location: Arlington, Washington
Project Number: 05430-007-00

Figure A-8
Sheet 1 of 1

Redmond: Date:9/12/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\54300700.GPJ DBTemplate/LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

General

Soil samples obtained from the explorations were transported to GeoEngineers' laboratory and examined to confirm or modify field classifications, as well as to evaluate index properties of the soil samples. Representative samples were selected for laboratory testing consisting of the determination of the moisture content, percent fines, and grain size distribution. The tests were performed in general accordance with test methods of the American Society for Testing and Materials (ASTM) or other applicable procedures.

The results of the moisture content and percent fines determinations are presented at the respective sample depths on the exploration logs in Appendix A. The sieve analyses test results are presented in Figures B-1 and B-2.

Moisture Content Testing

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented on the exploration logs in Appendix A at the depths at which the samples were obtained.

Percent Passing U.S. No. 200 Sieve

Selected samples were "washed" through the U.S. No. 200 mesh sieve to determine the relative percentages of coarse- and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted to verify field descriptions and to determine the fines content for analysis purposes. The tests were conducted in general accordance with ASTM D 1140, and the results are shown on the exploration logs in Appendix A at the respective sample depths.

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS).

5430-007-00 SAS: SAS 09-06-2012

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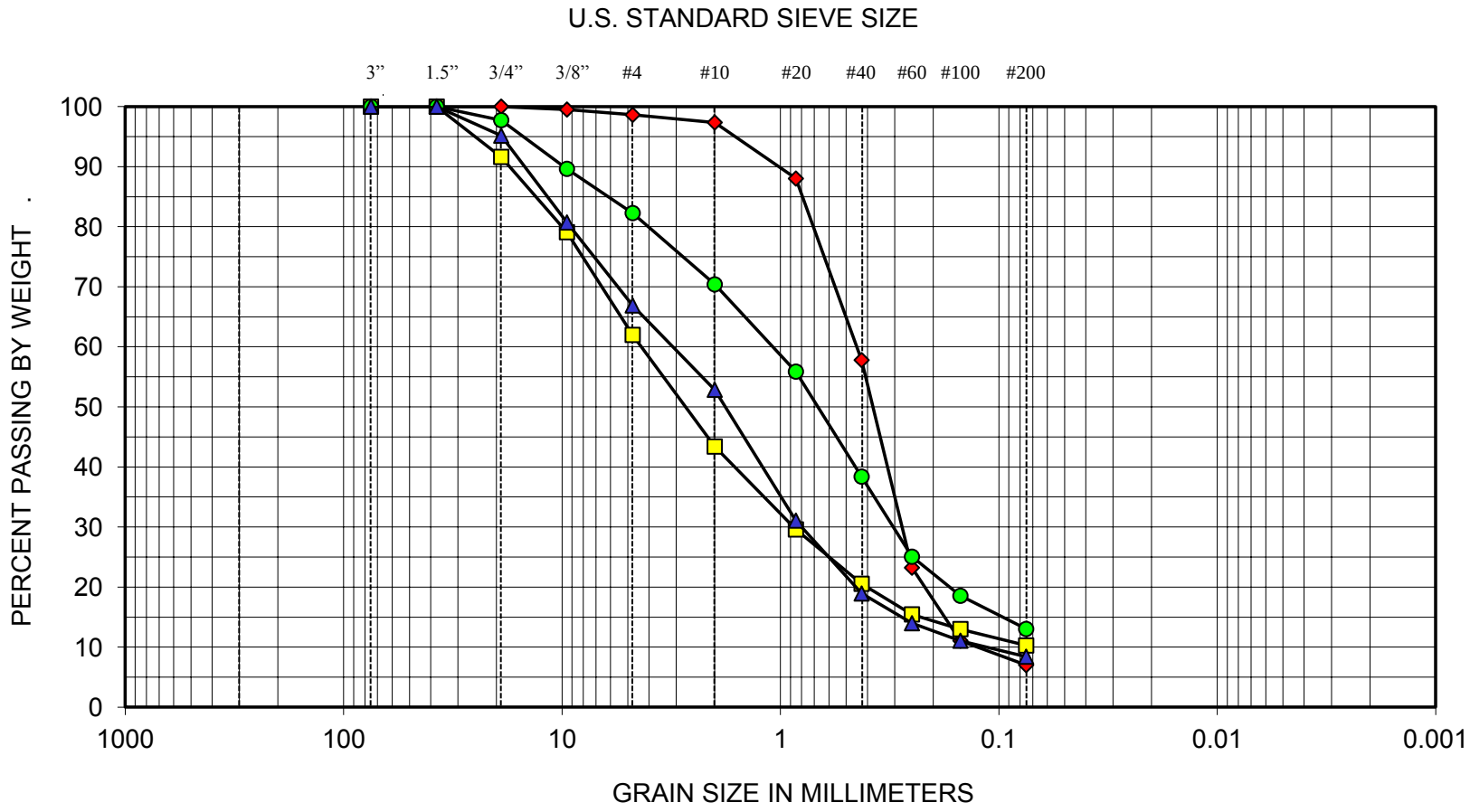

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	B-1c	17½	Brown fine to medium sand with silt (SP-SM)
■	B-2	17½	Brown fine to course sand with silt and gravel (SP-SM)
●	B-3	17½	Brown silty fine to medium sand with gravel (SM)
▲	B-4	12½	Gray fine to course sand with silt and gravel (SW-SM)

SIEVE ANALYSIS RESULTS

FIGURE B-1

5430-007-00 SAS: SAS 09-06-2012

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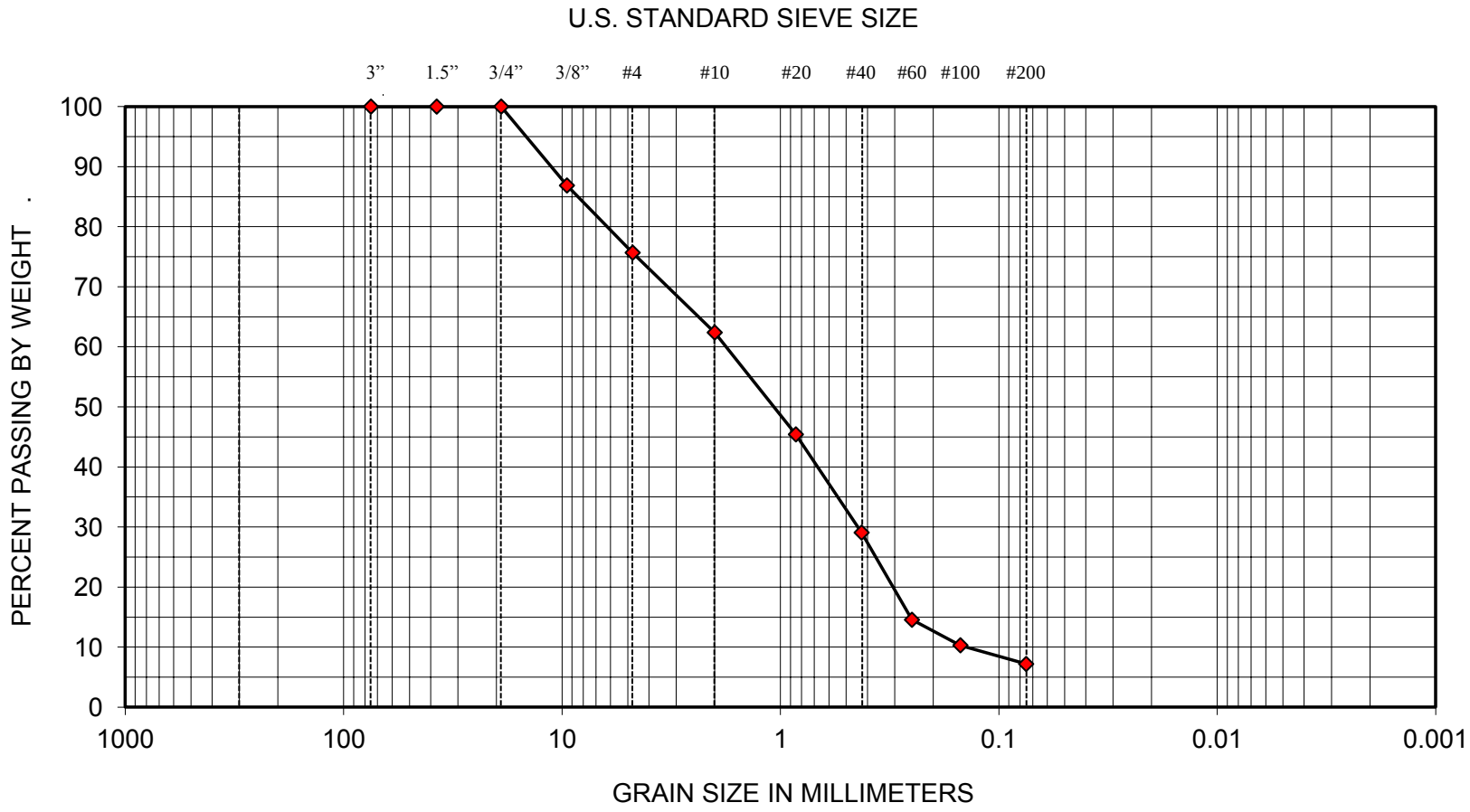

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	B-5	17½	Grayish brown fine to course sand with silt and gravel (SW-SM)

SIEVE ANALYSIS RESULTS

FIGURE B-2

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This attachment provides information to help you manage your risks with respect to the use of this report.

Geotechnical Services Are Performed For Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of The City of Arlington, Murray, Smith & Associates, Inc. and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

A Geotechnical Engineering Or Geologic Report Is Based On A Unique Set Of Project-Specific Factors

This report has been prepared for the proposed Prairie Creek Drainage Improvement project in Arlington, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

Subsurface Conditions Can Change

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

Most Geotechnical And Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Geotechnical Engineering Report Recommendations Are Not Final

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

A Geotechnical Engineering Or Geologic Report Could Be Subject To Misinterpretation

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

Do Not Redraw The Exploration Logs

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

Give Contractors A Complete Report And Guidance

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

Contractors Are Responsible For Site Safety On Their Own Construction Projects

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

Read These Provisions Closely

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical, Geologic And Environmental Reports Should Not Be Interchanged

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

APPENDICES

Type Name of Services Here

Name of Project Here

for

Type Client Name Here

Type Date of Report Here

GeoEngineers

Earth Science + Technology

APPENDIX B

MODELING METHODOLOGY TECHNICAL MEMORANDUM

Murray, Smith & Associates, Inc.
Engineers/Planners
2707 Colby Avenue, Suite 1110 ■ Everett, WA 98201-3566 ■ PHONE 425.252.9003 ■ FAX 425.252.8853

TECHNICAL MEMORANDUM

DATE: August 28, 2012

PROJECT: 12-1347.103

TO: James Kelly, P.E. - Public Works Director, City of Arlington

FROM: Nathan Hardy, P.E. - Murray, Smith & Associates, Inc.
Ken McIntyre, P.E. - Murray, Smith & Associates, Inc.
Saurabh Thapar - Murray, Smith & Associates, Inc.

RE: City of Arlington, Prairie Creek Drainage Improvement Project
Preliminary Modeling Methodology

Introduction and Background

Recent land development activity and altered stream routing in the Prairie Creek drainage basin has increased the stormwater runoff rates and subsequent stream flow in Prairie Creek. This increased flow has caused flooding impacts to important and growing businesses within the City of Arlington (City) due to numerous undersized culverts. The City's Comprehensive Stormwater Plan (Stormwater Plan), dated October 2010, identified the following undersized culverts in five problem areas in the Prairie Creek 5th Tier Basin, which consists of a total of six culverts:

- 67th Avenue (Problem 29): Culvert replacement design completed under a separate contract
- Burlington Northern Santa Fe (BNSF) Railroad and 69th Avenue (Problem 30): Two existing culverts
- 204th Street (Problem 31)
- 71st Avenue (Problem 33)
- 74th Avenue (Problem 35)

The City has authorized Murray, Smith and Associates, Inc. (MSA) to provide engineering services for a two phase work program to reduce the risk of local flooding impacts and

improve the drainage and function of Prairie Creek. The first phase of the engineering services will include development of a hydrologic basin model, a hydraulic stream routing model and preparation of a preliminary design memorandum. The memorandum will include recommendations for interim drainage improvement to be implemented in the fall of 2012, as well as a proposed approach and phasing recommendations for the replacement of up to five culverts to improve the drainage of the Prairie Creek.

Purpose

This Preliminary Modeling Methodology technical memorandum presents the City with MSA's general approach for the hydrologic and hydraulic modeling. The hydrologic model will be used to confirm and refine the basin runoff results from the City's 2010 Final Stormwater Comprehensive Plan, and define the individual sub-basin areas tributary to each of the culverts being analyzed. The hydraulic model will use the flows from the hydrologic model to determine interim drainage improvements and the culvert sizes necessary to provide sufficient hydraulic capacity, and meet fish passage requirements established by the Washington Department of Fish and Wildlife (WDFW). The preliminary design report will address the following task-list items identified in the scope of work:

1. Analyze the effects of replacing culverts in all five of the identified problem areas.
2. Analyze the effects of replacing only the 204th Street, 71st Avenue, and 74th Avenue culverts.
3. Identify critical locations where culverts must be replaced prior to others in order to improve drainage throughout the basin.
4. Identify potential interim flood mitigation solutions with a HEC-RAC analysis prior to culvert replacements.

Stormwater Methodology Discussion

Hydrologic Basin Analysis

The first step in the hydrologic analysis will be a delineation of the tributary basins. This will include a confirmation of the overall Prairie Creek 5th Tier basin limits, as well as determining the limits of the individual sub-basins tributary to each culvert being analyzed. The existing hydrologic model, aerial photos, GIS data, and LiDAR information will be studied to analyze topography and determine conveyance routes within the tributary basin area. City zoning information will be confirmed to determine the anticipated land use characteristics representing full build-out of the tributary basin.

The City has adopted the Washington State Department of Ecology's <u>2005 Stormwater Management Manual for Western Washington</u> (DOE Manual), as the governing document for hydrologic analyses and stormwater facility design. Volume III of the DOE Manual calls for basin planning to be performed with a continuous simulation hydrologic model. However, continuous simulation models are primarily calibrated for smaller basins, and do not account for routing effects of localized conveyance channels within larger watersheds.

The DOE Manual recommends the use of a locally calibrated HSPF model or other hydrologic models for basins exceeding 320 acres. A locally calibrated HSPF model has not been developed for the City of Arlington, or within the local watershed, so the analysis will be performed using the Santa Barbara Urban Hydrograph (SBUH) method. This is consistent with other recent studies in the area, including the city's current Stormwater Comprehensive Plan.

The SBUH model will analyze the individual sub-basins tributary to each of the culvert crossings in question, and will assume full build-out conditions for the tributary area in order to estimate the maximum anticipated future flow rates. Land use characteristics will be estimated, using current zoning code provisions as a guideline. Figure 1, attached, presents the Prairie Creek basin area with the corresponding City and Snohomish County zoning.

Arlington Municipal Code (AMC) section 20.48.064(b) specifies a 40% maximum impervious coverage for lots within the residential zones in the Prairie Creek watershed. This includes building coverage, driveways, patios, and all other impervious surface areas. Snohomish County Code (SCC) 30.23.030 specifies a maximum building coverage of 30%-35% for the residential zones found within the Prairie Creek watershed. Driveway, walkway, and patio areas are not accounted for in the County's zoning standards, and must be considered in addition to the building coverage. With this in mind, unincorporated residential zones will be assumed to be 40% impervious, which is consistent with the City's regulations, and accounts for the addition of driveway/patio area on each lot. For all residential areas, an additional 10% impervious coverage will be added to the allowable lot coverage, to account for roadways and sidewalks within the public rights-of-way.

There are no impervious coverage limitations for commercial or industrial areas within the AMC or SCC. However, there are typically small landscape/lawn components in these areas. As such, all commercial/industrial areas will be assumed to have 90% impervious coverage. In addition to residential and commercial zones, the City has designated a "Public/Semi-Public" zone. The AMC specifies that the land cover conditions in this zone should be the same as the surrounding zones, so the appropriate adjacent characteristics will be assumed.

There is a City-owned parcel between 74th Ave NE and SR-9, which will likely be utilized for wetland mitigation and stormwater management purposes in the future. This parcel will not be developed in the future, so rather than using the land cover assumptions for the underlying zone, this parcel will be assumed to be 50% forest and 50% pasture, which appears to be the apparent coverage, based on aerial photos and a recent site visit. Similarly, the GlenEagle golf course is located within a residential zone, but is not expected to be further developed. The golf course will be assumed to remain in a landscape/lawn condition.

Land cover assumptions are summarized in the following table:

Land Cover Assumptions				
	Impervious Coverage	Landscape/ Lawn Coverage	Pasture Coverage	Forest Coverage
Commercial & Industrial Zones	90%	10%	0%	0%
Residential Zones	50%	50%	0%	0%
GlenEagle Golf Course	0%	100%	0%	0%
Native Wetland Tract	0%	0%	50%	50%

In addition to the land coverage assumptions, the SBUH model will also account for variability in local soil conditions. MSA will obtain soil survey resource mapping information from the Natural Resources Conservation Service (NRCS) and classify the mapped soil regions based on infiltration potential.

The flow rates that are generated by the hydrologic basin analysis will be utilized in a HEC-RAS hydraulic model to determine the stream flow characteristics, interim drainage improvements, and required culvert dimensions.

Hydraulic Model Construction

MSA will utilize the U.S. Army Corps of Engineers River Analysis System (HEC-RAS) program developed by the Hydrologic Engineering Center to perform open channel flow analysis for Prairie Creek.

Surveying data will be incorporated into the HEC-RAS program. The survey is currently being conducted by Metron and Associates, Inc., subconsultant to MSA, beginning at the confluence point of the two upper forks of Prairie Creek to the downstream confluence point with Portage Creek. A small portion of Portage Creek consisting of approximately 100 feet upstream and downstream of the confluence point with Prairie Creek is also being surveyed and will be included in the HEC-RAS hydraulic model. The survey is being conducted to establish the topographic elements for both the creeks necessary to perform the hydraulic modeling analysis, including channel geometry and cross-sections. The HEC-RAS hydraulic model will comprise of the following components:

- Approximately 5,400 feet of the lower reach of Prairie Creek alignment, beginning at the point of confluence with Portage Creek and continuing upstream to the confluence point of the two upper forks of Prairie Creek.
- A small portion of Portage Creek consisting of approximately 100 feet upstream and downstream of the confluence point with Prairie Creek.
- Approximately 54 cross-sections along Prairie Creek alignment incorporated at 100 feet intervals. The cross-section data will consist of X and Y values representing the

distance along the creek and the corresponding elevation, respectively. The cross-section data will extend approximately 25 feet beyond the left and right banks of the creek.

Hydraulic Modeling Analysis

The HEC-RAS hydraulic modeling analysis will be performed to help identify recommendations for interim drainage improvements, appropriately size the future culvert replacements as well as to identify the impacts to Prairie Creek from implementing interim drainage improvements as well as replacing some or all of the culverts in the identified problem areas.

Steady flow hydraulic analysis will be performed to determine various elements of open channel flow along Prairie Creek as well as at the confluence point with Portage Creek. The HEC-RAS program uses an iterative process to compute the water surface elevation at each cross-section by performing one-dimensional steady flow analysis for gradually varied flow. The one-dimensional steady flow component of the HEC-RAS program will be utilized to evaluate steady flow water surface profiles for the natural open channel portions of the creek as well as the culverts.

Boundary Conditions for Hydraulic Modeling Analysis

1. ***Base Flow -*** As identified by City staff, irrigation water from the GlenEagle Golf Course represents a portion of the base flow within Prairie Creek, in addition to the variable stormwater runoff flows. Base flowrates in Prairie Creek will be established from the following information:
    - Historical stream gage records
    - Irrigation/pumping records from GlenEagle Golf Course
    - Surveyed water surface elevations

2. ***Design Storm -*** Steady flow hydraulic analysis will be performed for the 2-year and 100-year storm events. The 100-year storm event will be utilized to size the culverts, whereas the 2-year storm event will be analyzed to ensure that the stream flow meets the criteria for fish passage. The boundary conditions for the steady flow hydraulic analysis will be established by injecting the 2-year and 100-year storm flow rates, generated by the hydrologic analysis, upstream of each culvert.

3. ***Sedimentation -*** The impact of sediment deposit within the culverts will be evaluated by assuming 6 inches of sediment settlement in the culverts. The accumulation of sediments will be only considered in the culverts and not in the natural sections of the creek. Sediment deposit analysis will not consider the sediment transport but will only analyze the hypothetical effect of sediment accumulation inside the culverts.

Fish Passage Considerations

Prairie Creek has been identified as a fish-bearing stream, requiring that each of the proposed culverts to provide fish passage opportunities, subject to the Washington Department of Fish & Wildlife (WDFW) regulations. Field survey data and detailed site information and topography for the existing culverts and nearby stream reaches will be evaluated to determine the appropriate method of fish-passage culvert design. The WDFW offers three design options for fish-passage culvert design depending on the conditions that exist at each culvert location. The site conditions at these locations will be analyzed to select the appropriate WDFW design option.

NPH:kjm

Attachment

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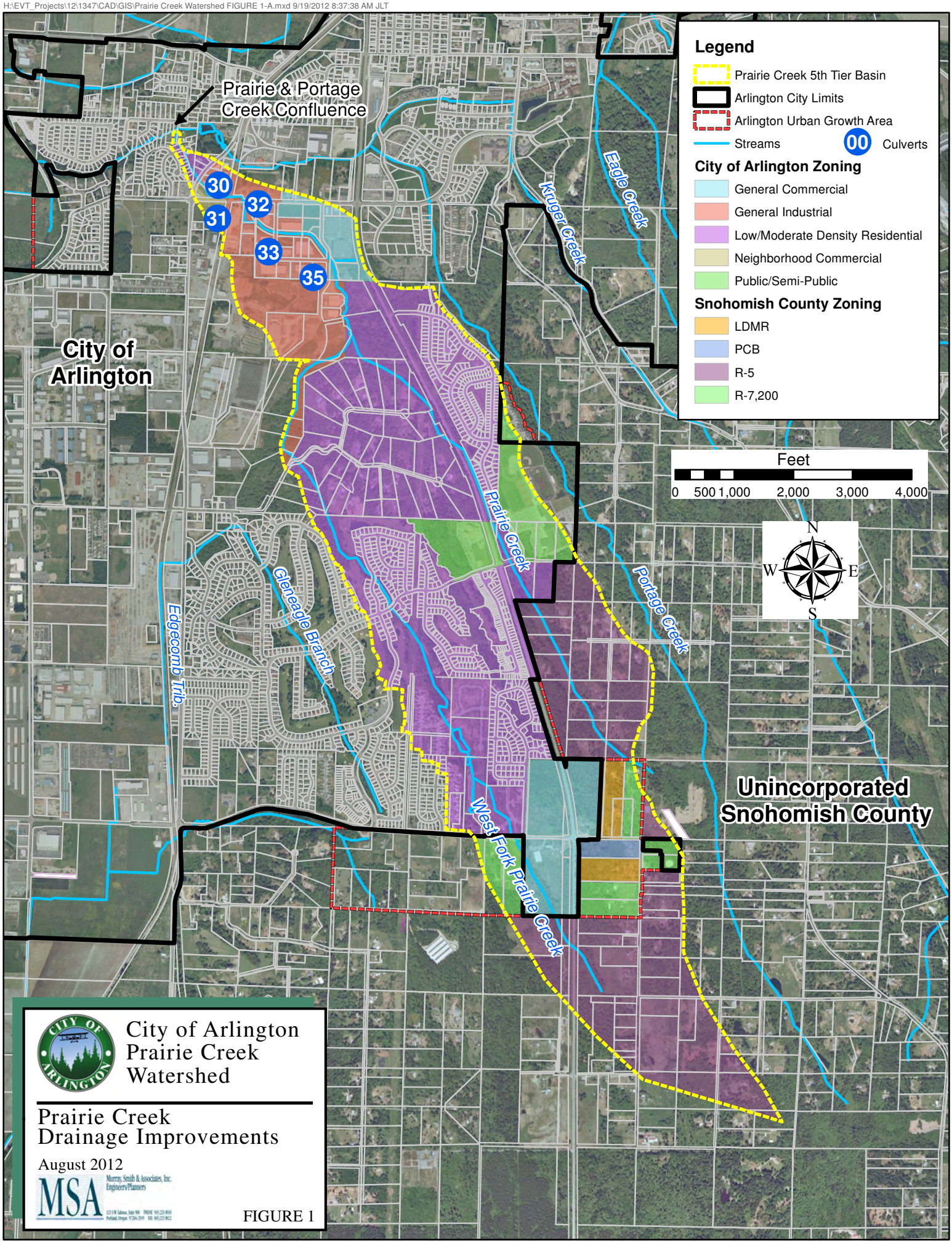


City of Arlington
Prairie Creek
Watershed

Prairie Creek
Drainage Improvements

August 2012

MSA Murray, Smith & Associates, Inc. Engineers/Planners

FIGURE 1

APPENDIX C

MODELING RESULTS

HYDROLOGIC MODEL

Hydrologic modeling was performed using the Santa Barbara Urban Hydrograph (SBUH) method. This methodology analyzes of a number of contributing factors to estimate the peak runoff rates for a given storm event. Once the peak runoff rates are determined, they are entered into the hydraulic stream model to determine the hydraulic response of the stream during a given storm event.

The SBUH model for this project utilized a Type 1A rainfall distribution, adjusted for the Puget Sound region. Tabular rainfall distribution data was obtained from the Washington State Department of Ecology's Stormwater Management Manual for Western Washington , 2001 edition (DOE Manual). Rainfall intensities for the 2-year, 10-year, and 100-year storm events were derived from isopluvial maps, obtained from the same manual and included as Exhibit C1 in this appendix.

Underlying soil conditions and land cover characteristics were analyzed to derive runoff curve numbers for use in the SBUH model. The runoff curve numbers are used to represent the amount of rainfall that is shed as surface runoff, as opposed to being lost to evaporation or infiltration. Soil conditions were obtained from the NRCS Soil Survey for Western Washington, and are identified in Exhibit C2 of this appendix. The underlying soils within the Prairie Creek watershed are further classified as being either 'Outwash' or 'Till' soils. Outwash soils can be generally described as having a gravelly or sandy consistency, with some capacity for infiltration. All of the outwash soils in this watershed are categorized as being within SCS Hydrologic Soil Group 'A' for the SBUH Analysis. Till soils are generally described as having a highly consolidated or hardpan consistency, with little infiltration capacity. Nearly all of the underlying till soil in this watershed are classified within Hydrologic Soil Group 'C'.

Land cover characteristics for the SBUH analysis were determined from the zoning designations for the parcels within the watershed. A detailed discussion of the land cover assumptions within each zone is provided in Appendix 'B'. Zoning information was obtained from the City of Arlington's GIS database, and has been summarized in Exhibit C3 of this appendix. The combined zoning and soils characteristics used to derive the SBUH runoff curve numbers is provided in Exhibit C4 of this appendix, and a summary of the SBUH input parameters is provided in Exhibit C5.

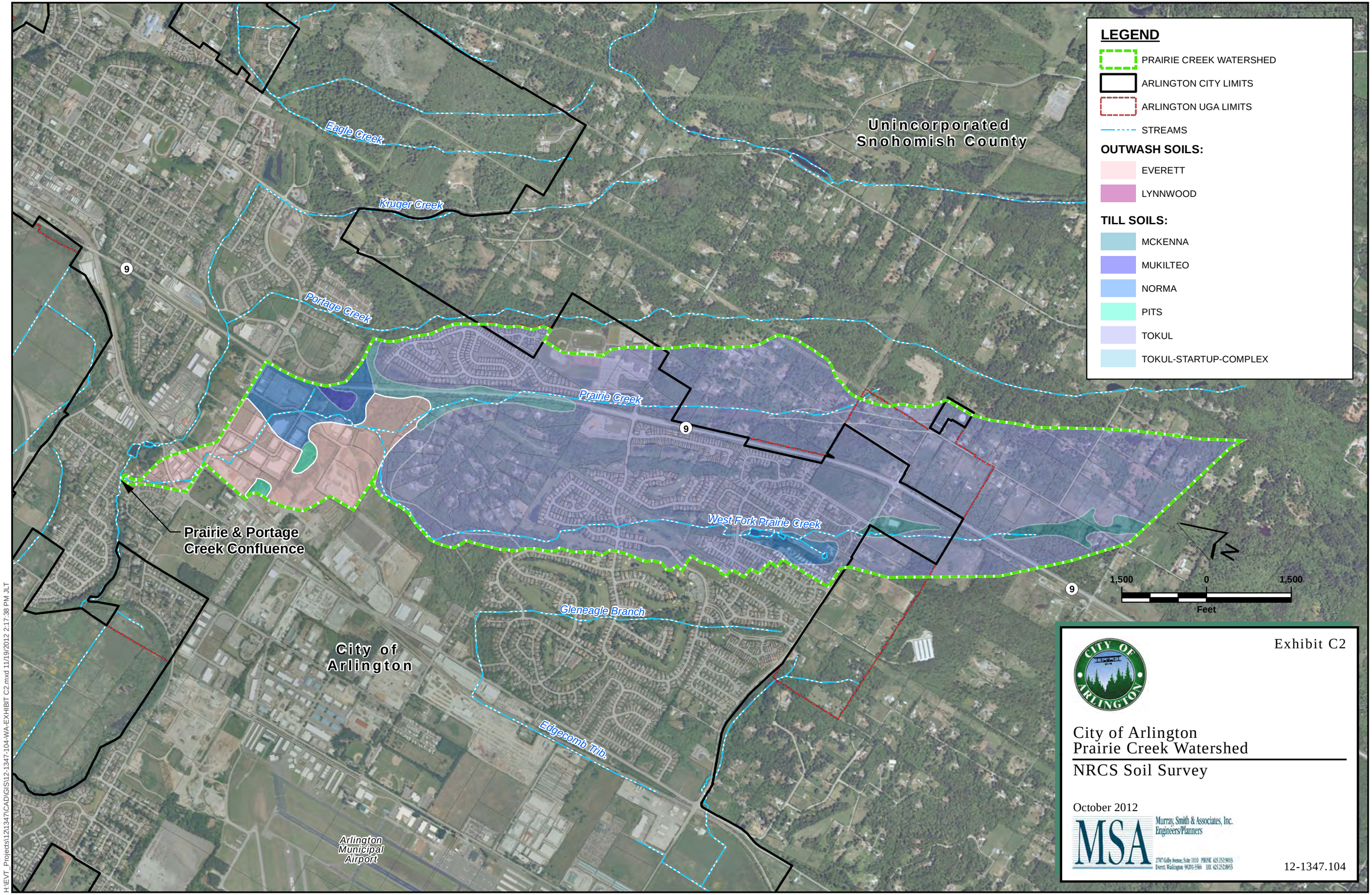
The goal of the overall drainage model is to analyze the hydraulic response of Prairie Creek at and near five specific culvert locations. To that end, the Prairie Creek watershed has been divided into seven distinct drainage basins. The model begins with a "Headwater" basin, which is tributary to that portion of Prairie Creek within the project study area. Five additional basins were defined, representing the basins tributary to each of the specific culverts being analyzed. One final basin was created to represent the area tributary to the confluence point of Prairie and Portage Creeks. This was performed to determine if flooding occurs at the confluence point, or if a tailwater condition at that point propagates up the Prairie Creek stream channel. SBUH calculations for each of these basins are included in Exhibit C6 of this appendix, and were performed using spreadsheets consistent with the

methodology outlined in Section 2.3.3 of the 2001 DOE Manual. Each spreadsheet calculates the full 24-hour design storm event, and extracts the peak flowrate. The input parameters and peak flowrate are reported on the first page of each SBUH spreadsheet calculation.

HYDRAULIC MODEL

Hydraulic modeling was performed using the Army Corps of Engineers' HEC-RAS hydraulic analysis software. Topographic characteristics of the stream channel were derived from a recent survey, and flowrates were obtained from the hydrologic model. A more detailed explanation of the hydraulic model can be found in Appendix 'B'.

Exhibit C7 of this appendix provides HEC-RAS profiles of the existing conditions, and each of the potential design alternatives described in Section 5 of this report.



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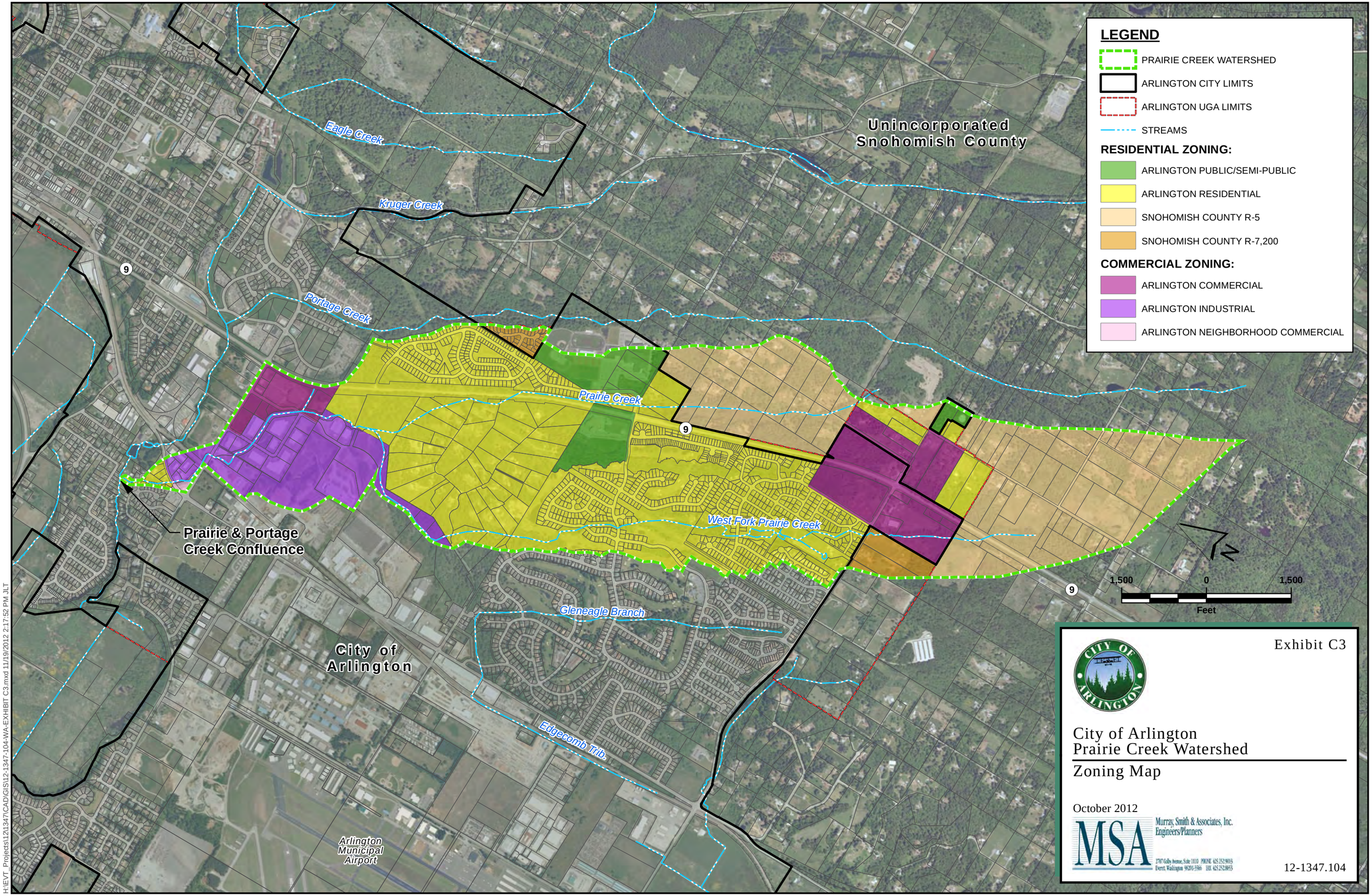

Exhibit C3

City of Arlington
Prairie Creek Watershed

Zoning Map

October 2012

Murray, Smith & Associates, Inc.
Engineers/Planners

12-1347.104

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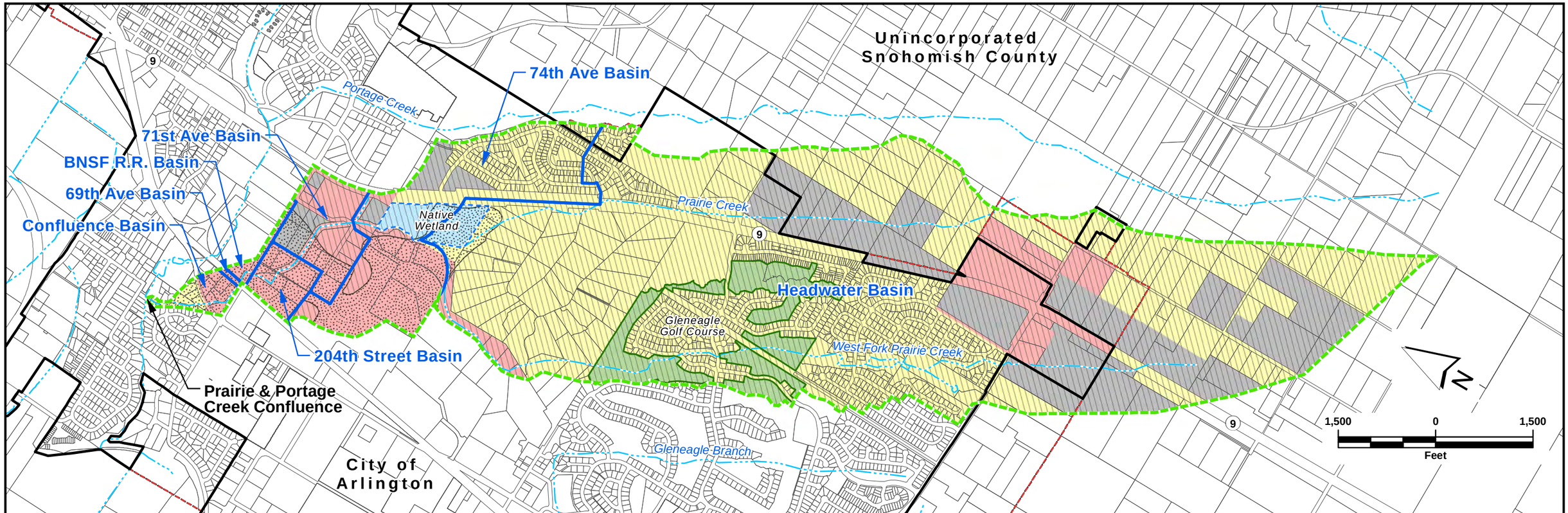

LEGEND

- PRAIRIE CREEK WATERSHED
- BASIN BOUNDARY
- ARLINGTON CITY LIMITS
- ARLINGTON UGA LIMITS
- UNDEVELOPED AREAS
- GOLF COURSE
- NATIVE WETLANDS
- STREAMS

SOIL TYPE:

- OUTWASH SOILS
- TILL SOILS

ZONING:

- COMMERCIAL
- RESIDENTIAL

PRAIRIE CREEK WATERSHED HYDROLOGIC CHARACTERISTICS

Headwater Basin Area			
Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	5.97 ac	657.52 ac	663.49 ac
Commercial (Assume 90% Impervious, 10% Grass)	0.77 ac	68.84 ac	69.61 ac
Native Wetland (Assume 50% Forest & 50% Pasture)	7.68 ac	0.00 ac	7.68 ac
Golf Course (Assume 100% grass)	0.00 ac	61.89 ac	61.89 ac
Undeveloped Parcels (Grass) (Assume 100% grass)	0.00 ac	61.18 ac	61.18 ac
Undeveloped Parcels (Forest) (Assume 100% forest)	0.00 ac	144.66 ac	144.66 ac
Total Basin Area			1008.51 ac

Basin Tributary to 74th Ave Culvert			
Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.64 ac	53.27 ac	53.91 ac
Commercial (Assume 90% Impervious, 10% Grass)	45.79 ac	10.44 ac	56.23 ac
Native Wetland (Assume 50% Forest & 50% Pasture)	2.89 ac	7.30 ac	10.19 ac
Undeveloped Parcels (Grass) (Assume 100% grass)	0.00 ac	2.43 ac	2.43 ac
Undeveloped Parcels (Forest) (Assume 100% forest)	0.00 ac	13.82 ac	13.82 ac
Total Basin Area			136.58 ac

Basin Tributary to 71st Ave Culvert			
Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	12.34 ac	19.88 ac	32.22 ac
Undeveloped Parcels (Grass) (Assume 100% grass)	0.00 ac	6.60 ac	6.60 ac
Undeveloped Parcels (Forest) (Assume 100% forest)	0.00 ac	0.00 ac	0.00 ac
Total Basin Area			38.82 ac

Basin Tributary to 204th Street Culvert			
Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	17.55 ac	0.00 ac	17.55 ac
Total Basin Area			17.55 ac

Basin Tributary to BNSF RR Culvert			
Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	3.95 ac	0.22 ac	4.17 ac
Total Basin Area			4.17 ac

Basin Tributary to 69th Ave Culvert			
Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	0.75 ac	0.00 ac	0.75 ac
Total Basin Area			0.75 ac

Basin Tributary to Confluence Point			
Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	4.70 ac	0.00 ac	4.70 ac
Commercial (Assume 90% Impervious, 10% Grass)	6.59 ac	0.00 ac	6.59 ac
Total Basin Area			11.29 ac

Exhibit C4.1

City of Arlington
Prairie Creek Watershed

Existing Hydrologic Characteristics

October 2012

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Everett, Washington 98201-5966 FAX 425.252.8853

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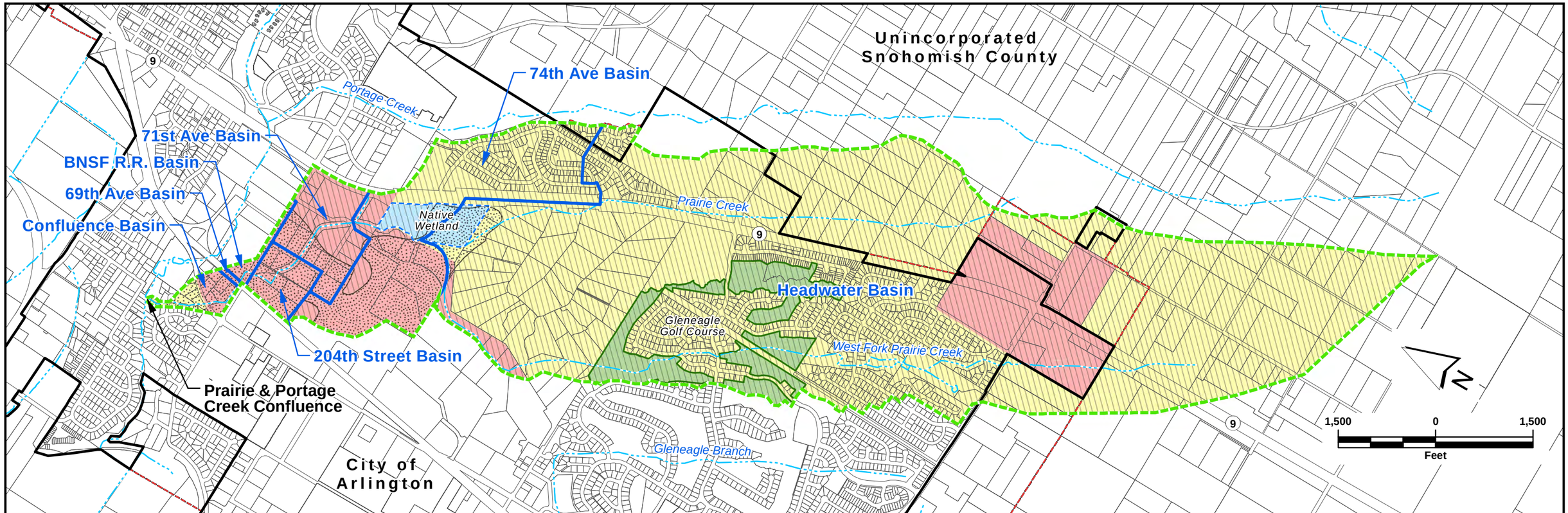

LEGEND

- PRAIRIE CREEK WATERSHED
- BASIN BOUNDARY
- ARLINGTON CITY LIMITS
- ARLINGTON UGA LIMITS
- GOLF COURSE
- NATIVE WETLANDS
- STREAMS

SOIL TYPE:

- OUTWASH SOILS
- TILL SOILS

ZONING:

- COMMERCIAL
- RESIDENTIAL

PRAIRIE CREEK WATERSHED HYDROLOGIC CHARACTERISTICS

Headwater Basin Area

Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	5.97 ac	825.29 ac	831.26 ac
Commercial (Assume 90% Impervious, 10% Grass)	0.77 ac	106.91 ac	107.68 ac
Native Wetland (Assume 50% Forest & 50% Pasture)	7.68 ac	0.00 ac	7.68 ac
Golf Course (Assume 100% grass)	0.00 ac	61.89 ac	61.89 ac
Total Basin Area			1008.51 ac

Basin Tributary to 74th Ave Culvert

Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.64 ac	67.09 ac	67.73 ac
Commercial (Assume 90% Impervious, 10% Grass)	45.79 ac	12.87 ac	58.66 ac
Native Wetland (Assume 50% Forest & 50% Pasture)	2.89 ac	7.30 ac	10.19 ac
Total Basin Area			136.58 ac

Basin Tributary to 71st Ave Culvert

Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	14.67 ac	24.15 ac	38.82 ac
Total Basin Area			38.82 ac

Basin Tributary to 204th Street Culvert

Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	17.55 ac	0.00 ac	17.55 ac
Total Basin Area			17.55 ac

Basin Tributary to BNSF RR Culvert

Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	3.95 ac	0.22 ac	4.17 ac
Total Basin Area			4.17 ac

Basin Tributary to 69th Ave Culvert

Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	0.00 ac	0.00 ac	0.00 ac
Commercial (Assume 90% Impervious, 10% Grass)	0.75 ac	0.00 ac	0.75 ac
Total Basin Area			0.75 ac

Basin Tributary to Confluence Point

Per GIS Mapping	Outwash	Till	Total
Residential (Assume 50% Impervious, 50% Grass)	4.70 ac	0.00 ac	4.70 ac
Commercial (Assume 90% Impervious, 10% Grass)	6.59 ac	0.00 ac	6.59 ac
Total Basin Area			11.29 ac

Exhibit C4.2

City of Arlington
Prairie Creek Watershed

Prairie Creek Hydrologic Characteristics
Full Build-Out

October 2012

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12-1347.104

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Murray, Smith & Associates, Inc. Engineers/Planners	Project: **Prairie Creek Drainage Improvements**	Calc. By: **KJM**	Date: **10/26/2012**
	Project No: **12-1347.104**	Check By:	Date:
	Description: **SBUH Input Parameters (Existing Conditions**	Backcheck By:	Date:

Headwater Basin Area			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	5.97 ac	657.52 ac	663.49 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	0.77 ac	68.84 ac	69.61 ac
Native Wetland *(Assume 50% Forest & 50% Pasture)*	7.68 ac	0.00 ac	7.68 ac
Golf Course *(Assume 100% grass)*	0.00 ac	61.89 ac	61.89 ac
Undeveloped Parcels (Grass) *(Assume 100% grass)*	0.00 ac	61.18 ac	61.18 ac
Undeveloped Parcels (Forest) *(Assume 100% forest)*	0.00 ac	144.66 ac	144.66 ac
Total Basin Area			***1008.51 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	3.84 ac (CN=30)	144.66 ac (CN=70)	*148.50 ac* (CN=68.97)
Pasture Area	3.84 ac (CN=39)	0.00 ac (CN=74)	*3.84 ac* (CN=39.00)
Lawn Area	3.06 ac (CN=68)	458.71 ac (CN=86)	*461.78 ac* (CN=85.88)
Total Area			***614.12 ac (CN=81.50)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	3.68 ac (CN=98)	390.72 ac (CN=98)	*394.40 ac* (CN=98.00)
Total Area			***394.40 ac (CN=98.00)***

Basin Tributary to 74th Ave Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.64 ac	53.27 ac	53.91 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	45.79 ac	10.44 ac	56.23 ac
Native Wetland *(Assume 50% Forest & 50% Pasture)*	2.89 ac	7.30 ac	10.19 ac
Undeveloped Parcels (Grass) *(Assume 100% grass)*	0.00 ac	2.43 ac	2.43 ac
Undeveloped Parcels (Forest) *(Assume 100% forest)*	0.00 ac	13.82 ac	13.82 ac
Total Basin Area			***136.58 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	1.45 ac (CN=30)	17.47 ac (CN=70)	*18.92 ac* (CN=66.94)
Pasture Area	1.45 ac (CN=39)	3.65 ac (CN=74)	*5.10 ac* (CN=64.07)
Lawn Area	4.90 ac (CN=68)	30.11 ac (CN=86)	*35.01 ac* (CN=83.48)
Total Area			***59.02 ac (CN=76.51)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	41.53 ac (CN=98)	36.03 ac (CN=98)	*77.56 ac* (CN=98.00)
Total Area			***77.56 ac (CN=98.00)***

Basin Tributary to 71st Ave Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	12.34 ac	19.88 ac	32.22 ac
Undeveloped Parcels (Grass) *(Assume 100% grass)*	0.00 ac	6.60 ac	6.60 ac
Undeveloped Parcels (Forest) *(Assume 100% forest)*	0.00 ac	0.00 ac	0.00 ac
Total Basin Area			***38.82 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	1.23 ac (CN=68)	8.59 ac (CN=86)	*9.82 ac* (CN=83.74)
Total Area			***9.82 ac (CN=83.74)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	11.11 ac (CN=98)	17.89 ac (CN=98)	*29.00 ac* (CN=98.00)
Total Area			***29.00 ac (CN=98.00)***

Basin Tributary to 204th Street Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	17.55 ac	0.00 ac	17.55 ac
Total Basin Area			***17.55 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	1.76 ac (CN=68)	0.00 ac (CN=86)	*1.76 ac* (CN=68.00)
Total Area			***1.76 ac (CN=68.00)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	15.80 ac (CN=98)	0.00 ac (CN=98)	*15.80 ac* (CN=98.00)
Total Area			***15.80 ac (CN=98.00)***

Basin Tributary to BNSF RR Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	3.95 ac	0.22 ac	4.17 ac
Total Basin Area			***4.17 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	0.40 ac (CN=68)	0.02 ac (CN=86)	*0.42 ac* (CN=68.95)
Total Area			***0.42 ac (CN=68.95)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	3.56 ac (CN=98)	0.20 ac (CN=98)	*3.76 ac* (CN=98.00)
Total Area			***3.76 ac (CN=98.00)***

Basin Tributary to 69th Ave Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	0.75 ac	0.00 ac	0.75 ac
Total Basin Area			***0.75 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	0.08 ac (CN=68)	0.00 ac (CN=86)	*0.08 ac* (CN=68.00)
Total Area			***0.08 ac (CN=68.00)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	0.68 ac (CN=98)	0.00 ac (CN=98)	*0.68 ac* (CN=98.00)
Total Area			***0.68 ac (CN=98.00)***

Basin Tributary to Confluence Point			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	4.70 ac	0.00 ac	4.70 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	6.59 ac	0.00 ac	6.59 ac
Total Basin Area			***11.29 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	3.01 ac (CN=68)	0.00 ac (CN=86)	*3.01 ac* (CN=68.00)
Total Area			***3.01 ac (CN=68.00)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	8.28 ac (CN=98)	0.00 ac (CN=98)	*8.28 ac* (CN=98.00)
Total Area			***8.28 ac (CN=98.00)***

Murray, Smith & Associates, Inc. Engineers/Planners	Project: **Prairie Creek Drainage Improvements**	Calc. By: **KJM**	Date: **10/26/2012**
	Project No: **12-1347.104**	Check By:	Date:
	Description: **SBUH Input Parameters (Full Build-Out)**	Backcheck By:	Date:

Headwater Basin Area			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	5.97 ac	825.29 ac	831.26 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	0.77 ac	106.91 ac	107.68 ac
Native Wetland *(Assume 50% Forest & 50% Pasture)*	7.68 ac	0.00 ac	7.68 ac
Golf Course *(Assume 100% grass)*	0.00 ac	61.89 ac	61.89 ac
Total Basin Area			***1008.51 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	3.84 ac (CN=30)	0.00 ac (CN=70)	*3.84 ac* (CN=30.00)
Pasture Area	3.84 ac (CN=39)	0.00 ac (CN=74)	*3.84 ac* (CN=39.00)
Lawn Area	3.06 ac (CN=68)	485.23 ac (CN=86)	*488.29 ac* (CN=85.89)
Total Area			***495.97 ac (CN=85.09)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	3.68 ac (CN=98)	508.86 ac (CN=98)	*512.54 ac* (CN=98.00)
Total Area			***512.54 ac (CN=98.00)***

Basin Tributary to 74th Ave Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.64 ac	67.09 ac	67.73 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	45.79 ac	12.87 ac	58.66 ac
Native Wetland *(Assume 50% Forest & 50% Pasture)*	2.89 ac	7.30 ac	10.19 ac
Total Basin Area			***136.58 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	1.45 ac (CN=30)	3.65 ac (CN=70)	*5.10 ac* (CN=58.63)
Pasture Area	1.45 ac (CN=39)	3.65 ac (CN=74)	*5.10 ac* (CN=64.05)
Lawn Area	4.90 ac (CN=68)	34.83 ac (CN=86)	*39.73 ac* (CN=83.78)
Total Area			***49.93 ac (CN=79.20)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	41.53 ac (CN=98)	45.13 ac (CN=98)	*86.66 ac* (CN=98.00)
Total Area			***86.66 ac (CN=98.00)***

Basin Tributary to 71st Ave Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	14.67 ac	24.15 ac	38.82 ac
Total Basin Area			***38.82 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	1.47 ac (CN=68)	2.42 ac (CN=86)	*3.89 ac* (CN=79.20)
Total Area			***3.89 ac (CN=79.20)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	13.20 ac (CN=98)	21.74 ac (CN=98)	*34.94 ac* (CN=98.00)
Total Area			***34.94 ac (CN=98.00)***

Basin Tributary to 204th Street Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	17.55 ac	0.00 ac	17.55 ac
Total Basin Area			***17.55 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	1.76 ac (CN=68)	0.00 ac (CN=86)	*1.76 ac* (CN=68.00)
Total Area			***1.76 ac (CN=68.00)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	15.80 ac (CN=98)	0.00 ac (CN=98)	*15.80 ac* (CN=98.00)
Total Area			***15.80 ac (CN=98.00)***

Basin Tributary to BNSF RR Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	3.95 ac	0.22 ac	4.17 ac
Total Basin Area			***4.17 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	0.40 ac (CN=68)	0.02 ac (CN=86)	*0.42 ac* (CN=68.95)
Total Area			***0.42 ac (CN=68.95)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	3.56 ac (CN=98)	0.20 ac (CN=98)	*3.76 ac* (CN=98.00)
Total Area			***3.76 ac (CN=98.00)***

Basin Tributary to 69th Ave Culvert			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	0.00 ac	0.00 ac	0.00 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	0.75 ac	0.00 ac	0.75 ac
Total Basin Area			***0.75 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	0.08 ac (CN=68)	0.00 ac (CN=86)	*0.08 ac* (CN=68.00)
Total Area			***0.08 ac (CN=68.00)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	0.68 ac (CN=98)	0.00 ac (CN=98)	*0.68 ac* (CN=98.00)
Total Area			***0.68 ac (CN=98.00)***

Basin Tributary to Confluence Point			
Per GIS Mapping	***Outwash***	***Till***	***Total***
Residential *(Assume 50% Impervious, 50% Grass)*	4.70 ac	0.00 ac	4.70 ac
Commercial *(Assume 90% Impervious, 10% Grass)*	6.59 ac	0.00 ac	6.59 ac
Total Basin Area			***11.29 ac***
Pervious Area Breakdown	***Outwash***	***Till***	***Total***
Forest Area	0.00 ac (CN=30)	0.00 ac (CN=70)	*0.00 ac* (CN=0.00)
Pasture Area	0.00 ac (CN=39)	0.00 ac (CN=74)	*0.00 ac* (CN=0.00)
Lawn Area	3.01 ac (CN=68)	0.00 ac (CN=86)	*3.01 ac* (CN=68.00)
Total Area			***3.01 ac (CN=68.00)***
Impervious Area Breakdown	***Outwash***	***Till***	***Total***
Impervious Area	8.28 ac (CN=98)	0.00 ac (CN=98)	*8.28 ac* (CN=98.00)
Total Area			***8.28 ac (CN=98.00)***

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Headwater Basin**
Design Storm : **2-yr / 24-hr**

Given: Area = 1008.52 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 614.12 Ac. CN = 81.50 S = 2.2699 0.2S = 0.45
IMPERVIOUS AREA: Area = 394.40 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 62.45 cfs ***$T_{(Peak)}$ = 8.83 hrs***
Total Volume = 2,996,261 cf ***$Tc_{(min)}$ = 187 min***

Equations:
Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.1	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	1.0	0.03
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.000	2.0	0.10
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.000	3.0	0.23
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	3.8	0.39
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.001	5.9	0.63
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.001	7.0	0.93
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.001	8.0	1.27
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.001	8.9	1.65

Exhibit 6.1

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.002	9.7	2.05
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.002	10.4	2.47
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.002	13.4	2.96
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.002	14.3	3.52
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.002	15.0	4.10
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.003	15.7	4.69
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.003	16.4	5.28
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.003	16.9	5.88
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.003	20.4	6.54
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.003	21.1	7.28
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.004	21.6	8.01
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.004	22.2	8.74
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.004	22.6	9.45
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.004	23.1	10.15
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.005	27.5	10.94
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.005	28.0	11.82
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.005	28.5	12.67
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.005	28.9	13.51
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.005	29.3	14.32
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.005	29.6	15.10
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.006	34.7	15.99
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.006	35.1	16.97
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.006	35.4	17.92
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.006	35.7	18.84
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.006	36.0	19.73
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.006	36.3	20.58
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.009	52.8	21.83
43	420	0.0134	0.024	0.506	0.001	0.001	0.323	0.022	0.009	55.1	23.50
44	430	0.0134	0.024	0.530	0.002	0.001	0.345	0.022	0.009	57.2	25.20
45	440	0.0180	0.032	0.562	0.005	0.002	0.375	0.030	0.013	80.1	27.47
46	450	0.0180	0.032	0.595	0.008	0.003	0.405	0.030	0.014	83.6	30.30
47	460	0.0340	0.061	0.656	0.016	0.008	0.462	0.057	0.027	167.0	35.25
48	470	0.0540	0.097	0.753	0.035	0.018	0.554	0.092	0.047	287.2	45.24
49	480	0.0270	0.049	0.802	0.046	0.011	0.600	0.046	0.025	152.7	54.34
50	490	0.0180	0.032	0.834	0.055	0.008	0.631	0.031	0.017	104.9	58.22
51	500	0.0134	0.024	0.858	0.061	0.007	0.654	0.023	0.013	79.7	59.99
52	510	0.0134	0.024	0.882	0.068	0.007	0.677	0.023	0.013	80.9	61.05
53	520	0.0134	0.024	0.906	0.075	0.007	0.701	0.023	0.013	82.2	62.12
54	530	0.0088	0.016	0.922	0.080	0.005	0.716	0.015	0.009	54.6	62.45
55	540	0.0088	0.016	0.938	0.085	0.005	0.731	0.015	0.009	55.1	62.05
56	550	0.0088	0.016	0.954	0.090	0.005	0.746	0.015	0.009	55.6	61.70
57	560	0.0088	0.016	0.970	0.096	0.005	0.762	0.015	0.009	56.1	61.40
58	570	0.0088	0.016	0.986	0.101	0.005	0.777	0.015	0.009	56.6	61.14
59	580	0.0088	0.016	1.002	0.106	0.006	0.792	0.015	0.009	57.1	60.91
60	590	0.0088	0.016	1.017	0.112	0.006	0.808	0.015	0.009	57.5	60.72
61	600	0.0088	0.016	1.033	0.118	0.006	0.823	0.015	0.010	58.0	60.57
62	610	0.0088	0.016	1.049	0.124	0.006	0.838	0.015	0.010	58.4	60.44
63	620	0.0088	0.016	1.065	0.130	0.006	0.854	0.015	0.010	58.9	60.35
64	630	0.0088	0.016	1.081	0.136	0.006	0.869	0.015	0.010	59.3	60.28
65	640	0.0088	0.016	1.097	0.142	0.006	0.885	0.015	0.010	59.7	60.24

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.147	0.005	0.897	0.013	0.008	49.2	59.94
67	660	0.0072	0.013	1.122	0.152	0.005	0.910	0.013	0.008	49.4	59.38
68	670	0.0072	0.013	1.135	0.157	0.005	0.923	0.013	0.008	49.7	58.87
69	680	0.0072	0.013	1.148	0.163	0.005	0.935	0.013	0.008	50.0	58.40
70	690	0.0072	0.013	1.161	0.168	0.005	0.948	0.013	0.008	50.2	57.97
71	700	0.0072	0.013	1.174	0.174	0.005	0.961	0.013	0.008	50.5	57.57
72	710	0.0072	0.013	1.187	0.179	0.006	0.973	0.013	0.008	50.7	57.21
73	720	0.0072	0.013	1.200	0.185	0.006	0.986	0.013	0.008	51.0	56.88
74	730	0.0072	0.013	1.213	0.190	0.006	0.999	0.013	0.008	51.2	56.58
75	740	0.0072	0.013	1.226	0.196	0.006	1.011	0.013	0.008	51.5	56.31
76	750	0.0072	0.013	1.239	0.202	0.006	1.024	0.013	0.008	51.7	56.06
77	760	0.0072	0.013	1.252	0.208	0.006	1.037	0.013	0.009	52.0	55.84
78	770	0.0057	0.010	1.262	0.212	0.005	1.047	0.010	0.007	41.3	55.36
79	780	0.0057	0.010	1.273	0.217	0.005	1.057	0.010	0.007	41.4	54.63
80	790	0.0057	0.010	1.283	0.222	0.005	1.067	0.010	0.007	41.6	53.95
81	800	0.0057	0.010	1.293	0.226	0.005	1.077	0.010	0.007	41.7	53.31
82	810	0.0057	0.010	1.303	0.231	0.005	1.087	0.010	0.007	41.9	52.71
83	820	0.0057	0.010	1.314	0.236	0.005	1.097	0.010	0.007	42.0	52.15
84	830	0.0057	0.010	1.324	0.241	0.005	1.107	0.010	0.007	42.1	51.62
85	840	0.0057	0.010	1.334	0.246	0.005	1.117	0.010	0.007	42.3	51.13
86	850	0.0057	0.010	1.344	0.251	0.005	1.127	0.010	0.007	42.4	50.68
87	860	0.0057	0.010	1.355	0.256	0.005	1.137	0.010	0.007	42.6	50.25
88	870	0.0057	0.010	1.365	0.261	0.005	1.147	0.010	0.007	42.7	49.85
89	880	0.0057	0.010	1.375	0.266	0.005	1.157	0.010	0.007	42.8	49.48
90	890	0.0050	0.009	1.384	0.270	0.004	1.166	0.009	0.006	37.7	49.00
91	900	0.0050	0.009	1.393	0.275	0.004	1.175	0.009	0.006	37.8	48.41
92	910	0.0050	0.009	1.402	0.279	0.005	1.184	0.009	0.006	37.9	47.86
93	920	0.0050	0.009	1.411	0.284	0.005	1.193	0.009	0.006	38.0	47.34
94	930	0.0050	0.009	1.420	0.288	0.005	1.202	0.009	0.006	38.1	46.86
95	940	0.0050	0.009	1.429	0.293	0.005	1.210	0.009	0.006	38.2	46.40
96	950	0.0050	0.009	1.438	0.298	0.005	1.219	0.009	0.006	38.2	45.97
97	960	0.0050	0.009	1.447	0.302	0.005	1.228	0.009	0.006	38.3	45.57
98	970	0.0050	0.009	1.456	0.307	0.005	1.237	0.009	0.006	38.4	45.20
99	980	0.0050	0.009	1.465	0.312	0.005	1.246	0.009	0.006	38.5	44.85
100	990	0.0050	0.009	1.474	0.316	0.005	1.255	0.009	0.006	38.6	44.52
101	1000	0.0050	0.009	1.483	0.321	0.005	1.264	0.009	0.006	38.7	44.22
102	1010	0.0040	0.007	1.490	0.325	0.004	1.271	0.007	0.005	31.0	43.73
103	1020	0.0040	0.007	1.498	0.329	0.004	1.278	0.007	0.005	31.1	43.07
104	1030	0.0040	0.007	1.505	0.333	0.004	1.285	0.007	0.005	31.1	42.45
105	1040	0.0040	0.007	1.512	0.336	0.004	1.292	0.007	0.005	31.2	41.86
106	1050	0.0040	0.007	1.519	0.340	0.004	1.299	0.007	0.005	31.3	41.31
107	1060	0.0040	0.007	1.526	0.344	0.004	1.306	0.007	0.005	31.3	40.79
108	1070	0.0040	0.007	1.534	0.348	0.004	1.313	0.007	0.005	31.4	40.29
109	1080	0.0040	0.007	1.541	0.352	0.004	1.320	0.007	0.005	31.4	39.83
110	1090	0.0040	0.007	1.548	0.356	0.004	1.327	0.007	0.005	31.5	39.39
111	1100	0.0040	0.007	1.555	0.360	0.004	1.335	0.007	0.005	31.5	38.98
112	1110	0.0040	0.007	1.562	0.364	0.004	1.342	0.007	0.005	31.6	38.60
113	1120	0.0040	0.007	1.570	0.368	0.004	1.349	0.007	0.005	31.6	38.23
114	1130	0.0040	0.007	1.577	0.372	0.004	1.356	0.007	0.005	31.7	37.89
115	1140	0.0040	0.007	1.584	0.376	0.004	1.363	0.007	0.005	31.7	37.57

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.380	0.004	1.370	0.007	0.005	31.8	37.27
117	1160	0.0040	0.007	1.598	0.384	0.004	1.377	0.007	0.005	31.9	36.98
118	1170	0.0040	0.007	1.606	0.388	0.004	1.384	0.007	0.005	31.9	36.72
119	1180	0.0040	0.007	1.613	0.392	0.004	1.391	0.007	0.005	32.0	36.47
120	1190	0.0040	0.007	1.620	0.396	0.004	1.398	0.007	0.005	32.0	36.24
121	1200	0.0040	0.007	1.627	0.400	0.004	1.406	0.007	0.005	32.1	36.02
122	1210	0.0040	0.007	1.634	0.404	0.004	1.413	0.007	0.005	32.1	35.81
123	1220	0.0040	0.007	1.642	0.408	0.004	1.420	0.007	0.005	32.2	35.62
124	1230	0.0040	0.007	1.649	0.412	0.004	1.427	0.007	0.005	32.2	35.44
125	1240	0.0040	0.007	1.656	0.416	0.004	1.434	0.007	0.005	32.3	35.27
126	1250	0.0040	0.007	1.663	0.420	0.004	1.441	0.007	0.005	32.3	35.12
127	1260	0.0040	0.007	1.670	0.424	0.004	1.448	0.007	0.005	32.4	34.97
128	1270	0.0040	0.007	1.678	0.429	0.004	1.455	0.007	0.005	32.4	34.84
129	1280	0.0040	0.007	1.685	0.433	0.004	1.462	0.007	0.005	32.5	34.71
130	1290	0.0040	0.007	1.692	0.437	0.004	1.470	0.007	0.005	32.5	34.59
131	1300	0.0040	0.007	1.699	0.441	0.004	1.477	0.007	0.005	32.5	34.49
132	1310	0.0040	0.007	1.706	0.445	0.004	1.484	0.007	0.005	32.6	34.39
133	1320	0.0040	0.007	1.714	0.450	0.004	1.491	0.007	0.005	32.6	34.29
134	1330	0.0040	0.007	1.721	0.454	0.004	1.498	0.007	0.005	32.7	34.21
135	1340	0.0040	0.007	1.728	0.458	0.004	1.505	0.007	0.005	32.7	34.13
136	1350	0.0040	0.007	1.735	0.462	0.004	1.512	0.007	0.005	32.8	34.06
137	1360	0.0040	0.007	1.742	0.467	0.004	1.519	0.007	0.005	32.8	33.99
138	1370	0.0040	0.007	1.750	0.471	0.004	1.526	0.007	0.005	32.9	33.93
139	1380	0.0040	0.007	1.757	0.475	0.004	1.534	0.007	0.005	32.9	33.88
140	1390	0.0040	0.007	1.764	0.479	0.004	1.541	0.007	0.005	33.0	33.83
141	1400	0.0040	0.007	1.771	0.484	0.004	1.548	0.007	0.005	33.0	33.79
142	1410	0.0040	0.007	1.778	0.488	0.004	1.555	0.007	0.005	33.1	33.75
143	1420	0.0040	0.007	1.786	0.492	0.004	1.562	0.007	0.005	33.1	33.71
144	1430	0.0040	0.007	1.793	0.497	0.004	1.569	0.007	0.005	33.1	33.68
145	1440	0.0040	0.007	1.800	0.501	0.004	1.576	0.007	0.005	33.2	33.65

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 74th Ave Culvert**

Design Storm : **2-yr / 24-hr**

Given: Area = 136.58 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 59.02 Ac. CN = 76.51 S = 3.0702 0.2S = 0.61

IMPERVIOUS AREA: Area = 77.56 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 10.35 cfs ***$T_{(Peak)}$ = 8.67 hrs***

Total Volume = 462,092 cf ***$Tc_{(min)}$ = 187 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.2	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.000	0.4	0.02
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.6	0.05
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.8	0.08
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.001	1.2	0.12
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.002	1.4	0.18
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.002	1.6	0.25
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.002	1.8	0.32

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.002	1.9	0.40
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.002	2.1	0.48
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.003	2.6	0.58
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.003	2.8	0.69
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.004	3.0	0.81
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.004	3.1	0.92
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.004	3.2	1.04
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.004	3.3	1.16
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.005	4.0	1.29
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.005	4.1	1.43
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.005	4.3	1.58
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.005	4.4	1.72
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.005	4.5	1.86
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.005	4.5	2.00
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.007	5.4	2.15
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.007	5.5	2.32
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.007	5.6	2.49
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.007	5.7	2.66
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.007	5.8	2.82
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.007	5.8	2.97
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.008	6.8	3.14
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.008	6.9	3.34
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.008	7.0	3.52
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.009	7.0	3.71
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.009	7.1	3.88
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.009	7.1	4.05
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.012	10.1	4.29
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.012	10.2	4.59
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.012	10.3	4.89
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.017	13.9	5.27
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.017	14.1	5.72
47	460	0.0340	0.061	0.656	0.001	0.001	0.462	0.057	0.033	27.0	6.49
48	470	0.0540	0.097	0.753	0.006	0.005	0.554	0.092	0.054	45.0	8.03
49	480	0.0270	0.049	0.802	0.011	0.005	0.600	0.046	0.028	23.4	9.39
50	490	0.0180	0.032	0.834	0.015	0.004	0.631	0.031	0.019	15.9	9.93
51	500	0.0134	0.024	0.858	0.018	0.003	0.654	0.023	0.015	12.0	10.14
52	510	0.0134	0.024	0.882	0.022	0.004	0.677	0.023	0.015	12.2	10.24
53	520	0.0134	0.024	0.906	0.025	0.004	0.701	0.023	0.015	12.3	10.35
54	530	0.0088	0.016	0.922	0.028	0.003	0.716	0.015	0.010	8.1	10.34
55	540	0.0088	0.016	0.938	0.031	0.003	0.731	0.015	0.010	8.2	10.22
56	550	0.0088	0.016	0.954	0.034	0.003	0.746	0.015	0.010	8.2	10.12
57	560	0.0088	0.016	0.970	0.037	0.003	0.762	0.015	0.010	8.3	10.02
58	570	0.0088	0.016	0.986	0.040	0.003	0.777	0.015	0.010	8.3	9.93
59	580	0.0088	0.016	1.002	0.043	0.003	0.792	0.015	0.010	8.4	9.85
60	590	0.0088	0.016	1.017	0.047	0.003	0.808	0.015	0.010	8.4	9.78
61	600	0.0088	0.016	1.033	0.050	0.004	0.823	0.015	0.010	8.5	9.71
62	610	0.0088	0.016	1.049	0.054	0.004	0.838	0.015	0.010	8.5	9.64
63	620	0.0088	0.016	1.065	0.058	0.004	0.854	0.015	0.010	8.6	9.59
64	630	0.0088	0.016	1.081	0.062	0.004	0.869	0.015	0.010	8.6	9.53
65	640	0.0088	0.016	1.097	0.066	0.004	0.885	0.015	0.010	8.6	9.49

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.069	0.003	0.897	0.013	0.009	7.1	9.40
67	660	0.0072	0.013	1.122	0.072	0.003	0.910	0.013	0.009	7.1	9.28
68	670	0.0072	0.013	1.135	0.076	0.003	0.923	0.013	0.009	7.2	9.17
69	680	0.0072	0.013	1.148	0.079	0.004	0.935	0.013	0.009	7.2	9.07
70	690	0.0072	0.013	1.161	0.083	0.004	0.948	0.013	0.009	7.2	8.97
71	700	0.0072	0.013	1.174	0.086	0.004	0.961	0.013	0.009	7.2	8.88
72	710	0.0072	0.013	1.187	0.090	0.004	0.973	0.013	0.009	7.3	8.80
73	720	0.0072	0.013	1.200	0.094	0.004	0.986	0.013	0.009	7.3	8.72
74	730	0.0072	0.013	1.213	0.098	0.004	0.999	0.013	0.009	7.3	8.64
75	740	0.0072	0.013	1.226	0.102	0.004	1.011	0.013	0.009	7.3	8.58
76	750	0.0072	0.013	1.239	0.106	0.004	1.024	0.013	0.009	7.4	8.51
77	760	0.0072	0.013	1.252	0.110	0.004	1.037	0.013	0.009	7.4	8.45
78	770	0.0057	0.010	1.262	0.113	0.003	1.047	0.010	0.007	5.9	8.36
79	780	0.0057	0.010	1.273	0.116	0.003	1.057	0.010	0.007	5.9	8.23
80	790	0.0057	0.010	1.283	0.120	0.003	1.067	0.010	0.007	5.9	8.11
81	800	0.0057	0.010	1.293	0.123	0.003	1.077	0.010	0.007	5.9	7.99
82	810	0.0057	0.010	1.303	0.126	0.003	1.087	0.010	0.007	5.9	7.89
83	820	0.0057	0.010	1.314	0.130	0.003	1.097	0.010	0.007	5.9	7.79
84	830	0.0057	0.010	1.324	0.133	0.003	1.107	0.010	0.007	6.0	7.69
85	840	0.0057	0.010	1.334	0.137	0.004	1.117	0.010	0.007	6.0	7.60
86	850	0.0057	0.010	1.344	0.140	0.004	1.127	0.010	0.007	6.0	7.52
87	860	0.0057	0.010	1.355	0.144	0.004	1.137	0.010	0.007	6.0	7.44
88	870	0.0057	0.010	1.365	0.148	0.004	1.147	0.010	0.007	6.0	7.36
89	880	0.0057	0.010	1.375	0.151	0.004	1.157	0.010	0.007	6.0	7.29
90	890	0.0050	0.009	1.384	0.154	0.003	1.166	0.009	0.006	5.3	7.21
91	900	0.0050	0.009	1.393	0.158	0.003	1.175	0.009	0.006	5.3	7.11
92	910	0.0050	0.009	1.402	0.161	0.003	1.184	0.009	0.006	5.3	7.02
93	920	0.0050	0.009	1.411	0.164	0.003	1.193	0.009	0.006	5.3	6.93
94	930	0.0050	0.009	1.420	0.168	0.003	1.202	0.009	0.006	5.3	6.85
95	940	0.0050	0.009	1.429	0.171	0.003	1.210	0.009	0.006	5.4	6.77
96	950	0.0050	0.009	1.438	0.174	0.003	1.219	0.009	0.006	5.4	6.69
97	960	0.0050	0.009	1.447	0.178	0.003	1.228	0.009	0.007	5.4	6.63
98	970	0.0050	0.009	1.456	0.181	0.003	1.237	0.009	0.007	5.4	6.56
99	980	0.0050	0.009	1.465	0.185	0.003	1.246	0.009	0.007	5.4	6.50
100	990	0.0050	0.009	1.474	0.188	0.003	1.255	0.009	0.007	5.4	6.44
101	1000	0.0050	0.009	1.483	0.192	0.004	1.264	0.009	0.007	5.4	6.39
102	1010	0.0040	0.007	1.490	0.195	0.003	1.271	0.007	0.005	4.3	6.31
103	1020	0.0040	0.007	1.498	0.197	0.003	1.278	0.007	0.005	4.3	6.21
104	1030	0.0040	0.007	1.505	0.200	0.003	1.285	0.007	0.005	4.4	6.11
105	1040	0.0040	0.007	1.512	0.203	0.003	1.292	0.007	0.005	4.4	6.02
106	1050	0.0040	0.007	1.519	0.206	0.003	1.299	0.007	0.005	4.4	5.93
107	1060	0.0040	0.007	1.526	0.209	0.003	1.306	0.007	0.005	4.4	5.85
108	1070	0.0040	0.007	1.534	0.212	0.003	1.313	0.007	0.005	4.4	5.77
109	1080	0.0040	0.007	1.541	0.215	0.003	1.320	0.007	0.005	4.4	5.70
110	1090	0.0040	0.007	1.548	0.218	0.003	1.327	0.007	0.005	4.4	5.63
111	1100	0.0040	0.007	1.555	0.221	0.003	1.335	0.007	0.005	4.4	5.57
112	1110	0.0040	0.007	1.562	0.224	0.003	1.342	0.007	0.005	4.4	5.51
113	1120	0.0040	0.007	1.570	0.227	0.003	1.349	0.007	0.005	4.4	5.45
114	1130	0.0040	0.007	1.577	0.230	0.003	1.356	0.007	0.005	4.4	5.40
115	1140	0.0040	0.007	1.584	0.233	0.003	1.363	0.007	0.005	4.4	5.34

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.236	0.003	1.370	0.007	0.005	4.4	5.30
117	1160	0.0040	0.007	1.598	0.239	0.003	1.377	0.007	0.005	4.4	5.25
118	1170	0.0040	0.007	1.606	0.242	0.003	1.384	0.007	0.005	4.4	5.21
119	1180	0.0040	0.007	1.613	0.245	0.003	1.391	0.007	0.005	4.4	5.17
120	1190	0.0040	0.007	1.620	0.248	0.003	1.398	0.007	0.005	4.4	5.13
121	1200	0.0040	0.007	1.627	0.251	0.003	1.406	0.007	0.005	4.4	5.09
122	1210	0.0040	0.007	1.634	0.255	0.003	1.413	0.007	0.005	4.5	5.06
123	1220	0.0040	0.007	1.642	0.258	0.003	1.420	0.007	0.005	4.5	5.03
124	1230	0.0040	0.007	1.649	0.261	0.003	1.427	0.007	0.005	4.5	5.00
125	1240	0.0040	0.007	1.656	0.264	0.003	1.434	0.007	0.005	4.5	4.97
126	1250	0.0040	0.007	1.663	0.267	0.003	1.441	0.007	0.005	4.5	4.95
127	1260	0.0040	0.007	1.670	0.270	0.003	1.448	0.007	0.005	4.5	4.92
128	1270	0.0040	0.007	1.678	0.274	0.003	1.455	0.007	0.005	4.5	4.90
129	1280	0.0040	0.007	1.685	0.277	0.003	1.462	0.007	0.005	4.5	4.88
130	1290	0.0040	0.007	1.692	0.280	0.003	1.470	0.007	0.005	4.5	4.86
131	1300	0.0040	0.007	1.699	0.283	0.003	1.477	0.007	0.005	4.5	4.84
132	1310	0.0040	0.007	1.706	0.287	0.003	1.484	0.007	0.005	4.5	4.82
133	1320	0.0040	0.007	1.714	0.290	0.003	1.491	0.007	0.005	4.5	4.81
134	1330	0.0040	0.007	1.721	0.293	0.003	1.498	0.007	0.005	4.5	4.79
135	1340	0.0040	0.007	1.728	0.297	0.003	1.505	0.007	0.005	4.5	4.78
136	1350	0.0040	0.007	1.735	0.300	0.003	1.512	0.007	0.005	4.5	4.76
137	1360	0.0040	0.007	1.742	0.303	0.003	1.519	0.007	0.005	4.5	4.75
138	1370	0.0040	0.007	1.750	0.307	0.003	1.526	0.007	0.005	4.5	4.74
139	1380	0.0040	0.007	1.757	0.310	0.003	1.534	0.007	0.005	4.5	4.73
140	1390	0.0040	0.007	1.764	0.313	0.003	1.541	0.007	0.006	4.5	4.72
141	1400	0.0040	0.007	1.771	0.317	0.003	1.548	0.007	0.006	4.6	4.71
142	1410	0.0040	0.007	1.778	0.320	0.003	1.555	0.007	0.006	4.6	4.70
143	1420	0.0040	0.007	1.786	0.324	0.003	1.562	0.007	0.006	4.6	4.70
144	1430	0.0040	0.007	1.793	0.327	0.003	1.569	0.007	0.006	4.6	4.69
145	1440	0.0040	0.007	1.800	0.330	0.003	1.576	0.007	0.006	4.6	4.68

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 71st Ave Culvert**

Design Storm : **2-yr / 24-hr**

Given: Area = 38.82 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 9.82 Ac. CN = 83.74 S = 1.9417 0.2S = 0.39

IMPERVIOUS AREA: Area = 29.00 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 63 Min. w = 0.073529

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 6.89 cfs ***$T_{(Peak)}$ = 8.17 hrs***

Total Volume = 181,340 cf ***$Tc_{(min)}$ = 63 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.074

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.1	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.1	0.02
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.2	0.04
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.3	0.08
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.4	0.12
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.002	0.5	0.17
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.6	0.23
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.7	0.28

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.003	0.7	0.34
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.003	0.8	0.40
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.004	1.0	0.47
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.004	1.0	0.55
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.005	1.1	0.63
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.005	1.2	0.70
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.005	1.2	0.77
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.005	1.2	0.84
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.006	1.5	0.92
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.007	1.5	1.01
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.007	1.6	1.09
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.007	1.6	1.17
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.007	1.7	1.24
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.007	1.7	1.30
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.009	2.0	1.38
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.009	2.1	1.48
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.009	2.1	1.57
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.009	2.1	1.65
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.009	2.2	1.72
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.009	2.2	1.79
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.011	2.5	1.87
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.011	2.6	1.97
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.011	2.6	2.06
39	380	0.0095	0.017	0.423	0.001	0.000	0.249	0.015	0.011	2.7	2.15
40	390	0.0095	0.017	0.440	0.001	0.001	0.265	0.015	0.011	2.7	2.22
41	400	0.0095	0.017	0.458	0.002	0.001	0.280	0.015	0.012	2.7	2.30
42	410	0.0134	0.024	0.482	0.004	0.002	0.301	0.022	0.017	3.9	2.45
43	420	0.0134	0.024	0.506	0.007	0.002	0.323	0.022	0.017	4.0	2.67
44	430	0.0134	0.024	0.530	0.010	0.003	0.345	0.022	0.017	4.0	2.86
45	440	0.0180	0.032	0.562	0.014	0.005	0.375	0.030	0.023	5.5	3.14
46	450	0.0180	0.032	0.595	0.020	0.006	0.405	0.030	0.024	5.6	3.49
47	460	0.0340	0.061	0.656	0.032	0.013	0.462	0.057	0.046	10.8	4.18
48	470	0.0540	0.097	0.753	0.058	0.025	0.554	0.092	0.075	17.6	5.65
49	480	0.0270	0.049	0.802	0.073	0.015	0.600	0.046	0.038	9.0	6.78
50	490	0.0180	0.032	0.834	0.083	0.011	0.631	0.031	0.026	6.1	6.89
51	500	0.0134	0.024	0.858	0.092	0.008	0.654	0.023	0.019	4.6	6.66
52	510	0.0134	0.024	0.882	0.100	0.009	0.677	0.023	0.020	4.6	6.35
53	520	0.0134	0.024	0.906	0.109	0.009	0.701	0.023	0.020	4.6	6.09
54	530	0.0088	0.016	0.922	0.115	0.006	0.716	0.015	0.013	3.0	5.76
55	540	0.0088	0.016	0.938	0.121	0.006	0.731	0.015	0.013	3.0	5.36
56	550	0.0088	0.016	0.954	0.128	0.006	0.746	0.015	0.013	3.1	5.02
57	560	0.0088	0.016	0.970	0.134	0.006	0.762	0.015	0.013	3.1	4.73
58	570	0.0088	0.016	0.986	0.141	0.007	0.777	0.015	0.013	3.1	4.49
59	580	0.0088	0.016	1.002	0.147	0.007	0.792	0.015	0.013	3.1	4.28
60	590	0.0088	0.016	1.017	0.154	0.007	0.808	0.015	0.013	3.1	4.11
61	600	0.0088	0.016	1.033	0.161	0.007	0.823	0.015	0.013	3.1	3.96
62	610	0.0088	0.016	1.049	0.168	0.007	0.838	0.015	0.013	3.1	3.83
63	620	0.0088	0.016	1.065	0.175	0.007	0.854	0.015	0.013	3.1	3.73
64	630	0.0088	0.016	1.081	0.182	0.007	0.869	0.015	0.013	3.1	3.64
65	640	0.0088	0.016	1.097	0.189	0.007	0.885	0.015	0.013	3.1	3.57

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.195	0.006	0.897	0.013	0.011	2.6	3.46
67	660	0.0072	0.013	1.122	0.201	0.006	0.910	0.013	0.011	2.6	3.33
68	670	0.0072	0.013	1.135	0.208	0.006	0.923	0.013	0.011	2.6	3.22
69	680	0.0072	0.013	1.148	0.214	0.006	0.935	0.013	0.011	2.6	3.13
70	690	0.0072	0.013	1.161	0.220	0.006	0.948	0.013	0.011	2.6	3.05
71	700	0.0072	0.013	1.174	0.226	0.006	0.961	0.013	0.011	2.6	2.98
72	710	0.0072	0.013	1.187	0.233	0.006	0.973	0.013	0.011	2.6	2.93
73	720	0.0072	0.013	1.200	0.239	0.006	0.986	0.013	0.011	2.6	2.88
74	730	0.0072	0.013	1.213	0.246	0.007	0.999	0.013	0.011	2.6	2.84
75	740	0.0072	0.013	1.226	0.253	0.007	1.011	0.013	0.011	2.6	2.81
76	750	0.0072	0.013	1.239	0.259	0.007	1.024	0.013	0.011	2.6	2.78
77	760	0.0072	0.013	1.252	0.266	0.007	1.037	0.013	0.011	2.6	2.76
78	770	0.0057	0.010	1.262	0.271	0.005	1.047	0.010	0.009	2.1	2.70
79	780	0.0057	0.010	1.273	0.277	0.005	1.057	0.010	0.009	2.1	2.61
80	790	0.0057	0.010	1.283	0.282	0.005	1.067	0.010	0.009	2.1	2.53
81	800	0.0057	0.010	1.293	0.288	0.005	1.077	0.010	0.009	2.1	2.46
82	810	0.0057	0.010	1.303	0.293	0.006	1.087	0.010	0.009	2.1	2.41
83	820	0.0057	0.010	1.314	0.299	0.006	1.097	0.010	0.009	2.1	2.36
84	830	0.0057	0.010	1.324	0.304	0.006	1.107	0.010	0.009	2.1	2.32
85	840	0.0057	0.010	1.334	0.310	0.006	1.117	0.010	0.009	2.1	2.29
86	850	0.0057	0.010	1.344	0.315	0.006	1.127	0.010	0.009	2.1	2.26
87	860	0.0057	0.010	1.355	0.321	0.006	1.137	0.010	0.009	2.1	2.24
88	870	0.0057	0.010	1.365	0.327	0.006	1.147	0.010	0.009	2.1	2.22
89	880	0.0057	0.010	1.375	0.333	0.006	1.157	0.010	0.009	2.1	2.20
90	890	0.0050	0.009	1.384	0.338	0.005	1.166	0.009	0.008	1.9	2.17
91	900	0.0050	0.009	1.393	0.343	0.005	1.175	0.009	0.008	1.9	2.12
92	910	0.0050	0.009	1.402	0.348	0.005	1.184	0.009	0.008	1.9	2.08
93	920	0.0050	0.009	1.411	0.353	0.005	1.193	0.009	0.008	1.9	2.05
94	930	0.0050	0.009	1.420	0.358	0.005	1.202	0.009	0.008	1.9	2.02
95	940	0.0050	0.009	1.429	0.363	0.005	1.210	0.009	0.008	1.9	2.00
96	950	0.0050	0.009	1.438	0.368	0.005	1.219	0.009	0.008	1.9	1.98
97	960	0.0050	0.009	1.447	0.374	0.005	1.228	0.009	0.008	1.9	1.96
98	970	0.0050	0.009	1.456	0.379	0.005	1.237	0.009	0.008	1.9	1.95
99	980	0.0050	0.009	1.465	0.384	0.005	1.246	0.009	0.008	1.9	1.94
100	990	0.0050	0.009	1.474	0.389	0.005	1.255	0.009	0.008	1.9	1.93
101	1000	0.0050	0.009	1.483	0.395	0.005	1.264	0.009	0.008	1.9	1.92
102	1010	0.0040	0.007	1.490	0.399	0.004	1.271	0.007	0.006	1.5	1.88
103	1020	0.0040	0.007	1.498	0.403	0.004	1.278	0.007	0.006	1.5	1.83
104	1030	0.0040	0.007	1.505	0.408	0.004	1.285	0.007	0.006	1.5	1.78
105	1040	0.0040	0.007	1.512	0.412	0.004	1.292	0.007	0.006	1.5	1.74
106	1050	0.0040	0.007	1.519	0.416	0.004	1.299	0.007	0.006	1.5	1.70
107	1060	0.0040	0.007	1.526	0.421	0.004	1.306	0.007	0.006	1.5	1.67
108	1070	0.0040	0.007	1.534	0.425	0.004	1.313	0.007	0.006	1.5	1.65
109	1080	0.0040	0.007	1.541	0.429	0.004	1.320	0.007	0.006	1.5	1.63
110	1090	0.0040	0.007	1.548	0.434	0.004	1.327	0.007	0.006	1.5	1.61
111	1100	0.0040	0.007	1.555	0.438	0.004	1.335	0.007	0.006	1.5	1.59
112	1110	0.0040	0.007	1.562	0.442	0.004	1.342	0.007	0.006	1.5	1.58
113	1120	0.0040	0.007	1.570	0.447	0.004	1.349	0.007	0.006	1.5	1.57
114	1130	0.0040	0.007	1.577	0.451	0.004	1.356	0.007	0.006	1.5	1.56
115	1140	0.0040	0.007	1.584	0.456	0.004	1.363	0.007	0.006	1.5	1.55

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.460	0.004	1.370	0.007	0.006	1.5	1.55
117	1160	0.0040	0.007	1.598	0.465	0.004	1.377	0.007	0.006	1.5	1.54
118	1170	0.0040	0.007	1.606	0.469	0.004	1.384	0.007	0.006	1.5	1.54
119	1180	0.0040	0.007	1.613	0.474	0.004	1.391	0.007	0.006	1.5	1.53
120	1190	0.0040	0.007	1.620	0.478	0.004	1.398	0.007	0.006	1.5	1.53
121	1200	0.0040	0.007	1.627	0.483	0.005	1.406	0.007	0.006	1.5	1.53
122	1210	0.0040	0.007	1.634	0.487	0.005	1.413	0.007	0.006	1.5	1.53
123	1220	0.0040	0.007	1.642	0.492	0.005	1.420	0.007	0.006	1.5	1.52
124	1230	0.0040	0.007	1.649	0.496	0.005	1.427	0.007	0.006	1.5	1.52
125	1240	0.0040	0.007	1.656	0.501	0.005	1.434	0.007	0.006	1.5	1.52
126	1250	0.0040	0.007	1.663	0.505	0.005	1.441	0.007	0.006	1.5	1.52
127	1260	0.0040	0.007	1.670	0.510	0.005	1.448	0.007	0.006	1.5	1.52
128	1270	0.0040	0.007	1.678	0.514	0.005	1.455	0.007	0.006	1.5	1.52
129	1280	0.0040	0.007	1.685	0.519	0.005	1.462	0.007	0.006	1.5	1.52
130	1290	0.0040	0.007	1.692	0.524	0.005	1.470	0.007	0.006	1.5	1.52
131	1300	0.0040	0.007	1.699	0.528	0.005	1.477	0.007	0.006	1.5	1.52
132	1310	0.0040	0.007	1.706	0.533	0.005	1.484	0.007	0.006	1.5	1.52
133	1320	0.0040	0.007	1.714	0.538	0.005	1.491	0.007	0.006	1.5	1.52
134	1330	0.0040	0.007	1.721	0.542	0.005	1.498	0.007	0.006	1.5	1.52
135	1340	0.0040	0.007	1.728	0.547	0.005	1.505	0.007	0.006	1.5	1.52
136	1350	0.0040	0.007	1.735	0.552	0.005	1.512	0.007	0.007	1.5	1.52
137	1360	0.0040	0.007	1.742	0.556	0.005	1.519	0.007	0.007	1.5	1.52
138	1370	0.0040	0.007	1.750	0.561	0.005	1.526	0.007	0.007	1.5	1.52
139	1380	0.0040	0.007	1.757	0.566	0.005	1.534	0.007	0.007	1.5	1.53
140	1390	0.0040	0.007	1.764	0.570	0.005	1.541	0.007	0.007	1.5	1.53
141	1400	0.0040	0.007	1.771	0.575	0.005	1.548	0.007	0.007	1.5	1.53
142	1410	0.0040	0.007	1.778	0.580	0.005	1.555	0.007	0.007	1.5	1.53
143	1420	0.0040	0.007	1.786	0.585	0.005	1.562	0.007	0.007	1.5	1.53
144	1430	0.0040	0.007	1.793	0.589	0.005	1.569	0.007	0.007	1.5	1.53
145	1440	0.0040	0.007	1.800	0.594	0.005	1.576	0.007	0.007	1.5	1.53

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 204th St Culvert**

Design Storm : **2-yr / 24-hr**

Given: Area = 17.56 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 1.76 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 15.80 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 33 Min. w = 0.131579

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 4.58 cfs ***$T_{(Peak)}$ = 8.00 hrs***

Total Volume = 89,865 cf ***$Tc_{(min)}$ = 33 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.132

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.1	0.02
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.1	0.04
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.2	0.07
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.2	0.10
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.003	0.3	0.14
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.3	0.18
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.4	0.22

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.004	0.4	0.26
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.004	0.4	0.30
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.005	0.5	0.35
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.005	0.6	0.40
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.006	0.6	0.45
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.006	0.6	0.49
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.006	0.7	0.53
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.006	0.7	0.57
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.008	0.8	0.62
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.008	0.8	0.67
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.008	0.9	0.72
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.008	0.9	0.76
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.009	0.9	0.80
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.009	0.9	0.83
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.010	1.1	0.88
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.011	1.1	0.94
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.011	1.1	0.99
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.011	1.2	1.03
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.011	1.2	1.07
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.011	1.2	1.10
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.013	1.4	1.15
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.013	1.4	1.21
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.013	1.4	1.26
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.013	1.4	1.31
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.014	1.4	1.34
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.014	1.5	1.37
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.019	2.1	1.47
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.020	2.1	1.63
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.020	2.1	1.75
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.027	2.8	1.94
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.027	2.9	2.18
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.051	5.5	2.70
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.083	8.8	3.86
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.042	4.4	4.58
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.028	3.0	4.35
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.021	2.2	3.89
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.021	2.2	3.45
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.021	2.2	3.12
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.014	1.5	2.79
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.014	1.5	2.44
56	550	0.0088	0.016	0.954	0.000	0.000	0.746	0.015	0.014	1.5	2.18
57	560	0.0088	0.016	0.970	0.000	0.000	0.762	0.015	0.014	1.5	1.99
58	570	0.0088	0.016	0.986	0.000	0.000	0.777	0.015	0.014	1.5	1.85
59	580	0.0088	0.016	1.002	0.001	0.000	0.792	0.015	0.014	1.5	1.75
60	590	0.0088	0.016	1.017	0.001	0.000	0.808	0.015	0.014	1.5	1.68
61	600	0.0088	0.016	1.033	0.002	0.001	0.823	0.015	0.014	1.5	1.62
62	610	0.0088	0.016	1.049	0.002	0.001	0.838	0.015	0.014	1.5	1.59
63	620	0.0088	0.016	1.065	0.003	0.001	0.854	0.015	0.014	1.5	1.56
64	630	0.0088	0.016	1.081	0.004	0.001	0.869	0.015	0.014	1.5	1.54
65	640	0.0088	0.016	1.097	0.005	0.001	0.885	0.015	0.014	1.5	1.52

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.006	0.001	0.897	0.013	0.011	1.2	1.48
67	660	0.0072	0.013	1.122	0.007	0.001	0.910	0.013	0.011	1.2	1.41
68	670	0.0072	0.013	1.135	0.008	0.001	0.923	0.013	0.011	1.2	1.36
69	680	0.0072	0.013	1.148	0.009	0.001	0.935	0.013	0.011	1.2	1.32
70	690	0.0072	0.013	1.161	0.010	0.001	0.948	0.013	0.011	1.2	1.30
71	700	0.0072	0.013	1.174	0.011	0.001	0.961	0.013	0.012	1.2	1.28
72	710	0.0072	0.013	1.187	0.012	0.001	0.973	0.013	0.012	1.2	1.26
73	720	0.0072	0.013	1.200	0.014	0.001	0.986	0.013	0.012	1.2	1.25
74	730	0.0072	0.013	1.213	0.015	0.001	0.999	0.013	0.012	1.2	1.24
75	740	0.0072	0.013	1.226	0.016	0.001	1.011	0.013	0.012	1.2	1.24
76	750	0.0072	0.013	1.239	0.018	0.001	1.024	0.013	0.012	1.2	1.24
77	760	0.0072	0.013	1.252	0.019	0.002	1.037	0.013	0.012	1.2	1.23
78	770	0.0057	0.010	1.262	0.021	0.001	1.047	0.010	0.009	1.0	1.20
79	780	0.0057	0.010	1.273	0.022	0.001	1.057	0.010	0.009	1.0	1.14
80	790	0.0057	0.010	1.283	0.023	0.001	1.067	0.010	0.009	1.0	1.10
81	800	0.0057	0.010	1.293	0.024	0.001	1.077	0.010	0.009	1.0	1.06
82	810	0.0057	0.010	1.303	0.026	0.001	1.087	0.010	0.009	1.0	1.04
83	820	0.0057	0.010	1.314	0.027	0.001	1.097	0.010	0.009	1.0	1.02
84	830	0.0057	0.010	1.324	0.029	0.001	1.107	0.010	0.009	1.0	1.01
85	840	0.0057	0.010	1.334	0.030	0.002	1.117	0.010	0.009	1.0	1.00
86	850	0.0057	0.010	1.344	0.032	0.002	1.127	0.010	0.009	1.0	1.00
87	860	0.0057	0.010	1.355	0.033	0.002	1.137	0.010	0.009	1.0	0.99
88	870	0.0057	0.010	1.365	0.035	0.002	1.147	0.010	0.009	1.0	0.99
89	880	0.0057	0.010	1.375	0.037	0.002	1.157	0.010	0.009	1.0	0.99
90	890	0.0050	0.009	1.384	0.038	0.001	1.166	0.009	0.008	0.9	0.97
91	900	0.0050	0.009	1.393	0.040	0.001	1.175	0.009	0.008	0.9	0.94
92	910	0.0050	0.009	1.402	0.041	0.002	1.184	0.009	0.008	0.9	0.92
93	920	0.0050	0.009	1.411	0.043	0.002	1.193	0.009	0.008	0.9	0.90
94	930	0.0050	0.009	1.420	0.044	0.002	1.202	0.009	0.008	0.9	0.89
95	940	0.0050	0.009	1.429	0.046	0.002	1.210	0.009	0.008	0.9	0.89
96	950	0.0050	0.009	1.438	0.047	0.002	1.219	0.009	0.008	0.9	0.88
97	960	0.0050	0.009	1.447	0.049	0.002	1.228	0.009	0.008	0.9	0.88
98	970	0.0050	0.009	1.456	0.051	0.002	1.237	0.009	0.008	0.9	0.87
99	980	0.0050	0.009	1.465	0.053	0.002	1.246	0.009	0.008	0.9	0.87
100	990	0.0050	0.009	1.474	0.054	0.002	1.255	0.009	0.008	0.9	0.87
101	1000	0.0050	0.009	1.483	0.056	0.002	1.264	0.009	0.008	0.9	0.87
102	1010	0.0040	0.007	1.490	0.057	0.001	1.271	0.007	0.007	0.7	0.84
103	1020	0.0040	0.007	1.498	0.059	0.001	1.278	0.007	0.007	0.7	0.80
104	1030	0.0040	0.007	1.505	0.060	0.001	1.285	0.007	0.007	0.7	0.78
105	1040	0.0040	0.007	1.512	0.062	0.001	1.292	0.007	0.007	0.7	0.75
106	1050	0.0040	0.007	1.519	0.063	0.001	1.299	0.007	0.007	0.7	0.74
107	1060	0.0040	0.007	1.526	0.065	0.001	1.306	0.007	0.007	0.7	0.73
108	1070	0.0040	0.007	1.534	0.066	0.002	1.313	0.007	0.007	0.7	0.72
109	1080	0.0040	0.007	1.541	0.068	0.002	1.320	0.007	0.007	0.7	0.71
110	1090	0.0040	0.007	1.548	0.069	0.002	1.327	0.007	0.007	0.7	0.71
111	1100	0.0040	0.007	1.555	0.071	0.002	1.335	0.007	0.007	0.7	0.70
112	1110	0.0040	0.007	1.562	0.072	0.002	1.342	0.007	0.007	0.7	0.70
113	1120	0.0040	0.007	1.570	0.074	0.002	1.349	0.007	0.007	0.7	0.70
114	1130	0.0040	0.007	1.577	0.076	0.002	1.356	0.007	0.007	0.7	0.70
115	1140	0.0040	0.007	1.584	0.077	0.002	1.363	0.007	0.007	0.7	0.70

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.079	0.002	1.370	0.007	0.007	0.7	0.70
117	1160	0.0040	0.007	1.598	0.081	0.002	1.377	0.007	0.007	0.7	0.70
118	1170	0.0040	0.007	1.606	0.082	0.002	1.384	0.007	0.007	0.7	0.70
119	1180	0.0040	0.007	1.613	0.084	0.002	1.391	0.007	0.007	0.7	0.70
120	1190	0.0040	0.007	1.620	0.086	0.002	1.398	0.007	0.007	0.7	0.70
121	1200	0.0040	0.007	1.627	0.087	0.002	1.406	0.007	0.007	0.7	0.70
122	1210	0.0040	0.007	1.634	0.089	0.002	1.413	0.007	0.007	0.7	0.70
123	1220	0.0040	0.007	1.642	0.091	0.002	1.420	0.007	0.007	0.7	0.70
124	1230	0.0040	0.007	1.649	0.092	0.002	1.427	0.007	0.007	0.7	0.70
125	1240	0.0040	0.007	1.656	0.094	0.002	1.434	0.007	0.007	0.7	0.70
126	1250	0.0040	0.007	1.663	0.096	0.002	1.441	0.007	0.007	0.7	0.70
127	1260	0.0040	0.007	1.670	0.098	0.002	1.448	0.007	0.007	0.7	0.70
128	1270	0.0040	0.007	1.678	0.100	0.002	1.455	0.007	0.007	0.7	0.70
129	1280	0.0040	0.007	1.685	0.101	0.002	1.462	0.007	0.007	0.7	0.70
130	1290	0.0040	0.007	1.692	0.103	0.002	1.470	0.007	0.007	0.7	0.70
131	1300	0.0040	0.007	1.699	0.105	0.002	1.477	0.007	0.007	0.7	0.70
132	1310	0.0040	0.007	1.706	0.107	0.002	1.484	0.007	0.007	0.7	0.70
133	1320	0.0040	0.007	1.714	0.109	0.002	1.491	0.007	0.007	0.7	0.70
134	1330	0.0040	0.007	1.721	0.111	0.002	1.498	0.007	0.007	0.7	0.70
135	1340	0.0040	0.007	1.728	0.113	0.002	1.505	0.007	0.007	0.7	0.70
136	1350	0.0040	0.007	1.735	0.115	0.002	1.512	0.007	0.007	0.7	0.70
137	1360	0.0040	0.007	1.742	0.117	0.002	1.519	0.007	0.007	0.7	0.70
138	1370	0.0040	0.007	1.750	0.119	0.002	1.526	0.007	0.007	0.7	0.70
139	1380	0.0040	0.007	1.757	0.120	0.002	1.534	0.007	0.007	0.7	0.70
140	1390	0.0040	0.007	1.764	0.122	0.002	1.541	0.007	0.007	0.7	0.70
141	1400	0.0040	0.007	1.771	0.124	0.002	1.548	0.007	0.007	0.7	0.70
142	1410	0.0040	0.007	1.778	0.126	0.002	1.555	0.007	0.007	0.7	0.70
143	1420	0.0040	0.007	1.786	0.128	0.002	1.562	0.007	0.007	0.7	0.70
144	1430	0.0040	0.007	1.793	0.131	0.002	1.569	0.007	0.007	0.7	0.70
145	1440	0.0040	0.007	1.800	0.133	0.002	1.576	0.007	0.007	0.7	0.70

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to BNSF RR Culvert**

Design Storm : **2-yr / 24-hr**

Given:	Area =	4.18	Ac.	P =	1.80	in.	dt =	10 min.
PERVIOUS AREA:	Area =	0.42	Ac.	CN =	68.95		S = 4.5033	0.2S = 0.90
IMPERVIOUS AREA:	Area =	3.76	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 1.69 cfs
Total Volume = 21,693 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.00
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.01
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.0	0.02
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.0	0.03
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.1	0.05
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.003	0.1	0.06
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.1	0.07
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.1	0.08

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.004	0.1	0.09
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.004	0.1	0.10
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.005	0.1	0.11
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.005	0.1	0.13
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.006	0.1	0.14
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.006	0.1	0.15
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.006	0.2	0.15
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.006	0.2	0.16
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.008	0.2	0.18
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.008	0.2	0.20
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.008	0.2	0.20
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.008	0.2	0.21
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.009	0.2	0.21
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.009	0.2	0.22
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.010	0.3	0.24
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.011	0.3	0.26
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.011	0.3	0.27
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.011	0.3	0.27
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.011	0.3	0.28
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.011	0.3	0.28
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.013	0.3	0.31
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.013	0.3	0.33
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.013	0.3	0.34
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.013	0.3	0.34
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.014	0.3	0.34
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.014	0.3	0.34
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.019	0.5	0.42
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.020	0.5	0.49
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.020	0.5	0.50
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.027	0.7	0.59
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.027	0.7	0.68
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.051	1.3	0.99
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.083	2.1	1.69
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.042	1.1	1.57
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.028	0.7	0.88
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.021	0.5	0.62
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.021	0.5	0.53
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.021	0.5	0.53
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.014	0.3	0.44
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.014	0.3	0.35
56	550	0.0088	0.016	0.954	0.001	0.000	0.746	0.015	0.014	0.3	0.35
57	560	0.0088	0.016	0.970	0.001	0.000	0.762	0.015	0.014	0.3	0.35
58	570	0.0088	0.016	0.986	0.002	0.001	0.777	0.015	0.014	0.4	0.35
59	580	0.0088	0.016	1.002	0.002	0.001	0.792	0.015	0.014	0.4	0.35
60	590	0.0088	0.016	1.017	0.003	0.001	0.808	0.015	0.014	0.4	0.35
61	600	0.0088	0.016	1.033	0.004	0.001	0.823	0.015	0.014	0.4	0.35
62	610	0.0088	0.016	1.049	0.005	0.001	0.838	0.015	0.014	0.4	0.35
63	620	0.0088	0.016	1.065	0.006	0.001	0.854	0.015	0.014	0.4	0.35
64	630	0.0088	0.016	1.081	0.007	0.001	0.869	0.015	0.014	0.4	0.35
65	640	0.0088	0.016	1.097	0.008	0.001	0.885	0.015	0.014	0.4	0.35

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.009	0.001	0.897	0.013	0.011	0.3	0.32
67	660	0.0072	0.013	1.122	0.010	0.001	0.910	0.013	0.011	0.3	0.29
68	670	0.0072	0.013	1.135	0.012	0.001	0.923	0.013	0.011	0.3	0.29
69	680	0.0072	0.013	1.148	0.013	0.001	0.935	0.013	0.012	0.3	0.29
70	690	0.0072	0.013	1.161	0.014	0.001	0.948	0.013	0.012	0.3	0.29
71	700	0.0072	0.013	1.174	0.016	0.001	0.961	0.013	0.012	0.3	0.29
72	710	0.0072	0.013	1.187	0.017	0.001	0.973	0.013	0.012	0.3	0.29
73	720	0.0072	0.013	1.200	0.019	0.002	0.986	0.013	0.012	0.3	0.29
74	730	0.0072	0.013	1.213	0.020	0.002	0.999	0.013	0.012	0.3	0.29
75	740	0.0072	0.013	1.226	0.022	0.002	1.011	0.013	0.012	0.3	0.29
76	750	0.0072	0.013	1.239	0.024	0.002	1.024	0.013	0.012	0.3	0.29
77	760	0.0072	0.013	1.252	0.025	0.002	1.037	0.013	0.012	0.3	0.29
78	770	0.0057	0.010	1.262	0.027	0.001	1.047	0.010	0.009	0.2	0.26
79	780	0.0057	0.010	1.273	0.028	0.001	1.057	0.010	0.009	0.2	0.23
80	790	0.0057	0.010	1.283	0.030	0.002	1.067	0.010	0.009	0.2	0.23
81	800	0.0057	0.010	1.293	0.031	0.002	1.077	0.010	0.009	0.2	0.23
82	810	0.0057	0.010	1.303	0.033	0.002	1.087	0.010	0.009	0.2	0.23
83	820	0.0057	0.010	1.314	0.035	0.002	1.097	0.010	0.009	0.2	0.23
84	830	0.0057	0.010	1.324	0.036	0.002	1.107	0.010	0.009	0.2	0.23
85	840	0.0057	0.010	1.334	0.038	0.002	1.117	0.010	0.009	0.2	0.23
86	850	0.0057	0.010	1.344	0.040	0.002	1.127	0.010	0.009	0.2	0.23
87	860	0.0057	0.010	1.355	0.042	0.002	1.137	0.010	0.009	0.2	0.23
88	870	0.0057	0.010	1.365	0.043	0.002	1.147	0.010	0.009	0.2	0.23
89	880	0.0057	0.010	1.375	0.045	0.002	1.157	0.010	0.009	0.2	0.23
90	890	0.0050	0.009	1.384	0.047	0.002	1.166	0.009	0.008	0.2	0.22
91	900	0.0050	0.009	1.393	0.049	0.002	1.175	0.009	0.008	0.2	0.21
92	910	0.0050	0.009	1.402	0.050	0.002	1.184	0.009	0.008	0.2	0.21
93	920	0.0050	0.009	1.411	0.052	0.002	1.193	0.009	0.008	0.2	0.21
94	930	0.0050	0.009	1.420	0.054	0.002	1.202	0.009	0.008	0.2	0.21
95	940	0.0050	0.009	1.429	0.056	0.002	1.210	0.009	0.008	0.2	0.21
96	950	0.0050	0.009	1.438	0.057	0.002	1.219	0.009	0.008	0.2	0.21
97	960	0.0050	0.009	1.447	0.059	0.002	1.228	0.009	0.008	0.2	0.21
98	970	0.0050	0.009	1.456	0.061	0.002	1.237	0.009	0.008	0.2	0.21
99	980	0.0050	0.009	1.465	0.063	0.002	1.246	0.009	0.008	0.2	0.21
100	990	0.0050	0.009	1.474	0.065	0.002	1.255	0.009	0.008	0.2	0.21
101	1000	0.0050	0.009	1.483	0.067	0.002	1.264	0.009	0.008	0.2	0.21
102	1010	0.0040	0.007	1.490	0.068	0.002	1.271	0.007	0.007	0.2	0.19
103	1020	0.0040	0.007	1.498	0.070	0.002	1.278	0.007	0.007	0.2	0.17
104	1030	0.0040	0.007	1.505	0.071	0.002	1.285	0.007	0.007	0.2	0.17
105	1040	0.0040	0.007	1.512	0.073	0.002	1.292	0.007	0.007	0.2	0.17
106	1050	0.0040	0.007	1.519	0.075	0.002	1.299	0.007	0.007	0.2	0.17
107	1060	0.0040	0.007	1.526	0.076	0.002	1.306	0.007	0.007	0.2	0.17
108	1070	0.0040	0.007	1.534	0.078	0.002	1.313	0.007	0.007	0.2	0.17
109	1080	0.0040	0.007	1.541	0.080	0.002	1.320	0.007	0.007	0.2	0.17
110	1090	0.0040	0.007	1.548	0.081	0.002	1.327	0.007	0.007	0.2	0.17
111	1100	0.0040	0.007	1.555	0.083	0.002	1.335	0.007	0.007	0.2	0.17
112	1110	0.0040	0.007	1.562	0.085	0.002	1.342	0.007	0.007	0.2	0.17
113	1120	0.0040	0.007	1.570	0.087	0.002	1.349	0.007	0.007	0.2	0.17
114	1130	0.0040	0.007	1.577	0.088	0.002	1.356	0.007	0.007	0.2	0.17
115	1140	0.0040	0.007	1.584	0.090	0.002	1.363	0.007	0.007	0.2	0.17

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.092	0.002	1.370	0.007	0.007	0.2	0.17
117	1160	0.0040	0.007	1.598	0.094	0.002	1.377	0.007	0.007	0.2	0.17
118	1170	0.0040	0.007	1.606	0.095	0.002	1.384	0.007	0.007	0.2	0.17
119	1180	0.0040	0.007	1.613	0.097	0.002	1.391	0.007	0.007	0.2	0.17
120	1190	0.0040	0.007	1.620	0.099	0.002	1.398	0.007	0.007	0.2	0.17
121	1200	0.0040	0.007	1.627	0.101	0.002	1.406	0.007	0.007	0.2	0.17
122	1210	0.0040	0.007	1.634	0.103	0.002	1.413	0.007	0.007	0.2	0.17
123	1220	0.0040	0.007	1.642	0.105	0.002	1.420	0.007	0.007	0.2	0.17
124	1230	0.0040	0.007	1.649	0.107	0.002	1.427	0.007	0.007	0.2	0.17
125	1240	0.0040	0.007	1.656	0.108	0.002	1.434	0.007	0.007	0.2	0.17
126	1250	0.0040	0.007	1.663	0.110	0.002	1.441	0.007	0.007	0.2	0.17
127	1260	0.0040	0.007	1.670	0.112	0.002	1.448	0.007	0.007	0.2	0.17
128	1270	0.0040	0.007	1.678	0.114	0.002	1.455	0.007	0.007	0.2	0.17
129	1280	0.0040	0.007	1.685	0.116	0.002	1.462	0.007	0.007	0.2	0.17
130	1290	0.0040	0.007	1.692	0.118	0.002	1.470	0.007	0.007	0.2	0.17
131	1300	0.0040	0.007	1.699	0.120	0.002	1.477	0.007	0.007	0.2	0.17
132	1310	0.0040	0.007	1.706	0.122	0.002	1.484	0.007	0.007	0.2	0.17
133	1320	0.0040	0.007	1.714	0.124	0.002	1.491	0.007	0.007	0.2	0.17
134	1330	0.0040	0.007	1.721	0.126	0.002	1.498	0.007	0.007	0.2	0.17
135	1340	0.0040	0.007	1.728	0.128	0.002	1.505	0.007	0.007	0.2	0.17
136	1350	0.0040	0.007	1.735	0.130	0.002	1.512	0.007	0.007	0.2	0.17
137	1360	0.0040	0.007	1.742	0.133	0.002	1.519	0.007	0.007	0.2	0.17
138	1370	0.0040	0.007	1.750	0.135	0.002	1.526	0.007	0.007	0.2	0.17
139	1380	0.0040	0.007	1.757	0.137	0.002	1.534	0.007	0.007	0.2	0.17
140	1390	0.0040	0.007	1.764	0.139	0.002	1.541	0.007	0.007	0.2	0.17
141	1400	0.0040	0.007	1.771	0.141	0.002	1.548	0.007	0.007	0.2	0.17
142	1410	0.0040	0.007	1.778	0.143	0.002	1.555	0.007	0.007	0.2	0.17
143	1420	0.0040	0.007	1.786	0.145	0.002	1.562	0.007	0.007	0.2	0.17
144	1430	0.0040	0.007	1.793	0.148	0.002	1.569	0.007	0.007	0.2	0.17
145	1440	0.0040	0.007	1.800	0.150	0.002	1.576	0.007	0.007	0.2	0.17

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 69th Ave Culvert**

Design Storm : **2-yr / 24-hr**

Given:	Area =	0.76	Ac.	P =	1.80	in.	dt =	10 min.
PERVIOUS AREA:	Area =	0.08	Ac.	CN =	68.00		S = 4.7059	0.2S = 0.94
IMPERVIOUS AREA:	Area =	0.68	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 0.31 cfs
Total Volume = 3,920 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.00
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.00
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.0	0.00
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.0	0.01
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.0	0.01
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.003	0.0	0.01
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.0	0.01
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.0	0.01

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.004	0.0	0.02
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.004	0.0	0.02
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.005	0.0	0.02
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.005	0.0	0.02
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.006	0.0	0.03
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.006	0.0	0.03
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.006	0.0	0.03
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.006	0.0	0.03
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.008	0.0	0.03
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.008	0.0	0.04
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.008	0.0	0.04
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.008	0.0	0.04
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.008	0.0	0.04
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.009	0.0	0.04
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.010	0.0	0.04
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.011	0.0	0.05
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.011	0.0	0.05
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.011	0.0	0.05
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.011	0.1	0.05
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.011	0.1	0.05
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.013	0.1	0.06
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.013	0.1	0.06
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.013	0.1	0.06
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.013	0.1	0.06
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.014	0.1	0.06
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.014	0.1	0.06
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.019	0.1	0.08
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.019	0.1	0.09
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.020	0.1	0.09
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.027	0.1	0.11
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.027	0.1	0.12
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.051	0.2	0.18
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.082	0.4	0.31
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.041	0.2	0.28
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.028	0.1	0.16
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.021	0.1	0.11
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.021	0.1	0.10
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.021	0.1	0.10
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.014	0.1	0.08
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.014	0.1	0.06
56	550	0.0088	0.016	0.954	0.000	0.000	0.746	0.015	0.014	0.1	0.06
57	560	0.0088	0.016	0.970	0.000	0.000	0.762	0.015	0.014	0.1	0.06
58	570	0.0088	0.016	0.986	0.000	0.000	0.777	0.015	0.014	0.1	0.06
59	580	0.0088	0.016	1.002	0.001	0.000	0.792	0.015	0.014	0.1	0.06
60	590	0.0088	0.016	1.017	0.001	0.000	0.808	0.015	0.014	0.1	0.06
61	600	0.0088	0.016	1.033	0.002	0.001	0.823	0.015	0.014	0.1	0.06
62	610	0.0088	0.016	1.049	0.002	0.001	0.838	0.015	0.014	0.1	0.06
63	620	0.0088	0.016	1.065	0.003	0.001	0.854	0.015	0.014	0.1	0.06
64	630	0.0088	0.016	1.081	0.004	0.001	0.869	0.015	0.014	0.1	0.06
65	640	0.0088	0.016	1.097	0.005	0.001	0.885	0.015	0.014	0.1	0.06

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.006	0.001	0.897	0.013	0.011	0.1	0.06
67	660	0.0072	0.013	1.122	0.007	0.001	0.910	0.013	0.011	0.1	0.05
68	670	0.0072	0.013	1.135	0.008	0.001	0.923	0.013	0.011	0.1	0.05
69	680	0.0072	0.013	1.148	0.009	0.001	0.935	0.013	0.011	0.1	0.05
70	690	0.0072	0.013	1.161	0.010	0.001	0.948	0.013	0.011	0.1	0.05
71	700	0.0072	0.013	1.174	0.011	0.001	0.961	0.013	0.011	0.1	0.05
72	710	0.0072	0.013	1.187	0.012	0.001	0.973	0.013	0.011	0.1	0.05
73	720	0.0072	0.013	1.200	0.014	0.001	0.986	0.013	0.011	0.1	0.05
74	730	0.0072	0.013	1.213	0.015	0.001	0.999	0.013	0.011	0.1	0.05
75	740	0.0072	0.013	1.226	0.016	0.001	1.011	0.013	0.011	0.1	0.05
76	750	0.0072	0.013	1.239	0.018	0.001	1.024	0.013	0.012	0.1	0.05
77	760	0.0072	0.013	1.252	0.019	0.002	1.037	0.013	0.012	0.1	0.05
78	770	0.0057	0.010	1.262	0.021	0.001	1.047	0.010	0.009	0.0	0.05
79	780	0.0057	0.010	1.273	0.022	0.001	1.057	0.010	0.009	0.0	0.04
80	790	0.0057	0.010	1.283	0.023	0.001	1.067	0.010	0.009	0.0	0.04
81	800	0.0057	0.010	1.293	0.024	0.001	1.077	0.010	0.009	0.0	0.04
82	810	0.0057	0.010	1.303	0.026	0.001	1.087	0.010	0.009	0.0	0.04
83	820	0.0057	0.010	1.314	0.027	0.001	1.097	0.010	0.009	0.0	0.04
84	830	0.0057	0.010	1.324	0.029	0.001	1.107	0.010	0.009	0.0	0.04
85	840	0.0057	0.010	1.334	0.030	0.002	1.117	0.010	0.009	0.0	0.04
86	850	0.0057	0.010	1.344	0.032	0.002	1.127	0.010	0.009	0.0	0.04
87	860	0.0057	0.010	1.355	0.033	0.002	1.137	0.010	0.009	0.0	0.04
88	870	0.0057	0.010	1.365	0.035	0.002	1.147	0.010	0.009	0.0	0.04
89	880	0.0057	0.010	1.375	0.037	0.002	1.157	0.010	0.009	0.0	0.04
90	890	0.0050	0.009	1.384	0.038	0.001	1.166	0.009	0.008	0.0	0.04
91	900	0.0050	0.009	1.393	0.040	0.001	1.175	0.009	0.008	0.0	0.04
92	910	0.0050	0.009	1.402	0.041	0.002	1.184	0.009	0.008	0.0	0.04
93	920	0.0050	0.009	1.411	0.043	0.002	1.193	0.009	0.008	0.0	0.04
94	930	0.0050	0.009	1.420	0.044	0.002	1.202	0.009	0.008	0.0	0.04
95	940	0.0050	0.009	1.429	0.046	0.002	1.210	0.009	0.008	0.0	0.04
96	950	0.0050	0.009	1.438	0.047	0.002	1.219	0.009	0.008	0.0	0.04
97	960	0.0050	0.009	1.447	0.049	0.002	1.228	0.009	0.008	0.0	0.04
98	970	0.0050	0.009	1.456	0.051	0.002	1.237	0.009	0.008	0.0	0.04
99	980	0.0050	0.009	1.465	0.053	0.002	1.246	0.009	0.008	0.0	0.04
100	990	0.0050	0.009	1.474	0.054	0.002	1.255	0.009	0.008	0.0	0.04
101	1000	0.0050	0.009	1.483	0.056	0.002	1.264	0.009	0.008	0.0	0.04
102	1010	0.0040	0.007	1.490	0.057	0.001	1.271	0.007	0.006	0.0	0.03
103	1020	0.0040	0.007	1.498	0.059	0.001	1.278	0.007	0.006	0.0	0.03
104	1030	0.0040	0.007	1.505	0.060	0.001	1.285	0.007	0.006	0.0	0.03
105	1040	0.0040	0.007	1.512	0.062	0.001	1.292	0.007	0.007	0.0	0.03
106	1050	0.0040	0.007	1.519	0.063	0.001	1.299	0.007	0.007	0.0	0.03
107	1060	0.0040	0.007	1.526	0.065	0.001	1.306	0.007	0.007	0.0	0.03
108	1070	0.0040	0.007	1.534	0.066	0.002	1.313	0.007	0.007	0.0	0.03
109	1080	0.0040	0.007	1.541	0.068	0.002	1.320	0.007	0.007	0.0	0.03
110	1090	0.0040	0.007	1.548	0.069	0.002	1.327	0.007	0.007	0.0	0.03
111	1100	0.0040	0.007	1.555	0.071	0.002	1.335	0.007	0.007	0.0	0.03
112	1110	0.0040	0.007	1.562	0.072	0.002	1.342	0.007	0.007	0.0	0.03
113	1120	0.0040	0.007	1.570	0.074	0.002	1.349	0.007	0.007	0.0	0.03
114	1130	0.0040	0.007	1.577	0.076	0.002	1.356	0.007	0.007	0.0	0.03
115	1140	0.0040	0.007	1.584	0.077	0.002	1.363	0.007	0.007	0.0	0.03

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.079	0.002	1.370	0.007	0.007	0.0	0.03
117	1160	0.0040	0.007	1.598	0.081	0.002	1.377	0.007	0.007	0.0	0.03
118	1170	0.0040	0.007	1.606	0.082	0.002	1.384	0.007	0.007	0.0	0.03
119	1180	0.0040	0.007	1.613	0.084	0.002	1.391	0.007	0.007	0.0	0.03
120	1190	0.0040	0.007	1.620	0.086	0.002	1.398	0.007	0.007	0.0	0.03
121	1200	0.0040	0.007	1.627	0.087	0.002	1.406	0.007	0.007	0.0	0.03
122	1210	0.0040	0.007	1.634	0.089	0.002	1.413	0.007	0.007	0.0	0.03
123	1220	0.0040	0.007	1.642	0.091	0.002	1.420	0.007	0.007	0.0	0.03
124	1230	0.0040	0.007	1.649	0.092	0.002	1.427	0.007	0.007	0.0	0.03
125	1240	0.0040	0.007	1.656	0.094	0.002	1.434	0.007	0.007	0.0	0.03
126	1250	0.0040	0.007	1.663	0.096	0.002	1.441	0.007	0.007	0.0	0.03
127	1260	0.0040	0.007	1.670	0.098	0.002	1.448	0.007	0.007	0.0	0.03
128	1270	0.0040	0.007	1.678	0.100	0.002	1.455	0.007	0.007	0.0	0.03
129	1280	0.0040	0.007	1.685	0.101	0.002	1.462	0.007	0.007	0.0	0.03
130	1290	0.0040	0.007	1.692	0.103	0.002	1.470	0.007	0.007	0.0	0.03
131	1300	0.0040	0.007	1.699	0.105	0.002	1.477	0.007	0.007	0.0	0.03
132	1310	0.0040	0.007	1.706	0.107	0.002	1.484	0.007	0.007	0.0	0.03
133	1320	0.0040	0.007	1.714	0.109	0.002	1.491	0.007	0.007	0.0	0.03
134	1330	0.0040	0.007	1.721	0.111	0.002	1.498	0.007	0.007	0.0	0.03
135	1340	0.0040	0.007	1.728	0.113	0.002	1.505	0.007	0.007	0.0	0.03
136	1350	0.0040	0.007	1.735	0.115	0.002	1.512	0.007	0.007	0.0	0.03
137	1360	0.0040	0.007	1.742	0.117	0.002	1.519	0.007	0.007	0.0	0.03
138	1370	0.0040	0.007	1.750	0.119	0.002	1.526	0.007	0.007	0.0	0.03
139	1380	0.0040	0.007	1.757	0.120	0.002	1.534	0.007	0.007	0.0	0.03
140	1390	0.0040	0.007	1.764	0.122	0.002	1.541	0.007	0.007	0.0	0.03
141	1400	0.0040	0.007	1.771	0.124	0.002	1.548	0.007	0.007	0.0	0.03
142	1410	0.0040	0.007	1.778	0.126	0.002	1.555	0.007	0.007	0.0	0.03
143	1420	0.0040	0.007	1.786	0.128	0.002	1.562	0.007	0.007	0.0	0.03
144	1430	0.0040	0.007	1.793	0.131	0.002	1.569	0.007	0.007	0.0	0.03
145	1440	0.0040	0.007	1.800	0.133	0.002	1.576	0.007	0.007	0.0	0.03

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to Confluence Point**

Design Storm : **2-yr / 24-hr**

Given:	Area =	11.29	Ac.	P =	1.80	in.	dt =	10 min.
PERVIOUS AREA:	Area =	3.01	Ac.	CN =	68.00		S = 4.7059	0.2S = 0.94
IMPERVIOUS AREA:	Area =	8.28	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 3.73 cfs
Total Volume = 48,708 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.03
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.1	0.05
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.1	0.07
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.1	0.10
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.002	0.1	0.14
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.002	0.2	0.16
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.2	0.18

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.003	0.2	0.20
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.003	0.2	0.21
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.004	0.3	0.25
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.004	0.3	0.29
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.005	0.3	0.31
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.005	0.3	0.32
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.005	0.3	0.34
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.005	0.4	0.35
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.006	0.4	0.39
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.006	0.4	0.44
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.007	0.5	0.45
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.007	0.5	0.46
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.007	0.5	0.47
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.007	0.5	0.48
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.008	0.6	0.53
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.009	0.6	0.58
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.009	0.6	0.59
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.009	0.6	0.60
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.009	0.6	0.61
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.009	0.6	0.62
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.011	0.7	0.67
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.011	0.7	0.73
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.011	0.7	0.74
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.011	0.7	0.75
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.011	0.8	0.75
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.011	0.8	0.76
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.016	1.1	0.92
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.016	1.1	1.09
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.016	1.1	1.10
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.022	1.5	1.29
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.022	1.5	1.49
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.042	2.9	2.18
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.067	4.6	3.73
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.034	2.3	3.46
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.023	1.6	1.94
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.017	1.2	1.36
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.017	1.2	1.16
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.017	1.2	1.16
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.011	0.8	0.96
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.011	0.8	0.77
56	550	0.0088	0.016	0.954	0.000	0.000	0.746	0.015	0.011	0.8	0.77
57	560	0.0088	0.016	0.970	0.000	0.000	0.762	0.015	0.011	0.8	0.77
58	570	0.0088	0.016	0.986	0.000	0.000	0.777	0.015	0.011	0.8	0.77
59	580	0.0088	0.016	1.002	0.001	0.000	0.792	0.015	0.011	0.8	0.77
60	590	0.0088	0.016	1.017	0.001	0.000	0.808	0.015	0.011	0.8	0.78
61	600	0.0088	0.016	1.033	0.002	0.001	0.823	0.015	0.011	0.8	0.78
62	610	0.0088	0.016	1.049	0.002	0.001	0.838	0.015	0.011	0.8	0.78
63	620	0.0088	0.016	1.065	0.003	0.001	0.854	0.015	0.011	0.8	0.78
64	630	0.0088	0.016	1.081	0.004	0.001	0.869	0.015	0.012	0.8	0.79
65	640	0.0088	0.016	1.097	0.005	0.001	0.885	0.015	0.012	0.8	0.79

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.006	0.001	0.897	0.013	0.009	0.6	0.72
67	660	0.0072	0.013	1.122	0.007	0.001	0.910	0.013	0.010	0.6	0.65
68	670	0.0072	0.013	1.135	0.008	0.001	0.923	0.013	0.010	0.7	0.65
69	680	0.0072	0.013	1.148	0.009	0.001	0.935	0.013	0.010	0.7	0.65
70	690	0.0072	0.013	1.161	0.010	0.001	0.948	0.013	0.010	0.7	0.65
71	700	0.0072	0.013	1.174	0.011	0.001	0.961	0.013	0.010	0.7	0.65
72	710	0.0072	0.013	1.187	0.012	0.001	0.973	0.013	0.010	0.7	0.66
73	720	0.0072	0.013	1.200	0.014	0.001	0.986	0.013	0.010	0.7	0.66
74	730	0.0072	0.013	1.213	0.015	0.001	0.999	0.013	0.010	0.7	0.66
75	740	0.0072	0.013	1.226	0.016	0.001	1.011	0.013	0.010	0.7	0.66
76	750	0.0072	0.013	1.239	0.018	0.001	1.024	0.013	0.010	0.7	0.66
77	760	0.0072	0.013	1.252	0.019	0.002	1.037	0.013	0.010	0.7	0.66
78	770	0.0057	0.010	1.262	0.021	0.001	1.047	0.010	0.008	0.5	0.59
79	780	0.0057	0.010	1.273	0.022	0.001	1.057	0.010	0.008	0.5	0.53
80	790	0.0057	0.010	1.283	0.023	0.001	1.067	0.010	0.008	0.5	0.53
81	800	0.0057	0.010	1.293	0.024	0.001	1.077	0.010	0.008	0.5	0.53
82	810	0.0057	0.010	1.303	0.026	0.001	1.087	0.010	0.008	0.5	0.53
83	820	0.0057	0.010	1.314	0.027	0.001	1.097	0.010	0.008	0.5	0.53
84	830	0.0057	0.010	1.324	0.029	0.001	1.107	0.010	0.008	0.5	0.53
85	840	0.0057	0.010	1.334	0.030	0.002	1.117	0.010	0.008	0.5	0.53
86	850	0.0057	0.010	1.344	0.032	0.002	1.127	0.010	0.008	0.5	0.53
87	860	0.0057	0.010	1.355	0.033	0.002	1.137	0.010	0.008	0.5	0.53
88	870	0.0057	0.010	1.365	0.035	0.002	1.147	0.010	0.008	0.5	0.53
89	880	0.0057	0.010	1.375	0.037	0.002	1.157	0.010	0.008	0.5	0.53
90	890	0.0050	0.009	1.384	0.038	0.001	1.166	0.009	0.007	0.5	0.50
91	900	0.0050	0.009	1.393	0.040	0.001	1.175	0.009	0.007	0.5	0.47
92	910	0.0050	0.009	1.402	0.041	0.002	1.184	0.009	0.007	0.5	0.47
93	920	0.0050	0.009	1.411	0.043	0.002	1.193	0.009	0.007	0.5	0.47
94	930	0.0050	0.009	1.420	0.044	0.002	1.202	0.009	0.007	0.5	0.47
95	940	0.0050	0.009	1.429	0.046	0.002	1.210	0.009	0.007	0.5	0.47
96	950	0.0050	0.009	1.438	0.047	0.002	1.219	0.009	0.007	0.5	0.47
97	960	0.0050	0.009	1.447	0.049	0.002	1.228	0.009	0.007	0.5	0.47
98	970	0.0050	0.009	1.456	0.051	0.002	1.237	0.009	0.007	0.5	0.47
99	980	0.0050	0.009	1.465	0.053	0.002	1.246	0.009	0.007	0.5	0.47
100	990	0.0050	0.009	1.474	0.054	0.002	1.255	0.009	0.007	0.5	0.47
101	1000	0.0050	0.009	1.483	0.056	0.002	1.264	0.009	0.007	0.5	0.48
102	1010	0.0040	0.007	1.490	0.057	0.001	1.271	0.007	0.006	0.4	0.43
103	1020	0.0040	0.007	1.498	0.059	0.001	1.278	0.007	0.006	0.4	0.38
104	1030	0.0040	0.007	1.505	0.060	0.001	1.285	0.007	0.006	0.4	0.38
105	1040	0.0040	0.007	1.512	0.062	0.001	1.292	0.007	0.006	0.4	0.38
106	1050	0.0040	0.007	1.519	0.063	0.001	1.299	0.007	0.006	0.4	0.38
107	1060	0.0040	0.007	1.526	0.065	0.001	1.306	0.007	0.006	0.4	0.38
108	1070	0.0040	0.007	1.534	0.066	0.002	1.313	0.007	0.006	0.4	0.38
109	1080	0.0040	0.007	1.541	0.068	0.002	1.320	0.007	0.006	0.4	0.38
110	1090	0.0040	0.007	1.548	0.069	0.002	1.327	0.007	0.006	0.4	0.38
111	1100	0.0040	0.007	1.555	0.071	0.002	1.335	0.007	0.006	0.4	0.38
112	1110	0.0040	0.007	1.562	0.072	0.002	1.342	0.007	0.006	0.4	0.38
113	1120	0.0040	0.007	1.570	0.074	0.002	1.349	0.007	0.006	0.4	0.38
114	1130	0.0040	0.007	1.577	0.076	0.002	1.356	0.007	0.006	0.4	0.38
115	1140	0.0040	0.007	1.584	0.077	0.002	1.363	0.007	0.006	0.4	0.39

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.079	0.002	1.370	0.007	0.006	0.4	0.39
117	1160	0.0040	0.007	1.598	0.081	0.002	1.377	0.007	0.006	0.4	0.39
118	1170	0.0040	0.007	1.606	0.082	0.002	1.384	0.007	0.006	0.4	0.39
119	1180	0.0040	0.007	1.613	0.084	0.002	1.391	0.007	0.006	0.4	0.39
120	1190	0.0040	0.007	1.620	0.086	0.002	1.398	0.007	0.006	0.4	0.39
121	1200	0.0040	0.007	1.627	0.087	0.002	1.406	0.007	0.006	0.4	0.39
122	1210	0.0040	0.007	1.634	0.089	0.002	1.413	0.007	0.006	0.4	0.39
123	1220	0.0040	0.007	1.642	0.091	0.002	1.420	0.007	0.006	0.4	0.39
124	1230	0.0040	0.007	1.649	0.092	0.002	1.427	0.007	0.006	0.4	0.39
125	1240	0.0040	0.007	1.656	0.094	0.002	1.434	0.007	0.006	0.4	0.39
126	1250	0.0040	0.007	1.663	0.096	0.002	1.441	0.007	0.006	0.4	0.39
127	1260	0.0040	0.007	1.670	0.098	0.002	1.448	0.007	0.006	0.4	0.39
128	1270	0.0040	0.007	1.678	0.100	0.002	1.455	0.007	0.006	0.4	0.39
129	1280	0.0040	0.007	1.685	0.101	0.002	1.462	0.007	0.006	0.4	0.39
130	1290	0.0040	0.007	1.692	0.103	0.002	1.470	0.007	0.006	0.4	0.39
131	1300	0.0040	0.007	1.699	0.105	0.002	1.477	0.007	0.006	0.4	0.39
132	1310	0.0040	0.007	1.706	0.107	0.002	1.484	0.007	0.006	0.4	0.39
133	1320	0.0040	0.007	1.714	0.109	0.002	1.491	0.007	0.006	0.4	0.39
134	1330	0.0040	0.007	1.721	0.111	0.002	1.498	0.007	0.006	0.4	0.39
135	1340	0.0040	0.007	1.728	0.113	0.002	1.505	0.007	0.006	0.4	0.39
136	1350	0.0040	0.007	1.735	0.115	0.002	1.512	0.007	0.006	0.4	0.39
137	1360	0.0040	0.007	1.742	0.117	0.002	1.519	0.007	0.006	0.4	0.39
138	1370	0.0040	0.007	1.750	0.119	0.002	1.526	0.007	0.006	0.4	0.39
139	1380	0.0040	0.007	1.757	0.120	0.002	1.534	0.007	0.006	0.4	0.39
140	1390	0.0040	0.007	1.764	0.122	0.002	1.541	0.007	0.006	0.4	0.39
141	1400	0.0040	0.007	1.771	0.124	0.002	1.548	0.007	0.006	0.4	0.39
142	1410	0.0040	0.007	1.778	0.126	0.002	1.555	0.007	0.006	0.4	0.39
143	1420	0.0040	0.007	1.786	0.128	0.002	1.562	0.007	0.006	0.4	0.39
144	1430	0.0040	0.007	1.793	0.131	0.002	1.569	0.007	0.006	0.4	0.39
145	1440	0.0040	0.007	1.800	0.133	0.002	1.576	0.007	0.006	0.4	0.39

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Headwater Basin**
Design Storm : **10-yr / 24-hr**

Given: Area = 1008.52 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 614.12 Ac. CN = 81.50 S = 2.2699 0.2S = 0.45
IMPERVIOUS AREA: Area = 394.40 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 130.77 cfs ***$T_{(Peak)}$ = 8.83 hrs***
Total Volume = 5,950,214 cf ***$Tc_{(min)}$ = 187 min***

Equations:
Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.4	0.01
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.000	2.8	0.09
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.001	5.3	0.30
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.001	7.4	0.61
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.002	9.3	1.02
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.002	10.9	1.49
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.002	12.3	2.01
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.003	17.0	2.67
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.003	18.7	3.46
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.003	20.1	4.29
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.004	21.4	5.15

Exhibit 6.1

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.004	22.5	6.02
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.004	23.4	6.90
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.005	29.2	7.91
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.005	30.3	9.05
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.005	31.2	10.18
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.005	32.0	11.30
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.005	32.8	12.40
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.005	33.4	13.47
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.007	39.7	14.68
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.007	40.4	16.00
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.007	41.0	17.29
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.007	41.6	18.54
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.007	42.0	19.75
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.007	42.5	20.92
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.008	50.3	22.25
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.008	51.6	23.74
32	310	0.0082	0.024	0.501	0.001	0.001	0.318	0.021	0.009	53.8	25.25
33	320	0.0082	0.024	0.524	0.002	0.001	0.340	0.022	0.009	55.9	26.79
34	330	0.0082	0.024	0.548	0.004	0.002	0.362	0.022	0.010	58.0	28.36
35	340	0.0082	0.024	0.572	0.006	0.002	0.384	0.022	0.010	59.9	29.96
36	350	0.0095	0.028	0.599	0.009	0.003	0.409	0.026	0.012	71.8	31.83
37	360	0.0095	0.028	0.627	0.012	0.003	0.435	0.026	0.012	74.2	33.97
38	370	0.0095	0.028	0.655	0.016	0.004	0.461	0.026	0.013	76.5	36.12
39	380	0.0095	0.028	0.682	0.021	0.005	0.486	0.026	0.013	78.7	38.28
40	390	0.0095	0.028	0.710	0.026	0.005	0.512	0.026	0.013	80.8	40.44
41	400	0.0095	0.028	0.737	0.031	0.006	0.539	0.026	0.014	82.8	42.59
42	410	0.0134	0.039	0.776	0.040	0.009	0.575	0.037	0.020	120.1	45.66
43	420	0.0134	0.039	0.815	0.050	0.009	0.613	0.037	0.020	123.8	49.64
44	430	0.0134	0.039	0.854	0.060	0.010	0.650	0.037	0.021	127.3	53.59
45	440	0.0180	0.052	0.906	0.075	0.015	0.700	0.050	0.029	176.2	58.70
46	450	0.0180	0.052	0.958	0.092	0.017	0.750	0.050	0.030	181.8	64.97
47	460	0.0340	0.099	1.057	0.126	0.035	0.846	0.096	0.059	357.6	75.63
48	470	0.0540	0.157	1.213	0.190	0.064	0.999	0.153	0.099	601.7	96.68
49	480	0.0270	0.078	1.292	0.226	0.035	1.075	0.077	0.052	314.6	115.50
50	490	0.0180	0.052	1.344	0.251	0.025	1.127	0.051	0.035	214.4	123.26
51	500	0.0134	0.039	1.383	0.270	0.019	1.165	0.038	0.027	161.8	126.64
52	510	0.0134	0.039	1.422	0.289	0.020	1.203	0.038	0.027	163.7	128.52
53	520	0.0134	0.039	1.460	0.309	0.020	1.241	0.038	0.027	165.5	130.40
54	530	0.0088	0.026	1.486	0.323	0.013	1.266	0.025	0.018	109.6	130.77
55	540	0.0088	0.026	1.511	0.336	0.014	1.291	0.025	0.018	110.3	129.69
56	550	0.0088	0.026	1.537	0.350	0.014	1.317	0.025	0.018	111.0	128.70
57	560	0.0088	0.026	1.563	0.364	0.014	1.342	0.025	0.018	111.7	127.80
58	570	0.0088	0.026	1.588	0.378	0.014	1.367	0.025	0.018	112.4	126.98
59	580	0.0088	0.026	1.614	0.392	0.014	1.392	0.025	0.019	113.0	126.23
60	590	0.0088	0.026	1.639	0.406	0.014	1.417	0.025	0.019	113.7	125.56
61	600	0.0088	0.026	1.665	0.421	0.015	1.442	0.025	0.019	114.3	124.96
62	610	0.0088	0.026	1.690	0.436	0.015	1.468	0.025	0.019	114.9	124.42
63	620	0.0088	0.026	1.716	0.451	0.015	1.493	0.025	0.019	115.5	123.94
64	630	0.0088	0.026	1.741	0.466	0.015	1.518	0.025	0.019	116.1	123.52
65	640	0.0088	0.026	1.767	0.481	0.015	1.543	0.025	0.019	116.7	123.15

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.494	0.013	1.564	0.021	0.016	95.9	122.27
67	660	0.0072	0.021	1.808	0.506	0.013	1.585	0.021	0.016	96.3	120.91
68	670	0.0072	0.021	1.829	0.519	0.013	1.605	0.021	0.016	96.6	119.63
69	680	0.0072	0.021	1.850	0.532	0.013	1.626	0.021	0.016	97.0	118.44
70	690	0.0072	0.021	1.871	0.545	0.013	1.647	0.021	0.016	97.3	117.33
71	700	0.0072	0.021	1.892	0.558	0.013	1.667	0.021	0.016	97.7	116.30
72	710	0.0072	0.021	1.913	0.571	0.013	1.688	0.021	0.016	98.0	115.34
73	720	0.0072	0.021	1.934	0.584	0.013	1.709	0.021	0.016	98.3	114.44
74	730	0.0072	0.021	1.955	0.597	0.013	1.729	0.021	0.016	98.7	113.61
75	740	0.0072	0.021	1.975	0.611	0.013	1.750	0.021	0.016	99.0	112.84
76	750	0.0072	0.021	1.996	0.624	0.013	1.771	0.021	0.016	99.3	112.13
77	760	0.0072	0.021	2.017	0.638	0.014	1.791	0.021	0.016	99.6	111.47
78	770	0.0057	0.017	2.034	0.648	0.011	1.808	0.016	0.013	79.1	110.32
79	780	0.0057	0.017	2.050	0.659	0.011	1.824	0.016	0.013	79.3	108.69
80	790	0.0057	0.017	2.067	0.670	0.011	1.841	0.016	0.013	79.4	107.17
81	800	0.0057	0.017	2.083	0.681	0.011	1.857	0.016	0.013	79.6	105.73
82	810	0.0057	0.017	2.100	0.692	0.011	1.873	0.016	0.013	79.8	104.37
83	820	0.0057	0.017	2.116	0.703	0.011	1.890	0.016	0.013	80.0	103.10
84	830	0.0057	0.017	2.133	0.714	0.011	1.906	0.016	0.013	80.2	101.90
85	840	0.0057	0.017	2.149	0.725	0.011	1.923	0.016	0.013	80.3	100.77
86	850	0.0057	0.017	2.166	0.736	0.011	1.939	0.016	0.013	80.5	99.71
87	860	0.0057	0.017	2.183	0.747	0.011	1.955	0.016	0.013	80.7	98.72
88	870	0.0057	0.017	2.199	0.758	0.011	1.972	0.016	0.013	80.9	97.78
89	880	0.0057	0.017	2.216	0.770	0.011	1.988	0.016	0.013	81.0	96.90
90	890	0.0050	0.015	2.230	0.780	0.010	2.003	0.014	0.012	71.2	95.82
91	900	0.0050	0.015	2.245	0.790	0.010	2.017	0.014	0.012	71.3	94.54
92	910	0.0050	0.015	2.259	0.800	0.010	2.031	0.014	0.012	71.4	93.34
93	920	0.0050	0.015	2.274	0.810	0.010	2.046	0.014	0.012	71.6	92.20
94	930	0.0050	0.015	2.288	0.820	0.010	2.060	0.014	0.012	71.7	91.13
95	940	0.0050	0.015	2.303	0.830	0.010	2.075	0.014	0.012	71.8	90.12
96	950	0.0050	0.015	2.317	0.840	0.010	2.089	0.014	0.012	71.9	89.17
97	960	0.0050	0.015	2.332	0.850	0.010	2.103	0.014	0.012	72.0	88.27
98	970	0.0050	0.015	2.346	0.860	0.010	2.118	0.014	0.012	72.2	87.43
99	980	0.0050	0.015	2.361	0.870	0.010	2.132	0.014	0.012	72.3	86.64
100	990	0.0050	0.015	2.375	0.881	0.010	2.147	0.014	0.012	72.4	85.89
101	1000	0.0050	0.015	2.390	0.891	0.010	2.161	0.014	0.012	72.5	85.19
102	1010	0.0040	0.012	2.401	0.899	0.008	2.173	0.012	0.010	58.1	84.16
103	1020	0.0040	0.012	2.413	0.907	0.008	2.184	0.012	0.010	58.2	82.80
104	1030	0.0040	0.012	2.424	0.916	0.008	2.196	0.012	0.010	58.2	81.52
105	1040	0.0040	0.012	2.436	0.924	0.008	2.207	0.012	0.010	58.3	80.31
106	1050	0.0040	0.012	2.448	0.932	0.008	2.219	0.012	0.010	58.4	79.16
107	1060	0.0040	0.012	2.459	0.941	0.008	2.230	0.012	0.010	58.4	78.08
108	1070	0.0040	0.012	2.471	0.949	0.008	2.242	0.012	0.010	58.5	77.06
109	1080	0.0040	0.012	2.482	0.957	0.008	2.253	0.012	0.010	58.6	76.09
110	1090	0.0040	0.012	2.494	0.966	0.008	2.265	0.012	0.010	58.6	75.18
111	1100	0.0040	0.012	2.506	0.974	0.008	2.276	0.012	0.010	58.7	74.32
112	1110	0.0040	0.012	2.517	0.982	0.008	2.288	0.012	0.010	58.8	73.51
113	1120	0.0040	0.012	2.529	0.991	0.008	2.299	0.012	0.010	58.8	72.74
114	1130	0.0040	0.012	2.540	0.999	0.008	2.311	0.012	0.010	58.9	72.02
115	1140	0.0040	0.012	2.552	1.008	0.008	2.322	0.012	0.010	59.0	71.34

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	1.016	0.008	2.334	0.012	0.010	59.0	70.69
117	1160	0.0040	0.012	2.575	1.025	0.008	2.346	0.012	0.010	59.1	70.09
118	1170	0.0040	0.012	2.587	1.033	0.009	2.357	0.012	0.010	59.1	69.51
119	1180	0.0040	0.012	2.598	1.042	0.009	2.369	0.012	0.010	59.2	68.98
120	1190	0.0040	0.012	2.610	1.050	0.009	2.380	0.012	0.010	59.3	68.47
121	1200	0.0040	0.012	2.622	1.059	0.009	2.392	0.012	0.010	59.3	67.99
122	1210	0.0040	0.012	2.633	1.067	0.009	2.403	0.012	0.010	59.4	67.54
123	1220	0.0040	0.012	2.645	1.076	0.009	2.415	0.012	0.010	59.4	67.12
124	1230	0.0040	0.012	2.656	1.085	0.009	2.426	0.012	0.010	59.5	66.72
125	1240	0.0040	0.012	2.668	1.093	0.009	2.438	0.012	0.010	59.6	66.34
126	1250	0.0040	0.012	2.680	1.102	0.009	2.449	0.012	0.010	59.6	65.99
127	1260	0.0040	0.012	2.691	1.110	0.009	2.461	0.012	0.010	59.7	65.66
128	1270	0.0040	0.012	2.703	1.119	0.009	2.472	0.012	0.010	59.7	65.35
129	1280	0.0040	0.012	2.714	1.128	0.009	2.484	0.012	0.010	59.8	65.06
130	1290	0.0040	0.012	2.726	1.137	0.009	2.496	0.012	0.010	59.8	64.79
131	1300	0.0040	0.012	2.738	1.145	0.009	2.507	0.012	0.010	59.9	64.53
132	1310	0.0040	0.012	2.749	1.154	0.009	2.519	0.012	0.010	60.0	64.29
133	1320	0.0040	0.012	2.761	1.163	0.009	2.530	0.012	0.010	60.0	64.07
134	1330	0.0040	0.012	2.772	1.171	0.009	2.542	0.012	0.010	60.1	63.86
135	1340	0.0040	0.012	2.784	1.180	0.009	2.553	0.012	0.010	60.1	63.66
136	1350	0.0040	0.012	2.796	1.189	0.009	2.565	0.012	0.010	60.2	63.48
137	1360	0.0040	0.012	2.807	1.198	0.009	2.576	0.012	0.010	60.2	63.31
138	1370	0.0040	0.012	2.819	1.207	0.009	2.588	0.012	0.010	60.3	63.15
139	1380	0.0040	0.012	2.830	1.215	0.009	2.599	0.012	0.010	60.3	63.00
140	1390	0.0040	0.012	2.842	1.224	0.009	2.611	0.012	0.010	60.4	62.86
141	1400	0.0040	0.012	2.854	1.233	0.009	2.623	0.012	0.010	60.4	62.74
142	1410	0.0040	0.012	2.865	1.242	0.009	2.634	0.012	0.010	60.5	62.62
143	1420	0.0040	0.012	2.877	1.251	0.009	2.646	0.012	0.010	60.5	62.51
144	1430	0.0040	0.012	2.888	1.260	0.009	2.657	0.012	0.010	60.6	62.41
145	1440	0.0040	0.012	2.900	1.269	0.009	2.669	0.012	0.010	60.6	62.31

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 74th Ave Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 136.58 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 59.02 Ac. CN = 76.51 S = 3.0702 0.2S = 0.61

IMPERVIOUS AREA: Area = 77.56 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 19.60 cfs ***$T_{(Peak)}$ = 8.67 hrs***

Total Volume = 865,544 cf ***$Tc_{(min)}$ = 187 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.1	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.6	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.001	1.0	0.06
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.002	1.5	0.12
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.002	1.8	0.20
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.003	2.1	0.29
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.003	2.4	0.40
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.004	3.3	0.53
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.004	3.7	0.68
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.005	4.0	0.84
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.005	4.2	1.01

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.005	4.4	1.18
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.006	4.6	1.36
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.007	5.7	1.56
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.007	6.0	1.78
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.007	6.1	2.00
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.008	6.3	2.22
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.008	6.4	2.44
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.008	6.6	2.65
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.009	7.8	2.89
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.010	7.9	3.15
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.010	8.1	3.40
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.010	8.2	3.65
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.010	8.3	3.88
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.010	8.4	4.11
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.012	9.9	4.37
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.012	10.0	4.66
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.012	10.1	4.94
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.012	10.1	5.21
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.012	10.2	5.47
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.012	10.3	5.72
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.014	12.0	6.00
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.015	12.1	6.31
38	370	0.0095	0.028	0.655	0.001	0.000	0.461	0.026	0.015	12.3	6.62
39	380	0.0095	0.028	0.682	0.001	0.001	0.486	0.026	0.015	12.5	6.92
40	390	0.0095	0.028	0.710	0.003	0.001	0.512	0.026	0.015	12.7	7.21
41	400	0.0095	0.028	0.737	0.005	0.002	0.539	0.026	0.016	12.9	7.50
42	410	0.0134	0.039	0.776	0.008	0.003	0.575	0.037	0.022	18.5	7.93
43	420	0.0134	0.039	0.815	0.012	0.004	0.613	0.037	0.023	18.9	8.49
44	430	0.0134	0.039	0.854	0.017	0.005	0.650	0.037	0.023	19.3	9.05
45	440	0.0180	0.052	0.906	0.025	0.008	0.700	0.050	0.032	26.4	9.76
46	450	0.0180	0.052	0.958	0.035	0.009	0.750	0.050	0.033	27.0	10.65
47	460	0.0340	0.099	1.057	0.056	0.021	0.846	0.096	0.063	52.4	12.16
48	470	0.0540	0.157	1.213	0.098	0.042	0.999	0.153	0.105	86.7	15.15
49	480	0.0270	0.078	1.292	0.123	0.025	1.075	0.077	0.054	44.8	17.78
50	490	0.0180	0.052	1.344	0.140	0.018	1.127	0.051	0.037	30.3	18.81
51	500	0.0134	0.039	1.383	0.154	0.014	1.165	0.038	0.028	22.8	19.22
52	510	0.0134	0.039	1.422	0.168	0.014	1.203	0.038	0.028	23.0	19.41
53	520	0.0134	0.039	1.460	0.183	0.015	1.241	0.038	0.028	23.2	19.60
54	530	0.0088	0.026	1.486	0.193	0.010	1.266	0.025	0.019	15.3	19.58
55	540	0.0088	0.026	1.511	0.203	0.010	1.291	0.025	0.019	15.4	19.37
56	550	0.0088	0.026	1.537	0.213	0.010	1.317	0.025	0.019	15.5	19.16
57	560	0.0088	0.026	1.563	0.224	0.011	1.342	0.025	0.019	15.6	18.97
58	570	0.0088	0.026	1.588	0.235	0.011	1.367	0.025	0.019	15.6	18.80
59	580	0.0088	0.026	1.614	0.245	0.011	1.392	0.025	0.019	15.7	18.63
60	590	0.0088	0.026	1.639	0.257	0.011	1.417	0.025	0.019	15.8	18.48
61	600	0.0088	0.026	1.665	0.268	0.011	1.442	0.025	0.019	15.8	18.34
62	610	0.0088	0.026	1.690	0.279	0.011	1.468	0.025	0.019	15.9	18.22
63	620	0.0088	0.026	1.716	0.291	0.012	1.493	0.025	0.019	16.0	18.10
64	630	0.0088	0.026	1.741	0.303	0.012	1.518	0.025	0.019	16.0	17.99
65	640	0.0088	0.026	1.767	0.315	0.012	1.543	0.025	0.019	16.1	17.89

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.325	0.010	1.564	0.021	0.016	13.2	17.72
67	660	0.0072	0.021	1.808	0.335	0.010	1.585	0.021	0.016	13.3	17.49
68	670	0.0072	0.021	1.829	0.345	0.010	1.605	0.021	0.016	13.3	17.27
69	680	0.0072	0.021	1.850	0.355	0.010	1.626	0.021	0.016	13.3	17.06
70	690	0.0072	0.021	1.871	0.365	0.010	1.647	0.021	0.016	13.4	16.87
71	700	0.0072	0.021	1.892	0.376	0.010	1.667	0.021	0.016	13.4	16.69
72	710	0.0072	0.021	1.913	0.386	0.011	1.688	0.021	0.016	13.5	16.52
73	720	0.0072	0.021	1.934	0.397	0.011	1.709	0.021	0.016	13.5	16.36
74	730	0.0072	0.021	1.955	0.407	0.011	1.729	0.021	0.016	13.5	16.21
75	740	0.0072	0.021	1.975	0.418	0.011	1.750	0.021	0.016	13.6	16.08
76	750	0.0072	0.021	1.996	0.429	0.011	1.771	0.021	0.016	13.6	15.95
77	760	0.0072	0.021	2.017	0.440	0.011	1.791	0.021	0.017	13.6	15.82
78	770	0.0057	0.017	2.034	0.449	0.009	1.808	0.016	0.013	10.8	15.64
79	780	0.0057	0.017	2.050	0.458	0.009	1.824	0.016	0.013	10.8	15.39
80	790	0.0057	0.017	2.067	0.467	0.009	1.841	0.016	0.013	10.9	15.15
81	800	0.0057	0.017	2.083	0.476	0.009	1.857	0.016	0.013	10.9	14.93
82	810	0.0057	0.017	2.100	0.485	0.009	1.873	0.016	0.013	10.9	14.72
83	820	0.0057	0.017	2.116	0.494	0.009	1.890	0.016	0.013	10.9	14.52
84	830	0.0057	0.017	2.133	0.503	0.009	1.906	0.016	0.013	10.9	14.33
85	840	0.0057	0.017	2.149	0.512	0.009	1.923	0.016	0.013	11.0	14.16
86	850	0.0057	0.017	2.166	0.521	0.009	1.939	0.016	0.013	11.0	13.99
87	860	0.0057	0.017	2.183	0.530	0.009	1.955	0.016	0.013	11.0	13.84
88	870	0.0057	0.017	2.199	0.540	0.009	1.972	0.016	0.013	11.0	13.69
89	880	0.0057	0.017	2.216	0.549	0.009	1.988	0.016	0.013	11.0	13.55
90	890	0.0050	0.015	2.230	0.557	0.008	2.003	0.014	0.012	9.7	13.38
91	900	0.0050	0.015	2.245	0.566	0.008	2.017	0.014	0.012	9.7	13.19
92	910	0.0050	0.015	2.259	0.574	0.008	2.031	0.014	0.012	9.7	13.01
93	920	0.0050	0.015	2.274	0.582	0.008	2.046	0.014	0.012	9.7	12.84
94	930	0.0050	0.015	2.288	0.591	0.008	2.060	0.014	0.012	9.8	12.68
95	940	0.0050	0.015	2.303	0.599	0.008	2.075	0.014	0.012	9.8	12.53
96	950	0.0050	0.015	2.317	0.608	0.008	2.089	0.014	0.012	9.8	12.39
97	960	0.0050	0.015	2.332	0.616	0.009	2.103	0.014	0.012	9.8	12.25
98	970	0.0050	0.015	2.346	0.625	0.009	2.118	0.014	0.012	9.8	12.12
99	980	0.0050	0.015	2.361	0.633	0.009	2.132	0.014	0.012	9.8	12.00
100	990	0.0050	0.015	2.375	0.642	0.009	2.147	0.014	0.012	9.8	11.89
101	1000	0.0050	0.015	2.390	0.651	0.009	2.161	0.014	0.012	9.9	11.78
102	1010	0.0040	0.012	2.401	0.658	0.007	2.173	0.012	0.010	7.9	11.63
103	1020	0.0040	0.012	2.413	0.665	0.007	2.184	0.012	0.010	7.9	11.44
104	1030	0.0040	0.012	2.424	0.672	0.007	2.196	0.012	0.010	7.9	11.25
105	1040	0.0040	0.012	2.436	0.679	0.007	2.207	0.012	0.010	7.9	11.08
106	1050	0.0040	0.012	2.448	0.686	0.007	2.219	0.012	0.010	7.9	10.92
107	1060	0.0040	0.012	2.459	0.693	0.007	2.230	0.012	0.010	7.9	10.76
108	1070	0.0040	0.012	2.471	0.700	0.007	2.242	0.012	0.010	7.9	10.61
109	1080	0.0040	0.012	2.482	0.707	0.007	2.253	0.012	0.010	7.9	10.47
110	1090	0.0040	0.012	2.494	0.714	0.007	2.265	0.012	0.010	8.0	10.34
111	1100	0.0040	0.012	2.506	0.721	0.007	2.276	0.012	0.010	8.0	10.22
112	1110	0.0040	0.012	2.517	0.728	0.007	2.288	0.012	0.010	8.0	10.10
113	1120	0.0040	0.012	2.529	0.735	0.007	2.299	0.012	0.010	8.0	9.99
114	1130	0.0040	0.012	2.540	0.743	0.007	2.311	0.012	0.010	8.0	9.89
115	1140	0.0040	0.012	2.552	0.750	0.007	2.322	0.012	0.010	8.0	9.79

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.757	0.007	2.334	0.012	0.010	8.0	9.69
117	1160	0.0040	0.012	2.575	0.764	0.007	2.346	0.012	0.010	8.0	9.61
118	1170	0.0040	0.012	2.587	0.772	0.007	2.357	0.012	0.010	8.0	9.52
119	1180	0.0040	0.012	2.598	0.779	0.007	2.369	0.012	0.010	8.0	9.44
120	1190	0.0040	0.012	2.610	0.786	0.007	2.380	0.012	0.010	8.0	9.37
121	1200	0.0040	0.012	2.622	0.794	0.007	2.392	0.012	0.010	8.0	9.30
122	1210	0.0040	0.012	2.633	0.801	0.007	2.403	0.012	0.010	8.0	9.24
123	1220	0.0040	0.012	2.645	0.808	0.007	2.415	0.012	0.010	8.1	9.17
124	1230	0.0040	0.012	2.656	0.816	0.007	2.426	0.012	0.010	8.1	9.12
125	1240	0.0040	0.012	2.668	0.823	0.007	2.438	0.012	0.010	8.1	9.06
126	1250	0.0040	0.012	2.680	0.831	0.007	2.449	0.012	0.010	8.1	9.01
127	1260	0.0040	0.012	2.691	0.838	0.007	2.461	0.012	0.010	8.1	8.96
128	1270	0.0040	0.012	2.703	0.846	0.007	2.472	0.012	0.010	8.1	8.91
129	1280	0.0040	0.012	2.714	0.853	0.008	2.484	0.012	0.010	8.1	8.87
130	1290	0.0040	0.012	2.726	0.861	0.008	2.496	0.012	0.010	8.1	8.83
131	1300	0.0040	0.012	2.738	0.868	0.008	2.507	0.012	0.010	8.1	8.79
132	1310	0.0040	0.012	2.749	0.876	0.008	2.519	0.012	0.010	8.1	8.76
133	1320	0.0040	0.012	2.761	0.883	0.008	2.530	0.012	0.010	8.1	8.72
134	1330	0.0040	0.012	2.772	0.891	0.008	2.542	0.012	0.010	8.1	8.69
135	1340	0.0040	0.012	2.784	0.899	0.008	2.553	0.012	0.010	8.1	8.66
136	1350	0.0040	0.012	2.796	0.906	0.008	2.565	0.012	0.010	8.1	8.64
137	1360	0.0040	0.012	2.807	0.914	0.008	2.576	0.012	0.010	8.1	8.61
138	1370	0.0040	0.012	2.819	0.922	0.008	2.588	0.012	0.010	8.2	8.59
139	1380	0.0040	0.012	2.830	0.929	0.008	2.599	0.012	0.010	8.2	8.56
140	1390	0.0040	0.012	2.842	0.937	0.008	2.611	0.012	0.010	8.2	8.54
141	1400	0.0040	0.012	2.854	0.945	0.008	2.623	0.012	0.010	8.2	8.52
142	1410	0.0040	0.012	2.865	0.952	0.008	2.634	0.012	0.010	8.2	8.51
143	1420	0.0040	0.012	2.877	0.960	0.008	2.646	0.012	0.010	8.2	8.49
144	1430	0.0040	0.012	2.888	0.968	0.008	2.657	0.012	0.010	8.2	8.47
145	1440	0.0040	0.012	2.900	0.976	0.008	2.669	0.012	0.010	8.2	8.46

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 71st Ave Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 38.82 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 9.82 Ac. CN = 83.74 S = 1.9417 0.2S = 0.39

IMPERVIOUS AREA: Area = 29.00 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 63 Min. w = 0.073529

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 12.33 cfs ***$T_{(Peak)}$ = 8.17 hrs***

Total Volume = 321,676 cf ***$Tc_{(min)}$ = 63 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.074

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.2	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.4	0.06
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.002	0.5	0.12
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.7	0.19
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.003	0.8	0.27
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.004	0.9	0.36
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.005	1.3	0.46
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.006	1.4	0.59
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.006	1.5	0.71
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.007	1.6	0.83

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.007	1.7	0.95
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.007	1.7	1.05
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.009	2.1	1.18
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.009	2.2	1.33
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.010	2.3	1.47
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.010	2.4	1.59
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.010	2.4	1.71
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.010	2.5	1.82
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.012	2.9	1.94
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.013	3.0	2.09
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.013	3.0	2.22
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.013	3.1	2.34
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.013	3.1	2.45
29	280	0.0070	0.020	0.429	0.001	0.001	0.255	0.018	0.013	3.2	2.55
30	290	0.0082	0.024	0.453	0.002	0.001	0.276	0.021	0.016	3.8	2.69
31	300	0.0082	0.024	0.477	0.004	0.002	0.297	0.021	0.016	3.8	2.85
32	310	0.0082	0.024	0.501	0.006	0.002	0.318	0.021	0.017	3.9	3.00
33	320	0.0082	0.024	0.524	0.009	0.003	0.340	0.022	0.017	4.0	3.14
34	330	0.0082	0.024	0.548	0.012	0.003	0.362	0.022	0.017	4.0	3.26
35	340	0.0082	0.024	0.572	0.016	0.004	0.384	0.022	0.017	4.1	3.37
36	350	0.0095	0.028	0.599	0.021	0.005	0.409	0.026	0.020	4.8	3.53
37	360	0.0095	0.028	0.627	0.026	0.005	0.435	0.026	0.021	4.8	3.71
38	370	0.0095	0.028	0.655	0.032	0.006	0.461	0.026	0.021	4.9	3.88
39	380	0.0095	0.028	0.682	0.039	0.007	0.486	0.026	0.021	4.9	4.03
40	390	0.0095	0.028	0.710	0.046	0.007	0.512	0.026	0.021	5.0	4.17
41	400	0.0095	0.028	0.737	0.053	0.008	0.539	0.026	0.021	5.0	4.29
42	410	0.0134	0.039	0.776	0.065	0.011	0.575	0.037	0.030	7.2	4.55
43	420	0.0134	0.039	0.815	0.077	0.012	0.613	0.037	0.031	7.2	4.94
44	430	0.0134	0.039	0.854	0.090	0.013	0.650	0.037	0.031	7.3	5.29
45	440	0.0180	0.052	0.906	0.109	0.019	0.700	0.050	0.042	9.9	5.78
46	450	0.0180	0.052	0.958	0.129	0.020	0.750	0.050	0.043	10.0	6.40
47	460	0.0340	0.099	1.057	0.171	0.042	0.846	0.096	0.082	19.3	7.61
48	470	0.0540	0.157	1.213	0.246	0.075	0.999	0.153	0.133	31.2	10.21
49	480	0.0270	0.078	1.292	0.287	0.041	1.075	0.077	0.068	15.9	12.17
50	490	0.0180	0.052	1.344	0.315	0.028	1.127	0.051	0.045	10.7	12.33
51	500	0.0134	0.039	1.383	0.337	0.022	1.165	0.038	0.034	8.0	11.89
52	510	0.0134	0.039	1.422	0.359	0.022	1.203	0.038	0.034	8.0	11.32
53	520	0.0134	0.039	1.460	0.381	0.023	1.241	0.038	0.034	8.0	10.83
54	530	0.0088	0.026	1.486	0.396	0.015	1.266	0.025	0.023	5.3	10.22
55	540	0.0088	0.026	1.511	0.412	0.015	1.291	0.025	0.023	5.3	9.50
56	550	0.0088	0.026	1.537	0.427	0.015	1.317	0.025	0.023	5.3	8.88
57	560	0.0088	0.026	1.563	0.442	0.016	1.342	0.025	0.023	5.3	8.36
58	570	0.0088	0.026	1.588	0.458	0.016	1.367	0.025	0.023	5.3	7.92
59	580	0.0088	0.026	1.614	0.474	0.016	1.392	0.025	0.023	5.4	7.54
60	590	0.0088	0.026	1.639	0.490	0.016	1.417	0.025	0.023	5.4	7.22
61	600	0.0088	0.026	1.665	0.506	0.016	1.442	0.025	0.023	5.4	6.95
62	610	0.0088	0.026	1.690	0.522	0.016	1.468	0.025	0.023	5.4	6.72
63	620	0.0088	0.026	1.716	0.539	0.016	1.493	0.025	0.023	5.4	6.52
64	630	0.0088	0.026	1.741	0.555	0.017	1.518	0.025	0.023	5.4	6.36
65	640	0.0088	0.026	1.767	0.572	0.017	1.543	0.025	0.023	5.4	6.22

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.586	0.014	1.564	0.021	0.019	4.4	6.03
67	660	0.0072	0.021	1.808	0.600	0.014	1.585	0.021	0.019	4.4	5.80
68	670	0.0072	0.021	1.829	0.614	0.014	1.605	0.021	0.019	4.5	5.60
69	680	0.0072	0.021	1.850	0.628	0.014	1.626	0.021	0.019	4.5	5.43
70	690	0.0072	0.021	1.871	0.642	0.014	1.647	0.021	0.019	4.5	5.29
71	700	0.0072	0.021	1.892	0.656	0.014	1.667	0.021	0.019	4.5	5.17
72	710	0.0072	0.021	1.913	0.670	0.014	1.688	0.021	0.019	4.5	5.07
73	720	0.0072	0.021	1.934	0.685	0.014	1.709	0.021	0.019	4.5	4.98
74	730	0.0072	0.021	1.955	0.699	0.014	1.729	0.021	0.019	4.5	4.91
75	740	0.0072	0.021	1.975	0.714	0.015	1.750	0.021	0.019	4.5	4.85
76	750	0.0072	0.021	1.996	0.728	0.015	1.771	0.021	0.019	4.5	4.79
77	760	0.0072	0.021	2.017	0.743	0.015	1.791	0.021	0.019	4.5	4.75
78	770	0.0057	0.017	2.034	0.755	0.012	1.808	0.016	0.015	3.6	4.65
79	780	0.0057	0.017	2.050	0.766	0.012	1.824	0.016	0.015	3.6	4.49
80	790	0.0057	0.017	2.067	0.778	0.012	1.841	0.016	0.015	3.6	4.35
81	800	0.0057	0.017	2.083	0.790	0.012	1.857	0.016	0.015	3.6	4.24
82	810	0.0057	0.017	2.100	0.802	0.012	1.873	0.016	0.015	3.6	4.14
83	820	0.0057	0.017	2.116	0.814	0.012	1.890	0.016	0.015	3.6	4.06
84	830	0.0057	0.017	2.133	0.826	0.012	1.906	0.016	0.015	3.6	3.99
85	840	0.0057	0.017	2.149	0.838	0.012	1.923	0.016	0.015	3.6	3.93
86	850	0.0057	0.017	2.166	0.850	0.012	1.939	0.016	0.015	3.6	3.88
87	860	0.0057	0.017	2.183	0.862	0.012	1.955	0.016	0.015	3.6	3.84
88	870	0.0057	0.017	2.199	0.874	0.012	1.972	0.016	0.015	3.6	3.80
89	880	0.0057	0.017	2.216	0.886	0.012	1.988	0.016	0.015	3.6	3.77
90	890	0.0050	0.015	2.230	0.897	0.011	2.003	0.014	0.013	3.2	3.71
91	900	0.0050	0.015	2.245	0.907	0.011	2.017	0.014	0.013	3.2	3.63
92	910	0.0050	0.015	2.259	0.918	0.011	2.031	0.014	0.013	3.2	3.56
93	920	0.0050	0.015	2.274	0.929	0.011	2.046	0.014	0.013	3.2	3.50
94	930	0.0050	0.015	2.288	0.939	0.011	2.060	0.014	0.013	3.2	3.45
95	940	0.0050	0.015	2.303	0.950	0.011	2.075	0.014	0.013	3.2	3.41
96	950	0.0050	0.015	2.317	0.961	0.011	2.089	0.014	0.013	3.2	3.38
97	960	0.0050	0.015	2.332	0.972	0.011	2.103	0.014	0.014	3.2	3.35
98	970	0.0050	0.015	2.346	0.983	0.011	2.118	0.014	0.014	3.2	3.32
99	980	0.0050	0.015	2.361	0.994	0.011	2.132	0.014	0.014	3.2	3.30
100	990	0.0050	0.015	2.375	1.005	0.011	2.147	0.014	0.014	3.2	3.28
101	1000	0.0050	0.015	2.390	1.016	0.011	2.161	0.014	0.014	3.2	3.27
102	1010	0.0040	0.012	2.401	1.025	0.009	2.173	0.012	0.011	2.5	3.21
103	1020	0.0040	0.012	2.413	1.033	0.009	2.184	0.012	0.011	2.5	3.11
104	1030	0.0040	0.012	2.424	1.042	0.009	2.196	0.012	0.011	2.5	3.03
105	1040	0.0040	0.012	2.436	1.051	0.009	2.207	0.012	0.011	2.5	2.96
106	1050	0.0040	0.012	2.448	1.060	0.009	2.219	0.012	0.011	2.5	2.90
107	1060	0.0040	0.012	2.459	1.069	0.009	2.230	0.012	0.011	2.6	2.85
108	1070	0.0040	0.012	2.471	1.078	0.009	2.242	0.012	0.011	2.6	2.80
109	1080	0.0040	0.012	2.482	1.087	0.009	2.253	0.012	0.011	2.6	2.77
110	1090	0.0040	0.012	2.494	1.095	0.009	2.265	0.012	0.011	2.6	2.73
111	1100	0.0040	0.012	2.506	1.104	0.009	2.276	0.012	0.011	2.6	2.71
112	1110	0.0040	0.012	2.517	1.113	0.009	2.288	0.012	0.011	2.6	2.69
113	1120	0.0040	0.012	2.529	1.122	0.009	2.299	0.012	0.011	2.6	2.67
114	1130	0.0040	0.012	2.540	1.131	0.009	2.311	0.012	0.011	2.6	2.65
115	1140	0.0040	0.012	2.552	1.140	0.009	2.322	0.012	0.011	2.6	2.64

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	1.149	0.009	2.334	0.012	0.011	2.6	2.62
117	1160	0.0040	0.012	2.575	1.158	0.009	2.346	0.012	0.011	2.6	2.62
118	1170	0.0040	0.012	2.587	1.167	0.009	2.357	0.012	0.011	2.6	2.61
119	1180	0.0040	0.012	2.598	1.176	0.009	2.369	0.012	0.011	2.6	2.60
120	1190	0.0040	0.012	2.610	1.186	0.009	2.380	0.012	0.011	2.6	2.60
121	1200	0.0040	0.012	2.622	1.195	0.009	2.392	0.012	0.011	2.6	2.59
122	1210	0.0040	0.012	2.633	1.204	0.009	2.403	0.012	0.011	2.6	2.59
123	1220	0.0040	0.012	2.645	1.213	0.009	2.415	0.012	0.011	2.6	2.58
124	1230	0.0040	0.012	2.656	1.222	0.009	2.426	0.012	0.011	2.6	2.58
125	1240	0.0040	0.012	2.668	1.231	0.009	2.438	0.012	0.011	2.6	2.58
126	1250	0.0040	0.012	2.680	1.240	0.009	2.449	0.012	0.011	2.6	2.58
127	1260	0.0040	0.012	2.691	1.249	0.009	2.461	0.012	0.011	2.6	2.58
128	1270	0.0040	0.012	2.703	1.259	0.009	2.472	0.012	0.011	2.6	2.58
129	1280	0.0040	0.012	2.714	1.268	0.009	2.484	0.012	0.011	2.6	2.57
130	1290	0.0040	0.012	2.726	1.277	0.009	2.496	0.012	0.011	2.6	2.57
131	1300	0.0040	0.012	2.738	1.286	0.009	2.507	0.012	0.011	2.6	2.57
132	1310	0.0040	0.012	2.749	1.295	0.009	2.519	0.012	0.011	2.6	2.57
133	1320	0.0040	0.012	2.761	1.305	0.009	2.530	0.012	0.011	2.6	2.57
134	1330	0.0040	0.012	2.772	1.314	0.009	2.542	0.012	0.011	2.6	2.57
135	1340	0.0040	0.012	2.784	1.323	0.009	2.553	0.012	0.011	2.6	2.57
136	1350	0.0040	0.012	2.796	1.332	0.009	2.565	0.012	0.011	2.6	2.57
137	1360	0.0040	0.012	2.807	1.342	0.009	2.576	0.012	0.011	2.6	2.57
138	1370	0.0040	0.012	2.819	1.351	0.009	2.588	0.012	0.011	2.6	2.58
139	1380	0.0040	0.012	2.830	1.360	0.009	2.599	0.012	0.011	2.6	2.58
140	1390	0.0040	0.012	2.842	1.370	0.009	2.611	0.012	0.011	2.6	2.58
141	1400	0.0040	0.012	2.854	1.379	0.009	2.623	0.012	0.011	2.6	2.58
142	1410	0.0040	0.012	2.865	1.388	0.009	2.634	0.012	0.011	2.6	2.58
143	1420	0.0040	0.012	2.877	1.398	0.009	2.646	0.012	0.011	2.6	2.58
144	1430	0.0040	0.012	2.888	1.407	0.009	2.657	0.012	0.011	2.6	2.58
145	1440	0.0040	0.012	2.900	1.417	0.009	2.669	0.012	0.011	2.6	2.58

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 204th St Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 17.56 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 1.76 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 15.80 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 33 Min. w = 0.131579

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 7.71 cfs ***$T_{(Peak)}$ = 8.00 hrs***

Total Volume = 154,432 cf ***$Tc_{(min)}$ = 33 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.132

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.1	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.2	0.06
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.003	0.3	0.11
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.4	0.17
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.004	0.4	0.23
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.005	0.5	0.29
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.006	0.7	0.37
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.007	0.7	0.46
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.008	0.8	0.54
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.008	0.9	0.62

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.008	0.9	0.69
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.009	0.9	0.75
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.011	1.2	0.83
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.011	1.2	0.92
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.012	1.3	1.01
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.012	1.3	1.07
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.012	1.3	1.13
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.013	1.3	1.18
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.015	1.6	1.26
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.015	1.6	1.35
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.015	1.6	1.42
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.016	1.7	1.48
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.016	1.7	1.53
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.016	1.7	1.58
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.019	2.0	1.65
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.019	2.0	1.75
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.019	2.1	1.83
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.019	2.1	1.89
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.020	2.1	1.94
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.020	2.1	1.98
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.023	2.4	2.05
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.023	2.5	2.15
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.023	2.5	2.23
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.023	2.5	2.30
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.023	2.5	2.34
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.023	2.5	2.38
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.033	3.5	2.55
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.033	3.5	2.81
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.034	3.6	3.00
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.045	4.8	3.31
46	450	0.0180	0.052	0.958	0.000	0.000	0.750	0.050	0.045	4.8	3.71
47	460	0.0340	0.099	1.057	0.003	0.003	0.846	0.096	0.086	9.2	4.57
48	470	0.0540	0.157	1.213	0.015	0.012	0.999	0.153	0.139	14.7	6.51
49	480	0.0270	0.078	1.292	0.024	0.009	1.075	0.077	0.070	7.4	7.71
50	490	0.0180	0.052	1.344	0.032	0.007	1.127	0.051	0.047	5.0	7.32
51	500	0.0134	0.039	1.383	0.038	0.006	1.165	0.038	0.035	3.7	6.53
52	510	0.0134	0.039	1.422	0.044	0.007	1.203	0.038	0.035	3.7	5.79
53	520	0.0134	0.039	1.460	0.052	0.007	1.241	0.038	0.035	3.7	5.25
54	530	0.0088	0.026	1.486	0.057	0.005	1.266	0.025	0.023	2.5	4.68
55	540	0.0088	0.026	1.511	0.062	0.005	1.291	0.025	0.023	2.5	4.10
56	550	0.0088	0.026	1.537	0.067	0.005	1.317	0.025	0.023	2.5	3.66
57	560	0.0088	0.026	1.563	0.072	0.006	1.342	0.025	0.023	2.5	3.35
58	570	0.0088	0.026	1.588	0.078	0.006	1.367	0.025	0.023	2.5	3.12
59	580	0.0088	0.026	1.614	0.084	0.006	1.392	0.025	0.023	2.5	2.95
60	590	0.0088	0.026	1.639	0.090	0.006	1.417	0.025	0.023	2.5	2.82
61	600	0.0088	0.026	1.665	0.096	0.006	1.442	0.025	0.023	2.5	2.73
62	610	0.0088	0.026	1.690	0.103	0.006	1.468	0.025	0.023	2.5	2.66
63	620	0.0088	0.026	1.716	0.109	0.007	1.493	0.025	0.023	2.5	2.61
64	630	0.0088	0.026	1.741	0.116	0.007	1.518	0.025	0.023	2.5	2.58
65	640	0.0088	0.026	1.767	0.123	0.007	1.543	0.025	0.023	2.5	2.55

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.129	0.006	1.564	0.021	0.019	2.0	2.48
67	660	0.0072	0.021	1.808	0.135	0.006	1.585	0.021	0.019	2.0	2.36
68	670	0.0072	0.021	1.829	0.141	0.006	1.605	0.021	0.019	2.0	2.28
69	680	0.0072	0.021	1.850	0.147	0.006	1.626	0.021	0.019	2.0	2.21
70	690	0.0072	0.021	1.871	0.153	0.006	1.647	0.021	0.019	2.0	2.17
71	700	0.0072	0.021	1.892	0.160	0.006	1.667	0.021	0.019	2.0	2.14
72	710	0.0072	0.021	1.913	0.166	0.006	1.688	0.021	0.019	2.0	2.11
73	720	0.0072	0.021	1.934	0.173	0.007	1.709	0.021	0.019	2.0	2.09
74	730	0.0072	0.021	1.955	0.180	0.007	1.729	0.021	0.019	2.0	2.08
75	740	0.0072	0.021	1.975	0.186	0.007	1.750	0.021	0.019	2.0	2.07
76	750	0.0072	0.021	1.996	0.193	0.007	1.771	0.021	0.019	2.1	2.07
77	760	0.0072	0.021	2.017	0.200	0.007	1.791	0.021	0.019	2.1	2.06
78	770	0.0057	0.017	2.034	0.206	0.006	1.808	0.016	0.015	1.6	2.00
79	780	0.0057	0.017	2.050	0.212	0.006	1.824	0.016	0.015	1.6	1.91
80	790	0.0057	0.017	2.067	0.217	0.006	1.841	0.016	0.015	1.6	1.83
81	800	0.0057	0.017	2.083	0.223	0.006	1.857	0.016	0.015	1.6	1.78
82	810	0.0057	0.017	2.100	0.229	0.006	1.873	0.016	0.015	1.6	1.74
83	820	0.0057	0.017	2.116	0.235	0.006	1.890	0.016	0.015	1.6	1.71
84	830	0.0057	0.017	2.133	0.241	0.006	1.906	0.016	0.015	1.6	1.69
85	840	0.0057	0.017	2.149	0.247	0.006	1.923	0.016	0.015	1.6	1.67
86	850	0.0057	0.017	2.166	0.253	0.006	1.939	0.016	0.015	1.6	1.66
87	860	0.0057	0.017	2.183	0.259	0.006	1.955	0.016	0.015	1.6	1.66
88	870	0.0057	0.017	2.199	0.265	0.006	1.972	0.016	0.015	1.6	1.65
89	880	0.0057	0.017	2.216	0.272	0.006	1.988	0.016	0.015	1.6	1.65
90	890	0.0050	0.015	2.230	0.277	0.006	2.003	0.014	0.014	1.4	1.62
91	900	0.0050	0.015	2.245	0.283	0.006	2.017	0.014	0.014	1.4	1.57
92	910	0.0050	0.015	2.259	0.288	0.006	2.031	0.014	0.014	1.4	1.53
93	920	0.0050	0.015	2.274	0.294	0.006	2.046	0.014	0.014	1.4	1.51
94	930	0.0050	0.015	2.288	0.300	0.006	2.060	0.014	0.014	1.4	1.49
95	940	0.0050	0.015	2.303	0.305	0.006	2.075	0.014	0.014	1.4	1.48
96	950	0.0050	0.015	2.317	0.311	0.006	2.089	0.014	0.014	1.4	1.47
97	960	0.0050	0.015	2.332	0.317	0.006	2.103	0.014	0.014	1.4	1.46
98	970	0.0050	0.015	2.346	0.323	0.006	2.118	0.014	0.014	1.4	1.45
99	980	0.0050	0.015	2.361	0.329	0.006	2.132	0.014	0.014	1.4	1.45
100	990	0.0050	0.015	2.375	0.335	0.006	2.147	0.014	0.014	1.4	1.45
101	1000	0.0050	0.015	2.390	0.341	0.006	2.161	0.014	0.014	1.4	1.45
102	1010	0.0040	0.012	2.401	0.346	0.005	2.173	0.012	0.011	1.2	1.41
103	1020	0.0040	0.012	2.413	0.351	0.005	2.184	0.012	0.011	1.2	1.34
104	1030	0.0040	0.012	2.424	0.355	0.005	2.196	0.012	0.011	1.2	1.29
105	1040	0.0040	0.012	2.436	0.360	0.005	2.207	0.012	0.011	1.2	1.25
106	1050	0.0040	0.012	2.448	0.365	0.005	2.219	0.012	0.011	1.2	1.23
107	1060	0.0040	0.012	2.459	0.370	0.005	2.230	0.012	0.011	1.2	1.21
108	1070	0.0040	0.012	2.471	0.375	0.005	2.242	0.012	0.011	1.2	1.19
109	1080	0.0040	0.012	2.482	0.380	0.005	2.253	0.012	0.011	1.2	1.18
110	1090	0.0040	0.012	2.494	0.385	0.005	2.265	0.012	0.011	1.2	1.18
111	1100	0.0040	0.012	2.506	0.390	0.005	2.276	0.012	0.011	1.2	1.17
112	1110	0.0040	0.012	2.517	0.395	0.005	2.288	0.012	0.011	1.2	1.17
113	1120	0.0040	0.012	2.529	0.400	0.005	2.299	0.012	0.011	1.2	1.16
114	1130	0.0040	0.012	2.540	0.406	0.005	2.311	0.012	0.011	1.2	1.16
115	1140	0.0040	0.012	2.552	0.411	0.005	2.322	0.012	0.011	1.2	1.16

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.416	0.005	2.334	0.012	0.011	1.2	1.16
117	1160	0.0040	0.012	2.575	0.421	0.005	2.346	0.012	0.011	1.2	1.16
118	1170	0.0040	0.012	2.587	0.426	0.005	2.357	0.012	0.011	1.2	1.16
119	1180	0.0040	0.012	2.598	0.432	0.005	2.369	0.012	0.011	1.2	1.16
120	1190	0.0040	0.012	2.610	0.437	0.005	2.380	0.012	0.011	1.2	1.16
121	1200	0.0040	0.012	2.622	0.442	0.005	2.392	0.012	0.011	1.2	1.16
122	1210	0.0040	0.012	2.633	0.447	0.005	2.403	0.012	0.011	1.2	1.16
123	1220	0.0040	0.012	2.645	0.453	0.005	2.415	0.012	0.011	1.2	1.16
124	1230	0.0040	0.012	2.656	0.458	0.005	2.426	0.012	0.011	1.2	1.16
125	1240	0.0040	0.012	2.668	0.464	0.005	2.438	0.012	0.011	1.2	1.16
126	1250	0.0040	0.012	2.680	0.469	0.005	2.449	0.012	0.011	1.2	1.16
127	1260	0.0040	0.012	2.691	0.474	0.005	2.461	0.012	0.011	1.2	1.16
128	1270	0.0040	0.012	2.703	0.480	0.005	2.472	0.012	0.011	1.2	1.16
129	1280	0.0040	0.012	2.714	0.485	0.005	2.484	0.012	0.011	1.2	1.16
130	1290	0.0040	0.012	2.726	0.491	0.005	2.496	0.012	0.011	1.2	1.16
131	1300	0.0040	0.012	2.738	0.496	0.006	2.507	0.012	0.011	1.2	1.16
132	1310	0.0040	0.012	2.749	0.502	0.006	2.519	0.012	0.011	1.2	1.16
133	1320	0.0040	0.012	2.761	0.507	0.006	2.530	0.012	0.011	1.2	1.16
134	1330	0.0040	0.012	2.772	0.513	0.006	2.542	0.012	0.011	1.2	1.16
135	1340	0.0040	0.012	2.784	0.519	0.006	2.553	0.012	0.011	1.2	1.16
136	1350	0.0040	0.012	2.796	0.524	0.006	2.565	0.012	0.011	1.2	1.16
137	1360	0.0040	0.012	2.807	0.530	0.006	2.576	0.012	0.011	1.2	1.16
138	1370	0.0040	0.012	2.819	0.536	0.006	2.588	0.012	0.011	1.2	1.16
139	1380	0.0040	0.012	2.830	0.541	0.006	2.599	0.012	0.011	1.2	1.16
140	1390	0.0040	0.012	2.842	0.547	0.006	2.611	0.012	0.011	1.2	1.16
141	1400	0.0040	0.012	2.854	0.553	0.006	2.623	0.012	0.011	1.2	1.16
142	1410	0.0040	0.012	2.865	0.558	0.006	2.634	0.012	0.011	1.2	1.16
143	1420	0.0040	0.012	2.877	0.564	0.006	2.646	0.012	0.011	1.2	1.16
144	1430	0.0040	0.012	2.888	0.570	0.006	2.657	0.012	0.011	1.2	1.16
145	1440	0.0040	0.012	2.900	0.576	0.006	2.669	0.012	0.011	1.2	1.16

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to BNSF RR Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 4.18 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 0.42 Ac. CN = 68.95 S = 4.5033 0.2S = 0.90

IMPERVIOUS AREA: Area = 3.76 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 2.85 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 37,278 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.1	0.04
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.003	0.1	0.06
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.1	0.08
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.004	0.1	0.10
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.005	0.1	0.11
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.006	0.2	0.14
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.007	0.2	0.17
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.008	0.2	0.18
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.008	0.2	0.20

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.008	0.2	0.21
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.009	0.2	0.22
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.011	0.3	0.25
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.011	0.3	0.28
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.012	0.3	0.29
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.012	0.3	0.30
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.012	0.3	0.31
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.013	0.3	0.32
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.015	0.4	0.35
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.015	0.4	0.38
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.015	0.4	0.39
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.016	0.4	0.39
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.016	0.4	0.40
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.016	0.4	0.40
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.019	0.5	0.44
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.019	0.5	0.48
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.019	0.5	0.49
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.019	0.5	0.49
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.020	0.5	0.49
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.020	0.5	0.50
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.023	0.6	0.54
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.023	0.6	0.58
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.023	0.6	0.58
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.023	0.6	0.59
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.023	0.6	0.59
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.023	0.6	0.59
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.033	0.8	0.72
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.033	0.8	0.84
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.033	0.8	0.85
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.045	1.1	0.99
46	450	0.0180	0.052	0.958	0.001	0.001	0.750	0.050	0.045	1.1	1.15
47	460	0.0340	0.099	1.057	0.005	0.005	0.846	0.096	0.086	2.2	1.67
48	470	0.0540	0.157	1.213	0.020	0.015	0.999	0.153	0.139	3.5	2.85
49	480	0.0270	0.078	1.292	0.031	0.011	1.075	0.077	0.070	1.8	2.64
50	490	0.0180	0.052	1.344	0.040	0.008	1.127	0.051	0.047	1.2	1.48
51	500	0.0134	0.039	1.383	0.047	0.007	1.165	0.038	0.035	0.9	1.04
52	510	0.0134	0.039	1.422	0.054	0.007	1.203	0.038	0.035	0.9	0.89
53	520	0.0134	0.039	1.460	0.062	0.008	1.241	0.038	0.035	0.9	0.89
54	530	0.0088	0.026	1.486	0.067	0.005	1.266	0.025	0.023	0.6	0.74
55	540	0.0088	0.026	1.511	0.073	0.006	1.291	0.025	0.023	0.6	0.59
56	550	0.0088	0.026	1.537	0.079	0.006	1.317	0.025	0.023	0.6	0.59
57	560	0.0088	0.026	1.563	0.085	0.006	1.342	0.025	0.023	0.6	0.59
58	570	0.0088	0.026	1.588	0.091	0.006	1.367	0.025	0.023	0.6	0.59
59	580	0.0088	0.026	1.614	0.097	0.006	1.392	0.025	0.023	0.6	0.59
60	590	0.0088	0.026	1.639	0.104	0.007	1.417	0.025	0.023	0.6	0.59
61	600	0.0088	0.026	1.665	0.111	0.007	1.442	0.025	0.023	0.6	0.59
62	610	0.0088	0.026	1.690	0.118	0.007	1.468	0.025	0.023	0.6	0.59
63	620	0.0088	0.026	1.716	0.125	0.007	1.493	0.025	0.023	0.6	0.59
64	630	0.0088	0.026	1.741	0.132	0.007	1.518	0.025	0.023	0.6	0.59
65	640	0.0088	0.026	1.767	0.140	0.007	1.543	0.025	0.023	0.6	0.59

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.146	0.006	1.564	0.021	0.019	0.5	0.54
67	660	0.0072	0.021	1.808	0.152	0.006	1.585	0.021	0.019	0.5	0.49
68	670	0.0072	0.021	1.829	0.159	0.006	1.605	0.021	0.019	0.5	0.49
69	680	0.0072	0.021	1.850	0.165	0.007	1.626	0.021	0.019	0.5	0.49
70	690	0.0072	0.021	1.871	0.172	0.007	1.647	0.021	0.019	0.5	0.49
71	700	0.0072	0.021	1.892	0.179	0.007	1.667	0.021	0.019	0.5	0.49
72	710	0.0072	0.021	1.913	0.186	0.007	1.688	0.021	0.019	0.5	0.49
73	720	0.0072	0.021	1.934	0.193	0.007	1.709	0.021	0.019	0.5	0.49
74	730	0.0072	0.021	1.955	0.200	0.007	1.729	0.021	0.019	0.5	0.49
75	740	0.0072	0.021	1.975	0.207	0.007	1.750	0.021	0.019	0.5	0.49
76	750	0.0072	0.021	1.996	0.214	0.007	1.771	0.021	0.019	0.5	0.49
77	760	0.0072	0.021	2.017	0.222	0.007	1.791	0.021	0.019	0.5	0.49
78	770	0.0057	0.017	2.034	0.228	0.006	1.808	0.016	0.015	0.4	0.44
79	780	0.0057	0.017	2.050	0.234	0.006	1.824	0.016	0.015	0.4	0.39
80	790	0.0057	0.017	2.067	0.240	0.006	1.841	0.016	0.015	0.4	0.39
81	800	0.0057	0.017	2.083	0.246	0.006	1.857	0.016	0.015	0.4	0.39
82	810	0.0057	0.017	2.100	0.252	0.006	1.873	0.016	0.015	0.4	0.39
83	820	0.0057	0.017	2.116	0.258	0.006	1.890	0.016	0.015	0.4	0.39
84	830	0.0057	0.017	2.133	0.265	0.006	1.906	0.016	0.015	0.4	0.39
85	840	0.0057	0.017	2.149	0.271	0.006	1.923	0.016	0.015	0.4	0.39
86	850	0.0057	0.017	2.166	0.278	0.006	1.939	0.016	0.015	0.4	0.39
87	860	0.0057	0.017	2.183	0.284	0.006	1.955	0.016	0.015	0.4	0.39
88	870	0.0057	0.017	2.199	0.291	0.007	1.972	0.016	0.015	0.4	0.39
89	880	0.0057	0.017	2.216	0.297	0.007	1.988	0.016	0.015	0.4	0.39
90	890	0.0050	0.015	2.230	0.303	0.006	2.003	0.014	0.014	0.3	0.37
91	900	0.0050	0.015	2.245	0.309	0.006	2.017	0.014	0.014	0.3	0.34
92	910	0.0050	0.015	2.259	0.315	0.006	2.031	0.014	0.014	0.3	0.34
93	920	0.0050	0.015	2.274	0.321	0.006	2.046	0.014	0.014	0.3	0.34
94	930	0.0050	0.015	2.288	0.327	0.006	2.060	0.014	0.014	0.3	0.34
95	940	0.0050	0.015	2.303	0.333	0.006	2.075	0.014	0.014	0.3	0.34
96	950	0.0050	0.015	2.317	0.339	0.006	2.089	0.014	0.014	0.3	0.34
97	960	0.0050	0.015	2.332	0.345	0.006	2.103	0.014	0.014	0.3	0.34
98	970	0.0050	0.015	2.346	0.351	0.006	2.118	0.014	0.014	0.3	0.34
99	980	0.0050	0.015	2.361	0.357	0.006	2.132	0.014	0.014	0.3	0.34
100	990	0.0050	0.015	2.375	0.364	0.006	2.147	0.014	0.014	0.3	0.34
101	1000	0.0050	0.015	2.390	0.370	0.006	2.161	0.014	0.014	0.3	0.34
102	1010	0.0040	0.012	2.401	0.375	0.005	2.173	0.012	0.011	0.3	0.31
103	1020	0.0040	0.012	2.413	0.380	0.005	2.184	0.012	0.011	0.3	0.28
104	1030	0.0040	0.012	2.424	0.385	0.005	2.196	0.012	0.011	0.3	0.28
105	1040	0.0040	0.012	2.436	0.390	0.005	2.207	0.012	0.011	0.3	0.28
106	1050	0.0040	0.012	2.448	0.396	0.005	2.219	0.012	0.011	0.3	0.28
107	1060	0.0040	0.012	2.459	0.401	0.005	2.230	0.012	0.011	0.3	0.28
108	1070	0.0040	0.012	2.471	0.406	0.005	2.242	0.012	0.011	0.3	0.28
109	1080	0.0040	0.012	2.482	0.411	0.005	2.253	0.012	0.011	0.3	0.28
110	1090	0.0040	0.012	2.494	0.416	0.005	2.265	0.012	0.011	0.3	0.28
111	1100	0.0040	0.012	2.506	0.422	0.005	2.276	0.012	0.011	0.3	0.28
112	1110	0.0040	0.012	2.517	0.427	0.005	2.288	0.012	0.011	0.3	0.28
113	1120	0.0040	0.012	2.529	0.432	0.005	2.299	0.012	0.011	0.3	0.28
114	1130	0.0040	0.012	2.540	0.438	0.005	2.311	0.012	0.011	0.3	0.28
115	1140	0.0040	0.012	2.552	0.443	0.005	2.322	0.012	0.011	0.3	0.28

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.448	0.005	2.334	0.012	0.011	0.3	0.28
117	1160	0.0040	0.012	2.575	0.454	0.005	2.346	0.012	0.011	0.3	0.28
118	1170	0.0040	0.012	2.587	0.459	0.005	2.357	0.012	0.011	0.3	0.28
119	1180	0.0040	0.012	2.598	0.465	0.005	2.369	0.012	0.011	0.3	0.28
120	1190	0.0040	0.012	2.610	0.470	0.005	2.380	0.012	0.011	0.3	0.28
121	1200	0.0040	0.012	2.622	0.476	0.006	2.392	0.012	0.011	0.3	0.28
122	1210	0.0040	0.012	2.633	0.481	0.006	2.403	0.012	0.011	0.3	0.28
123	1220	0.0040	0.012	2.645	0.487	0.006	2.415	0.012	0.011	0.3	0.28
124	1230	0.0040	0.012	2.656	0.493	0.006	2.426	0.012	0.011	0.3	0.28
125	1240	0.0040	0.012	2.668	0.498	0.006	2.438	0.012	0.011	0.3	0.28
126	1250	0.0040	0.012	2.680	0.504	0.006	2.449	0.012	0.011	0.3	0.28
127	1260	0.0040	0.012	2.691	0.509	0.006	2.461	0.012	0.011	0.3	0.28
128	1270	0.0040	0.012	2.703	0.515	0.006	2.472	0.012	0.011	0.3	0.28
129	1280	0.0040	0.012	2.714	0.521	0.006	2.484	0.012	0.011	0.3	0.28
130	1290	0.0040	0.012	2.726	0.526	0.006	2.496	0.012	0.011	0.3	0.28
131	1300	0.0040	0.012	2.738	0.532	0.006	2.507	0.012	0.011	0.3	0.28
132	1310	0.0040	0.012	2.749	0.538	0.006	2.519	0.012	0.011	0.3	0.28
133	1320	0.0040	0.012	2.761	0.544	0.006	2.530	0.012	0.011	0.3	0.28
134	1330	0.0040	0.012	2.772	0.550	0.006	2.542	0.012	0.011	0.3	0.28
135	1340	0.0040	0.012	2.784	0.555	0.006	2.553	0.012	0.011	0.3	0.28
136	1350	0.0040	0.012	2.796	0.561	0.006	2.565	0.012	0.011	0.3	0.28
137	1360	0.0040	0.012	2.807	0.567	0.006	2.576	0.012	0.011	0.3	0.28
138	1370	0.0040	0.012	2.819	0.573	0.006	2.588	0.012	0.011	0.3	0.28
139	1380	0.0040	0.012	2.830	0.579	0.006	2.599	0.012	0.011	0.3	0.28
140	1390	0.0040	0.012	2.842	0.585	0.006	2.611	0.012	0.011	0.3	0.28
141	1400	0.0040	0.012	2.854	0.591	0.006	2.623	0.012	0.011	0.3	0.28
142	1410	0.0040	0.012	2.865	0.597	0.006	2.634	0.012	0.011	0.3	0.28
143	1420	0.0040	0.012	2.877	0.603	0.006	2.646	0.012	0.011	0.3	0.28
144	1430	0.0040	0.012	2.888	0.609	0.006	2.657	0.012	0.011	0.3	0.28
145	1440	0.0040	0.012	2.900	0.615	0.006	2.669	0.012	0.011	0.3	0.28

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 69th Ave Culvert**

Design Storm : **10-yr / 24-hr**

Given:	Area =	0.76	Ac.	P =	2.90	in.	dt =	10 min.
PERVIOUS AREA:	Area =	0.08	Ac.	CN =	68.00		S = 4.7059	0.2S = 0.94
IMPERVIOUS AREA:	Area =	0.68	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 0.51 cfs
Total Volume = 6,740 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.00
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.0	0.01
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.003	0.0	0.01
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.0	0.01
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.004	0.0	0.02
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.005	0.0	0.02
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.006	0.0	0.03
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.007	0.0	0.03
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.008	0.0	0.03
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.008	0.0	0.04

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.008	0.0	0.04
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.009	0.0	0.04
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.011	0.1	0.05
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.011	0.1	0.05
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.012	0.1	0.05
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.012	0.1	0.05
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.012	0.1	0.06
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.013	0.1	0.06
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.015	0.1	0.06
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.015	0.1	0.07
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.015	0.1	0.07
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.016	0.1	0.07
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.016	0.1	0.07
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.016	0.1	0.07
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.019	0.1	0.08
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.019	0.1	0.09
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.019	0.1	0.09
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.019	0.1	0.09
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.019	0.1	0.09
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.020	0.1	0.09
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.023	0.1	0.10
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.023	0.1	0.11
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.023	0.1	0.11
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.023	0.1	0.11
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.023	0.1	0.11
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.023	0.1	0.11
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.033	0.2	0.13
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.033	0.2	0.15
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.033	0.2	0.15
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.045	0.2	0.18
46	450	0.0180	0.052	0.958	0.000	0.000	0.750	0.050	0.045	0.2	0.21
47	460	0.0340	0.099	1.057	0.003	0.003	0.846	0.096	0.086	0.4	0.30
48	470	0.0540	0.157	1.213	0.015	0.012	0.999	0.153	0.138	0.6	0.51
49	480	0.0270	0.078	1.292	0.024	0.009	1.075	0.077	0.070	0.3	0.48
50	490	0.0180	0.052	1.344	0.032	0.007	1.127	0.051	0.047	0.2	0.27
51	500	0.0134	0.039	1.383	0.038	0.006	1.165	0.038	0.035	0.2	0.19
52	510	0.0134	0.039	1.422	0.044	0.007	1.203	0.038	0.035	0.2	0.16
53	520	0.0134	0.039	1.460	0.052	0.007	1.241	0.038	0.035	0.2	0.16
54	530	0.0088	0.026	1.486	0.057	0.005	1.266	0.025	0.023	0.1	0.13
55	540	0.0088	0.026	1.511	0.062	0.005	1.291	0.025	0.023	0.1	0.11
56	550	0.0088	0.026	1.537	0.067	0.005	1.317	0.025	0.023	0.1	0.11
57	560	0.0088	0.026	1.563	0.072	0.006	1.342	0.025	0.023	0.1	0.11
58	570	0.0088	0.026	1.588	0.078	0.006	1.367	0.025	0.023	0.1	0.11
59	580	0.0088	0.026	1.614	0.084	0.006	1.392	0.025	0.023	0.1	0.11
60	590	0.0088	0.026	1.639	0.090	0.006	1.417	0.025	0.023	0.1	0.11
61	600	0.0088	0.026	1.665	0.096	0.006	1.442	0.025	0.023	0.1	0.11
62	610	0.0088	0.026	1.690	0.103	0.006	1.468	0.025	0.023	0.1	0.11
63	620	0.0088	0.026	1.716	0.109	0.007	1.493	0.025	0.023	0.1	0.11
64	630	0.0088	0.026	1.741	0.116	0.007	1.518	0.025	0.023	0.1	0.11
65	640	0.0088	0.026	1.767	0.123	0.007	1.543	0.025	0.023	0.1	0.11

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.129	0.006	1.564	0.021	0.019	0.1	0.10
67	660	0.0072	0.021	1.808	0.135	0.006	1.585	0.021	0.019	0.1	0.09
68	670	0.0072	0.021	1.829	0.141	0.006	1.605	0.021	0.019	0.1	0.09
69	680	0.0072	0.021	1.850	0.147	0.006	1.626	0.021	0.019	0.1	0.09
70	690	0.0072	0.021	1.871	0.153	0.006	1.647	0.021	0.019	0.1	0.09
71	700	0.0072	0.021	1.892	0.160	0.006	1.667	0.021	0.019	0.1	0.09
72	710	0.0072	0.021	1.913	0.166	0.006	1.688	0.021	0.019	0.1	0.09
73	720	0.0072	0.021	1.934	0.173	0.007	1.709	0.021	0.019	0.1	0.09
74	730	0.0072	0.021	1.955	0.180	0.007	1.729	0.021	0.019	0.1	0.09
75	740	0.0072	0.021	1.975	0.186	0.007	1.750	0.021	0.019	0.1	0.09
76	750	0.0072	0.021	1.996	0.193	0.007	1.771	0.021	0.019	0.1	0.09
77	760	0.0072	0.021	2.017	0.200	0.007	1.791	0.021	0.019	0.1	0.09
78	770	0.0057	0.017	2.034	0.206	0.006	1.808	0.016	0.015	0.1	0.08
79	780	0.0057	0.017	2.050	0.212	0.006	1.824	0.016	0.015	0.1	0.07
80	790	0.0057	0.017	2.067	0.217	0.006	1.841	0.016	0.015	0.1	0.07
81	800	0.0057	0.017	2.083	0.223	0.006	1.857	0.016	0.015	0.1	0.07
82	810	0.0057	0.017	2.100	0.229	0.006	1.873	0.016	0.015	0.1	0.07
83	820	0.0057	0.017	2.116	0.235	0.006	1.890	0.016	0.015	0.1	0.07
84	830	0.0057	0.017	2.133	0.241	0.006	1.906	0.016	0.015	0.1	0.07
85	840	0.0057	0.017	2.149	0.247	0.006	1.923	0.016	0.015	0.1	0.07
86	850	0.0057	0.017	2.166	0.253	0.006	1.939	0.016	0.015	0.1	0.07
87	860	0.0057	0.017	2.183	0.259	0.006	1.955	0.016	0.015	0.1	0.07
88	870	0.0057	0.017	2.199	0.265	0.006	1.972	0.016	0.015	0.1	0.07
89	880	0.0057	0.017	2.216	0.272	0.006	1.988	0.016	0.015	0.1	0.07
90	890	0.0050	0.015	2.230	0.277	0.006	2.003	0.014	0.013	0.1	0.07
91	900	0.0050	0.015	2.245	0.283	0.006	2.017	0.014	0.013	0.1	0.06
92	910	0.0050	0.015	2.259	0.288	0.006	2.031	0.014	0.013	0.1	0.06
93	920	0.0050	0.015	2.274	0.294	0.006	2.046	0.014	0.013	0.1	0.06
94	930	0.0050	0.015	2.288	0.300	0.006	2.060	0.014	0.013	0.1	0.06
95	940	0.0050	0.015	2.303	0.305	0.006	2.075	0.014	0.013	0.1	0.06
96	950	0.0050	0.015	2.317	0.311	0.006	2.089	0.014	0.013	0.1	0.06
97	960	0.0050	0.015	2.332	0.317	0.006	2.103	0.014	0.014	0.1	0.06
98	970	0.0050	0.015	2.346	0.323	0.006	2.118	0.014	0.014	0.1	0.06
99	980	0.0050	0.015	2.361	0.329	0.006	2.132	0.014	0.014	0.1	0.06
100	990	0.0050	0.015	2.375	0.335	0.006	2.147	0.014	0.014	0.1	0.06
101	1000	0.0050	0.015	2.390	0.341	0.006	2.161	0.014	0.014	0.1	0.06
102	1010	0.0040	0.012	2.401	0.346	0.005	2.173	0.012	0.011	0.0	0.06
103	1020	0.0040	0.012	2.413	0.351	0.005	2.184	0.012	0.011	0.0	0.05
104	1030	0.0040	0.012	2.424	0.355	0.005	2.196	0.012	0.011	0.0	0.05
105	1040	0.0040	0.012	2.436	0.360	0.005	2.207	0.012	0.011	0.0	0.05
106	1050	0.0040	0.012	2.448	0.365	0.005	2.219	0.012	0.011	0.0	0.05
107	1060	0.0040	0.012	2.459	0.370	0.005	2.230	0.012	0.011	0.0	0.05
108	1070	0.0040	0.012	2.471	0.375	0.005	2.242	0.012	0.011	0.0	0.05
109	1080	0.0040	0.012	2.482	0.380	0.005	2.253	0.012	0.011	0.0	0.05
110	1090	0.0040	0.012	2.494	0.385	0.005	2.265	0.012	0.011	0.0	0.05
111	1100	0.0040	0.012	2.506	0.390	0.005	2.276	0.012	0.011	0.0	0.05
112	1110	0.0040	0.012	2.517	0.395	0.005	2.288	0.012	0.011	0.0	0.05
113	1120	0.0040	0.012	2.529	0.400	0.005	2.299	0.012	0.011	0.0	0.05
114	1130	0.0040	0.012	2.540	0.406	0.005	2.311	0.012	0.011	0.0	0.05
115	1140	0.0040	0.012	2.552	0.411	0.005	2.322	0.012	0.011	0.0	0.05

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.416	0.005	2.334	0.012	0.011	0.0	0.05
117	1160	0.0040	0.012	2.575	0.421	0.005	2.346	0.012	0.011	0.0	0.05
118	1170	0.0040	0.012	2.587	0.426	0.005	2.357	0.012	0.011	0.0	0.05
119	1180	0.0040	0.012	2.598	0.432	0.005	2.369	0.012	0.011	0.0	0.05
120	1190	0.0040	0.012	2.610	0.437	0.005	2.380	0.012	0.011	0.1	0.05
121	1200	0.0040	0.012	2.622	0.442	0.005	2.392	0.012	0.011	0.1	0.05
122	1210	0.0040	0.012	2.633	0.447	0.005	2.403	0.012	0.011	0.1	0.05
123	1220	0.0040	0.012	2.645	0.453	0.005	2.415	0.012	0.011	0.1	0.05
124	1230	0.0040	0.012	2.656	0.458	0.005	2.426	0.012	0.011	0.1	0.05
125	1240	0.0040	0.012	2.668	0.464	0.005	2.438	0.012	0.011	0.1	0.05
126	1250	0.0040	0.012	2.680	0.469	0.005	2.449	0.012	0.011	0.1	0.05
127	1260	0.0040	0.012	2.691	0.474	0.005	2.461	0.012	0.011	0.1	0.05
128	1270	0.0040	0.012	2.703	0.480	0.005	2.472	0.012	0.011	0.1	0.05
129	1280	0.0040	0.012	2.714	0.485	0.005	2.484	0.012	0.011	0.1	0.05
130	1290	0.0040	0.012	2.726	0.491	0.005	2.496	0.012	0.011	0.1	0.05
131	1300	0.0040	0.012	2.738	0.496	0.006	2.507	0.012	0.011	0.1	0.05
132	1310	0.0040	0.012	2.749	0.502	0.006	2.519	0.012	0.011	0.1	0.05
133	1320	0.0040	0.012	2.761	0.507	0.006	2.530	0.012	0.011	0.1	0.05
134	1330	0.0040	0.012	2.772	0.513	0.006	2.542	0.012	0.011	0.1	0.05
135	1340	0.0040	0.012	2.784	0.519	0.006	2.553	0.012	0.011	0.1	0.05
136	1350	0.0040	0.012	2.796	0.524	0.006	2.565	0.012	0.011	0.1	0.05
137	1360	0.0040	0.012	2.807	0.530	0.006	2.576	0.012	0.011	0.1	0.05
138	1370	0.0040	0.012	2.819	0.536	0.006	2.588	0.012	0.011	0.1	0.05
139	1380	0.0040	0.012	2.830	0.541	0.006	2.599	0.012	0.011	0.1	0.05
140	1390	0.0040	0.012	2.842	0.547	0.006	2.611	0.012	0.011	0.1	0.05
141	1400	0.0040	0.012	2.854	0.553	0.006	2.623	0.012	0.011	0.1	0.05
142	1410	0.0040	0.012	2.865	0.558	0.006	2.634	0.012	0.011	0.1	0.05
143	1420	0.0040	0.012	2.877	0.564	0.006	2.646	0.012	0.011	0.1	0.05
144	1430	0.0040	0.012	2.888	0.570	0.006	2.657	0.012	0.011	0.1	0.05
145	1440	0.0040	0.012	2.900	0.576	0.006	2.669	0.012	0.011	0.1	0.05

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to Confluence Point**

Design Storm : **10-yr / 24-hr**

Given: Area = 11.29 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 3.01 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 8.28 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 6.35 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 86,297 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.1	0.03
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.1	0.09
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.002	0.2	0.13
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.2	0.18
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.003	0.2	0.21
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.004	0.3	0.24
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.005	0.4	0.31
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.006	0.4	0.37
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.006	0.4	0.41
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.007	0.4	0.44

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.007	0.5	0.46
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.007	0.5	0.48
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.009	0.6	0.55
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.009	0.6	0.62
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.010	0.7	0.65
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.010	0.7	0.66
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.010	0.7	0.68
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.010	0.7	0.69
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.012	0.8	0.77
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.012	0.8	0.84
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.013	0.9	0.85
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.013	0.9	0.87
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.013	0.9	0.88
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.013	0.9	0.89
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.015	1.1	0.97
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.016	1.1	1.06
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.016	1.1	1.07
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.016	1.1	1.08
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.016	1.1	1.09
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.016	1.1	1.09
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.019	1.3	1.19
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.019	1.3	1.28
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.019	1.3	1.29
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.019	1.3	1.29
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.019	1.3	1.30
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.019	1.3	1.30
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.027	1.9	1.58
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.027	1.9	1.85
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.027	1.9	1.86
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.037	2.5	2.19
46	450	0.0180	0.052	0.958	0.000	0.000	0.750	0.050	0.037	2.5	2.52
47	460	0.0340	0.099	1.057	0.003	0.003	0.846	0.096	0.071	4.8	3.68
48	470	0.0540	0.157	1.213	0.015	0.012	0.999	0.153	0.115	7.9	6.35
49	480	0.0270	0.078	1.292	0.024	0.009	1.075	0.077	0.059	4.0	5.94
50	490	0.0180	0.052	1.344	0.032	0.007	1.127	0.051	0.040	2.7	3.36
51	500	0.0134	0.039	1.383	0.038	0.006	1.165	0.038	0.030	2.0	2.36
52	510	0.0134	0.039	1.422	0.044	0.007	1.203	0.038	0.030	2.0	2.03
53	520	0.0134	0.039	1.460	0.052	0.007	1.241	0.038	0.030	2.0	2.04
54	530	0.0088	0.026	1.486	0.057	0.005	1.266	0.025	0.020	1.3	1.70
55	540	0.0088	0.026	1.511	0.062	0.005	1.291	0.025	0.020	1.4	1.35
56	550	0.0088	0.026	1.537	0.067	0.005	1.317	0.025	0.020	1.4	1.35
57	560	0.0088	0.026	1.563	0.072	0.006	1.342	0.025	0.020	1.4	1.36
58	570	0.0088	0.026	1.588	0.078	0.006	1.367	0.025	0.020	1.4	1.36
59	580	0.0088	0.026	1.614	0.084	0.006	1.392	0.025	0.020	1.4	1.37
60	590	0.0088	0.026	1.639	0.090	0.006	1.417	0.025	0.020	1.4	1.37
61	600	0.0088	0.026	1.665	0.096	0.006	1.442	0.025	0.020	1.4	1.37
62	610	0.0088	0.026	1.690	0.103	0.006	1.468	0.025	0.020	1.4	1.38
63	620	0.0088	0.026	1.716	0.109	0.007	1.493	0.025	0.020	1.4	1.38
64	630	0.0088	0.026	1.741	0.116	0.007	1.518	0.025	0.020	1.4	1.39
65	640	0.0088	0.026	1.767	0.123	0.007	1.543	0.025	0.020	1.4	1.39

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.129	0.006	1.564	0.021	0.017	1.1	1.27
67	660	0.0072	0.021	1.808	0.135	0.006	1.585	0.021	0.017	1.1	1.14
68	670	0.0072	0.021	1.829	0.141	0.006	1.605	0.021	0.017	1.1	1.14
69	680	0.0072	0.021	1.850	0.147	0.006	1.626	0.021	0.017	1.1	1.15
70	690	0.0072	0.021	1.871	0.153	0.006	1.647	0.021	0.017	1.1	1.15
71	700	0.0072	0.021	1.892	0.160	0.006	1.667	0.021	0.017	1.2	1.15
72	710	0.0072	0.021	1.913	0.166	0.006	1.688	0.021	0.017	1.2	1.15
73	720	0.0072	0.021	1.934	0.173	0.007	1.709	0.021	0.017	1.2	1.15
74	730	0.0072	0.021	1.955	0.180	0.007	1.729	0.021	0.017	1.2	1.16
75	740	0.0072	0.021	1.975	0.186	0.007	1.750	0.021	0.017	1.2	1.16
76	750	0.0072	0.021	1.996	0.193	0.007	1.771	0.021	0.017	1.2	1.16
77	760	0.0072	0.021	2.017	0.200	0.007	1.791	0.021	0.017	1.2	1.16
78	770	0.0057	0.017	2.034	0.206	0.006	1.808	0.016	0.014	0.9	1.04
79	780	0.0057	0.017	2.050	0.212	0.006	1.824	0.016	0.014	0.9	0.92
80	790	0.0057	0.017	2.067	0.217	0.006	1.841	0.016	0.014	0.9	0.92
81	800	0.0057	0.017	2.083	0.223	0.006	1.857	0.016	0.014	0.9	0.93
82	810	0.0057	0.017	2.100	0.229	0.006	1.873	0.016	0.014	0.9	0.93
83	820	0.0057	0.017	2.116	0.235	0.006	1.890	0.016	0.014	0.9	0.93
84	830	0.0057	0.017	2.133	0.241	0.006	1.906	0.016	0.014	0.9	0.93
85	840	0.0057	0.017	2.149	0.247	0.006	1.923	0.016	0.014	0.9	0.93
86	850	0.0057	0.017	2.166	0.253	0.006	1.939	0.016	0.014	0.9	0.93
87	860	0.0057	0.017	2.183	0.259	0.006	1.955	0.016	0.014	0.9	0.93
88	870	0.0057	0.017	2.199	0.265	0.006	1.972	0.016	0.014	0.9	0.93
89	880	0.0057	0.017	2.216	0.272	0.006	1.988	0.016	0.014	0.9	0.94
90	890	0.0050	0.015	2.230	0.277	0.006	2.003	0.014	0.012	0.8	0.88
91	900	0.0050	0.015	2.245	0.283	0.006	2.017	0.014	0.012	0.8	0.82
92	910	0.0050	0.015	2.259	0.288	0.006	2.031	0.014	0.012	0.8	0.82
93	920	0.0050	0.015	2.274	0.294	0.006	2.046	0.014	0.012	0.8	0.82
94	930	0.0050	0.015	2.288	0.300	0.006	2.060	0.014	0.012	0.8	0.82
95	940	0.0050	0.015	2.303	0.305	0.006	2.075	0.014	0.012	0.8	0.83
96	950	0.0050	0.015	2.317	0.311	0.006	2.089	0.014	0.012	0.8	0.83
97	960	0.0050	0.015	2.332	0.317	0.006	2.103	0.014	0.012	0.8	0.83
98	970	0.0050	0.015	2.346	0.323	0.006	2.118	0.014	0.012	0.8	0.83
99	980	0.0050	0.015	2.361	0.329	0.006	2.132	0.014	0.012	0.8	0.83
100	990	0.0050	0.015	2.375	0.335	0.006	2.147	0.014	0.012	0.8	0.83
101	1000	0.0050	0.015	2.390	0.341	0.006	2.161	0.014	0.012	0.8	0.83
102	1010	0.0040	0.012	2.401	0.346	0.005	2.173	0.012	0.010	0.7	0.75
103	1020	0.0040	0.012	2.413	0.351	0.005	2.184	0.012	0.010	0.7	0.67
104	1030	0.0040	0.012	2.424	0.355	0.005	2.196	0.012	0.010	0.7	0.67
105	1040	0.0040	0.012	2.436	0.360	0.005	2.207	0.012	0.010	0.7	0.67
106	1050	0.0040	0.012	2.448	0.365	0.005	2.219	0.012	0.010	0.7	0.67
107	1060	0.0040	0.012	2.459	0.370	0.005	2.230	0.012	0.010	0.7	0.67
108	1070	0.0040	0.012	2.471	0.375	0.005	2.242	0.012	0.010	0.7	0.67
109	1080	0.0040	0.012	2.482	0.380	0.005	2.253	0.012	0.010	0.7	0.67
110	1090	0.0040	0.012	2.494	0.385	0.005	2.265	0.012	0.010	0.7	0.67
111	1100	0.0040	0.012	2.506	0.390	0.005	2.276	0.012	0.010	0.7	0.67
112	1110	0.0040	0.012	2.517	0.395	0.005	2.288	0.012	0.010	0.7	0.67
113	1120	0.0040	0.012	2.529	0.400	0.005	2.299	0.012	0.010	0.7	0.67
114	1130	0.0040	0.012	2.540	0.406	0.005	2.311	0.012	0.010	0.7	0.67
115	1140	0.0040	0.012	2.552	0.411	0.005	2.322	0.012	0.010	0.7	0.67

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.416	0.005	2.334	0.012	0.010	0.7	0.67
117	1160	0.0040	0.012	2.575	0.421	0.005	2.346	0.012	0.010	0.7	0.67
118	1170	0.0040	0.012	2.587	0.426	0.005	2.357	0.012	0.010	0.7	0.67
119	1180	0.0040	0.012	2.598	0.432	0.005	2.369	0.012	0.010	0.7	0.67
120	1190	0.0040	0.012	2.610	0.437	0.005	2.380	0.012	0.010	0.7	0.67
121	1200	0.0040	0.012	2.622	0.442	0.005	2.392	0.012	0.010	0.7	0.67
122	1210	0.0040	0.012	2.633	0.447	0.005	2.403	0.012	0.010	0.7	0.67
123	1220	0.0040	0.012	2.645	0.453	0.005	2.415	0.012	0.010	0.7	0.67
124	1230	0.0040	0.012	2.656	0.458	0.005	2.426	0.012	0.010	0.7	0.68
125	1240	0.0040	0.012	2.668	0.464	0.005	2.438	0.012	0.010	0.7	0.68
126	1250	0.0040	0.012	2.680	0.469	0.005	2.449	0.012	0.010	0.7	0.68
127	1260	0.0040	0.012	2.691	0.474	0.005	2.461	0.012	0.010	0.7	0.68
128	1270	0.0040	0.012	2.703	0.480	0.005	2.472	0.012	0.010	0.7	0.68
129	1280	0.0040	0.012	2.714	0.485	0.005	2.484	0.012	0.010	0.7	0.68
130	1290	0.0040	0.012	2.726	0.491	0.005	2.496	0.012	0.010	0.7	0.68
131	1300	0.0040	0.012	2.738	0.496	0.006	2.507	0.012	0.010	0.7	0.68
132	1310	0.0040	0.012	2.749	0.502	0.006	2.519	0.012	0.010	0.7	0.68
133	1320	0.0040	0.012	2.761	0.507	0.006	2.530	0.012	0.010	0.7	0.68
134	1330	0.0040	0.012	2.772	0.513	0.006	2.542	0.012	0.010	0.7	0.68
135	1340	0.0040	0.012	2.784	0.519	0.006	2.553	0.012	0.010	0.7	0.68
136	1350	0.0040	0.012	2.796	0.524	0.006	2.565	0.012	0.010	0.7	0.68
137	1360	0.0040	0.012	2.807	0.530	0.006	2.576	0.012	0.010	0.7	0.68
138	1370	0.0040	0.012	2.819	0.536	0.006	2.588	0.012	0.010	0.7	0.68
139	1380	0.0040	0.012	2.830	0.541	0.006	2.599	0.012	0.010	0.7	0.68
140	1390	0.0040	0.012	2.842	0.547	0.006	2.611	0.012	0.010	0.7	0.68
141	1400	0.0040	0.012	2.854	0.553	0.006	2.623	0.012	0.010	0.7	0.68
142	1410	0.0040	0.012	2.865	0.558	0.006	2.634	0.012	0.010	0.7	0.68
143	1420	0.0040	0.012	2.877	0.564	0.006	2.646	0.012	0.010	0.7	0.68
144	1430	0.0040	0.012	2.888	0.570	0.006	2.657	0.012	0.010	0.7	0.68
145	1440	0.0040	0.012	2.900	0.576	0.006	2.669	0.012	0.010	0.7	0.68

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Headwater Basin**
Design Storm : **100-yr / 24-hr**

Given: Area = 1008.52 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 614.12 Ac. CN = 81.50 S = 2.2699 0.2S = 0.45
IMPERVIOUS AREA: Area = 394.40 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 190.24 cfs ***$T_{(Peak)}$ = 8.83 hrs***
Total Volume = 8,432,646 cf ***$Tc_{(min)}$ = 187 min***

Equations:
Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.2	0.01
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	3.7	0.11
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.001	7.8	0.40
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.002	11.1	0.87
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.002	13.9	1.48
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.003	16.2	2.18
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.003	18.1	2.96
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.003	19.8	3.80
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.004	26.8	4.81
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.005	28.7	6.01
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.005	30.4	7.24
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.005	31.8	8.48

Exhibit 6.1

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.005	32.9	9.72
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.006	34.0	10.96
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.007	42.0	12.36
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.007	43.1	13.94
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.007	44.1	15.48
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.007	44.9	16.99
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.007	45.6	18.46
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.008	46.3	19.89
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.009	54.7	21.49
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.009	55.4	23.24
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.009	56.8	24.95
27	260	0.0070	0.026	0.503	0.001	0.001	0.320	0.024	0.010	59.5	26.68
28	270	0.0070	0.026	0.529	0.002	0.001	0.344	0.024	0.010	62.1	28.45
29	280	0.0070	0.026	0.555	0.004	0.002	0.368	0.024	0.011	64.5	30.27
30	290	0.0082	0.031	0.586	0.007	0.003	0.396	0.028	0.013	78.6	32.42
31	300	0.0082	0.031	0.617	0.011	0.004	0.425	0.029	0.013	81.6	34.90
32	310	0.0082	0.031	0.647	0.015	0.004	0.454	0.029	0.014	84.5	37.41
33	320	0.0082	0.031	0.678	0.020	0.005	0.483	0.029	0.014	87.3	39.93
34	330	0.0082	0.031	0.709	0.026	0.006	0.512	0.029	0.015	90.0	42.47
35	340	0.0082	0.031	0.740	0.032	0.006	0.541	0.029	0.015	92.5	45.01
36	350	0.0095	0.036	0.775	0.040	0.008	0.575	0.034	0.018	110.2	47.94
37	360	0.0095	0.036	0.811	0.048	0.009	0.609	0.034	0.019	113.3	51.27
38	370	0.0095	0.036	0.846	0.058	0.009	0.643	0.034	0.019	116.2	54.57
39	380	0.0095	0.036	0.882	0.068	0.010	0.677	0.034	0.020	119.1	57.86
40	390	0.0095	0.036	0.918	0.079	0.011	0.711	0.034	0.020	121.8	61.12
41	400	0.0095	0.036	0.953	0.090	0.011	0.746	0.034	0.020	124.3	64.34
42	410	0.0134	0.050	1.004	0.107	0.017	0.794	0.049	0.029	179.6	68.91
43	420	0.0134	0.050	1.054	0.125	0.018	0.843	0.049	0.030	184.2	74.79
44	430	0.0134	0.050	1.104	0.145	0.019	0.892	0.049	0.031	188.6	80.60
45	440	0.0180	0.068	1.172	0.172	0.028	0.958	0.066	0.043	259.8	88.08
46	450	0.0180	0.068	1.239	0.202	0.029	1.024	0.066	0.044	266.7	97.20
47	460	0.0340	0.128	1.367	0.262	0.060	1.149	0.125	0.085	521.0	112.65
48	470	0.0540	0.203	1.569	0.367	0.106	1.348	0.199	0.142	868.1	142.96
49	480	0.0270	0.101	1.670	0.424	0.057	1.448	0.100	0.074	450.4	169.84
50	490	0.0180	0.068	1.738	0.464	0.039	1.515	0.067	0.050	305.6	180.69
51	500	0.0134	0.050	1.788	0.494	0.030	1.564	0.050	0.038	230.1	185.23
52	510	0.0134	0.050	1.838	0.524	0.031	1.614	0.050	0.038	232.3	187.62
53	520	0.0134	0.050	1.889	0.556	0.031	1.664	0.050	0.038	234.3	190.00
54	530	0.0088	0.033	1.922	0.576	0.021	1.697	0.033	0.025	155.0	190.24
55	540	0.0088	0.033	1.955	0.597	0.021	1.729	0.033	0.026	155.8	188.43
56	550	0.0088	0.033	1.988	0.618	0.021	1.762	0.033	0.026	156.6	186.75
57	560	0.0088	0.033	2.021	0.640	0.021	1.795	0.033	0.026	157.4	185.20
58	570	0.0088	0.033	2.054	0.661	0.022	1.827	0.033	0.026	158.1	183.77
59	580	0.0088	0.033	2.087	0.683	0.022	1.860	0.033	0.026	158.9	182.45
60	590	0.0088	0.033	2.120	0.705	0.022	1.893	0.033	0.026	159.6	181.24
61	600	0.0088	0.033	2.153	0.727	0.022	1.926	0.033	0.026	160.3	180.13
62	610	0.0088	0.033	2.186	0.749	0.022	1.958	0.033	0.026	161.0	179.11
63	620	0.0088	0.033	2.219	0.772	0.022	1.991	0.033	0.026	161.6	178.19
64	630	0.0088	0.033	2.252	0.794	0.023	2.024	0.033	0.027	162.3	177.34
65	640	0.0088	0.033	2.285	0.817	0.023	2.057	0.033	0.027	162.9	176.57

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.836	0.019	2.083	0.027	0.022	133.8	175.10
67	660	0.0072	0.027	2.339	0.855	0.019	2.110	0.027	0.022	134.2	172.96
68	670	0.0072	0.027	2.366	0.874	0.019	2.137	0.027	0.022	134.6	170.95
69	680	0.0072	0.027	2.393	0.893	0.019	2.164	0.027	0.022	135.0	169.06
70	690	0.0072	0.027	2.420	0.912	0.019	2.191	0.027	0.022	135.3	167.30
71	700	0.0072	0.027	2.447	0.931	0.019	2.218	0.027	0.022	135.7	165.64
72	710	0.0072	0.027	2.474	0.951	0.019	2.244	0.027	0.022	136.1	164.09
73	720	0.0072	0.027	2.501	0.970	0.019	2.271	0.027	0.022	136.4	162.64
74	730	0.0072	0.027	2.528	0.990	0.020	2.298	0.027	0.022	136.8	161.29
75	740	0.0072	0.027	2.555	1.010	0.020	2.325	0.027	0.022	137.1	160.02
76	750	0.0072	0.027	2.582	1.029	0.020	2.352	0.027	0.023	137.5	158.84
77	760	0.0072	0.027	2.609	1.049	0.020	2.379	0.027	0.023	137.8	157.74
78	770	0.0057	0.021	2.630	1.065	0.016	2.400	0.021	0.018	109.3	155.96
79	780	0.0057	0.021	2.651	1.081	0.016	2.421	0.021	0.018	109.5	153.53
80	790	0.0057	0.021	2.673	1.097	0.016	2.442	0.021	0.018	109.7	151.25
81	800	0.0057	0.021	2.694	1.113	0.016	2.464	0.021	0.018	109.9	149.09
82	810	0.0057	0.021	2.715	1.129	0.016	2.485	0.021	0.018	110.1	147.06
83	820	0.0057	0.021	2.737	1.145	0.016	2.506	0.021	0.018	110.3	145.14
84	830	0.0057	0.021	2.758	1.161	0.016	2.527	0.021	0.018	110.5	143.33
85	840	0.0057	0.021	2.780	1.177	0.016	2.549	0.021	0.018	110.7	141.63
86	850	0.0057	0.021	2.801	1.193	0.016	2.570	0.021	0.018	110.9	140.02
87	860	0.0057	0.021	2.822	1.209	0.016	2.591	0.021	0.018	111.1	138.51
88	870	0.0057	0.021	2.844	1.226	0.016	2.613	0.021	0.018	111.2	137.09
89	880	0.0057	0.021	2.865	1.242	0.016	2.634	0.021	0.018	111.4	135.74
90	890	0.0050	0.019	2.884	1.256	0.014	2.653	0.019	0.016	97.9	134.13
91	900	0.0050	0.019	2.903	1.271	0.014	2.671	0.019	0.016	98.0	132.24
92	910	0.0050	0.019	2.921	1.285	0.014	2.690	0.019	0.016	98.1	130.46
93	920	0.0050	0.019	2.940	1.299	0.014	2.709	0.019	0.016	98.3	128.78
94	930	0.0050	0.019	2.959	1.314	0.014	2.727	0.019	0.016	98.4	127.20
95	940	0.0050	0.019	2.978	1.329	0.015	2.746	0.019	0.016	98.5	125.70
96	950	0.0050	0.019	2.996	1.343	0.015	2.765	0.019	0.016	98.7	124.29
97	960	0.0050	0.019	3.015	1.358	0.015	2.783	0.019	0.016	98.8	122.96
98	970	0.0050	0.019	3.034	1.372	0.015	2.802	0.019	0.016	98.9	121.70
99	980	0.0050	0.019	3.053	1.387	0.015	2.821	0.019	0.016	99.0	120.52
100	990	0.0050	0.019	3.071	1.402	0.015	2.839	0.019	0.016	99.1	119.40
101	1000	0.0050	0.019	3.090	1.416	0.015	2.858	0.019	0.016	99.3	118.35
102	1010	0.0040	0.015	3.105	1.428	0.012	2.873	0.015	0.013	79.5	116.84
103	1020	0.0040	0.015	3.120	1.440	0.012	2.888	0.015	0.013	79.6	114.89
104	1030	0.0040	0.015	3.135	1.452	0.012	2.903	0.015	0.013	79.6	113.06
105	1040	0.0040	0.015	3.150	1.464	0.012	2.918	0.015	0.013	79.7	111.32
106	1050	0.0040	0.015	3.165	1.476	0.012	2.933	0.015	0.013	79.8	109.67
107	1060	0.0040	0.015	3.180	1.487	0.012	2.948	0.015	0.013	79.8	108.12
108	1070	0.0040	0.015	3.195	1.499	0.012	2.963	0.015	0.013	79.9	106.65
109	1080	0.0040	0.015	3.210	1.511	0.012	2.977	0.015	0.013	80.0	105.26
110	1090	0.0040	0.015	3.225	1.523	0.012	2.992	0.015	0.013	80.1	103.94
111	1100	0.0040	0.015	3.240	1.535	0.012	3.007	0.015	0.013	80.1	102.70
112	1110	0.0040	0.015	3.255	1.547	0.012	3.022	0.015	0.013	80.2	101.53
113	1120	0.0040	0.015	3.270	1.559	0.012	3.037	0.015	0.013	80.3	100.42
114	1130	0.0040	0.015	3.285	1.571	0.012	3.052	0.015	0.013	80.3	99.37
115	1140	0.0040	0.015	3.300	1.583	0.012	3.067	0.015	0.013	80.4	98.38

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	1.595	0.012	3.082	0.015	0.013	80.5	97.44
117	1160	0.0040	0.015	3.330	1.607	0.012	3.097	0.015	0.013	80.5	96.56
118	1170	0.0040	0.015	3.345	1.619	0.012	3.112	0.015	0.013	80.6	95.73
119	1180	0.0040	0.015	3.360	1.632	0.012	3.127	0.015	0.013	80.7	94.94
120	1190	0.0040	0.015	3.375	1.644	0.012	3.142	0.015	0.013	80.7	94.20
121	1200	0.0040	0.015	3.390	1.656	0.012	3.157	0.015	0.013	80.8	93.50
122	1210	0.0040	0.015	3.405	1.668	0.012	3.172	0.015	0.013	80.8	92.84
123	1220	0.0040	0.015	3.420	1.680	0.012	3.187	0.015	0.013	80.9	92.21
124	1230	0.0040	0.015	3.435	1.692	0.012	3.202	0.015	0.013	81.0	91.63
125	1240	0.0040	0.015	3.450	1.705	0.012	3.217	0.015	0.013	81.0	91.07
126	1250	0.0040	0.015	3.465	1.717	0.012	3.232	0.015	0.013	81.1	90.55
127	1260	0.0040	0.015	3.480	1.729	0.012	3.247	0.015	0.013	81.1	90.06
128	1270	0.0040	0.015	3.495	1.741	0.012	3.261	0.015	0.013	81.2	89.60
129	1280	0.0040	0.015	3.510	1.754	0.012	3.276	0.015	0.013	81.3	89.16
130	1290	0.0040	0.015	3.525	1.766	0.012	3.291	0.015	0.013	81.3	88.75
131	1300	0.0040	0.015	3.540	1.778	0.012	3.306	0.015	0.013	81.4	88.36
132	1310	0.0040	0.015	3.555	1.790	0.012	3.321	0.015	0.013	81.4	88.00
133	1320	0.0040	0.015	3.570	1.803	0.012	3.336	0.015	0.013	81.5	87.66
134	1330	0.0040	0.015	3.585	1.815	0.012	3.351	0.015	0.013	81.5	87.34
135	1340	0.0040	0.015	3.600	1.827	0.012	3.366	0.015	0.013	81.6	87.04
136	1350	0.0040	0.015	3.615	1.840	0.012	3.381	0.015	0.013	81.7	86.76
137	1360	0.0040	0.015	3.630	1.852	0.012	3.396	0.015	0.013	81.7	86.49
138	1370	0.0040	0.015	3.645	1.865	0.012	3.411	0.015	0.013	81.8	86.25
139	1380	0.0040	0.015	3.660	1.877	0.012	3.426	0.015	0.013	81.8	86.01
140	1390	0.0040	0.015	3.675	1.889	0.012	3.441	0.015	0.013	81.9	85.80
141	1400	0.0040	0.015	3.690	1.902	0.012	3.456	0.015	0.013	81.9	85.59
142	1410	0.0040	0.015	3.705	1.914	0.012	3.471	0.015	0.013	82.0	85.40
143	1420	0.0040	0.015	3.720	1.927	0.012	3.486	0.015	0.013	82.0	85.23
144	1430	0.0040	0.015	3.735	1.939	0.012	3.501	0.015	0.013	82.1	85.06
145	1440	0.0040	0.015	3.750	1.952	0.012	3.516	0.015	0.013	82.1	84.91

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 74th Ave Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 136.58 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 59.02 Ac. CN = 76.51 S = 3.0702 0.2S = 0.61

IMPERVIOUS AREA: Area = 77.56 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 27.53 cfs ***$T_{(Peak)}$ = 8.67 hrs***

Total Volume = 1,200,826 cf ***$Tc_{(min)}$ = 187 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.7	0.02
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.002	1.5	0.08
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.003	2.2	0.17
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.003	2.7	0.29
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.004	3.2	0.43
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.004	3.6	0.58
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.005	3.9	0.75
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.006	5.3	0.95
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.007	5.7	1.18
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.007	6.0	1.42
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.008	6.2	1.67

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.008	6.5	1.91
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.008	6.7	2.15
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.010	8.3	2.43
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.010	8.5	2.74
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.010	8.7	3.04
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.011	8.8	3.34
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.011	9.0	3.63
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.011	9.1	3.91
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.013	10.8	4.23
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.013	10.9	4.57
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.013	11.0	4.90
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.013	11.1	5.22
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.014	11.2	5.53
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.014	11.3	5.83
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.016	13.3	6.17
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.016	13.4	6.54
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.016	13.6	6.90
33	320	0.0082	0.031	0.678	0.001	0.001	0.483	0.029	0.017	13.9	7.26
34	330	0.0082	0.031	0.709	0.003	0.002	0.512	0.029	0.017	14.2	7.61
35	340	0.0082	0.031	0.740	0.005	0.002	0.541	0.029	0.017	14.4	7.96
36	350	0.0095	0.036	0.775	0.008	0.003	0.575	0.034	0.021	17.0	8.36
37	360	0.0095	0.036	0.811	0.012	0.004	0.609	0.034	0.021	17.3	8.82
38	370	0.0095	0.036	0.846	0.016	0.005	0.643	0.034	0.021	17.6	9.27
39	380	0.0095	0.036	0.882	0.022	0.005	0.677	0.034	0.022	17.9	9.71
40	390	0.0095	0.036	0.918	0.027	0.006	0.711	0.034	0.022	18.2	10.15
41	400	0.0095	0.036	0.953	0.034	0.006	0.746	0.034	0.022	18.4	10.57
42	410	0.0134	0.050	1.004	0.044	0.010	0.794	0.049	0.032	26.4	11.19
43	420	0.0134	0.050	1.054	0.055	0.011	0.843	0.049	0.033	26.9	12.00
44	430	0.0134	0.050	1.104	0.067	0.012	0.892	0.049	0.033	27.4	12.78
45	440	0.0180	0.068	1.172	0.086	0.018	0.958	0.066	0.045	37.4	13.80
46	450	0.0180	0.068	1.239	0.106	0.020	1.024	0.066	0.046	38.1	15.05
47	460	0.0340	0.128	1.367	0.148	0.042	1.149	0.125	0.089	73.8	17.18
48	470	0.0540	0.203	1.569	0.227	0.078	1.348	0.199	0.147	121.5	21.38
49	480	0.0270	0.101	1.670	0.270	0.044	1.448	0.100	0.076	62.5	25.06
50	490	0.0180	0.068	1.738	0.301	0.031	1.515	0.067	0.051	42.3	26.48
51	500	0.0134	0.050	1.788	0.325	0.024	1.564	0.050	0.038	31.8	27.03
52	510	0.0134	0.050	1.838	0.349	0.024	1.614	0.050	0.039	32.0	27.28
53	520	0.0134	0.050	1.889	0.374	0.025	1.664	0.050	0.039	32.2	27.53
54	530	0.0088	0.033	1.922	0.390	0.017	1.697	0.033	0.026	21.3	27.49
55	540	0.0088	0.033	1.955	0.407	0.017	1.729	0.033	0.026	21.4	27.17
56	550	0.0088	0.033	1.988	0.425	0.017	1.762	0.033	0.026	21.5	26.87
57	560	0.0088	0.033	2.021	0.442	0.017	1.795	0.033	0.026	21.5	26.59
58	570	0.0088	0.033	2.054	0.459	0.018	1.827	0.033	0.026	21.6	26.33
59	580	0.0088	0.033	2.087	0.477	0.018	1.860	0.033	0.026	21.7	26.09
60	590	0.0088	0.033	2.120	0.495	0.018	1.893	0.033	0.026	21.8	25.86
61	600	0.0088	0.033	2.153	0.514	0.018	1.926	0.033	0.026	21.9	25.65
62	610	0.0088	0.033	2.186	0.532	0.018	1.958	0.033	0.027	22.0	25.46
63	620	0.0088	0.033	2.219	0.551	0.019	1.991	0.033	0.027	22.0	25.28
64	630	0.0088	0.033	2.252	0.570	0.019	2.024	0.033	0.027	22.1	25.11
65	640	0.0088	0.033	2.285	0.589	0.019	2.057	0.033	0.027	22.2	24.96

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.604	0.016	2.083	0.027	0.022	18.2	24.71
67	660	0.0072	0.027	2.339	0.620	0.016	2.110	0.027	0.022	18.2	24.37
68	670	0.0072	0.027	2.366	0.636	0.016	2.137	0.027	0.022	18.3	24.05
69	680	0.0072	0.027	2.393	0.652	0.016	2.164	0.027	0.022	18.3	23.75
70	690	0.0072	0.027	2.420	0.669	0.016	2.191	0.027	0.022	18.4	23.47
71	700	0.0072	0.027	2.447	0.685	0.016	2.218	0.027	0.022	18.4	23.21
72	710	0.0072	0.027	2.474	0.701	0.016	2.244	0.027	0.022	18.5	22.96
73	720	0.0072	0.027	2.501	0.718	0.017	2.271	0.027	0.022	18.5	22.73
74	730	0.0072	0.027	2.528	0.735	0.017	2.298	0.027	0.022	18.6	22.51
75	740	0.0072	0.027	2.555	0.751	0.017	2.325	0.027	0.023	18.6	22.31
76	750	0.0072	0.027	2.582	0.768	0.017	2.352	0.027	0.023	18.6	22.11
77	760	0.0072	0.027	2.609	0.785	0.017	2.379	0.027	0.023	18.7	21.93
78	770	0.0057	0.021	2.630	0.799	0.014	2.400	0.021	0.018	14.8	21.66
79	780	0.0057	0.021	2.651	0.813	0.014	2.421	0.021	0.018	14.8	21.31
80	790	0.0057	0.021	2.673	0.826	0.014	2.442	0.021	0.018	14.9	20.97
81	800	0.0057	0.021	2.694	0.840	0.014	2.464	0.021	0.018	14.9	20.65
82	810	0.0057	0.021	2.715	0.854	0.014	2.485	0.021	0.018	14.9	20.35
83	820	0.0057	0.021	2.737	0.868	0.014	2.506	0.021	0.018	14.9	20.07
84	830	0.0057	0.021	2.758	0.882	0.014	2.527	0.021	0.018	15.0	19.80
85	840	0.0057	0.021	2.780	0.896	0.014	2.549	0.021	0.018	15.0	19.55
86	850	0.0057	0.021	2.801	0.910	0.014	2.570	0.021	0.018	15.0	19.31
87	860	0.0057	0.021	2.822	0.924	0.014	2.591	0.021	0.018	15.0	19.09
88	870	0.0057	0.021	2.844	0.938	0.014	2.613	0.021	0.018	15.0	18.88
89	880	0.0057	0.021	2.865	0.952	0.014	2.634	0.021	0.018	15.1	18.68
90	890	0.0050	0.019	2.884	0.965	0.013	2.653	0.019	0.016	13.2	18.44
91	900	0.0050	0.019	2.903	0.977	0.013	2.671	0.019	0.016	13.2	18.17
92	910	0.0050	0.019	2.921	0.990	0.013	2.690	0.019	0.016	13.3	17.92
93	920	0.0050	0.019	2.940	1.003	0.013	2.709	0.019	0.016	13.3	17.68
94	930	0.0050	0.019	2.959	1.015	0.013	2.727	0.019	0.016	13.3	17.45
95	940	0.0050	0.019	2.978	1.028	0.013	2.746	0.019	0.016	13.3	17.23
96	950	0.0050	0.019	2.996	1.041	0.013	2.765	0.019	0.016	13.3	17.03
97	960	0.0050	0.019	3.015	1.054	0.013	2.783	0.019	0.016	13.3	16.83
98	970	0.0050	0.019	3.034	1.067	0.013	2.802	0.019	0.016	13.4	16.65
99	980	0.0050	0.019	3.053	1.079	0.013	2.821	0.019	0.016	13.4	16.48
100	990	0.0050	0.019	3.071	1.092	0.013	2.839	0.019	0.016	13.4	16.32
101	1000	0.0050	0.019	3.090	1.105	0.013	2.858	0.019	0.016	13.4	16.17
102	1010	0.0040	0.015	3.105	1.116	0.010	2.873	0.015	0.013	10.7	15.95
103	1020	0.0040	0.015	3.120	1.126	0.010	2.888	0.015	0.013	10.7	15.68
104	1030	0.0040	0.015	3.135	1.137	0.010	2.903	0.015	0.013	10.7	15.42
105	1040	0.0040	0.015	3.150	1.147	0.010	2.918	0.015	0.013	10.8	15.18
106	1050	0.0040	0.015	3.165	1.158	0.011	2.933	0.015	0.013	10.8	14.95
107	1060	0.0040	0.015	3.180	1.168	0.011	2.948	0.015	0.013	10.8	14.73
108	1070	0.0040	0.015	3.195	1.179	0.011	2.963	0.015	0.013	10.8	14.53
109	1080	0.0040	0.015	3.210	1.189	0.011	2.977	0.015	0.013	10.8	14.33
110	1090	0.0040	0.015	3.225	1.200	0.011	2.992	0.015	0.013	10.8	14.15
111	1100	0.0040	0.015	3.240	1.211	0.011	3.007	0.015	0.013	10.8	13.97
112	1110	0.0040	0.015	3.255	1.221	0.011	3.022	0.015	0.013	10.8	13.81
113	1120	0.0040	0.015	3.270	1.232	0.011	3.037	0.015	0.013	10.8	13.65
114	1130	0.0040	0.015	3.285	1.243	0.011	3.052	0.015	0.013	10.8	13.51
115	1140	0.0040	0.015	3.300	1.253	0.011	3.067	0.015	0.013	10.8	13.37

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	1.264	0.011	3.082	0.015	0.013	10.9	13.24
117	1160	0.0040	0.015	3.330	1.275	0.011	3.097	0.015	0.013	10.9	13.11
118	1170	0.0040	0.015	3.345	1.286	0.011	3.112	0.015	0.013	10.9	13.00
119	1180	0.0040	0.015	3.360	1.296	0.011	3.127	0.015	0.013	10.9	12.88
120	1190	0.0040	0.015	3.375	1.307	0.011	3.142	0.015	0.013	10.9	12.78
121	1200	0.0040	0.015	3.390	1.318	0.011	3.157	0.015	0.013	10.9	12.68
122	1210	0.0040	0.015	3.405	1.329	0.011	3.172	0.015	0.013	10.9	12.59
123	1220	0.0040	0.015	3.420	1.340	0.011	3.187	0.015	0.013	10.9	12.50
124	1230	0.0040	0.015	3.435	1.351	0.011	3.202	0.015	0.013	10.9	12.42
125	1240	0.0040	0.015	3.450	1.362	0.011	3.217	0.015	0.013	10.9	12.34
126	1250	0.0040	0.015	3.465	1.373	0.011	3.232	0.015	0.013	10.9	12.27
127	1260	0.0040	0.015	3.480	1.384	0.011	3.247	0.015	0.013	10.9	12.20
128	1270	0.0040	0.015	3.495	1.395	0.011	3.261	0.015	0.013	10.9	12.13
129	1280	0.0040	0.015	3.510	1.406	0.011	3.276	0.015	0.013	11.0	12.07
130	1290	0.0040	0.015	3.525	1.417	0.011	3.291	0.015	0.013	11.0	12.01
131	1300	0.0040	0.015	3.540	1.428	0.011	3.306	0.015	0.013	11.0	11.96
132	1310	0.0040	0.015	3.555	1.439	0.011	3.321	0.015	0.013	11.0	11.91
133	1320	0.0040	0.015	3.570	1.450	0.011	3.336	0.015	0.013	11.0	11.86
134	1330	0.0040	0.015	3.585	1.461	0.011	3.351	0.015	0.013	11.0	11.81
135	1340	0.0040	0.015	3.600	1.472	0.011	3.366	0.015	0.013	11.0	11.77
136	1350	0.0040	0.015	3.615	1.483	0.011	3.381	0.015	0.013	11.0	11.73
137	1360	0.0040	0.015	3.630	1.495	0.011	3.396	0.015	0.013	11.0	11.69
138	1370	0.0040	0.015	3.645	1.506	0.011	3.411	0.015	0.013	11.0	11.66
139	1380	0.0040	0.015	3.660	1.517	0.011	3.426	0.015	0.013	11.0	11.62
140	1390	0.0040	0.015	3.675	1.528	0.011	3.441	0.015	0.013	11.0	11.59
141	1400	0.0040	0.015	3.690	1.539	0.011	3.456	0.015	0.013	11.0	11.56
142	1410	0.0040	0.015	3.705	1.551	0.011	3.471	0.015	0.013	11.0	11.53
143	1420	0.0040	0.015	3.720	1.562	0.011	3.486	0.015	0.013	11.0	11.51
144	1430	0.0040	0.015	3.735	1.573	0.011	3.501	0.015	0.013	11.1	11.49
145	1440	0.0040	0.015	3.750	1.585	0.011	3.516	0.015	0.013	11.1	11.46

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 71st Ave Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 38.82 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 9.82 Ac. CN = 83.74 S = 1.9417 0.2S = 0.39

IMPERVIOUS AREA: Area = 29.00 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 63 Min. w = 0.073529

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 16.65 cfs ***$T_{(Peak)}$ = 8.17 hrs***

Total Volume = 433,237 cf ***$Tc_{(min)}$ = 63 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.074

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.3	0.02
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.002	0.6	0.08
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.003	0.8	0.17
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.004	1.0	0.28
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.005	1.2	0.40
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.006	1.3	0.53
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.006	1.5	0.66
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.008	2.0	0.81
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.009	2.1	0.99
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.010	2.2	1.17
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.010	2.3	1.33

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.010	2.4	1.48
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.011	2.5	1.63
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.013	3.1	1.80
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.013	3.2	1.99
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.014	3.2	2.17
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.014	3.3	2.33
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.014	3.4	2.48
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.014	3.4	2.61
24	230	0.0070	0.026	0.424	0.001	0.001	0.250	0.023	0.017	4.1	2.78
25	240	0.0070	0.026	0.450	0.002	0.001	0.273	0.023	0.018	4.1	2.97
26	250	0.0070	0.026	0.476	0.004	0.002	0.296	0.023	0.018	4.2	3.15
27	260	0.0070	0.026	0.503	0.006	0.003	0.320	0.024	0.018	4.3	3.32
28	270	0.0070	0.026	0.529	0.009	0.003	0.344	0.024	0.019	4.4	3.47
29	280	0.0070	0.026	0.555	0.013	0.004	0.368	0.024	0.019	4.4	3.60
30	290	0.0082	0.031	0.586	0.018	0.005	0.396	0.028	0.022	5.3	3.79
31	300	0.0082	0.031	0.617	0.024	0.006	0.425	0.029	0.023	5.4	4.01
32	310	0.0082	0.031	0.647	0.030	0.006	0.454	0.029	0.023	5.4	4.22
33	320	0.0082	0.031	0.678	0.038	0.007	0.483	0.029	0.023	5.5	4.40
34	330	0.0082	0.031	0.709	0.045	0.008	0.512	0.029	0.024	5.6	4.56
35	340	0.0082	0.031	0.740	0.054	0.008	0.541	0.029	0.024	5.6	4.71
36	350	0.0095	0.036	0.775	0.064	0.010	0.575	0.034	0.028	6.6	4.91
37	360	0.0095	0.036	0.811	0.075	0.011	0.609	0.034	0.028	6.6	5.16
38	370	0.0095	0.036	0.846	0.087	0.012	0.643	0.034	0.029	6.7	5.38
39	380	0.0095	0.036	0.882	0.100	0.013	0.677	0.034	0.029	6.8	5.58
40	390	0.0095	0.036	0.918	0.113	0.013	0.711	0.034	0.029	6.8	5.76
41	400	0.0095	0.036	0.953	0.127	0.014	0.746	0.034	0.029	6.9	5.92
42	410	0.0134	0.050	1.004	0.148	0.021	0.794	0.049	0.042	9.8	6.27
43	420	0.0134	0.050	1.054	0.170	0.022	0.843	0.049	0.042	9.9	6.79
44	430	0.0134	0.050	1.104	0.193	0.023	0.892	0.049	0.042	9.9	7.25
45	440	0.0180	0.068	1.172	0.225	0.032	0.958	0.066	0.057	13.5	7.90
46	450	0.0180	0.068	1.239	0.259	0.034	1.024	0.066	0.058	13.6	8.73
47	460	0.0340	0.128	1.367	0.328	0.069	1.149	0.125	0.111	26.0	10.36
48	470	0.0540	0.203	1.569	0.446	0.119	1.348	0.199	0.179	42.0	13.84
49	480	0.0270	0.101	1.670	0.510	0.063	1.448	0.100	0.091	21.3	16.46
50	490	0.0180	0.068	1.738	0.553	0.044	1.515	0.067	0.061	14.3	16.65
51	500	0.0134	0.050	1.788	0.586	0.033	1.564	0.050	0.045	10.7	16.04
52	510	0.0134	0.050	1.838	0.620	0.034	1.614	0.050	0.046	10.7	15.26
53	520	0.0134	0.050	1.889	0.654	0.034	1.664	0.050	0.046	10.7	14.59
54	530	0.0088	0.033	1.922	0.676	0.023	1.697	0.033	0.030	7.1	13.76
55	540	0.0088	0.033	1.955	0.699	0.023	1.729	0.033	0.030	7.1	12.77
56	550	0.0088	0.033	1.988	0.722	0.023	1.762	0.033	0.030	7.1	11.94
57	560	0.0088	0.033	2.021	0.745	0.023	1.795	0.033	0.030	7.1	11.23
58	570	0.0088	0.033	2.054	0.769	0.023	1.827	0.033	0.030	7.1	10.62
59	580	0.0088	0.033	2.087	0.792	0.024	1.860	0.033	0.030	7.1	10.11
60	590	0.0088	0.033	2.120	0.816	0.024	1.893	0.033	0.030	7.2	9.67
61	600	0.0088	0.033	2.153	0.840	0.024	1.926	0.033	0.030	7.2	9.30
62	610	0.0088	0.033	2.186	0.864	0.024	1.958	0.033	0.031	7.2	8.99
63	620	0.0088	0.033	2.219	0.888	0.024	1.991	0.033	0.031	7.2	8.72
64	630	0.0088	0.033	2.252	0.912	0.024	2.024	0.033	0.031	7.2	8.50
65	640	0.0088	0.033	2.285	0.937	0.024	2.057	0.033	0.031	7.2	8.31

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.957	0.020	2.083	0.027	0.025	5.9	8.05
67	660	0.0072	0.027	2.339	0.977	0.020	2.110	0.027	0.025	5.9	7.73
68	670	0.0072	0.027	2.366	0.998	0.020	2.137	0.027	0.025	5.9	7.47
69	680	0.0072	0.027	2.393	1.018	0.020	2.164	0.027	0.025	5.9	7.24
70	690	0.0072	0.027	2.420	1.038	0.021	2.191	0.027	0.025	5.9	7.04
71	700	0.0072	0.027	2.447	1.059	0.021	2.218	0.027	0.025	5.9	6.88
72	710	0.0072	0.027	2.474	1.080	0.021	2.244	0.027	0.025	5.9	6.74
73	720	0.0072	0.027	2.501	1.100	0.021	2.271	0.027	0.025	5.9	6.62
74	730	0.0072	0.027	2.528	1.121	0.021	2.298	0.027	0.025	5.9	6.52
75	740	0.0072	0.027	2.555	1.142	0.021	2.325	0.027	0.025	6.0	6.44
76	750	0.0072	0.027	2.582	1.163	0.021	2.352	0.027	0.025	6.0	6.37
77	760	0.0072	0.027	2.609	1.184	0.021	2.379	0.027	0.025	6.0	6.31
78	770	0.0057	0.021	2.630	1.201	0.017	2.400	0.021	0.020	4.7	6.17
79	780	0.0057	0.021	2.651	1.218	0.017	2.421	0.021	0.020	4.7	5.95
80	790	0.0057	0.021	2.673	1.235	0.017	2.442	0.021	0.020	4.7	5.77
81	800	0.0057	0.021	2.694	1.252	0.017	2.464	0.021	0.020	4.7	5.62
82	810	0.0057	0.021	2.715	1.269	0.017	2.485	0.021	0.020	4.7	5.49
83	820	0.0057	0.021	2.737	1.286	0.017	2.506	0.021	0.020	4.7	5.38
84	830	0.0057	0.021	2.758	1.303	0.017	2.527	0.021	0.020	4.7	5.29
85	840	0.0057	0.021	2.780	1.320	0.017	2.549	0.021	0.020	4.7	5.21
86	850	0.0057	0.021	2.801	1.337	0.017	2.570	0.021	0.020	4.7	5.14
87	860	0.0057	0.021	2.822	1.354	0.017	2.591	0.021	0.020	4.8	5.08
88	870	0.0057	0.021	2.844	1.371	0.017	2.613	0.021	0.020	4.8	5.03
89	880	0.0057	0.021	2.865	1.388	0.017	2.634	0.021	0.020	4.8	4.99
90	890	0.0050	0.019	2.884	1.403	0.015	2.653	0.019	0.018	4.2	4.92
91	900	0.0050	0.019	2.903	1.419	0.015	2.671	0.019	0.018	4.2	4.81
92	910	0.0050	0.019	2.921	1.434	0.015	2.690	0.019	0.018	4.2	4.71
93	920	0.0050	0.019	2.940	1.449	0.015	2.709	0.019	0.018	4.2	4.64
94	930	0.0050	0.019	2.959	1.464	0.015	2.727	0.019	0.018	4.2	4.57
95	940	0.0050	0.019	2.978	1.480	0.015	2.746	0.019	0.018	4.2	4.51
96	950	0.0050	0.019	2.996	1.495	0.015	2.765	0.019	0.018	4.2	4.46
97	960	0.0050	0.019	3.015	1.510	0.015	2.783	0.019	0.018	4.2	4.42
98	970	0.0050	0.019	3.034	1.526	0.015	2.802	0.019	0.018	4.2	4.39
99	980	0.0050	0.019	3.053	1.541	0.015	2.821	0.019	0.018	4.2	4.36
100	990	0.0050	0.019	3.071	1.556	0.015	2.839	0.019	0.018	4.2	4.33
101	1000	0.0050	0.019	3.090	1.572	0.015	2.858	0.019	0.018	4.2	4.31
102	1010	0.0040	0.015	3.105	1.584	0.012	2.873	0.015	0.014	3.4	4.24
103	1020	0.0040	0.015	3.120	1.597	0.012	2.888	0.015	0.014	3.4	4.11
104	1030	0.0040	0.015	3.135	1.609	0.012	2.903	0.015	0.014	3.4	4.00
105	1040	0.0040	0.015	3.150	1.622	0.012	2.918	0.015	0.014	3.4	3.90
106	1050	0.0040	0.015	3.165	1.634	0.012	2.933	0.015	0.014	3.4	3.82
107	1060	0.0040	0.015	3.180	1.646	0.012	2.948	0.015	0.014	3.4	3.76
108	1070	0.0040	0.015	3.195	1.659	0.012	2.963	0.015	0.014	3.4	3.70
109	1080	0.0040	0.015	3.210	1.671	0.012	2.977	0.015	0.014	3.4	3.65
110	1090	0.0040	0.015	3.225	1.684	0.013	2.992	0.015	0.014	3.4	3.61
111	1100	0.0040	0.015	3.240	1.696	0.013	3.007	0.015	0.014	3.4	3.57
112	1110	0.0040	0.015	3.255	1.709	0.013	3.022	0.015	0.014	3.4	3.54
113	1120	0.0040	0.015	3.270	1.722	0.013	3.037	0.015	0.014	3.4	3.52
114	1130	0.0040	0.015	3.285	1.734	0.013	3.052	0.015	0.014	3.4	3.49
115	1140	0.0040	0.015	3.300	1.747	0.013	3.067	0.015	0.014	3.4	3.48

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	1.759	0.013	3.082	0.015	0.014	3.4	3.46
117	1160	0.0040	0.015	3.330	1.772	0.013	3.097	0.015	0.014	3.4	3.45
118	1170	0.0040	0.015	3.345	1.785	0.013	3.112	0.015	0.014	3.4	3.44
119	1180	0.0040	0.015	3.360	1.797	0.013	3.127	0.015	0.014	3.4	3.43
120	1190	0.0040	0.015	3.375	1.810	0.013	3.142	0.015	0.014	3.4	3.42
121	1200	0.0040	0.015	3.390	1.823	0.013	3.157	0.015	0.014	3.4	3.41
122	1210	0.0040	0.015	3.405	1.835	0.013	3.172	0.015	0.014	3.4	3.41
123	1220	0.0040	0.015	3.420	1.848	0.013	3.187	0.015	0.014	3.4	3.40
124	1230	0.0040	0.015	3.435	1.861	0.013	3.202	0.015	0.014	3.4	3.40
125	1240	0.0040	0.015	3.450	1.873	0.013	3.217	0.015	0.014	3.4	3.40
126	1250	0.0040	0.015	3.465	1.886	0.013	3.232	0.015	0.014	3.4	3.39
127	1260	0.0040	0.015	3.480	1.899	0.013	3.247	0.015	0.014	3.4	3.39
128	1270	0.0040	0.015	3.495	1.912	0.013	3.261	0.015	0.014	3.4	3.39
129	1280	0.0040	0.015	3.510	1.925	0.013	3.276	0.015	0.014	3.4	3.39
130	1290	0.0040	0.015	3.525	1.937	0.013	3.291	0.015	0.014	3.4	3.39
131	1300	0.0040	0.015	3.540	1.950	0.013	3.306	0.015	0.014	3.4	3.39
132	1310	0.0040	0.015	3.555	1.963	0.013	3.321	0.015	0.014	3.4	3.39
133	1320	0.0040	0.015	3.570	1.976	0.013	3.336	0.015	0.014	3.4	3.39
134	1330	0.0040	0.015	3.585	1.989	0.013	3.351	0.015	0.014	3.4	3.39
135	1340	0.0040	0.015	3.600	2.002	0.013	3.366	0.015	0.014	3.4	3.39
136	1350	0.0040	0.015	3.615	2.014	0.013	3.381	0.015	0.014	3.4	3.39
137	1360	0.0040	0.015	3.630	2.027	0.013	3.396	0.015	0.014	3.4	3.39
138	1370	0.0040	0.015	3.645	2.040	0.013	3.411	0.015	0.014	3.4	3.39
139	1380	0.0040	0.015	3.660	2.053	0.013	3.426	0.015	0.014	3.4	3.39
140	1390	0.0040	0.015	3.675	2.066	0.013	3.441	0.015	0.014	3.4	3.39
141	1400	0.0040	0.015	3.690	2.079	0.013	3.456	0.015	0.014	3.4	3.39
142	1410	0.0040	0.015	3.705	2.092	0.013	3.471	0.015	0.014	3.4	3.39
143	1420	0.0040	0.015	3.720	2.105	0.013	3.486	0.015	0.014	3.4	3.39
144	1430	0.0040	0.015	3.735	2.118	0.013	3.501	0.015	0.014	3.4	3.39
145	1440	0.0040	0.015	3.750	2.131	0.013	3.516	0.015	0.014	3.4	3.39

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 204th St Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 17.56 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 1.76 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 15.80 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 33 Min. w = 0.131579

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 10.20 cfs ***$T_{(Peak)}$ = 8.00 hrs***

Total Volume = 205,328 cf ***$Tc_{(min)}$ = 33 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.132

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.1	0.02
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.003	0.3	0.08
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.004	0.4	0.16
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.005	0.6	0.25
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.006	0.6	0.34
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.007	0.7	0.43
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.007	0.8	0.52
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.010	1.1	0.63
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.011	1.2	0.76
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.011	1.2	0.87
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.012	1.3	0.97

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.012	1.3	1.05
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.013	1.4	1.13
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.016	1.7	1.23
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.016	1.7	1.36
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.017	1.8	1.46
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.017	1.8	1.54
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.017	1.8	1.61
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.017	1.9	1.67
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.021	2.2	1.77
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.021	2.2	1.88
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.021	2.2	1.97
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.021	2.3	2.05
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.021	2.3	2.11
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.022	2.3	2.16
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.026	2.7	2.25
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.026	2.7	2.37
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.026	2.7	2.47
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.026	2.8	2.54
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.026	2.8	2.60
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.026	2.8	2.65
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.030	3.2	2.74
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.031	3.3	2.88
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.031	3.3	2.98
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.031	3.3	3.05
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.031	3.3	3.11
41	400	0.0095	0.036	0.953	0.000	0.000	0.746	0.034	0.031	3.3	3.16
42	410	0.0134	0.050	1.004	0.001	0.001	0.794	0.049	0.044	4.7	3.37
43	420	0.0134	0.050	1.054	0.003	0.002	0.843	0.049	0.044	4.7	3.71
44	430	0.0134	0.050	1.104	0.005	0.003	0.892	0.049	0.044	4.7	3.97
45	440	0.0180	0.068	1.172	0.011	0.005	0.958	0.066	0.060	6.3	4.38
46	450	0.0180	0.068	1.239	0.018	0.007	1.024	0.066	0.060	6.4	4.90
47	460	0.0340	0.128	1.367	0.035	0.018	1.149	0.125	0.114	12.1	6.05
48	470	0.0540	0.203	1.569	0.074	0.039	1.348	0.199	0.183	19.5	8.62
49	480	0.0270	0.101	1.670	0.098	0.024	1.448	0.100	0.092	9.8	10.20
50	490	0.0180	0.068	1.738	0.115	0.018	1.515	0.067	0.062	6.6	9.67
51	500	0.0134	0.050	1.788	0.129	0.014	1.564	0.050	0.046	4.9	8.63
52	510	0.0134	0.050	1.838	0.144	0.014	1.614	0.050	0.046	4.9	7.65
53	520	0.0134	0.050	1.889	0.159	0.015	1.664	0.050	0.046	4.9	6.93
54	530	0.0088	0.033	1.922	0.169	0.010	1.697	0.033	0.030	3.2	6.18
55	540	0.0088	0.033	1.955	0.180	0.011	1.729	0.033	0.030	3.2	5.40
56	550	0.0088	0.033	1.988	0.190	0.011	1.762	0.033	0.031	3.2	4.83
57	560	0.0088	0.033	2.021	0.201	0.011	1.795	0.033	0.031	3.2	4.42
58	570	0.0088	0.033	2.054	0.213	0.011	1.827	0.033	0.031	3.2	4.11
59	580	0.0088	0.033	2.087	0.224	0.012	1.860	0.033	0.031	3.3	3.88
60	590	0.0088	0.033	2.120	0.236	0.012	1.893	0.033	0.031	3.3	3.72
61	600	0.0088	0.033	2.153	0.248	0.012	1.926	0.033	0.031	3.3	3.59
62	610	0.0088	0.033	2.186	0.260	0.012	1.958	0.033	0.031	3.3	3.51
63	620	0.0088	0.033	2.219	0.273	0.012	1.991	0.033	0.031	3.3	3.44
64	630	0.0088	0.033	2.252	0.285	0.013	2.024	0.033	0.031	3.3	3.40
65	640	0.0088	0.033	2.285	0.298	0.013	2.057	0.033	0.031	3.3	3.36

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.309	0.011	2.083	0.027	0.025	2.7	3.26
67	660	0.0072	0.027	2.339	0.320	0.011	2.110	0.027	0.025	2.7	3.11
68	670	0.0072	0.027	2.366	0.331	0.011	2.137	0.027	0.025	2.7	2.99
69	680	0.0072	0.027	2.393	0.342	0.011	2.164	0.027	0.025	2.7	2.91
70	690	0.0072	0.027	2.420	0.353	0.011	2.191	0.027	0.025	2.7	2.85
71	700	0.0072	0.027	2.447	0.365	0.011	2.218	0.027	0.025	2.7	2.81
72	710	0.0072	0.027	2.474	0.376	0.012	2.244	0.027	0.025	2.7	2.78
73	720	0.0072	0.027	2.501	0.388	0.012	2.271	0.027	0.025	2.7	2.75
74	730	0.0072	0.027	2.528	0.400	0.012	2.298	0.027	0.025	2.7	2.74
75	740	0.0072	0.027	2.555	0.412	0.012	2.325	0.027	0.025	2.7	2.73
76	750	0.0072	0.027	2.582	0.424	0.012	2.352	0.027	0.025	2.7	2.72
77	760	0.0072	0.027	2.609	0.436	0.012	2.379	0.027	0.025	2.7	2.71
78	770	0.0057	0.021	2.630	0.446	0.010	2.400	0.021	0.020	2.1	2.63
79	780	0.0057	0.021	2.651	0.456	0.010	2.421	0.021	0.020	2.1	2.50
80	790	0.0057	0.021	2.673	0.466	0.010	2.442	0.021	0.020	2.1	2.41
81	800	0.0057	0.021	2.694	0.476	0.010	2.464	0.021	0.020	2.1	2.34
82	810	0.0057	0.021	2.715	0.486	0.010	2.485	0.021	0.020	2.1	2.28
83	820	0.0057	0.021	2.737	0.496	0.010	2.506	0.021	0.020	2.1	2.25
84	830	0.0057	0.021	2.758	0.506	0.010	2.527	0.021	0.020	2.1	2.22
85	840	0.0057	0.021	2.780	0.516	0.010	2.549	0.021	0.020	2.1	2.20
86	850	0.0057	0.021	2.801	0.527	0.010	2.570	0.021	0.020	2.1	2.18
87	860	0.0057	0.021	2.822	0.537	0.010	2.591	0.021	0.020	2.1	2.17
88	870	0.0057	0.021	2.844	0.548	0.011	2.613	0.021	0.020	2.1	2.17
89	880	0.0057	0.021	2.865	0.558	0.011	2.634	0.021	0.020	2.1	2.16
90	890	0.0050	0.019	2.884	0.568	0.009	2.653	0.019	0.018	1.9	2.12
91	900	0.0050	0.019	2.903	0.577	0.009	2.671	0.019	0.018	1.9	2.06
92	910	0.0050	0.019	2.921	0.586	0.009	2.690	0.019	0.018	1.9	2.01
93	920	0.0050	0.019	2.940	0.596	0.009	2.709	0.019	0.018	1.9	1.98
94	930	0.0050	0.019	2.959	0.605	0.010	2.727	0.019	0.018	1.9	1.96
95	940	0.0050	0.019	2.978	0.615	0.010	2.746	0.019	0.018	1.9	1.94
96	950	0.0050	0.019	2.996	0.625	0.010	2.765	0.019	0.018	1.9	1.92
97	960	0.0050	0.019	3.015	0.634	0.010	2.783	0.019	0.018	1.9	1.91
98	970	0.0050	0.019	3.034	0.644	0.010	2.802	0.019	0.018	1.9	1.91
99	980	0.0050	0.019	3.053	0.654	0.010	2.821	0.019	0.018	1.9	1.90
100	990	0.0050	0.019	3.071	0.664	0.010	2.839	0.019	0.018	1.9	1.90
101	1000	0.0050	0.019	3.090	0.674	0.010	2.858	0.019	0.018	1.9	1.90
102	1010	0.0040	0.015	3.105	0.682	0.008	2.873	0.015	0.014	1.5	1.85
103	1020	0.0040	0.015	3.120	0.690	0.008	2.888	0.015	0.014	1.5	1.76
104	1030	0.0040	0.015	3.135	0.698	0.008	2.903	0.015	0.014	1.5	1.69
105	1040	0.0040	0.015	3.150	0.706	0.008	2.918	0.015	0.014	1.5	1.65
106	1050	0.0040	0.015	3.165	0.714	0.008	2.933	0.015	0.014	1.5	1.61
107	1060	0.0040	0.015	3.180	0.722	0.008	2.948	0.015	0.014	1.5	1.59
108	1070	0.0040	0.015	3.195	0.730	0.008	2.963	0.015	0.014	1.5	1.57
109	1080	0.0040	0.015	3.210	0.738	0.008	2.977	0.015	0.014	1.5	1.55
110	1090	0.0040	0.015	3.225	0.746	0.008	2.992	0.015	0.014	1.5	1.54
111	1100	0.0040	0.015	3.240	0.754	0.008	3.007	0.015	0.014	1.5	1.54
112	1110	0.0040	0.015	3.255	0.763	0.008	3.022	0.015	0.014	1.5	1.53
113	1120	0.0040	0.015	3.270	0.771	0.008	3.037	0.015	0.014	1.5	1.53
114	1130	0.0040	0.015	3.285	0.779	0.008	3.052	0.015	0.014	1.5	1.52
115	1140	0.0040	0.015	3.300	0.788	0.008	3.067	0.015	0.014	1.5	1.52

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.796	0.008	3.082	0.015	0.014	1.5	1.52
117	1160	0.0040	0.015	3.330	0.804	0.008	3.097	0.015	0.014	1.5	1.52
118	1170	0.0040	0.015	3.345	0.813	0.008	3.112	0.015	0.014	1.5	1.52
119	1180	0.0040	0.015	3.360	0.821	0.008	3.127	0.015	0.014	1.5	1.52
120	1190	0.0040	0.015	3.375	0.830	0.008	3.142	0.015	0.014	1.5	1.52
121	1200	0.0040	0.015	3.390	0.838	0.008	3.157	0.015	0.014	1.5	1.52
122	1210	0.0040	0.015	3.405	0.847	0.009	3.172	0.015	0.014	1.5	1.52
123	1220	0.0040	0.015	3.420	0.855	0.009	3.187	0.015	0.014	1.5	1.52
124	1230	0.0040	0.015	3.435	0.864	0.009	3.202	0.015	0.014	1.5	1.52
125	1240	0.0040	0.015	3.450	0.872	0.009	3.217	0.015	0.014	1.5	1.52
126	1250	0.0040	0.015	3.465	0.881	0.009	3.232	0.015	0.014	1.5	1.52
127	1260	0.0040	0.015	3.480	0.890	0.009	3.247	0.015	0.014	1.5	1.52
128	1270	0.0040	0.015	3.495	0.898	0.009	3.261	0.015	0.014	1.5	1.52
129	1280	0.0040	0.015	3.510	0.907	0.009	3.276	0.015	0.014	1.5	1.52
130	1290	0.0040	0.015	3.525	0.916	0.009	3.291	0.015	0.014	1.5	1.52
131	1300	0.0040	0.015	3.540	0.925	0.009	3.306	0.015	0.014	1.5	1.52
132	1310	0.0040	0.015	3.555	0.933	0.009	3.321	0.015	0.014	1.5	1.52
133	1320	0.0040	0.015	3.570	0.942	0.009	3.336	0.015	0.014	1.5	1.52
134	1330	0.0040	0.015	3.585	0.951	0.009	3.351	0.015	0.014	1.5	1.52
135	1340	0.0040	0.015	3.600	0.960	0.009	3.366	0.015	0.014	1.5	1.52
136	1350	0.0040	0.015	3.615	0.969	0.009	3.381	0.015	0.014	1.5	1.52
137	1360	0.0040	0.015	3.630	0.978	0.009	3.396	0.015	0.014	1.5	1.52
138	1370	0.0040	0.015	3.645	0.987	0.009	3.411	0.015	0.014	1.5	1.52
139	1380	0.0040	0.015	3.660	0.996	0.009	3.426	0.015	0.014	1.5	1.52
140	1390	0.0040	0.015	3.675	1.005	0.009	3.441	0.015	0.014	1.5	1.52
141	1400	0.0040	0.015	3.690	1.014	0.009	3.456	0.015	0.014	1.5	1.52
142	1410	0.0040	0.015	3.705	1.023	0.009	3.471	0.015	0.014	1.5	1.53
143	1420	0.0040	0.015	3.720	1.032	0.009	3.486	0.015	0.014	1.5	1.53
144	1430	0.0040	0.015	3.735	1.041	0.009	3.501	0.015	0.014	1.5	1.53
145	1440	0.0040	0.015	3.750	1.050	0.009	3.516	0.015	0.014	1.5	1.53

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to BNSF RR Culvert**

Design Storm : **100-yr / 24-hr**

Given:	Area =	4.18	Ac.	P =	3.75	in.	dt =	10 min.
PERVIOUS AREA:	Area =	0.42	Ac.	CN =	68.95		S = 4.5033	0.2S = 0.90
IMPERVIOUS AREA:	Area =	3.76	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 3.77 cfs
Total Volume = 49,560 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.0	0.02
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.003	0.1	0.05
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.004	0.1	0.09
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.005	0.1	0.12
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.006	0.2	0.14
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.007	0.2	0.16
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.007	0.2	0.18
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.010	0.3	0.22
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.011	0.3	0.26
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.011	0.3	0.28
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.012	0.3	0.30

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.012	0.3	0.31
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.013	0.3	0.32
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.016	0.4	0.36
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.016	0.4	0.41
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.017	0.4	0.42
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.017	0.4	0.42
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.017	0.4	0.43
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.017	0.4	0.44
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.021	0.5	0.48
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.021	0.5	0.52
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.021	0.5	0.53
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.021	0.5	0.54
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.021	0.5	0.54
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.022	0.5	0.55
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.026	0.6	0.60
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.026	0.6	0.65
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.026	0.7	0.65
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.026	0.7	0.66
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.026	0.7	0.66
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.026	0.7	0.66
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.030	0.8	0.72
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.031	0.8	0.77
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.031	0.8	0.77
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.031	0.8	0.78
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.031	0.8	0.78
41	400	0.0095	0.036	0.953	0.001	0.001	0.746	0.034	0.031	0.8	0.78
42	410	0.0134	0.050	1.004	0.002	0.002	0.794	0.049	0.044	1.1	0.95
43	420	0.0134	0.050	1.054	0.005	0.003	0.843	0.049	0.044	1.1	1.11
44	430	0.0134	0.050	1.104	0.009	0.004	0.892	0.049	0.044	1.1	1.12
45	440	0.0180	0.068	1.172	0.015	0.007	0.958	0.066	0.060	1.5	1.32
46	450	0.0180	0.068	1.239	0.024	0.008	1.024	0.066	0.060	1.5	1.52
47	460	0.0340	0.128	1.367	0.044	0.020	1.149	0.125	0.114	2.9	2.21
48	470	0.0540	0.203	1.569	0.086	0.043	1.348	0.199	0.184	4.6	3.77
49	480	0.0270	0.101	1.670	0.112	0.026	1.448	0.100	0.092	2.3	3.49
50	490	0.0180	0.068	1.738	0.131	0.019	1.515	0.067	0.062	1.6	1.95
51	500	0.0134	0.050	1.788	0.146	0.015	1.564	0.050	0.046	1.2	1.37
52	510	0.0134	0.050	1.838	0.162	0.016	1.614	0.050	0.046	1.2	1.17
53	520	0.0134	0.050	1.889	0.178	0.016	1.664	0.050	0.046	1.2	1.17
54	530	0.0088	0.033	1.922	0.189	0.011	1.697	0.033	0.030	0.8	0.97
55	540	0.0088	0.033	1.955	0.200	0.011	1.729	0.033	0.031	0.8	0.77
56	550	0.0088	0.033	1.988	0.211	0.011	1.762	0.033	0.031	0.8	0.77
57	560	0.0088	0.033	2.021	0.223	0.012	1.795	0.033	0.031	0.8	0.77
58	570	0.0088	0.033	2.054	0.235	0.012	1.827	0.033	0.031	0.8	0.77
59	580	0.0088	0.033	2.087	0.247	0.012	1.860	0.033	0.031	0.8	0.78
60	590	0.0088	0.033	2.120	0.260	0.012	1.893	0.033	0.031	0.8	0.78
61	600	0.0088	0.033	2.153	0.272	0.013	1.926	0.033	0.031	0.8	0.78
62	610	0.0088	0.033	2.186	0.285	0.013	1.958	0.033	0.031	0.8	0.78
63	620	0.0088	0.033	2.219	0.298	0.013	1.991	0.033	0.031	0.8	0.78
64	630	0.0088	0.033	2.252	0.312	0.013	2.024	0.033	0.031	0.8	0.78
65	640	0.0088	0.033	2.285	0.325	0.014	2.057	0.033	0.031	0.8	0.78

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.337	0.011	2.083	0.027	0.025	0.6	0.71
67	660	0.0072	0.027	2.339	0.348	0.011	2.110	0.027	0.025	0.6	0.64
68	670	0.0072	0.027	2.366	0.360	0.012	2.137	0.027	0.025	0.6	0.64
69	680	0.0072	0.027	2.393	0.371	0.012	2.164	0.027	0.025	0.6	0.64
70	690	0.0072	0.027	2.420	0.383	0.012	2.191	0.027	0.025	0.6	0.64
71	700	0.0072	0.027	2.447	0.395	0.012	2.218	0.027	0.025	0.6	0.64
72	710	0.0072	0.027	2.474	0.407	0.012	2.244	0.027	0.025	0.6	0.64
73	720	0.0072	0.027	2.501	0.419	0.012	2.271	0.027	0.025	0.6	0.64
74	730	0.0072	0.027	2.528	0.432	0.012	2.298	0.027	0.025	0.6	0.64
75	740	0.0072	0.027	2.555	0.444	0.012	2.325	0.027	0.025	0.6	0.64
76	750	0.0072	0.027	2.582	0.457	0.013	2.352	0.027	0.025	0.6	0.64
77	760	0.0072	0.027	2.609	0.470	0.013	2.379	0.027	0.025	0.6	0.64
78	770	0.0057	0.021	2.630	0.480	0.010	2.400	0.021	0.020	0.5	0.58
79	780	0.0057	0.021	2.651	0.490	0.010	2.421	0.021	0.020	0.5	0.51
80	790	0.0057	0.021	2.673	0.500	0.010	2.442	0.021	0.020	0.5	0.51
81	800	0.0057	0.021	2.694	0.511	0.010	2.464	0.021	0.020	0.5	0.51
82	810	0.0057	0.021	2.715	0.521	0.010	2.485	0.021	0.020	0.5	0.51
83	820	0.0057	0.021	2.737	0.532	0.011	2.506	0.021	0.020	0.5	0.51
84	830	0.0057	0.021	2.758	0.542	0.011	2.527	0.021	0.020	0.5	0.51
85	840	0.0057	0.021	2.780	0.553	0.011	2.549	0.021	0.020	0.5	0.51
86	850	0.0057	0.021	2.801	0.564	0.011	2.570	0.021	0.020	0.5	0.51
87	860	0.0057	0.021	2.822	0.575	0.011	2.591	0.021	0.020	0.5	0.51
88	870	0.0057	0.021	2.844	0.586	0.011	2.613	0.021	0.020	0.5	0.51
89	880	0.0057	0.021	2.865	0.597	0.011	2.634	0.021	0.020	0.5	0.51
90	890	0.0050	0.019	2.884	0.606	0.010	2.653	0.019	0.018	0.4	0.48
91	900	0.0050	0.019	2.903	0.616	0.010	2.671	0.019	0.018	0.4	0.45
92	910	0.0050	0.019	2.921	0.626	0.010	2.690	0.019	0.018	0.4	0.45
93	920	0.0050	0.019	2.940	0.636	0.010	2.709	0.019	0.018	0.4	0.45
94	930	0.0050	0.019	2.959	0.646	0.010	2.727	0.019	0.018	0.4	0.45
95	940	0.0050	0.019	2.978	0.656	0.010	2.746	0.019	0.018	0.4	0.45
96	950	0.0050	0.019	2.996	0.665	0.010	2.765	0.019	0.018	0.5	0.45
97	960	0.0050	0.019	3.015	0.676	0.010	2.783	0.019	0.018	0.5	0.45
98	970	0.0050	0.019	3.034	0.686	0.010	2.802	0.019	0.018	0.5	0.45
99	980	0.0050	0.019	3.053	0.696	0.010	2.821	0.019	0.018	0.5	0.45
100	990	0.0050	0.019	3.071	0.706	0.010	2.839	0.019	0.018	0.5	0.45
101	1000	0.0050	0.019	3.090	0.716	0.010	2.858	0.019	0.018	0.5	0.45
102	1010	0.0040	0.015	3.105	0.724	0.008	2.873	0.015	0.014	0.4	0.41
103	1020	0.0040	0.015	3.120	0.733	0.008	2.888	0.015	0.014	0.4	0.36
104	1030	0.0040	0.015	3.135	0.741	0.008	2.903	0.015	0.014	0.4	0.36
105	1040	0.0040	0.015	3.150	0.749	0.008	2.918	0.015	0.014	0.4	0.36
106	1050	0.0040	0.015	3.165	0.758	0.008	2.933	0.015	0.014	0.4	0.36
107	1060	0.0040	0.015	3.180	0.766	0.008	2.948	0.015	0.014	0.4	0.36
108	1070	0.0040	0.015	3.195	0.774	0.008	2.963	0.015	0.014	0.4	0.36
109	1080	0.0040	0.015	3.210	0.783	0.008	2.977	0.015	0.014	0.4	0.36
110	1090	0.0040	0.015	3.225	0.791	0.008	2.992	0.015	0.014	0.4	0.36
111	1100	0.0040	0.015	3.240	0.800	0.008	3.007	0.015	0.014	0.4	0.36
112	1110	0.0040	0.015	3.255	0.808	0.009	3.022	0.015	0.014	0.4	0.36
113	1120	0.0040	0.015	3.270	0.817	0.009	3.037	0.015	0.014	0.4	0.36
114	1130	0.0040	0.015	3.285	0.825	0.009	3.052	0.015	0.014	0.4	0.36
115	1140	0.0040	0.015	3.300	0.834	0.009	3.067	0.015	0.014	0.4	0.36

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.843	0.009	3.082	0.015	0.014	0.4	0.36
117	1160	0.0040	0.015	3.330	0.851	0.009	3.097	0.015	0.014	0.4	0.36
118	1170	0.0040	0.015	3.345	0.860	0.009	3.112	0.015	0.014	0.4	0.36
119	1180	0.0040	0.015	3.360	0.869	0.009	3.127	0.015	0.014	0.4	0.36
120	1190	0.0040	0.015	3.375	0.877	0.009	3.142	0.015	0.014	0.4	0.36
121	1200	0.0040	0.015	3.390	0.886	0.009	3.157	0.015	0.014	0.4	0.36
122	1210	0.0040	0.015	3.405	0.895	0.009	3.172	0.015	0.014	0.4	0.36
123	1220	0.0040	0.015	3.420	0.904	0.009	3.187	0.015	0.014	0.4	0.36
124	1230	0.0040	0.015	3.435	0.913	0.009	3.202	0.015	0.014	0.4	0.36
125	1240	0.0040	0.015	3.450	0.922	0.009	3.217	0.015	0.014	0.4	0.36
126	1250	0.0040	0.015	3.465	0.930	0.009	3.232	0.015	0.014	0.4	0.36
127	1260	0.0040	0.015	3.480	0.939	0.009	3.247	0.015	0.014	0.4	0.36
128	1270	0.0040	0.015	3.495	0.948	0.009	3.261	0.015	0.014	0.4	0.36
129	1280	0.0040	0.015	3.510	0.957	0.009	3.276	0.015	0.014	0.4	0.36
130	1290	0.0040	0.015	3.525	0.966	0.009	3.291	0.015	0.014	0.4	0.36
131	1300	0.0040	0.015	3.540	0.975	0.009	3.306	0.015	0.014	0.4	0.36
132	1310	0.0040	0.015	3.555	0.984	0.009	3.321	0.015	0.014	0.4	0.36
133	1320	0.0040	0.015	3.570	0.993	0.009	3.336	0.015	0.014	0.4	0.36
134	1330	0.0040	0.015	3.585	1.003	0.009	3.351	0.015	0.014	0.4	0.36
135	1340	0.0040	0.015	3.600	1.012	0.009	3.366	0.015	0.014	0.4	0.36
136	1350	0.0040	0.015	3.615	1.021	0.009	3.381	0.015	0.014	0.4	0.36
137	1360	0.0040	0.015	3.630	1.030	0.009	3.396	0.015	0.014	0.4	0.36
138	1370	0.0040	0.015	3.645	1.039	0.009	3.411	0.015	0.014	0.4	0.36
139	1380	0.0040	0.015	3.660	1.048	0.009	3.426	0.015	0.014	0.4	0.36
140	1390	0.0040	0.015	3.675	1.058	0.009	3.441	0.015	0.014	0.4	0.36
141	1400	0.0040	0.015	3.690	1.067	0.009	3.456	0.015	0.014	0.4	0.36
142	1410	0.0040	0.015	3.705	1.076	0.009	3.471	0.015	0.014	0.4	0.36
143	1420	0.0040	0.015	3.720	1.086	0.009	3.486	0.015	0.014	0.4	0.36
144	1430	0.0040	0.015	3.735	1.095	0.009	3.501	0.015	0.014	0.4	0.36
145	1440	0.0040	0.015	3.750	1.104	0.009	3.516	0.015	0.014	0.4	0.36

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 69th Ave Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 0.76 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 0.08 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 0.68 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 0.68 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 8,963 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.0	0.00
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.003	0.0	0.01
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.004	0.0	0.02
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.005	0.0	0.02
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.006	0.0	0.03
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.007	0.0	0.03
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.007	0.0	0.03
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.010	0.0	0.04
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.011	0.0	0.05
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.011	0.1	0.05
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.012	0.1	0.05

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.012	0.1	0.06
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.013	0.1	0.06
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.016	0.1	0.07
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.016	0.1	0.07
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.017	0.1	0.08
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.017	0.1	0.08
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.017	0.1	0.08
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.017	0.1	0.08
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.021	0.1	0.09
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.021	0.1	0.09
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.021	0.1	0.10
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.021	0.1	0.10
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.021	0.1	0.10
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.022	0.1	0.10
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.025	0.1	0.11
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.026	0.1	0.12
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.026	0.1	0.12
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.026	0.1	0.12
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.026	0.1	0.12
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.026	0.1	0.12
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.030	0.1	0.13
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.030	0.1	0.14
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.031	0.1	0.14
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.031	0.1	0.14
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.031	0.1	0.14
41	400	0.0095	0.036	0.953	0.000	0.000	0.746	0.034	0.031	0.1	0.14
42	410	0.0134	0.050	1.004	0.001	0.001	0.794	0.049	0.044	0.2	0.17
43	420	0.0134	0.050	1.054	0.003	0.002	0.843	0.049	0.044	0.2	0.20
44	430	0.0134	0.050	1.104	0.005	0.003	0.892	0.049	0.044	0.2	0.20
45	440	0.0180	0.068	1.172	0.011	0.005	0.958	0.066	0.059	0.3	0.24
46	450	0.0180	0.068	1.239	0.018	0.007	1.024	0.066	0.060	0.3	0.27
47	460	0.0340	0.128	1.367	0.035	0.018	1.149	0.125	0.114	0.5	0.40
48	470	0.0540	0.203	1.569	0.074	0.039	1.348	0.199	0.182	0.8	0.68
49	480	0.0270	0.101	1.670	0.098	0.024	1.448	0.100	0.092	0.4	0.63
50	490	0.0180	0.068	1.738	0.115	0.018	1.515	0.067	0.062	0.3	0.35
51	500	0.0134	0.050	1.788	0.129	0.014	1.564	0.050	0.046	0.2	0.25
52	510	0.0134	0.050	1.838	0.144	0.014	1.614	0.050	0.046	0.2	0.21
53	520	0.0134	0.050	1.889	0.159	0.015	1.664	0.050	0.046	0.2	0.21
54	530	0.0088	0.033	1.922	0.169	0.010	1.697	0.033	0.030	0.1	0.18
55	540	0.0088	0.033	1.955	0.180	0.011	1.729	0.033	0.030	0.1	0.14
56	550	0.0088	0.033	1.988	0.190	0.011	1.762	0.033	0.030	0.1	0.14
57	560	0.0088	0.033	2.021	0.201	0.011	1.795	0.033	0.030	0.1	0.14
58	570	0.0088	0.033	2.054	0.213	0.011	1.827	0.033	0.030	0.1	0.14
59	580	0.0088	0.033	2.087	0.224	0.012	1.860	0.033	0.030	0.1	0.14
60	590	0.0088	0.033	2.120	0.236	0.012	1.893	0.033	0.031	0.1	0.14
61	600	0.0088	0.033	2.153	0.248	0.012	1.926	0.033	0.031	0.1	0.14
62	610	0.0088	0.033	2.186	0.260	0.012	1.958	0.033	0.031	0.1	0.14
63	620	0.0088	0.033	2.219	0.273	0.012	1.991	0.033	0.031	0.1	0.14
64	630	0.0088	0.033	2.252	0.285	0.013	2.024	0.033	0.031	0.1	0.14
65	640	0.0088	0.033	2.285	0.298	0.013	2.057	0.033	0.031	0.1	0.14

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.309	0.011	2.083	0.027	0.025	0.1	0.13
67	660	0.0072	0.027	2.339	0.320	0.011	2.110	0.027	0.025	0.1	0.12
68	670	0.0072	0.027	2.366	0.331	0.011	2.137	0.027	0.025	0.1	0.12
69	680	0.0072	0.027	2.393	0.342	0.011	2.164	0.027	0.025	0.1	0.12
70	690	0.0072	0.027	2.420	0.353	0.011	2.191	0.027	0.025	0.1	0.12
71	700	0.0072	0.027	2.447	0.365	0.011	2.218	0.027	0.025	0.1	0.12
72	710	0.0072	0.027	2.474	0.376	0.012	2.244	0.027	0.025	0.1	0.12
73	720	0.0072	0.027	2.501	0.388	0.012	2.271	0.027	0.025	0.1	0.12
74	730	0.0072	0.027	2.528	0.400	0.012	2.298	0.027	0.025	0.1	0.12
75	740	0.0072	0.027	2.555	0.412	0.012	2.325	0.027	0.025	0.1	0.12
76	750	0.0072	0.027	2.582	0.424	0.012	2.352	0.027	0.025	0.1	0.12
77	760	0.0072	0.027	2.609	0.436	0.012	2.379	0.027	0.025	0.1	0.12
78	770	0.0057	0.021	2.630	0.446	0.010	2.400	0.021	0.020	0.1	0.10
79	780	0.0057	0.021	2.651	0.456	0.010	2.421	0.021	0.020	0.1	0.09
80	790	0.0057	0.021	2.673	0.466	0.010	2.442	0.021	0.020	0.1	0.09
81	800	0.0057	0.021	2.694	0.476	0.010	2.464	0.021	0.020	0.1	0.09
82	810	0.0057	0.021	2.715	0.486	0.010	2.485	0.021	0.020	0.1	0.09
83	820	0.0057	0.021	2.737	0.496	0.010	2.506	0.021	0.020	0.1	0.09
84	830	0.0057	0.021	2.758	0.506	0.010	2.527	0.021	0.020	0.1	0.09
85	840	0.0057	0.021	2.780	0.516	0.010	2.549	0.021	0.020	0.1	0.09
86	850	0.0057	0.021	2.801	0.527	0.010	2.570	0.021	0.020	0.1	0.09
87	860	0.0057	0.021	2.822	0.537	0.010	2.591	0.021	0.020	0.1	0.09
88	870	0.0057	0.021	2.844	0.548	0.011	2.613	0.021	0.020	0.1	0.09
89	880	0.0057	0.021	2.865	0.558	0.011	2.634	0.021	0.020	0.1	0.09
90	890	0.0050	0.019	2.884	0.568	0.009	2.653	0.019	0.018	0.1	0.09
91	900	0.0050	0.019	2.903	0.577	0.009	2.671	0.019	0.018	0.1	0.08
92	910	0.0050	0.019	2.921	0.586	0.009	2.690	0.019	0.018	0.1	0.08
93	920	0.0050	0.019	2.940	0.596	0.009	2.709	0.019	0.018	0.1	0.08
94	930	0.0050	0.019	2.959	0.605	0.010	2.727	0.019	0.018	0.1	0.08
95	940	0.0050	0.019	2.978	0.615	0.010	2.746	0.019	0.018	0.1	0.08
96	950	0.0050	0.019	2.996	0.625	0.010	2.765	0.019	0.018	0.1	0.08
97	960	0.0050	0.019	3.015	0.634	0.010	2.783	0.019	0.018	0.1	0.08
98	970	0.0050	0.019	3.034	0.644	0.010	2.802	0.019	0.018	0.1	0.08
99	980	0.0050	0.019	3.053	0.654	0.010	2.821	0.019	0.018	0.1	0.08
100	990	0.0050	0.019	3.071	0.664	0.010	2.839	0.019	0.018	0.1	0.08
101	1000	0.0050	0.019	3.090	0.674	0.010	2.858	0.019	0.018	0.1	0.08
102	1010	0.0040	0.015	3.105	0.682	0.008	2.873	0.015	0.014	0.1	0.07
103	1020	0.0040	0.015	3.120	0.690	0.008	2.888	0.015	0.014	0.1	0.07
104	1030	0.0040	0.015	3.135	0.698	0.008	2.903	0.015	0.014	0.1	0.07
105	1040	0.0040	0.015	3.150	0.706	0.008	2.918	0.015	0.014	0.1	0.07
106	1050	0.0040	0.015	3.165	0.714	0.008	2.933	0.015	0.014	0.1	0.07
107	1060	0.0040	0.015	3.180	0.722	0.008	2.948	0.015	0.014	0.1	0.07
108	1070	0.0040	0.015	3.195	0.730	0.008	2.963	0.015	0.014	0.1	0.07
109	1080	0.0040	0.015	3.210	0.738	0.008	2.977	0.015	0.014	0.1	0.07
110	1090	0.0040	0.015	3.225	0.746	0.008	2.992	0.015	0.014	0.1	0.07
111	1100	0.0040	0.015	3.240	0.754	0.008	3.007	0.015	0.014	0.1	0.07
112	1110	0.0040	0.015	3.255	0.763	0.008	3.022	0.015	0.014	0.1	0.07
113	1120	0.0040	0.015	3.270	0.771	0.008	3.037	0.015	0.014	0.1	0.07
114	1130	0.0040	0.015	3.285	0.779	0.008	3.052	0.015	0.014	0.1	0.07
115	1140	0.0040	0.015	3.300	0.788	0.008	3.067	0.015	0.014	0.1	0.07

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.796	0.008	3.082	0.015	0.014	0.1	0.07
117	1160	0.0040	0.015	3.330	0.804	0.008	3.097	0.015	0.014	0.1	0.07
118	1170	0.0040	0.015	3.345	0.813	0.008	3.112	0.015	0.014	0.1	0.07
119	1180	0.0040	0.015	3.360	0.821	0.008	3.127	0.015	0.014	0.1	0.07
120	1190	0.0040	0.015	3.375	0.830	0.008	3.142	0.015	0.014	0.1	0.07
121	1200	0.0040	0.015	3.390	0.838	0.008	3.157	0.015	0.014	0.1	0.07
122	1210	0.0040	0.015	3.405	0.847	0.009	3.172	0.015	0.014	0.1	0.07
123	1220	0.0040	0.015	3.420	0.855	0.009	3.187	0.015	0.014	0.1	0.07
124	1230	0.0040	0.015	3.435	0.864	0.009	3.202	0.015	0.014	0.1	0.07
125	1240	0.0040	0.015	3.450	0.872	0.009	3.217	0.015	0.014	0.1	0.07
126	1250	0.0040	0.015	3.465	0.881	0.009	3.232	0.015	0.014	0.1	0.07
127	1260	0.0040	0.015	3.480	0.890	0.009	3.247	0.015	0.014	0.1	0.07
128	1270	0.0040	0.015	3.495	0.898	0.009	3.261	0.015	0.014	0.1	0.07
129	1280	0.0040	0.015	3.510	0.907	0.009	3.276	0.015	0.014	0.1	0.07
130	1290	0.0040	0.015	3.525	0.916	0.009	3.291	0.015	0.014	0.1	0.07
131	1300	0.0040	0.015	3.540	0.925	0.009	3.306	0.015	0.014	0.1	0.07
132	1310	0.0040	0.015	3.555	0.933	0.009	3.321	0.015	0.014	0.1	0.07
133	1320	0.0040	0.015	3.570	0.942	0.009	3.336	0.015	0.014	0.1	0.07
134	1330	0.0040	0.015	3.585	0.951	0.009	3.351	0.015	0.014	0.1	0.07
135	1340	0.0040	0.015	3.600	0.960	0.009	3.366	0.015	0.014	0.1	0.07
136	1350	0.0040	0.015	3.615	0.969	0.009	3.381	0.015	0.014	0.1	0.07
137	1360	0.0040	0.015	3.630	0.978	0.009	3.396	0.015	0.014	0.1	0.07
138	1370	0.0040	0.015	3.645	0.987	0.009	3.411	0.015	0.014	0.1	0.07
139	1380	0.0040	0.015	3.660	0.996	0.009	3.426	0.015	0.014	0.1	0.07
140	1390	0.0040	0.015	3.675	1.005	0.009	3.441	0.015	0.014	0.1	0.07
141	1400	0.0040	0.015	3.690	1.014	0.009	3.456	0.015	0.014	0.1	0.07
142	1410	0.0040	0.015	3.705	1.023	0.009	3.471	0.015	0.014	0.1	0.07
143	1420	0.0040	0.015	3.720	1.032	0.009	3.486	0.015	0.014	0.1	0.07
144	1430	0.0040	0.015	3.735	1.041	0.009	3.501	0.015	0.014	0.1	0.07
145	1440	0.0040	0.015	3.750	1.050	0.009	3.516	0.015	0.014	0.1	0.07

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Existing Basin Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to Confluence Point**

Design Storm : **100-yr / 24-hr**

Given: Area = 11.29 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 3.01 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 8.28 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 8.64 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 116,867 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.1	0.04
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.002	0.2	0.12
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.003	0.2	0.20
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.004	0.3	0.26
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.005	0.3	0.32
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.006	0.4	0.36
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.006	0.4	0.40
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.008	0.6	0.49
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.009	0.6	0.58
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.009	0.6	0.62
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.010	0.7	0.65

Exhibit 6.1

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.010	0.7	0.68
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.010	0.7	0.70
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.013	0.9	0.80
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.013	0.9	0.89
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.014	0.9	0.91
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.014	0.9	0.93
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.014	1.0	0.95
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.014	1.0	0.96
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.017	1.1	1.06
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.017	1.2	1.16
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.017	1.2	1.17
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.017	1.2	1.18
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.018	1.2	1.19
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.018	1.2	1.20
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.021	1.4	1.31
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.021	1.4	1.43
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.021	1.4	1.43
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.021	1.4	1.44
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.021	1.5	1.45
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.021	1.5	1.46
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.025	1.7	1.58
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.025	1.7	1.70
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.025	1.7	1.71
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.025	1.7	1.71
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.025	1.7	1.72
41	400	0.0095	0.036	0.953	0.000	0.000	0.746	0.034	0.025	1.7	1.72
42	410	0.0134	0.050	1.004	0.001	0.001	0.794	0.049	0.036	2.5	2.09
43	420	0.0134	0.050	1.054	0.003	0.002	0.843	0.049	0.036	2.5	2.46
44	430	0.0134	0.050	1.104	0.005	0.003	0.892	0.049	0.037	2.5	2.49
45	440	0.0180	0.068	1.172	0.011	0.005	0.958	0.066	0.050	3.4	2.95
46	450	0.0180	0.068	1.239	0.018	0.007	1.024	0.066	0.050	3.4	3.41
47	460	0.0340	0.128	1.367	0.035	0.018	1.149	0.125	0.096	6.6	5.01
48	470	0.0540	0.203	1.569	0.074	0.039	1.348	0.199	0.156	10.7	8.64
49	480	0.0270	0.101	1.670	0.098	0.024	1.448	0.100	0.080	5.4	8.06
50	490	0.0180	0.068	1.738	0.115	0.018	1.515	0.067	0.054	3.7	4.55
51	500	0.0134	0.050	1.788	0.129	0.014	1.564	0.050	0.040	2.7	3.20
52	510	0.0134	0.050	1.838	0.144	0.014	1.614	0.050	0.040	2.8	2.75
53	520	0.0134	0.050	1.889	0.159	0.015	1.664	0.050	0.041	2.8	2.76
54	530	0.0088	0.033	1.922	0.169	0.010	1.697	0.033	0.027	1.8	2.30
55	540	0.0088	0.033	1.955	0.180	0.011	1.729	0.033	0.027	1.8	1.83
56	550	0.0088	0.033	1.988	0.190	0.011	1.762	0.033	0.027	1.8	1.83
57	560	0.0088	0.033	2.021	0.201	0.011	1.795	0.033	0.027	1.8	1.84
58	570	0.0088	0.033	2.054	0.213	0.011	1.827	0.033	0.027	1.8	1.84
59	580	0.0088	0.033	2.087	0.224	0.012	1.860	0.033	0.027	1.8	1.85
60	590	0.0088	0.033	2.120	0.236	0.012	1.893	0.033	0.027	1.9	1.85
61	600	0.0088	0.033	2.153	0.248	0.012	1.926	0.033	0.027	1.9	1.86
62	610	0.0088	0.033	2.186	0.260	0.012	1.958	0.033	0.027	1.9	1.86
63	620	0.0088	0.033	2.219	0.273	0.012	1.991	0.033	0.027	1.9	1.87
64	630	0.0088	0.033	2.252	0.285	0.013	2.024	0.033	0.027	1.9	1.87
65	640	0.0088	0.033	2.285	0.298	0.013	2.057	0.033	0.027	1.9	1.87

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.309	0.011	2.083	0.027	0.023	1.5	1.71
67	660	0.0072	0.027	2.339	0.320	0.011	2.110	0.027	0.023	1.5	1.54
68	670	0.0072	0.027	2.366	0.331	0.011	2.137	0.027	0.023	1.5	1.54
69	680	0.0072	0.027	2.393	0.342	0.011	2.164	0.027	0.023	1.5	1.55
70	690	0.0072	0.027	2.420	0.353	0.011	2.191	0.027	0.023	1.5	1.55
71	700	0.0072	0.027	2.447	0.365	0.011	2.218	0.027	0.023	1.6	1.55
72	710	0.0072	0.027	2.474	0.376	0.012	2.244	0.027	0.023	1.6	1.55
73	720	0.0072	0.027	2.501	0.388	0.012	2.271	0.027	0.023	1.6	1.56
74	730	0.0072	0.027	2.528	0.400	0.012	2.298	0.027	0.023	1.6	1.56
75	740	0.0072	0.027	2.555	0.412	0.012	2.325	0.027	0.023	1.6	1.56
76	750	0.0072	0.027	2.582	0.424	0.012	2.352	0.027	0.023	1.6	1.56
77	760	0.0072	0.027	2.609	0.436	0.012	2.379	0.027	0.023	1.6	1.57
78	770	0.0057	0.021	2.630	0.446	0.010	2.400	0.021	0.018	1.2	1.41
79	780	0.0057	0.021	2.651	0.456	0.010	2.421	0.021	0.018	1.2	1.24
80	790	0.0057	0.021	2.673	0.466	0.010	2.442	0.021	0.018	1.2	1.24
81	800	0.0057	0.021	2.694	0.476	0.010	2.464	0.021	0.018	1.2	1.25
82	810	0.0057	0.021	2.715	0.486	0.010	2.485	0.021	0.018	1.2	1.25
83	820	0.0057	0.021	2.737	0.496	0.010	2.506	0.021	0.018	1.3	1.25
84	830	0.0057	0.021	2.758	0.506	0.010	2.527	0.021	0.018	1.3	1.25
85	840	0.0057	0.021	2.780	0.516	0.010	2.549	0.021	0.018	1.3	1.25
86	850	0.0057	0.021	2.801	0.527	0.010	2.570	0.021	0.018	1.3	1.25
87	860	0.0057	0.021	2.822	0.537	0.010	2.591	0.021	0.018	1.3	1.25
88	870	0.0057	0.021	2.844	0.548	0.011	2.613	0.021	0.018	1.3	1.26
89	880	0.0057	0.021	2.865	0.558	0.011	2.634	0.021	0.018	1.3	1.26
90	890	0.0050	0.019	2.884	0.568	0.009	2.653	0.019	0.016	1.1	1.18
91	900	0.0050	0.019	2.903	0.577	0.009	2.671	0.019	0.016	1.1	1.11
92	910	0.0050	0.019	2.921	0.586	0.009	2.690	0.019	0.016	1.1	1.11
93	920	0.0050	0.019	2.940	0.596	0.009	2.709	0.019	0.016	1.1	1.11
94	930	0.0050	0.019	2.959	0.605	0.010	2.727	0.019	0.016	1.1	1.11
95	940	0.0050	0.019	2.978	0.615	0.010	2.746	0.019	0.016	1.1	1.11
96	950	0.0050	0.019	2.996	0.625	0.010	2.765	0.019	0.016	1.1	1.11
97	960	0.0050	0.019	3.015	0.634	0.010	2.783	0.019	0.016	1.1	1.11
98	970	0.0050	0.019	3.034	0.644	0.010	2.802	0.019	0.016	1.1	1.11
99	980	0.0050	0.019	3.053	0.654	0.010	2.821	0.019	0.016	1.1	1.11
100	990	0.0050	0.019	3.071	0.664	0.010	2.839	0.019	0.016	1.1	1.11
101	1000	0.0050	0.019	3.090	0.674	0.010	2.858	0.019	0.016	1.1	1.12
102	1010	0.0040	0.015	3.105	0.682	0.008	2.873	0.015	0.013	0.9	1.00
103	1020	0.0040	0.015	3.120	0.690	0.008	2.888	0.015	0.013	0.9	0.89
104	1030	0.0040	0.015	3.135	0.698	0.008	2.903	0.015	0.013	0.9	0.89
105	1040	0.0040	0.015	3.150	0.706	0.008	2.918	0.015	0.013	0.9	0.89
106	1050	0.0040	0.015	3.165	0.714	0.008	2.933	0.015	0.013	0.9	0.90
107	1060	0.0040	0.015	3.180	0.722	0.008	2.948	0.015	0.013	0.9	0.90
108	1070	0.0040	0.015	3.195	0.730	0.008	2.963	0.015	0.013	0.9	0.90
109	1080	0.0040	0.015	3.210	0.738	0.008	2.977	0.015	0.013	0.9	0.90
110	1090	0.0040	0.015	3.225	0.746	0.008	2.992	0.015	0.013	0.9	0.90
111	1100	0.0040	0.015	3.240	0.754	0.008	3.007	0.015	0.013	0.9	0.90
112	1110	0.0040	0.015	3.255	0.763	0.008	3.022	0.015	0.013	0.9	0.90
113	1120	0.0040	0.015	3.270	0.771	0.008	3.037	0.015	0.013	0.9	0.90
114	1130	0.0040	0.015	3.285	0.779	0.008	3.052	0.015	0.013	0.9	0.90
115	1140	0.0040	0.015	3.300	0.788	0.008	3.067	0.015	0.013	0.9	0.90

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.796	0.008	3.082	0.015	0.013	0.9	0.90
117	1160	0.0040	0.015	3.330	0.804	0.008	3.097	0.015	0.013	0.9	0.90
118	1170	0.0040	0.015	3.345	0.813	0.008	3.112	0.015	0.013	0.9	0.90
119	1180	0.0040	0.015	3.360	0.821	0.008	3.127	0.015	0.013	0.9	0.90
120	1190	0.0040	0.015	3.375	0.830	0.008	3.142	0.015	0.013	0.9	0.90
121	1200	0.0040	0.015	3.390	0.838	0.008	3.157	0.015	0.013	0.9	0.90
122	1210	0.0040	0.015	3.405	0.847	0.009	3.172	0.015	0.013	0.9	0.90
123	1220	0.0040	0.015	3.420	0.855	0.009	3.187	0.015	0.013	0.9	0.90
124	1230	0.0040	0.015	3.435	0.864	0.009	3.202	0.015	0.013	0.9	0.90
125	1240	0.0040	0.015	3.450	0.872	0.009	3.217	0.015	0.013	0.9	0.91
126	1250	0.0040	0.015	3.465	0.881	0.009	3.232	0.015	0.013	0.9	0.91
127	1260	0.0040	0.015	3.480	0.890	0.009	3.247	0.015	0.013	0.9	0.91
128	1270	0.0040	0.015	3.495	0.898	0.009	3.261	0.015	0.013	0.9	0.91
129	1280	0.0040	0.015	3.510	0.907	0.009	3.276	0.015	0.013	0.9	0.91
130	1290	0.0040	0.015	3.525	0.916	0.009	3.291	0.015	0.013	0.9	0.91
131	1300	0.0040	0.015	3.540	0.925	0.009	3.306	0.015	0.013	0.9	0.91
132	1310	0.0040	0.015	3.555	0.933	0.009	3.321	0.015	0.013	0.9	0.91
133	1320	0.0040	0.015	3.570	0.942	0.009	3.336	0.015	0.013	0.9	0.91
134	1330	0.0040	0.015	3.585	0.951	0.009	3.351	0.015	0.013	0.9	0.91
135	1340	0.0040	0.015	3.600	0.960	0.009	3.366	0.015	0.013	0.9	0.91
136	1350	0.0040	0.015	3.615	0.969	0.009	3.381	0.015	0.013	0.9	0.91
137	1360	0.0040	0.015	3.630	0.978	0.009	3.396	0.015	0.013	0.9	0.91
138	1370	0.0040	0.015	3.645	0.987	0.009	3.411	0.015	0.013	0.9	0.91
139	1380	0.0040	0.015	3.660	0.996	0.009	3.426	0.015	0.013	0.9	0.91
140	1390	0.0040	0.015	3.675	1.005	0.009	3.441	0.015	0.013	0.9	0.91
141	1400	0.0040	0.015	3.690	1.014	0.009	3.456	0.015	0.013	0.9	0.91
142	1410	0.0040	0.015	3.705	1.023	0.009	3.471	0.015	0.013	0.9	0.91
143	1420	0.0040	0.015	3.720	1.032	0.009	3.486	0.015	0.013	0.9	0.91
144	1430	0.0040	0.015	3.735	1.041	0.009	3.501	0.015	0.013	0.9	0.91
145	1440	0.0040	0.015	3.750	1.050	0.009	3.516	0.015	0.013	0.9	0.91

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Headwater Basin**
Design Storm : **2-yr / 24-hr**

Given: Area = 1008.51 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 495.97 Ac. CN = 85.09 S = 1.7523 0.2S = 0.35
IMPERVIOUS AREA: Area = 512.54 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 81.92 cfs ***$T_{(Peak)}$ = 8.83 hrs***
Total Volume = 3,685,446 cf ***$Tc_{(min)}$ = 187 min***

Equations:
Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.1	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	1.2	0.04
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.000	2.6	0.14
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	3.9	0.30
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	5.0	0.51
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.001	7.7	0.82
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.001	9.1	1.21
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.002	10.4	1.66
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.002	11.6	2.14

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.002	12.6	2.66
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.002	13.6	3.20
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.003	17.4	3.84
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.003	18.5	4.58
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.003	19.5	5.33
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.003	20.4	6.10
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.003	21.3	6.87
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.004	22.0	7.64
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.004	26.5	8.50
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.004	27.4	9.46
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.005	28.1	10.42
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.005	28.8	11.36
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.005	29.4	12.28
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.005	30.0	13.19
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.006	35.8	14.21
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.006	36.4	15.35
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.006	37.0	16.47
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.006	37.5	17.55
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.006	38.0	18.60
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.006	38.5	19.63
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.008	45.8	20.80
37	360	0.0095	0.017	0.389	0.001	0.001	0.220	0.015	0.008	47.3	22.14
38	370	0.0095	0.017	0.406	0.002	0.001	0.234	0.015	0.008	48.7	23.49
39	380	0.0095	0.017	0.423	0.003	0.001	0.249	0.015	0.008	50.0	24.83
40	390	0.0095	0.017	0.440	0.004	0.001	0.265	0.015	0.008	51.2	26.18
41	400	0.0095	0.017	0.458	0.006	0.002	0.280	0.015	0.009	52.5	27.51
42	410	0.0134	0.024	0.482	0.009	0.003	0.301	0.022	0.012	75.9	29.42
43	420	0.0134	0.024	0.506	0.013	0.004	0.323	0.022	0.013	78.1	31.90
44	430	0.0134	0.024	0.530	0.017	0.004	0.345	0.022	0.013	80.1	34.36
45	440	0.0180	0.032	0.562	0.023	0.006	0.375	0.030	0.018	110.7	37.54
46	450	0.0180	0.032	0.595	0.030	0.007	0.405	0.030	0.019	114.0	41.44
47	460	0.0340	0.061	0.656	0.045	0.015	0.462	0.057	0.037	223.4	48.07
48	470	0.0540	0.097	0.753	0.075	0.030	0.554	0.092	0.061	374.4	61.13
49	480	0.0270	0.049	0.802	0.092	0.017	0.600	0.046	0.032	195.1	72.78
50	490	0.0180	0.032	0.834	0.105	0.012	0.631	0.031	0.022	132.8	77.53
51	500	0.0134	0.024	0.858	0.114	0.009	0.654	0.023	0.016	100.1	79.55
52	510	0.0134	0.024	0.882	0.124	0.010	0.677	0.023	0.017	101.2	80.65
53	520	0.0134	0.024	0.906	0.134	0.010	0.701	0.023	0.017	102.2	81.75
54	530	0.0088	0.016	0.922	0.141	0.007	0.716	0.015	0.011	67.7	81.92
55	540	0.0088	0.016	0.938	0.148	0.007	0.731	0.015	0.011	68.1	81.19
56	550	0.0088	0.016	0.954	0.155	0.007	0.746	0.015	0.011	68.5	80.52
57	560	0.0088	0.016	0.970	0.162	0.007	0.762	0.015	0.011	68.9	79.90
58	570	0.0088	0.016	0.986	0.169	0.007	0.777	0.015	0.011	69.3	79.34
59	580	0.0088	0.016	1.002	0.176	0.007	0.792	0.015	0.011	69.7	78.83
60	590	0.0088	0.016	1.017	0.184	0.007	0.808	0.015	0.011	70.1	78.36
61	600	0.0088	0.016	1.033	0.191	0.008	0.823	0.015	0.012	70.4	77.94
62	610	0.0088	0.016	1.049	0.199	0.008	0.838	0.015	0.012	70.8	77.56
63	620	0.0088	0.016	1.065	0.207	0.008	0.854	0.015	0.012	71.1	77.21
64	630	0.0088	0.016	1.081	0.215	0.008	0.869	0.015	0.012	71.5	76.90
65	640	0.0088	0.016	1.097	0.223	0.008	0.885	0.015	0.012	71.8	76.63

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.229	0.007	0.897	0.013	0.010	59.0	76.05
67	660	0.0072	0.013	1.122	0.236	0.007	0.910	0.013	0.010	59.2	75.16
68	670	0.0072	0.013	1.135	0.243	0.007	0.923	0.013	0.010	59.4	74.34
69	680	0.0072	0.013	1.148	0.250	0.007	0.935	0.013	0.010	59.6	73.57
70	690	0.0072	0.013	1.161	0.257	0.007	0.948	0.013	0.010	59.8	72.85
71	700	0.0072	0.013	1.174	0.263	0.007	0.961	0.013	0.010	60.0	72.18
72	710	0.0072	0.013	1.187	0.270	0.007	0.973	0.013	0.010	60.2	71.55
73	720	0.0072	0.013	1.200	0.278	0.007	0.986	0.013	0.010	60.4	70.97
74	730	0.0072	0.013	1.213	0.285	0.007	0.999	0.013	0.010	60.6	70.42
75	740	0.0072	0.013	1.226	0.292	0.007	1.011	0.013	0.010	60.8	69.92
76	750	0.0072	0.013	1.239	0.299	0.007	1.024	0.013	0.010	61.0	69.45
77	760	0.0072	0.013	1.252	0.306	0.007	1.037	0.013	0.010	61.2	69.01
78	770	0.0057	0.010	1.262	0.312	0.006	1.047	0.010	0.008	48.6	68.28
79	780	0.0057	0.010	1.273	0.318	0.006	1.057	0.010	0.008	48.7	67.26
80	790	0.0057	0.010	1.283	0.324	0.006	1.067	0.010	0.008	48.8	66.29
81	800	0.0057	0.010	1.293	0.330	0.006	1.077	0.010	0.008	48.9	65.38
82	810	0.0057	0.010	1.303	0.336	0.006	1.087	0.010	0.008	49.0	64.53
83	820	0.0057	0.010	1.314	0.342	0.006	1.097	0.010	0.008	49.1	63.72
84	830	0.0057	0.010	1.324	0.348	0.006	1.107	0.010	0.008	49.2	62.96
85	840	0.0057	0.010	1.334	0.354	0.006	1.117	0.010	0.008	49.3	62.25
86	850	0.0057	0.010	1.344	0.360	0.006	1.127	0.010	0.008	49.4	61.58
87	860	0.0057	0.010	1.355	0.366	0.006	1.137	0.010	0.008	49.5	60.95
88	870	0.0057	0.010	1.365	0.372	0.006	1.147	0.010	0.008	49.6	60.36
89	880	0.0057	0.010	1.375	0.378	0.006	1.157	0.010	0.008	49.7	59.80
90	890	0.0050	0.009	1.384	0.384	0.005	1.166	0.009	0.007	43.7	59.12
91	900	0.0050	0.009	1.393	0.389	0.005	1.175	0.009	0.007	43.8	58.32
92	910	0.0050	0.009	1.402	0.394	0.005	1.184	0.009	0.007	43.9	57.57
93	920	0.0050	0.009	1.411	0.400	0.005	1.193	0.009	0.007	43.9	56.85
94	930	0.0050	0.009	1.420	0.406	0.006	1.202	0.009	0.007	44.0	56.18
95	940	0.0050	0.009	1.429	0.411	0.006	1.210	0.009	0.007	44.1	55.55
96	950	0.0050	0.009	1.438	0.417	0.006	1.219	0.009	0.007	44.1	54.95
97	960	0.0050	0.009	1.447	0.422	0.006	1.228	0.009	0.007	44.2	54.39
98	970	0.0050	0.009	1.456	0.428	0.006	1.237	0.009	0.007	44.3	53.86
99	980	0.0050	0.009	1.465	0.433	0.006	1.246	0.009	0.007	44.4	53.37
100	990	0.0050	0.009	1.474	0.439	0.006	1.255	0.009	0.007	44.4	52.90
101	1000	0.0050	0.009	1.483	0.445	0.006	1.264	0.009	0.007	44.5	52.46
102	1010	0.0040	0.007	1.490	0.449	0.005	1.271	0.007	0.006	35.6	51.81
103	1020	0.0040	0.007	1.498	0.454	0.005	1.278	0.007	0.006	35.7	50.97
104	1030	0.0040	0.007	1.505	0.458	0.005	1.285	0.007	0.006	35.7	50.18
105	1040	0.0040	0.007	1.512	0.463	0.005	1.292	0.007	0.006	35.8	49.43
106	1050	0.0040	0.007	1.519	0.468	0.005	1.299	0.007	0.006	35.8	48.72
107	1060	0.0040	0.007	1.526	0.472	0.005	1.306	0.007	0.006	35.8	48.04
108	1070	0.0040	0.007	1.534	0.477	0.005	1.313	0.007	0.006	35.9	47.41
109	1080	0.0040	0.007	1.541	0.482	0.005	1.320	0.007	0.006	35.9	46.81
110	1090	0.0040	0.007	1.548	0.486	0.005	1.327	0.007	0.006	36.0	46.25
111	1100	0.0040	0.007	1.555	0.491	0.005	1.335	0.007	0.006	36.0	45.71
112	1110	0.0040	0.007	1.562	0.496	0.005	1.342	0.007	0.006	36.0	45.21
113	1120	0.0040	0.007	1.570	0.500	0.005	1.349	0.007	0.006	36.1	44.73
114	1130	0.0040	0.007	1.577	0.505	0.005	1.356	0.007	0.006	36.1	44.28
115	1140	0.0040	0.007	1.584	0.510	0.005	1.363	0.007	0.006	36.2	43.86

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.514	0.005	1.370	0.007	0.006	36.2	43.46
117	1160	0.0040	0.007	1.598	0.519	0.005	1.377	0.007	0.006	36.2	43.08
118	1170	0.0040	0.007	1.606	0.524	0.005	1.384	0.007	0.006	36.3	42.73
119	1180	0.0040	0.007	1.613	0.529	0.005	1.391	0.007	0.006	36.3	42.39
120	1190	0.0040	0.007	1.620	0.533	0.005	1.398	0.007	0.006	36.4	42.08
121	1200	0.0040	0.007	1.627	0.538	0.005	1.406	0.007	0.006	36.4	41.78
122	1210	0.0040	0.007	1.634	0.543	0.005	1.413	0.007	0.006	36.4	41.50
123	1220	0.0040	0.007	1.642	0.548	0.005	1.420	0.007	0.006	36.5	41.24
124	1230	0.0040	0.007	1.649	0.553	0.005	1.427	0.007	0.006	36.5	40.99
125	1240	0.0040	0.007	1.656	0.557	0.005	1.434	0.007	0.006	36.5	40.76
126	1250	0.0040	0.007	1.663	0.562	0.005	1.441	0.007	0.006	36.6	40.54
127	1260	0.0040	0.007	1.670	0.567	0.005	1.448	0.007	0.006	36.6	40.33
128	1270	0.0040	0.007	1.678	0.572	0.005	1.455	0.007	0.006	36.6	40.14
129	1280	0.0040	0.007	1.685	0.577	0.005	1.462	0.007	0.006	36.7	39.96
130	1290	0.0040	0.007	1.692	0.582	0.005	1.470	0.007	0.006	36.7	39.79
131	1300	0.0040	0.007	1.699	0.587	0.005	1.477	0.007	0.006	36.7	39.63
132	1310	0.0040	0.007	1.706	0.592	0.005	1.484	0.007	0.006	36.8	39.48
133	1320	0.0040	0.007	1.714	0.596	0.005	1.491	0.007	0.006	36.8	39.34
134	1330	0.0040	0.007	1.721	0.601	0.005	1.498	0.007	0.006	36.8	39.21
135	1340	0.0040	0.007	1.728	0.606	0.005	1.505	0.007	0.006	36.9	39.09
136	1350	0.0040	0.007	1.735	0.611	0.005	1.512	0.007	0.006	36.9	38.97
137	1360	0.0040	0.007	1.742	0.616	0.005	1.519	0.007	0.006	36.9	38.87
138	1370	0.0040	0.007	1.750	0.621	0.005	1.526	0.007	0.006	37.0	38.77
139	1380	0.0040	0.007	1.757	0.626	0.005	1.534	0.007	0.006	37.0	38.68
140	1390	0.0040	0.007	1.764	0.631	0.005	1.541	0.007	0.006	37.0	38.59
141	1400	0.0040	0.007	1.771	0.636	0.005	1.548	0.007	0.006	37.1	38.51
142	1410	0.0040	0.007	1.778	0.641	0.005	1.555	0.007	0.006	37.1	38.44
143	1420	0.0040	0.007	1.786	0.646	0.005	1.562	0.007	0.006	37.1	38.37
144	1430	0.0040	0.007	1.793	0.651	0.005	1.569	0.007	0.006	37.2	38.31
145	1440	0.0040	0.007	1.800	0.656	0.005	1.576	0.007	0.006	37.2	38.25

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 74th Ave Culvert**

Design Storm : **2-yr / 24-hr**

Given: Area = 136.59 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 49.93 Ac. CN = 79.20 S = 2.6263 0.2S = 0.53

IMPERVIOUS AREA: Area = 86.66 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 11.74 cfs ***$T_{(Peak)}$ = 8.67 hrs***

Total Volume = 514,498 cf ***$Tc_{(min)}$ = 187 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.2	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.4	0.02
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.7	0.05
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.8	0.09
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	1.3	0.14
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.002	1.5	0.20
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.002	1.8	0.28
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.002	2.0	0.36

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.003	2.1	0.45
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.003	2.3	0.54
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.004	2.9	0.65
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.004	3.1	0.77
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.004	3.3	0.90
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.004	3.5	1.03
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.004	3.6	1.16
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.005	3.7	1.29
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.005	4.5	1.44
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.006	4.6	1.60
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.006	4.8	1.76
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.006	4.9	1.92
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.006	5.0	2.08
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.006	5.1	2.23
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.007	6.1	2.40
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.007	6.2	2.60
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.008	6.3	2.78
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.008	6.3	2.97
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.008	6.4	3.15
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.008	6.5	3.32
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.009	7.6	3.51
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.009	7.7	3.73
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.009	7.8	3.94
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.009	7.8	4.14
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.010	7.9	4.33
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.010	8.0	4.52
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.014	11.3	4.79
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.014	11.4	5.13
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.014	11.5	5.46
45	440	0.0180	0.032	0.562	0.001	0.001	0.375	0.030	0.019	15.7	5.89
46	450	0.0180	0.032	0.595	0.002	0.001	0.405	0.030	0.019	16.1	6.41
47	460	0.0340	0.061	0.656	0.006	0.004	0.462	0.057	0.038	31.3	7.31
48	470	0.0540	0.097	0.753	0.018	0.012	0.554	0.092	0.063	51.8	9.09
49	480	0.0270	0.049	0.802	0.026	0.008	0.600	0.046	0.032	26.7	10.66
50	490	0.0180	0.032	0.834	0.033	0.006	0.631	0.031	0.022	18.1	11.27
51	500	0.0134	0.024	0.858	0.037	0.005	0.654	0.023	0.016	13.6	11.51
52	510	0.0134	0.024	0.882	0.043	0.005	0.677	0.023	0.017	13.7	11.63
53	520	0.0134	0.024	0.906	0.048	0.006	0.701	0.023	0.017	13.9	11.74
54	530	0.0088	0.016	0.922	0.052	0.004	0.716	0.015	0.011	9.2	11.73
55	540	0.0088	0.016	0.938	0.056	0.004	0.731	0.015	0.011	9.2	11.60
56	550	0.0088	0.016	0.954	0.060	0.004	0.746	0.015	0.011	9.3	11.47
57	560	0.0088	0.016	0.970	0.064	0.004	0.762	0.015	0.011	9.3	11.36
58	570	0.0088	0.016	0.986	0.069	0.004	0.777	0.015	0.011	9.3	11.25
59	580	0.0088	0.016	1.002	0.073	0.004	0.792	0.015	0.011	9.4	11.15
60	590	0.0088	0.016	1.017	0.078	0.005	0.808	0.015	0.011	9.4	11.06
61	600	0.0088	0.016	1.033	0.082	0.005	0.823	0.015	0.011	9.5	10.98
62	610	0.0088	0.016	1.049	0.087	0.005	0.838	0.015	0.012	9.5	10.90
63	620	0.0088	0.016	1.065	0.092	0.005	0.854	0.015	0.012	9.5	10.83
64	630	0.0088	0.016	1.081	0.097	0.005	0.869	0.015	0.012	9.6	10.76
65	640	0.0088	0.016	1.097	0.102	0.005	0.885	0.015	0.012	9.6	10.70

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.106	0.004	0.897	0.013	0.010	7.9	10.60
67	660	0.0072	0.013	1.122	0.111	0.004	0.910	0.013	0.010	7.9	10.46
68	670	0.0072	0.013	1.135	0.115	0.004	0.923	0.013	0.010	8.0	10.33
69	680	0.0072	0.013	1.148	0.120	0.004	0.935	0.013	0.010	8.0	10.21
70	690	0.0072	0.013	1.161	0.124	0.005	0.948	0.013	0.010	8.0	10.09
71	700	0.0072	0.013	1.174	0.129	0.005	0.961	0.013	0.010	8.0	9.98
72	710	0.0072	0.013	1.187	0.133	0.005	0.973	0.013	0.010	8.0	9.88
73	720	0.0072	0.013	1.200	0.138	0.005	0.986	0.013	0.010	8.1	9.79
74	730	0.0072	0.013	1.213	0.143	0.005	0.999	0.013	0.010	8.1	9.70
75	740	0.0072	0.013	1.226	0.148	0.005	1.011	0.013	0.010	8.1	9.62
76	750	0.0072	0.013	1.239	0.153	0.005	1.024	0.013	0.010	8.1	9.54
77	760	0.0072	0.013	1.252	0.158	0.005	1.037	0.013	0.010	8.2	9.47
78	770	0.0057	0.010	1.262	0.162	0.004	1.047	0.010	0.008	6.5	9.35
79	780	0.0057	0.010	1.273	0.166	0.004	1.057	0.010	0.008	6.5	9.20
80	790	0.0057	0.010	1.283	0.170	0.004	1.067	0.010	0.008	6.5	9.06
81	800	0.0057	0.010	1.293	0.174	0.004	1.077	0.010	0.008	6.5	8.93
82	810	0.0057	0.010	1.303	0.178	0.004	1.087	0.010	0.008	6.5	8.80
83	820	0.0057	0.010	1.314	0.182	0.004	1.097	0.010	0.008	6.5	8.68
84	830	0.0057	0.010	1.324	0.186	0.004	1.107	0.010	0.008	6.5	8.57
85	840	0.0057	0.010	1.334	0.190	0.004	1.117	0.010	0.008	6.6	8.47
86	850	0.0057	0.010	1.344	0.195	0.004	1.127	0.010	0.008	6.6	8.37
87	860	0.0057	0.010	1.355	0.199	0.004	1.137	0.010	0.008	6.6	8.28
88	870	0.0057	0.010	1.365	0.203	0.004	1.147	0.010	0.008	6.6	8.19
89	880	0.0057	0.010	1.375	0.208	0.004	1.157	0.010	0.008	6.6	8.11
90	890	0.0050	0.009	1.384	0.212	0.004	1.166	0.009	0.007	5.8	8.01
91	900	0.0050	0.009	1.393	0.216	0.004	1.175	0.009	0.007	5.8	7.89
92	910	0.0050	0.009	1.402	0.220	0.004	1.184	0.009	0.007	5.8	7.78
93	920	0.0050	0.009	1.411	0.223	0.004	1.193	0.009	0.007	5.8	7.68
94	930	0.0050	0.009	1.420	0.227	0.004	1.202	0.009	0.007	5.8	7.59
95	940	0.0050	0.009	1.429	0.231	0.004	1.210	0.009	0.007	5.9	7.50
96	950	0.0050	0.009	1.438	0.235	0.004	1.219	0.009	0.007	5.9	7.41
97	960	0.0050	0.009	1.447	0.240	0.004	1.228	0.009	0.007	5.9	7.33
98	970	0.0050	0.009	1.456	0.244	0.004	1.237	0.009	0.007	5.9	7.25
99	980	0.0050	0.009	1.465	0.248	0.004	1.246	0.009	0.007	5.9	7.18
100	990	0.0050	0.009	1.474	0.252	0.004	1.255	0.009	0.007	5.9	7.12
101	1000	0.0050	0.009	1.483	0.256	0.004	1.264	0.009	0.007	5.9	7.05
102	1010	0.0040	0.007	1.490	0.259	0.003	1.271	0.007	0.006	4.7	6.96
103	1020	0.0040	0.007	1.498	0.263	0.003	1.278	0.007	0.006	4.7	6.84
104	1030	0.0040	0.007	1.505	0.266	0.003	1.285	0.007	0.006	4.7	6.73
105	1040	0.0040	0.007	1.512	0.269	0.003	1.292	0.007	0.006	4.7	6.63
106	1050	0.0040	0.007	1.519	0.273	0.003	1.299	0.007	0.006	4.7	6.53
107	1060	0.0040	0.007	1.526	0.276	0.003	1.306	0.007	0.006	4.8	6.44
108	1070	0.0040	0.007	1.534	0.280	0.003	1.313	0.007	0.006	4.8	6.35
109	1080	0.0040	0.007	1.541	0.283	0.003	1.320	0.007	0.006	4.8	6.27
110	1090	0.0040	0.007	1.548	0.287	0.003	1.327	0.007	0.006	4.8	6.19
111	1100	0.0040	0.007	1.555	0.290	0.003	1.335	0.007	0.006	4.8	6.12
112	1110	0.0040	0.007	1.562	0.294	0.003	1.342	0.007	0.006	4.8	6.05
113	1120	0.0040	0.007	1.570	0.297	0.004	1.349	0.007	0.006	4.8	5.98
114	1130	0.0040	0.007	1.577	0.301	0.004	1.356	0.007	0.006	4.8	5.92
115	1140	0.0040	0.007	1.584	0.304	0.004	1.363	0.007	0.006	4.8	5.86

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.308	0.004	1.370	0.007	0.006	4.8	5.80
117	1160	0.0040	0.007	1.598	0.311	0.004	1.377	0.007	0.006	4.8	5.75
118	1170	0.0040	0.007	1.606	0.315	0.004	1.384	0.007	0.006	4.8	5.70
119	1180	0.0040	0.007	1.613	0.318	0.004	1.391	0.007	0.006	4.8	5.66
120	1190	0.0040	0.007	1.620	0.322	0.004	1.398	0.007	0.006	4.8	5.61
121	1200	0.0040	0.007	1.627	0.326	0.004	1.406	0.007	0.006	4.8	5.57
122	1210	0.0040	0.007	1.634	0.329	0.004	1.413	0.007	0.006	4.8	5.53
123	1220	0.0040	0.007	1.642	0.333	0.004	1.420	0.007	0.006	4.8	5.49
124	1230	0.0040	0.007	1.649	0.337	0.004	1.427	0.007	0.006	4.8	5.46
125	1240	0.0040	0.007	1.656	0.340	0.004	1.434	0.007	0.006	4.8	5.43
126	1250	0.0040	0.007	1.663	0.344	0.004	1.441	0.007	0.006	4.8	5.40
127	1260	0.0040	0.007	1.670	0.348	0.004	1.448	0.007	0.006	4.8	5.37
128	1270	0.0040	0.007	1.678	0.351	0.004	1.455	0.007	0.006	4.9	5.34
129	1280	0.0040	0.007	1.685	0.355	0.004	1.462	0.007	0.006	4.9	5.32
130	1290	0.0040	0.007	1.692	0.359	0.004	1.470	0.007	0.006	4.9	5.29
131	1300	0.0040	0.007	1.699	0.363	0.004	1.477	0.007	0.006	4.9	5.27
132	1310	0.0040	0.007	1.706	0.366	0.004	1.484	0.007	0.006	4.9	5.25
133	1320	0.0040	0.007	1.714	0.370	0.004	1.491	0.007	0.006	4.9	5.23
134	1330	0.0040	0.007	1.721	0.374	0.004	1.498	0.007	0.006	4.9	5.21
135	1340	0.0040	0.007	1.728	0.378	0.004	1.505	0.007	0.006	4.9	5.19
136	1350	0.0040	0.007	1.735	0.382	0.004	1.512	0.007	0.006	4.9	5.18
137	1360	0.0040	0.007	1.742	0.385	0.004	1.519	0.007	0.006	4.9	5.16
138	1370	0.0040	0.007	1.750	0.389	0.004	1.526	0.007	0.006	4.9	5.15
139	1380	0.0040	0.007	1.757	0.393	0.004	1.534	0.007	0.006	4.9	5.13
140	1390	0.0040	0.007	1.764	0.397	0.004	1.541	0.007	0.006	4.9	5.12
141	1400	0.0040	0.007	1.771	0.401	0.004	1.548	0.007	0.006	4.9	5.11
142	1410	0.0040	0.007	1.778	0.405	0.004	1.555	0.007	0.006	4.9	5.10
143	1420	0.0040	0.007	1.786	0.409	0.004	1.562	0.007	0.006	4.9	5.09
144	1430	0.0040	0.007	1.793	0.413	0.004	1.569	0.007	0.006	4.9	5.08
145	1440	0.0040	0.007	1.800	0.417	0.004	1.576	0.007	0.006	4.9	5.07

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 71st Ave Culvert**

Design Storm : **2-yr / 24-hr**

Given: Area = 38.83 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 3.89 Ac. CN = 79.20 S = 2.6263 0.2S = 0.53

IMPERVIOUS AREA: Area = 34.94 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 63 Min. w = 0.073529

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 7.79 cfs ***$T_{(Peak)}$ = 8.17 hrs***

Total Volume = 199,777 cf ***$Tc_{(min)}$ = 63 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.074

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.1	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.2	0.03
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.3	0.05
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.3	0.09
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.5	0.14
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.003	0.6	0.20
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.7	0.27
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.8	0.34

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.004	0.9	0.41
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.004	0.9	0.48
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.005	1.2	0.57
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.005	1.3	0.66
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.006	1.3	0.76
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.006	1.4	0.85
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.006	1.4	0.93
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.006	1.5	1.01
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.008	1.8	1.11
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.008	1.9	1.21
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.008	1.9	1.31
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.008	2.0	1.41
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.009	2.0	1.49
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.009	2.0	1.57
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.010	2.4	1.67
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.011	2.5	1.78
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.011	2.5	1.89
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.011	2.6	1.99
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.011	2.6	2.07
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.011	2.6	2.15
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.013	3.1	2.25
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.013	3.1	2.38
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.013	3.1	2.49
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.013	3.2	2.58
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.014	3.2	2.67
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.014	3.2	2.75
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.019	4.6	2.92
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.020	4.6	3.16
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.020	4.6	3.38
45	440	0.0180	0.032	0.562	0.001	0.001	0.375	0.030	0.027	6.3	3.68
46	450	0.0180	0.032	0.595	0.002	0.001	0.405	0.030	0.027	6.4	4.07
47	460	0.0340	0.061	0.656	0.006	0.004	0.462	0.057	0.052	12.2	4.84
48	470	0.0540	0.097	0.753	0.018	0.012	0.554	0.092	0.084	19.7	6.47
49	480	0.0270	0.049	0.802	0.026	0.008	0.600	0.046	0.042	10.0	7.70
50	490	0.0180	0.032	0.834	0.033	0.006	0.631	0.031	0.029	6.7	7.79
51	500	0.0134	0.024	0.858	0.037	0.005	0.654	0.023	0.021	5.0	7.51
52	510	0.0134	0.024	0.882	0.043	0.005	0.677	0.023	0.021	5.0	7.14
53	520	0.0134	0.024	0.906	0.048	0.006	0.701	0.023	0.021	5.0	6.83
54	530	0.0088	0.016	0.922	0.052	0.004	0.716	0.015	0.014	3.3	6.44
55	540	0.0088	0.016	0.938	0.056	0.004	0.731	0.015	0.014	3.3	5.98
56	550	0.0088	0.016	0.954	0.060	0.004	0.746	0.015	0.014	3.3	5.59
57	560	0.0088	0.016	0.970	0.064	0.004	0.762	0.015	0.014	3.3	5.26
58	570	0.0088	0.016	0.986	0.069	0.004	0.777	0.015	0.014	3.3	4.98
59	580	0.0088	0.016	1.002	0.073	0.004	0.792	0.015	0.014	3.3	4.74
60	590	0.0088	0.016	1.017	0.078	0.005	0.808	0.015	0.014	3.4	4.53
61	600	0.0088	0.016	1.033	0.082	0.005	0.823	0.015	0.014	3.4	4.36
62	610	0.0088	0.016	1.049	0.087	0.005	0.838	0.015	0.014	3.4	4.21
63	620	0.0088	0.016	1.065	0.092	0.005	0.854	0.015	0.014	3.4	4.09
64	630	0.0088	0.016	1.081	0.097	0.005	0.869	0.015	0.014	3.4	3.98
65	640	0.0088	0.016	1.097	0.102	0.005	0.885	0.015	0.014	3.4	3.89

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.106	0.004	0.897	0.013	0.012	2.8	3.77
67	660	0.0072	0.013	1.122	0.111	0.004	0.910	0.013	0.012	2.8	3.63
68	670	0.0072	0.013	1.135	0.115	0.004	0.923	0.013	0.012	2.8	3.50
69	680	0.0072	0.013	1.148	0.120	0.004	0.935	0.013	0.012	2.8	3.39
70	690	0.0072	0.013	1.161	0.124	0.005	0.948	0.013	0.012	2.8	3.30
71	700	0.0072	0.013	1.174	0.129	0.005	0.961	0.013	0.012	2.8	3.23
72	710	0.0072	0.013	1.187	0.133	0.005	0.973	0.013	0.012	2.8	3.16
73	720	0.0072	0.013	1.200	0.138	0.005	0.986	0.013	0.012	2.8	3.11
74	730	0.0072	0.013	1.213	0.143	0.005	0.999	0.013	0.012	2.8	3.06
75	740	0.0072	0.013	1.226	0.148	0.005	1.011	0.013	0.012	2.8	3.02
76	750	0.0072	0.013	1.239	0.153	0.005	1.024	0.013	0.012	2.8	2.99
77	760	0.0072	0.013	1.252	0.158	0.005	1.037	0.013	0.012	2.8	2.96
78	770	0.0057	0.010	1.262	0.162	0.004	1.047	0.010	0.009	2.2	2.89
79	780	0.0057	0.010	1.273	0.166	0.004	1.057	0.010	0.009	2.2	2.79
80	790	0.0057	0.010	1.283	0.170	0.004	1.067	0.010	0.009	2.2	2.71
81	800	0.0057	0.010	1.293	0.174	0.004	1.077	0.010	0.009	2.2	2.64
82	810	0.0057	0.010	1.303	0.178	0.004	1.087	0.010	0.009	2.2	2.58
83	820	0.0057	0.010	1.314	0.182	0.004	1.097	0.010	0.009	2.2	2.53
84	830	0.0057	0.010	1.324	0.186	0.004	1.107	0.010	0.009	2.2	2.48
85	840	0.0057	0.010	1.334	0.190	0.004	1.117	0.010	0.009	2.2	2.44
86	850	0.0057	0.010	1.344	0.195	0.004	1.127	0.010	0.009	2.2	2.41
87	860	0.0057	0.010	1.355	0.199	0.004	1.137	0.010	0.009	2.2	2.39
88	870	0.0057	0.010	1.365	0.203	0.004	1.147	0.010	0.010	2.2	2.36
89	880	0.0057	0.010	1.375	0.208	0.004	1.157	0.010	0.010	2.2	2.34
90	890	0.0050	0.009	1.384	0.212	0.004	1.166	0.009	0.008	2.0	2.31
91	900	0.0050	0.009	1.393	0.216	0.004	1.175	0.009	0.008	2.0	2.26
92	910	0.0050	0.009	1.402	0.220	0.004	1.184	0.009	0.008	2.0	2.21
93	920	0.0050	0.009	1.411	0.223	0.004	1.193	0.009	0.008	2.0	2.18
94	930	0.0050	0.009	1.420	0.227	0.004	1.202	0.009	0.008	2.0	2.15
95	940	0.0050	0.009	1.429	0.231	0.004	1.210	0.009	0.008	2.0	2.12
96	950	0.0050	0.009	1.438	0.235	0.004	1.219	0.009	0.008	2.0	2.10
97	960	0.0050	0.009	1.447	0.240	0.004	1.228	0.009	0.008	2.0	2.08
98	970	0.0050	0.009	1.456	0.244	0.004	1.237	0.009	0.008	2.0	2.06
99	980	0.0050	0.009	1.465	0.248	0.004	1.246	0.009	0.008	2.0	2.05
100	990	0.0050	0.009	1.474	0.252	0.004	1.255	0.009	0.008	2.0	2.04
101	1000	0.0050	0.009	1.483	0.256	0.004	1.264	0.009	0.008	2.0	2.03
102	1010	0.0040	0.007	1.490	0.259	0.003	1.271	0.007	0.007	1.6	1.99
103	1020	0.0040	0.007	1.498	0.263	0.003	1.278	0.007	0.007	1.6	1.93
104	1030	0.0040	0.007	1.505	0.266	0.003	1.285	0.007	0.007	1.6	1.88
105	1040	0.0040	0.007	1.512	0.269	0.003	1.292	0.007	0.007	1.6	1.83
106	1050	0.0040	0.007	1.519	0.273	0.003	1.299	0.007	0.007	1.6	1.80
107	1060	0.0040	0.007	1.526	0.276	0.003	1.306	0.007	0.007	1.6	1.76
108	1070	0.0040	0.007	1.534	0.280	0.003	1.313	0.007	0.007	1.6	1.74
109	1080	0.0040	0.007	1.541	0.283	0.003	1.320	0.007	0.007	1.6	1.71
110	1090	0.0040	0.007	1.548	0.287	0.003	1.327	0.007	0.007	1.6	1.69
111	1100	0.0040	0.007	1.555	0.290	0.003	1.335	0.007	0.007	1.6	1.68
112	1110	0.0040	0.007	1.562	0.294	0.003	1.342	0.007	0.007	1.6	1.66
113	1120	0.0040	0.007	1.570	0.297	0.004	1.349	0.007	0.007	1.6	1.65
114	1130	0.0040	0.007	1.577	0.301	0.004	1.356	0.007	0.007	1.6	1.64
115	1140	0.0040	0.007	1.584	0.304	0.004	1.363	0.007	0.007	1.6	1.63

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.308	0.004	1.370	0.007	0.007	1.6	1.63
117	1160	0.0040	0.007	1.598	0.311	0.004	1.377	0.007	0.007	1.6	1.62
118	1170	0.0040	0.007	1.606	0.315	0.004	1.384	0.007	0.007	1.6	1.62
119	1180	0.0040	0.007	1.613	0.318	0.004	1.391	0.007	0.007	1.6	1.61
120	1190	0.0040	0.007	1.620	0.322	0.004	1.398	0.007	0.007	1.6	1.61
121	1200	0.0040	0.007	1.627	0.326	0.004	1.406	0.007	0.007	1.6	1.60
122	1210	0.0040	0.007	1.634	0.329	0.004	1.413	0.007	0.007	1.6	1.60
123	1220	0.0040	0.007	1.642	0.333	0.004	1.420	0.007	0.007	1.6	1.60
124	1230	0.0040	0.007	1.649	0.337	0.004	1.427	0.007	0.007	1.6	1.60
125	1240	0.0040	0.007	1.656	0.340	0.004	1.434	0.007	0.007	1.6	1.60
126	1250	0.0040	0.007	1.663	0.344	0.004	1.441	0.007	0.007	1.6	1.60
127	1260	0.0040	0.007	1.670	0.348	0.004	1.448	0.007	0.007	1.6	1.59
128	1270	0.0040	0.007	1.678	0.351	0.004	1.455	0.007	0.007	1.6	1.59
129	1280	0.0040	0.007	1.685	0.355	0.004	1.462	0.007	0.007	1.6	1.59
130	1290	0.0040	0.007	1.692	0.359	0.004	1.470	0.007	0.007	1.6	1.59
131	1300	0.0040	0.007	1.699	0.363	0.004	1.477	0.007	0.007	1.6	1.59
132	1310	0.0040	0.007	1.706	0.366	0.004	1.484	0.007	0.007	1.6	1.59
133	1320	0.0040	0.007	1.714	0.370	0.004	1.491	0.007	0.007	1.6	1.59
134	1330	0.0040	0.007	1.721	0.374	0.004	1.498	0.007	0.007	1.6	1.59
135	1340	0.0040	0.007	1.728	0.378	0.004	1.505	0.007	0.007	1.6	1.59
136	1350	0.0040	0.007	1.735	0.382	0.004	1.512	0.007	0.007	1.6	1.59
137	1360	0.0040	0.007	1.742	0.385	0.004	1.519	0.007	0.007	1.6	1.59
138	1370	0.0040	0.007	1.750	0.389	0.004	1.526	0.007	0.007	1.6	1.59
139	1380	0.0040	0.007	1.757	0.393	0.004	1.534	0.007	0.007	1.6	1.59
140	1390	0.0040	0.007	1.764	0.397	0.004	1.541	0.007	0.007	1.6	1.59
141	1400	0.0040	0.007	1.771	0.401	0.004	1.548	0.007	0.007	1.6	1.59
142	1410	0.0040	0.007	1.778	0.405	0.004	1.555	0.007	0.007	1.6	1.59
143	1420	0.0040	0.007	1.786	0.409	0.004	1.562	0.007	0.007	1.6	1.60
144	1430	0.0040	0.007	1.793	0.413	0.004	1.569	0.007	0.007	1.6	1.60
145	1440	0.0040	0.007	1.800	0.417	0.004	1.576	0.007	0.007	1.6	1.60

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 204th St Culvert**

Design Storm : **2-yr / 24-hr**

Given: Area = 17.56 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 1.76 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 15.80 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 33 Min. w = 0.131579

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 4.58 cfs ***$T_{(Peak)}$ = 8.00 hrs***

Total Volume = 89,865 cf ***$Tc_{(min)}$ = 33 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.132

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.1	0.02
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.1	0.04
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.2	0.07
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.2	0.10
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.003	0.3	0.14
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.3	0.18
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.4	0.22

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.004	0.4	0.26
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.004	0.4	0.30
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.005	0.5	0.35
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.005	0.6	0.40
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.006	0.6	0.45
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.006	0.6	0.49
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.006	0.7	0.53
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.006	0.7	0.57
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.008	0.8	0.62
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.008	0.8	0.67
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.008	0.9	0.72
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.008	0.9	0.76
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.009	0.9	0.80
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.009	0.9	0.83
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.010	1.1	0.88
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.011	1.1	0.94
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.011	1.1	0.99
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.011	1.2	1.03
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.011	1.2	1.07
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.011	1.2	1.10
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.013	1.4	1.15
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.013	1.4	1.21
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.013	1.4	1.26
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.013	1.4	1.31
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.014	1.4	1.34
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.014	1.5	1.37
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.019	2.1	1.47
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.020	2.1	1.63
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.020	2.1	1.75
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.027	2.8	1.94
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.027	2.9	2.18
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.051	5.5	2.70
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.083	8.8	3.86
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.042	4.4	4.58
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.028	3.0	4.35
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.021	2.2	3.89
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.021	2.2	3.45
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.021	2.2	3.12
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.014	1.5	2.79
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.014	1.5	2.44
56	550	0.0088	0.016	0.954	0.000	0.000	0.746	0.015	0.014	1.5	2.18
57	560	0.0088	0.016	0.970	0.000	0.000	0.762	0.015	0.014	1.5	1.99
58	570	0.0088	0.016	0.986	0.000	0.000	0.777	0.015	0.014	1.5	1.85
59	580	0.0088	0.016	1.002	0.001	0.000	0.792	0.015	0.014	1.5	1.75
60	590	0.0088	0.016	1.017	0.001	0.000	0.808	0.015	0.014	1.5	1.68
61	600	0.0088	0.016	1.033	0.002	0.001	0.823	0.015	0.014	1.5	1.62
62	610	0.0088	0.016	1.049	0.002	0.001	0.838	0.015	0.014	1.5	1.59
63	620	0.0088	0.016	1.065	0.003	0.001	0.854	0.015	0.014	1.5	1.56
64	630	0.0088	0.016	1.081	0.004	0.001	0.869	0.015	0.014	1.5	1.54
65	640	0.0088	0.016	1.097	0.005	0.001	0.885	0.015	0.014	1.5	1.52

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.006	0.001	0.897	0.013	0.011	1.2	1.48
67	660	0.0072	0.013	1.122	0.007	0.001	0.910	0.013	0.011	1.2	1.41
68	670	0.0072	0.013	1.135	0.008	0.001	0.923	0.013	0.011	1.2	1.36
69	680	0.0072	0.013	1.148	0.009	0.001	0.935	0.013	0.011	1.2	1.32
70	690	0.0072	0.013	1.161	0.010	0.001	0.948	0.013	0.011	1.2	1.30
71	700	0.0072	0.013	1.174	0.011	0.001	0.961	0.013	0.012	1.2	1.28
72	710	0.0072	0.013	1.187	0.012	0.001	0.973	0.013	0.012	1.2	1.26
73	720	0.0072	0.013	1.200	0.014	0.001	0.986	0.013	0.012	1.2	1.25
74	730	0.0072	0.013	1.213	0.015	0.001	0.999	0.013	0.012	1.2	1.24
75	740	0.0072	0.013	1.226	0.016	0.001	1.011	0.013	0.012	1.2	1.24
76	750	0.0072	0.013	1.239	0.018	0.001	1.024	0.013	0.012	1.2	1.24
77	760	0.0072	0.013	1.252	0.019	0.002	1.037	0.013	0.012	1.2	1.23
78	770	0.0057	0.010	1.262	0.021	0.001	1.047	0.010	0.009	1.0	1.20
79	780	0.0057	0.010	1.273	0.022	0.001	1.057	0.010	0.009	1.0	1.14
80	790	0.0057	0.010	1.283	0.023	0.001	1.067	0.010	0.009	1.0	1.10
81	800	0.0057	0.010	1.293	0.024	0.001	1.077	0.010	0.009	1.0	1.06
82	810	0.0057	0.010	1.303	0.026	0.001	1.087	0.010	0.009	1.0	1.04
83	820	0.0057	0.010	1.314	0.027	0.001	1.097	0.010	0.009	1.0	1.02
84	830	0.0057	0.010	1.324	0.029	0.001	1.107	0.010	0.009	1.0	1.01
85	840	0.0057	0.010	1.334	0.030	0.002	1.117	0.010	0.009	1.0	1.00
86	850	0.0057	0.010	1.344	0.032	0.002	1.127	0.010	0.009	1.0	1.00
87	860	0.0057	0.010	1.355	0.033	0.002	1.137	0.010	0.009	1.0	0.99
88	870	0.0057	0.010	1.365	0.035	0.002	1.147	0.010	0.009	1.0	0.99
89	880	0.0057	0.010	1.375	0.037	0.002	1.157	0.010	0.009	1.0	0.99
90	890	0.0050	0.009	1.384	0.038	0.001	1.166	0.009	0.008	0.9	0.97
91	900	0.0050	0.009	1.393	0.040	0.001	1.175	0.009	0.008	0.9	0.94
92	910	0.0050	0.009	1.402	0.041	0.002	1.184	0.009	0.008	0.9	0.92
93	920	0.0050	0.009	1.411	0.043	0.002	1.193	0.009	0.008	0.9	0.90
94	930	0.0050	0.009	1.420	0.044	0.002	1.202	0.009	0.008	0.9	0.89
95	940	0.0050	0.009	1.429	0.046	0.002	1.210	0.009	0.008	0.9	0.89
96	950	0.0050	0.009	1.438	0.047	0.002	1.219	0.009	0.008	0.9	0.88
97	960	0.0050	0.009	1.447	0.049	0.002	1.228	0.009	0.008	0.9	0.88
98	970	0.0050	0.009	1.456	0.051	0.002	1.237	0.009	0.008	0.9	0.87
99	980	0.0050	0.009	1.465	0.053	0.002	1.246	0.009	0.008	0.9	0.87
100	990	0.0050	0.009	1.474	0.054	0.002	1.255	0.009	0.008	0.9	0.87
101	1000	0.0050	0.009	1.483	0.056	0.002	1.264	0.009	0.008	0.9	0.87
102	1010	0.0040	0.007	1.490	0.057	0.001	1.271	0.007	0.007	0.7	0.84
103	1020	0.0040	0.007	1.498	0.059	0.001	1.278	0.007	0.007	0.7	0.80
104	1030	0.0040	0.007	1.505	0.060	0.001	1.285	0.007	0.007	0.7	0.78
105	1040	0.0040	0.007	1.512	0.062	0.001	1.292	0.007	0.007	0.7	0.75
106	1050	0.0040	0.007	1.519	0.063	0.001	1.299	0.007	0.007	0.7	0.74
107	1060	0.0040	0.007	1.526	0.065	0.001	1.306	0.007	0.007	0.7	0.73
108	1070	0.0040	0.007	1.534	0.066	0.002	1.313	0.007	0.007	0.7	0.72
109	1080	0.0040	0.007	1.541	0.068	0.002	1.320	0.007	0.007	0.7	0.71
110	1090	0.0040	0.007	1.548	0.069	0.002	1.327	0.007	0.007	0.7	0.71
111	1100	0.0040	0.007	1.555	0.071	0.002	1.335	0.007	0.007	0.7	0.70
112	1110	0.0040	0.007	1.562	0.072	0.002	1.342	0.007	0.007	0.7	0.70
113	1120	0.0040	0.007	1.570	0.074	0.002	1.349	0.007	0.007	0.7	0.70
114	1130	0.0040	0.007	1.577	0.076	0.002	1.356	0.007	0.007	0.7	0.70
115	1140	0.0040	0.007	1.584	0.077	0.002	1.363	0.007	0.007	0.7	0.70

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.079	0.002	1.370	0.007	0.007	0.7	0.70
117	1160	0.0040	0.007	1.598	0.081	0.002	1.377	0.007	0.007	0.7	0.70
118	1170	0.0040	0.007	1.606	0.082	0.002	1.384	0.007	0.007	0.7	0.70
119	1180	0.0040	0.007	1.613	0.084	0.002	1.391	0.007	0.007	0.7	0.70
120	1190	0.0040	0.007	1.620	0.086	0.002	1.398	0.007	0.007	0.7	0.70
121	1200	0.0040	0.007	1.627	0.087	0.002	1.406	0.007	0.007	0.7	0.70
122	1210	0.0040	0.007	1.634	0.089	0.002	1.413	0.007	0.007	0.7	0.70
123	1220	0.0040	0.007	1.642	0.091	0.002	1.420	0.007	0.007	0.7	0.70
124	1230	0.0040	0.007	1.649	0.092	0.002	1.427	0.007	0.007	0.7	0.70
125	1240	0.0040	0.007	1.656	0.094	0.002	1.434	0.007	0.007	0.7	0.70
126	1250	0.0040	0.007	1.663	0.096	0.002	1.441	0.007	0.007	0.7	0.70
127	1260	0.0040	0.007	1.670	0.098	0.002	1.448	0.007	0.007	0.7	0.70
128	1270	0.0040	0.007	1.678	0.100	0.002	1.455	0.007	0.007	0.7	0.70
129	1280	0.0040	0.007	1.685	0.101	0.002	1.462	0.007	0.007	0.7	0.70
130	1290	0.0040	0.007	1.692	0.103	0.002	1.470	0.007	0.007	0.7	0.70
131	1300	0.0040	0.007	1.699	0.105	0.002	1.477	0.007	0.007	0.7	0.70
132	1310	0.0040	0.007	1.706	0.107	0.002	1.484	0.007	0.007	0.7	0.70
133	1320	0.0040	0.007	1.714	0.109	0.002	1.491	0.007	0.007	0.7	0.70
134	1330	0.0040	0.007	1.721	0.111	0.002	1.498	0.007	0.007	0.7	0.70
135	1340	0.0040	0.007	1.728	0.113	0.002	1.505	0.007	0.007	0.7	0.70
136	1350	0.0040	0.007	1.735	0.115	0.002	1.512	0.007	0.007	0.7	0.70
137	1360	0.0040	0.007	1.742	0.117	0.002	1.519	0.007	0.007	0.7	0.70
138	1370	0.0040	0.007	1.750	0.119	0.002	1.526	0.007	0.007	0.7	0.70
139	1380	0.0040	0.007	1.757	0.120	0.002	1.534	0.007	0.007	0.7	0.70
140	1390	0.0040	0.007	1.764	0.122	0.002	1.541	0.007	0.007	0.7	0.70
141	1400	0.0040	0.007	1.771	0.124	0.002	1.548	0.007	0.007	0.7	0.70
142	1410	0.0040	0.007	1.778	0.126	0.002	1.555	0.007	0.007	0.7	0.70
143	1420	0.0040	0.007	1.786	0.128	0.002	1.562	0.007	0.007	0.7	0.70
144	1430	0.0040	0.007	1.793	0.131	0.002	1.569	0.007	0.007	0.7	0.70
145	1440	0.0040	0.007	1.800	0.133	0.002	1.576	0.007	0.007	0.7	0.70

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to BNSF RR Culvert**

Design Storm : **2-yr / 24-hr**

Given: Area = 4.18 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 0.42 Ac. CN = 68.95 S = 4.5033 0.2S = 0.90

IMPERVIOUS AREA: Area = 3.76 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 1.69 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 21,693 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.00
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.01
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.0	0.02
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.0	0.03
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.1	0.05
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.003	0.1	0.06
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.1	0.07
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.1	0.08

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.004	0.1	0.09
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.004	0.1	0.10
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.005	0.1	0.11
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.005	0.1	0.13
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.006	0.1	0.14
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.006	0.1	0.15
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.006	0.2	0.15
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.006	0.2	0.16
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.008	0.2	0.18
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.008	0.2	0.20
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.008	0.2	0.20
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.008	0.2	0.21
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.009	0.2	0.21
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.009	0.2	0.22
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.010	0.3	0.24
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.011	0.3	0.26
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.011	0.3	0.27
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.011	0.3	0.27
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.011	0.3	0.28
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.011	0.3	0.28
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.013	0.3	0.31
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.013	0.3	0.33
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.013	0.3	0.34
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.013	0.3	0.34
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.014	0.3	0.34
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.014	0.3	0.34
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.019	0.5	0.42
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.020	0.5	0.49
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.020	0.5	0.50
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.027	0.7	0.59
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.027	0.7	0.68
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.051	1.3	0.99
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.083	2.1	1.69
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.042	1.1	1.57
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.028	0.7	0.88
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.021	0.5	0.62
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.021	0.5	0.53
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.021	0.5	0.53
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.014	0.3	0.44
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.014	0.3	0.35
56	550	0.0088	0.016	0.954	0.001	0.000	0.746	0.015	0.014	0.3	0.35
57	560	0.0088	0.016	0.970	0.001	0.000	0.762	0.015	0.014	0.3	0.35
58	570	0.0088	0.016	0.986	0.002	0.001	0.777	0.015	0.014	0.4	0.35
59	580	0.0088	0.016	1.002	0.002	0.001	0.792	0.015	0.014	0.4	0.35
60	590	0.0088	0.016	1.017	0.003	0.001	0.808	0.015	0.014	0.4	0.35
61	600	0.0088	0.016	1.033	0.004	0.001	0.823	0.015	0.014	0.4	0.35
62	610	0.0088	0.016	1.049	0.005	0.001	0.838	0.015	0.014	0.4	0.35
63	620	0.0088	0.016	1.065	0.006	0.001	0.854	0.015	0.014	0.4	0.35
64	630	0.0088	0.016	1.081	0.007	0.001	0.869	0.015	0.014	0.4	0.35
65	640	0.0088	0.016	1.097	0.008	0.001	0.885	0.015	0.014	0.4	0.35

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.009	0.001	0.897	0.013	0.011	0.3	0.32
67	660	0.0072	0.013	1.122	0.010	0.001	0.910	0.013	0.011	0.3	0.29
68	670	0.0072	0.013	1.135	0.012	0.001	0.923	0.013	0.011	0.3	0.29
69	680	0.0072	0.013	1.148	0.013	0.001	0.935	0.013	0.012	0.3	0.29
70	690	0.0072	0.013	1.161	0.014	0.001	0.948	0.013	0.012	0.3	0.29
71	700	0.0072	0.013	1.174	0.016	0.001	0.961	0.013	0.012	0.3	0.29
72	710	0.0072	0.013	1.187	0.017	0.001	0.973	0.013	0.012	0.3	0.29
73	720	0.0072	0.013	1.200	0.019	0.002	0.986	0.013	0.012	0.3	0.29
74	730	0.0072	0.013	1.213	0.020	0.002	0.999	0.013	0.012	0.3	0.29
75	740	0.0072	0.013	1.226	0.022	0.002	1.011	0.013	0.012	0.3	0.29
76	750	0.0072	0.013	1.239	0.024	0.002	1.024	0.013	0.012	0.3	0.29
77	760	0.0072	0.013	1.252	0.025	0.002	1.037	0.013	0.012	0.3	0.29
78	770	0.0057	0.010	1.262	0.027	0.001	1.047	0.010	0.009	0.2	0.26
79	780	0.0057	0.010	1.273	0.028	0.001	1.057	0.010	0.009	0.2	0.23
80	790	0.0057	0.010	1.283	0.030	0.002	1.067	0.010	0.009	0.2	0.23
81	800	0.0057	0.010	1.293	0.031	0.002	1.077	0.010	0.009	0.2	0.23
82	810	0.0057	0.010	1.303	0.033	0.002	1.087	0.010	0.009	0.2	0.23
83	820	0.0057	0.010	1.314	0.035	0.002	1.097	0.010	0.009	0.2	0.23
84	830	0.0057	0.010	1.324	0.036	0.002	1.107	0.010	0.009	0.2	0.23
85	840	0.0057	0.010	1.334	0.038	0.002	1.117	0.010	0.009	0.2	0.23
86	850	0.0057	0.010	1.344	0.040	0.002	1.127	0.010	0.009	0.2	0.23
87	860	0.0057	0.010	1.355	0.042	0.002	1.137	0.010	0.009	0.2	0.23
88	870	0.0057	0.010	1.365	0.043	0.002	1.147	0.010	0.009	0.2	0.23
89	880	0.0057	0.010	1.375	0.045	0.002	1.157	0.010	0.009	0.2	0.23
90	890	0.0050	0.009	1.384	0.047	0.002	1.166	0.009	0.008	0.2	0.22
91	900	0.0050	0.009	1.393	0.049	0.002	1.175	0.009	0.008	0.2	0.21
92	910	0.0050	0.009	1.402	0.050	0.002	1.184	0.009	0.008	0.2	0.21
93	920	0.0050	0.009	1.411	0.052	0.002	1.193	0.009	0.008	0.2	0.21
94	930	0.0050	0.009	1.420	0.054	0.002	1.202	0.009	0.008	0.2	0.21
95	940	0.0050	0.009	1.429	0.056	0.002	1.210	0.009	0.008	0.2	0.21
96	950	0.0050	0.009	1.438	0.057	0.002	1.219	0.009	0.008	0.2	0.21
97	960	0.0050	0.009	1.447	0.059	0.002	1.228	0.009	0.008	0.2	0.21
98	970	0.0050	0.009	1.456	0.061	0.002	1.237	0.009	0.008	0.2	0.21
99	980	0.0050	0.009	1.465	0.063	0.002	1.246	0.009	0.008	0.2	0.21
100	990	0.0050	0.009	1.474	0.065	0.002	1.255	0.009	0.008	0.2	0.21
101	1000	0.0050	0.009	1.483	0.067	0.002	1.264	0.009	0.008	0.2	0.21
102	1010	0.0040	0.007	1.490	0.068	0.002	1.271	0.007	0.007	0.2	0.19
103	1020	0.0040	0.007	1.498	0.070	0.002	1.278	0.007	0.007	0.2	0.17
104	1030	0.0040	0.007	1.505	0.071	0.002	1.285	0.007	0.007	0.2	0.17
105	1040	0.0040	0.007	1.512	0.073	0.002	1.292	0.007	0.007	0.2	0.17
106	1050	0.0040	0.007	1.519	0.075	0.002	1.299	0.007	0.007	0.2	0.17
107	1060	0.0040	0.007	1.526	0.076	0.002	1.306	0.007	0.007	0.2	0.17
108	1070	0.0040	0.007	1.534	0.078	0.002	1.313	0.007	0.007	0.2	0.17
109	1080	0.0040	0.007	1.541	0.080	0.002	1.320	0.007	0.007	0.2	0.17
110	1090	0.0040	0.007	1.548	0.081	0.002	1.327	0.007	0.007	0.2	0.17
111	1100	0.0040	0.007	1.555	0.083	0.002	1.335	0.007	0.007	0.2	0.17
112	1110	0.0040	0.007	1.562	0.085	0.002	1.342	0.007	0.007	0.2	0.17
113	1120	0.0040	0.007	1.570	0.087	0.002	1.349	0.007	0.007	0.2	0.17
114	1130	0.0040	0.007	1.577	0.088	0.002	1.356	0.007	0.007	0.2	0.17
115	1140	0.0040	0.007	1.584	0.090	0.002	1.363	0.007	0.007	0.2	0.17

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.092	0.002	1.370	0.007	0.007	0.2	0.17
117	1160	0.0040	0.007	1.598	0.094	0.002	1.377	0.007	0.007	0.2	0.17
118	1170	0.0040	0.007	1.606	0.095	0.002	1.384	0.007	0.007	0.2	0.17
119	1180	0.0040	0.007	1.613	0.097	0.002	1.391	0.007	0.007	0.2	0.17
120	1190	0.0040	0.007	1.620	0.099	0.002	1.398	0.007	0.007	0.2	0.17
121	1200	0.0040	0.007	1.627	0.101	0.002	1.406	0.007	0.007	0.2	0.17
122	1210	0.0040	0.007	1.634	0.103	0.002	1.413	0.007	0.007	0.2	0.17
123	1220	0.0040	0.007	1.642	0.105	0.002	1.420	0.007	0.007	0.2	0.17
124	1230	0.0040	0.007	1.649	0.107	0.002	1.427	0.007	0.007	0.2	0.17
125	1240	0.0040	0.007	1.656	0.108	0.002	1.434	0.007	0.007	0.2	0.17
126	1250	0.0040	0.007	1.663	0.110	0.002	1.441	0.007	0.007	0.2	0.17
127	1260	0.0040	0.007	1.670	0.112	0.002	1.448	0.007	0.007	0.2	0.17
128	1270	0.0040	0.007	1.678	0.114	0.002	1.455	0.007	0.007	0.2	0.17
129	1280	0.0040	0.007	1.685	0.116	0.002	1.462	0.007	0.007	0.2	0.17
130	1290	0.0040	0.007	1.692	0.118	0.002	1.470	0.007	0.007	0.2	0.17
131	1300	0.0040	0.007	1.699	0.120	0.002	1.477	0.007	0.007	0.2	0.17
132	1310	0.0040	0.007	1.706	0.122	0.002	1.484	0.007	0.007	0.2	0.17
133	1320	0.0040	0.007	1.714	0.124	0.002	1.491	0.007	0.007	0.2	0.17
134	1330	0.0040	0.007	1.721	0.126	0.002	1.498	0.007	0.007	0.2	0.17
135	1340	0.0040	0.007	1.728	0.128	0.002	1.505	0.007	0.007	0.2	0.17
136	1350	0.0040	0.007	1.735	0.130	0.002	1.512	0.007	0.007	0.2	0.17
137	1360	0.0040	0.007	1.742	0.133	0.002	1.519	0.007	0.007	0.2	0.17
138	1370	0.0040	0.007	1.750	0.135	0.002	1.526	0.007	0.007	0.2	0.17
139	1380	0.0040	0.007	1.757	0.137	0.002	1.534	0.007	0.007	0.2	0.17
140	1390	0.0040	0.007	1.764	0.139	0.002	1.541	0.007	0.007	0.2	0.17
141	1400	0.0040	0.007	1.771	0.141	0.002	1.548	0.007	0.007	0.2	0.17
142	1410	0.0040	0.007	1.778	0.143	0.002	1.555	0.007	0.007	0.2	0.17
143	1420	0.0040	0.007	1.786	0.145	0.002	1.562	0.007	0.007	0.2	0.17
144	1430	0.0040	0.007	1.793	0.148	0.002	1.569	0.007	0.007	0.2	0.17
145	1440	0.0040	0.007	1.800	0.150	0.002	1.576	0.007	0.007	0.2	0.17

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 69th Ave Culvert**

Design Storm : **2-yr / 24-hr**

Given:	Area =	0.76	Ac.	P =	1.80	in.	dt =	10 min.
PERVIOUS AREA:	Area =	0.08	Ac.	CN =	68.00		S = 4.7059	0.2S = 0.94
IMPERVIOUS AREA:	Area =	0.68	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 0.31 cfs
Total Volume = 3,920 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.00
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.00
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.0	0.00
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.0	0.01
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.0	0.01
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.003	0.0	0.01
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.003	0.0	0.01
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.0	0.01

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.004	0.0	0.02
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.004	0.0	0.02
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.005	0.0	0.02
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.005	0.0	0.02
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.006	0.0	0.03
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.006	0.0	0.03
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.006	0.0	0.03
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.006	0.0	0.03
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.008	0.0	0.03
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.008	0.0	0.04
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.008	0.0	0.04
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.008	0.0	0.04
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.008	0.0	0.04
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.009	0.0	0.04
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.010	0.0	0.04
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.011	0.0	0.05
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.011	0.0	0.05
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.011	0.0	0.05
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.011	0.1	0.05
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.011	0.1	0.05
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.013	0.1	0.06
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.013	0.1	0.06
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.013	0.1	0.06
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.013	0.1	0.06
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.014	0.1	0.06
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.014	0.1	0.06
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.019	0.1	0.08
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.019	0.1	0.09
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.020	0.1	0.09
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.027	0.1	0.11
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.027	0.1	0.12
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.051	0.2	0.18
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.082	0.4	0.31
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.041	0.2	0.28
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.028	0.1	0.16
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.021	0.1	0.11
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.021	0.1	0.10
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.021	0.1	0.10
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.014	0.1	0.08
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.014	0.1	0.06
56	550	0.0088	0.016	0.954	0.000	0.000	0.746	0.015	0.014	0.1	0.06
57	560	0.0088	0.016	0.970	0.000	0.000	0.762	0.015	0.014	0.1	0.06
58	570	0.0088	0.016	0.986	0.000	0.000	0.777	0.015	0.014	0.1	0.06
59	580	0.0088	0.016	1.002	0.001	0.000	0.792	0.015	0.014	0.1	0.06
60	590	0.0088	0.016	1.017	0.001	0.000	0.808	0.015	0.014	0.1	0.06
61	600	0.0088	0.016	1.033	0.002	0.001	0.823	0.015	0.014	0.1	0.06
62	610	0.0088	0.016	1.049	0.002	0.001	0.838	0.015	0.014	0.1	0.06
63	620	0.0088	0.016	1.065	0.003	0.001	0.854	0.015	0.014	0.1	0.06
64	630	0.0088	0.016	1.081	0.004	0.001	0.869	0.015	0.014	0.1	0.06
65	640	0.0088	0.016	1.097	0.005	0.001	0.885	0.015	0.014	0.1	0.06

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.006	0.001	0.897	0.013	0.011	0.1	0.06
67	660	0.0072	0.013	1.122	0.007	0.001	0.910	0.013	0.011	0.1	0.05
68	670	0.0072	0.013	1.135	0.008	0.001	0.923	0.013	0.011	0.1	0.05
69	680	0.0072	0.013	1.148	0.009	0.001	0.935	0.013	0.011	0.1	0.05
70	690	0.0072	0.013	1.161	0.010	0.001	0.948	0.013	0.011	0.1	0.05
71	700	0.0072	0.013	1.174	0.011	0.001	0.961	0.013	0.011	0.1	0.05
72	710	0.0072	0.013	1.187	0.012	0.001	0.973	0.013	0.011	0.1	0.05
73	720	0.0072	0.013	1.200	0.014	0.001	0.986	0.013	0.011	0.1	0.05
74	730	0.0072	0.013	1.213	0.015	0.001	0.999	0.013	0.011	0.1	0.05
75	740	0.0072	0.013	1.226	0.016	0.001	1.011	0.013	0.011	0.1	0.05
76	750	0.0072	0.013	1.239	0.018	0.001	1.024	0.013	0.012	0.1	0.05
77	760	0.0072	0.013	1.252	0.019	0.002	1.037	0.013	0.012	0.1	0.05
78	770	0.0057	0.010	1.262	0.021	0.001	1.047	0.010	0.009	0.0	0.05
79	780	0.0057	0.010	1.273	0.022	0.001	1.057	0.010	0.009	0.0	0.04
80	790	0.0057	0.010	1.283	0.023	0.001	1.067	0.010	0.009	0.0	0.04
81	800	0.0057	0.010	1.293	0.024	0.001	1.077	0.010	0.009	0.0	0.04
82	810	0.0057	0.010	1.303	0.026	0.001	1.087	0.010	0.009	0.0	0.04
83	820	0.0057	0.010	1.314	0.027	0.001	1.097	0.010	0.009	0.0	0.04
84	830	0.0057	0.010	1.324	0.029	0.001	1.107	0.010	0.009	0.0	0.04
85	840	0.0057	0.010	1.334	0.030	0.002	1.117	0.010	0.009	0.0	0.04
86	850	0.0057	0.010	1.344	0.032	0.002	1.127	0.010	0.009	0.0	0.04
87	860	0.0057	0.010	1.355	0.033	0.002	1.137	0.010	0.009	0.0	0.04
88	870	0.0057	0.010	1.365	0.035	0.002	1.147	0.010	0.009	0.0	0.04
89	880	0.0057	0.010	1.375	0.037	0.002	1.157	0.010	0.009	0.0	0.04
90	890	0.0050	0.009	1.384	0.038	0.001	1.166	0.009	0.008	0.0	0.04
91	900	0.0050	0.009	1.393	0.040	0.001	1.175	0.009	0.008	0.0	0.04
92	910	0.0050	0.009	1.402	0.041	0.002	1.184	0.009	0.008	0.0	0.04
93	920	0.0050	0.009	1.411	0.043	0.002	1.193	0.009	0.008	0.0	0.04
94	930	0.0050	0.009	1.420	0.044	0.002	1.202	0.009	0.008	0.0	0.04
95	940	0.0050	0.009	1.429	0.046	0.002	1.210	0.009	0.008	0.0	0.04
96	950	0.0050	0.009	1.438	0.047	0.002	1.219	0.009	0.008	0.0	0.04
97	960	0.0050	0.009	1.447	0.049	0.002	1.228	0.009	0.008	0.0	0.04
98	970	0.0050	0.009	1.456	0.051	0.002	1.237	0.009	0.008	0.0	0.04
99	980	0.0050	0.009	1.465	0.053	0.002	1.246	0.009	0.008	0.0	0.04
100	990	0.0050	0.009	1.474	0.054	0.002	1.255	0.009	0.008	0.0	0.04
101	1000	0.0050	0.009	1.483	0.056	0.002	1.264	0.009	0.008	0.0	0.04
102	1010	0.0040	0.007	1.490	0.057	0.001	1.271	0.007	0.006	0.0	0.03
103	1020	0.0040	0.007	1.498	0.059	0.001	1.278	0.007	0.006	0.0	0.03
104	1030	0.0040	0.007	1.505	0.060	0.001	1.285	0.007	0.006	0.0	0.03
105	1040	0.0040	0.007	1.512	0.062	0.001	1.292	0.007	0.007	0.0	0.03
106	1050	0.0040	0.007	1.519	0.063	0.001	1.299	0.007	0.007	0.0	0.03
107	1060	0.0040	0.007	1.526	0.065	0.001	1.306	0.007	0.007	0.0	0.03
108	1070	0.0040	0.007	1.534	0.066	0.002	1.313	0.007	0.007	0.0	0.03
109	1080	0.0040	0.007	1.541	0.068	0.002	1.320	0.007	0.007	0.0	0.03
110	1090	0.0040	0.007	1.548	0.069	0.002	1.327	0.007	0.007	0.0	0.03
111	1100	0.0040	0.007	1.555	0.071	0.002	1.335	0.007	0.007	0.0	0.03
112	1110	0.0040	0.007	1.562	0.072	0.002	1.342	0.007	0.007	0.0	0.03
113	1120	0.0040	0.007	1.570	0.074	0.002	1.349	0.007	0.007	0.0	0.03
114	1130	0.0040	0.007	1.577	0.076	0.002	1.356	0.007	0.007	0.0	0.03
115	1140	0.0040	0.007	1.584	0.077	0.002	1.363	0.007	0.007	0.0	0.03

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.079	0.002	1.370	0.007	0.007	0.0	0.03
117	1160	0.0040	0.007	1.598	0.081	0.002	1.377	0.007	0.007	0.0	0.03
118	1170	0.0040	0.007	1.606	0.082	0.002	1.384	0.007	0.007	0.0	0.03
119	1180	0.0040	0.007	1.613	0.084	0.002	1.391	0.007	0.007	0.0	0.03
120	1190	0.0040	0.007	1.620	0.086	0.002	1.398	0.007	0.007	0.0	0.03
121	1200	0.0040	0.007	1.627	0.087	0.002	1.406	0.007	0.007	0.0	0.03
122	1210	0.0040	0.007	1.634	0.089	0.002	1.413	0.007	0.007	0.0	0.03
123	1220	0.0040	0.007	1.642	0.091	0.002	1.420	0.007	0.007	0.0	0.03
124	1230	0.0040	0.007	1.649	0.092	0.002	1.427	0.007	0.007	0.0	0.03
125	1240	0.0040	0.007	1.656	0.094	0.002	1.434	0.007	0.007	0.0	0.03
126	1250	0.0040	0.007	1.663	0.096	0.002	1.441	0.007	0.007	0.0	0.03
127	1260	0.0040	0.007	1.670	0.098	0.002	1.448	0.007	0.007	0.0	0.03
128	1270	0.0040	0.007	1.678	0.100	0.002	1.455	0.007	0.007	0.0	0.03
129	1280	0.0040	0.007	1.685	0.101	0.002	1.462	0.007	0.007	0.0	0.03
130	1290	0.0040	0.007	1.692	0.103	0.002	1.470	0.007	0.007	0.0	0.03
131	1300	0.0040	0.007	1.699	0.105	0.002	1.477	0.007	0.007	0.0	0.03
132	1310	0.0040	0.007	1.706	0.107	0.002	1.484	0.007	0.007	0.0	0.03
133	1320	0.0040	0.007	1.714	0.109	0.002	1.491	0.007	0.007	0.0	0.03
134	1330	0.0040	0.007	1.721	0.111	0.002	1.498	0.007	0.007	0.0	0.03
135	1340	0.0040	0.007	1.728	0.113	0.002	1.505	0.007	0.007	0.0	0.03
136	1350	0.0040	0.007	1.735	0.115	0.002	1.512	0.007	0.007	0.0	0.03
137	1360	0.0040	0.007	1.742	0.117	0.002	1.519	0.007	0.007	0.0	0.03
138	1370	0.0040	0.007	1.750	0.119	0.002	1.526	0.007	0.007	0.0	0.03
139	1380	0.0040	0.007	1.757	0.120	0.002	1.534	0.007	0.007	0.0	0.03
140	1390	0.0040	0.007	1.764	0.122	0.002	1.541	0.007	0.007	0.0	0.03
141	1400	0.0040	0.007	1.771	0.124	0.002	1.548	0.007	0.007	0.0	0.03
142	1410	0.0040	0.007	1.778	0.126	0.002	1.555	0.007	0.007	0.0	0.03
143	1420	0.0040	0.007	1.786	0.128	0.002	1.562	0.007	0.007	0.0	0.03
144	1430	0.0040	0.007	1.793	0.131	0.002	1.569	0.007	0.007	0.0	0.03
145	1440	0.0040	0.007	1.800	0.133	0.002	1.576	0.007	0.007	0.0	0.03

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to Confluence Point**

Design Storm : **2-yr / 24-hr**

Given: Area = 11.29 Ac. P = 1.80 in. dt = 10 min.

PERVIOUS AREA: Area = 3.01 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 8.28 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 3.73 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 48,708 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.007	0.007	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.007	0.014	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.007	0.022	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.007	0.029	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.007	0.036	0.000	0.000	0.000	0.000	0.000	0.0	0.00
7	60	0.0040	0.007	0.043	0.000	0.000	0.000	0.000	0.000	0.0	0.00
8	70	0.0040	0.007	0.050	0.000	0.000	0.000	0.000	0.000	0.0	0.01
9	80	0.0040	0.007	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.03
10	90	0.0040	0.007	0.065	0.000	0.000	0.003	0.001	0.001	0.1	0.05
11	100	0.0040	0.007	0.072	0.000	0.000	0.004	0.002	0.001	0.1	0.07
12	110	0.0050	0.009	0.081	0.000	0.000	0.007	0.002	0.002	0.1	0.10
13	120	0.0050	0.009	0.090	0.000	0.000	0.010	0.003	0.002	0.1	0.14
14	130	0.0050	0.009	0.099	0.000	0.000	0.013	0.003	0.002	0.2	0.16
15	140	0.0050	0.009	0.108	0.000	0.000	0.017	0.004	0.003	0.2	0.18

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.009	0.117	0.000	0.000	0.021	0.004	0.003	0.2	0.20
17	160	0.0050	0.009	0.126	0.000	0.000	0.025	0.004	0.003	0.2	0.21
18	170	0.0060	0.011	0.137	0.000	0.000	0.031	0.006	0.004	0.3	0.25
19	180	0.0060	0.011	0.148	0.000	0.000	0.037	0.006	0.004	0.3	0.29
20	190	0.0060	0.011	0.158	0.000	0.000	0.043	0.006	0.005	0.3	0.31
21	200	0.0060	0.011	0.169	0.000	0.000	0.050	0.007	0.005	0.3	0.32
22	210	0.0060	0.011	0.180	0.000	0.000	0.056	0.007	0.005	0.3	0.34
23	220	0.0060	0.011	0.191	0.000	0.000	0.064	0.007	0.005	0.4	0.35
24	230	0.0070	0.013	0.203	0.000	0.000	0.072	0.009	0.006	0.4	0.39
25	240	0.0070	0.013	0.216	0.000	0.000	0.081	0.009	0.006	0.4	0.44
26	250	0.0070	0.013	0.229	0.000	0.000	0.090	0.009	0.007	0.5	0.45
27	260	0.0070	0.013	0.241	0.000	0.000	0.099	0.009	0.007	0.5	0.46
28	270	0.0070	0.013	0.254	0.000	0.000	0.109	0.009	0.007	0.5	0.47
29	280	0.0070	0.013	0.266	0.000	0.000	0.118	0.010	0.007	0.5	0.48
30	290	0.0082	0.015	0.281	0.000	0.000	0.130	0.012	0.008	0.6	0.53
31	300	0.0082	0.015	0.296	0.000	0.000	0.142	0.012	0.009	0.6	0.58
32	310	0.0082	0.015	0.311	0.000	0.000	0.154	0.012	0.009	0.6	0.59
33	320	0.0082	0.015	0.325	0.000	0.000	0.166	0.012	0.009	0.6	0.60
34	330	0.0082	0.015	0.340	0.000	0.000	0.178	0.012	0.009	0.6	0.61
35	340	0.0082	0.015	0.355	0.000	0.000	0.190	0.012	0.009	0.6	0.62
36	350	0.0095	0.017	0.372	0.000	0.000	0.205	0.015	0.011	0.7	0.67
37	360	0.0095	0.017	0.389	0.000	0.000	0.220	0.015	0.011	0.7	0.73
38	370	0.0095	0.017	0.406	0.000	0.000	0.234	0.015	0.011	0.7	0.74
39	380	0.0095	0.017	0.423	0.000	0.000	0.249	0.015	0.011	0.7	0.75
40	390	0.0095	0.017	0.440	0.000	0.000	0.265	0.015	0.011	0.8	0.75
41	400	0.0095	0.017	0.458	0.000	0.000	0.280	0.015	0.011	0.8	0.76
42	410	0.0134	0.024	0.482	0.000	0.000	0.301	0.022	0.016	1.1	0.92
43	420	0.0134	0.024	0.506	0.000	0.000	0.323	0.022	0.016	1.1	1.09
44	430	0.0134	0.024	0.530	0.000	0.000	0.345	0.022	0.016	1.1	1.10
45	440	0.0180	0.032	0.562	0.000	0.000	0.375	0.030	0.022	1.5	1.29
46	450	0.0180	0.032	0.595	0.000	0.000	0.405	0.030	0.022	1.5	1.49
47	460	0.0340	0.061	0.656	0.000	0.000	0.462	0.057	0.042	2.9	2.18
48	470	0.0540	0.097	0.753	0.000	0.000	0.554	0.092	0.067	4.6	3.73
49	480	0.0270	0.049	0.802	0.000	0.000	0.600	0.046	0.034	2.3	3.46
50	490	0.0180	0.032	0.834	0.000	0.000	0.631	0.031	0.023	1.6	1.94
51	500	0.0134	0.024	0.858	0.000	0.000	0.654	0.023	0.017	1.2	1.36
52	510	0.0134	0.024	0.882	0.000	0.000	0.677	0.023	0.017	1.2	1.16
53	520	0.0134	0.024	0.906	0.000	0.000	0.701	0.023	0.017	1.2	1.16
54	530	0.0088	0.016	0.922	0.000	0.000	0.716	0.015	0.011	0.8	0.96
55	540	0.0088	0.016	0.938	0.000	0.000	0.731	0.015	0.011	0.8	0.77
56	550	0.0088	0.016	0.954	0.000	0.000	0.746	0.015	0.011	0.8	0.77
57	560	0.0088	0.016	0.970	0.000	0.000	0.762	0.015	0.011	0.8	0.77
58	570	0.0088	0.016	0.986	0.000	0.000	0.777	0.015	0.011	0.8	0.77
59	580	0.0088	0.016	1.002	0.001	0.000	0.792	0.015	0.011	0.8	0.77
60	590	0.0088	0.016	1.017	0.001	0.000	0.808	0.015	0.011	0.8	0.78
61	600	0.0088	0.016	1.033	0.002	0.001	0.823	0.015	0.011	0.8	0.78
62	610	0.0088	0.016	1.049	0.002	0.001	0.838	0.015	0.011	0.8	0.78
63	620	0.0088	0.016	1.065	0.003	0.001	0.854	0.015	0.011	0.8	0.78
64	630	0.0088	0.016	1.081	0.004	0.001	0.869	0.015	0.012	0.8	0.79
65	640	0.0088	0.016	1.097	0.005	0.001	0.885	0.015	0.012	0.8	0.79

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.013	1.110	0.006	0.001	0.897	0.013	0.009	0.6	0.72
67	660	0.0072	0.013	1.122	0.007	0.001	0.910	0.013	0.010	0.6	0.65
68	670	0.0072	0.013	1.135	0.008	0.001	0.923	0.013	0.010	0.7	0.65
69	680	0.0072	0.013	1.148	0.009	0.001	0.935	0.013	0.010	0.7	0.65
70	690	0.0072	0.013	1.161	0.010	0.001	0.948	0.013	0.010	0.7	0.65
71	700	0.0072	0.013	1.174	0.011	0.001	0.961	0.013	0.010	0.7	0.65
72	710	0.0072	0.013	1.187	0.012	0.001	0.973	0.013	0.010	0.7	0.66
73	720	0.0072	0.013	1.200	0.014	0.001	0.986	0.013	0.010	0.7	0.66
74	730	0.0072	0.013	1.213	0.015	0.001	0.999	0.013	0.010	0.7	0.66
75	740	0.0072	0.013	1.226	0.016	0.001	1.011	0.013	0.010	0.7	0.66
76	750	0.0072	0.013	1.239	0.018	0.001	1.024	0.013	0.010	0.7	0.66
77	760	0.0072	0.013	1.252	0.019	0.002	1.037	0.013	0.010	0.7	0.66
78	770	0.0057	0.010	1.262	0.021	0.001	1.047	0.010	0.008	0.5	0.59
79	780	0.0057	0.010	1.273	0.022	0.001	1.057	0.010	0.008	0.5	0.53
80	790	0.0057	0.010	1.283	0.023	0.001	1.067	0.010	0.008	0.5	0.53
81	800	0.0057	0.010	1.293	0.024	0.001	1.077	0.010	0.008	0.5	0.53
82	810	0.0057	0.010	1.303	0.026	0.001	1.087	0.010	0.008	0.5	0.53
83	820	0.0057	0.010	1.314	0.027	0.001	1.097	0.010	0.008	0.5	0.53
84	830	0.0057	0.010	1.324	0.029	0.001	1.107	0.010	0.008	0.5	0.53
85	840	0.0057	0.010	1.334	0.030	0.002	1.117	0.010	0.008	0.5	0.53
86	850	0.0057	0.010	1.344	0.032	0.002	1.127	0.010	0.008	0.5	0.53
87	860	0.0057	0.010	1.355	0.033	0.002	1.137	0.010	0.008	0.5	0.53
88	870	0.0057	0.010	1.365	0.035	0.002	1.147	0.010	0.008	0.5	0.53
89	880	0.0057	0.010	1.375	0.037	0.002	1.157	0.010	0.008	0.5	0.53
90	890	0.0050	0.009	1.384	0.038	0.001	1.166	0.009	0.007	0.5	0.50
91	900	0.0050	0.009	1.393	0.040	0.001	1.175	0.009	0.007	0.5	0.47
92	910	0.0050	0.009	1.402	0.041	0.002	1.184	0.009	0.007	0.5	0.47
93	920	0.0050	0.009	1.411	0.043	0.002	1.193	0.009	0.007	0.5	0.47
94	930	0.0050	0.009	1.420	0.044	0.002	1.202	0.009	0.007	0.5	0.47
95	940	0.0050	0.009	1.429	0.046	0.002	1.210	0.009	0.007	0.5	0.47
96	950	0.0050	0.009	1.438	0.047	0.002	1.219	0.009	0.007	0.5	0.47
97	960	0.0050	0.009	1.447	0.049	0.002	1.228	0.009	0.007	0.5	0.47
98	970	0.0050	0.009	1.456	0.051	0.002	1.237	0.009	0.007	0.5	0.47
99	980	0.0050	0.009	1.465	0.053	0.002	1.246	0.009	0.007	0.5	0.47
100	990	0.0050	0.009	1.474	0.054	0.002	1.255	0.009	0.007	0.5	0.47
101	1000	0.0050	0.009	1.483	0.056	0.002	1.264	0.009	0.007	0.5	0.48
102	1010	0.0040	0.007	1.490	0.057	0.001	1.271	0.007	0.006	0.4	0.43
103	1020	0.0040	0.007	1.498	0.059	0.001	1.278	0.007	0.006	0.4	0.38
104	1030	0.0040	0.007	1.505	0.060	0.001	1.285	0.007	0.006	0.4	0.38
105	1040	0.0040	0.007	1.512	0.062	0.001	1.292	0.007	0.006	0.4	0.38
106	1050	0.0040	0.007	1.519	0.063	0.001	1.299	0.007	0.006	0.4	0.38
107	1060	0.0040	0.007	1.526	0.065	0.001	1.306	0.007	0.006	0.4	0.38
108	1070	0.0040	0.007	1.534	0.066	0.002	1.313	0.007	0.006	0.4	0.38
109	1080	0.0040	0.007	1.541	0.068	0.002	1.320	0.007	0.006	0.4	0.38
110	1090	0.0040	0.007	1.548	0.069	0.002	1.327	0.007	0.006	0.4	0.38
111	1100	0.0040	0.007	1.555	0.071	0.002	1.335	0.007	0.006	0.4	0.38
112	1110	0.0040	0.007	1.562	0.072	0.002	1.342	0.007	0.006	0.4	0.38
113	1120	0.0040	0.007	1.570	0.074	0.002	1.349	0.007	0.006	0.4	0.38
114	1130	0.0040	0.007	1.577	0.076	0.002	1.356	0.007	0.006	0.4	0.38
115	1140	0.0040	0.007	1.584	0.077	0.002	1.363	0.007	0.006	0.4	0.39

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.007	1.591	0.079	0.002	1.370	0.007	0.006	0.4	0.39
117	1160	0.0040	0.007	1.598	0.081	0.002	1.377	0.007	0.006	0.4	0.39
118	1170	0.0040	0.007	1.606	0.082	0.002	1.384	0.007	0.006	0.4	0.39
119	1180	0.0040	0.007	1.613	0.084	0.002	1.391	0.007	0.006	0.4	0.39
120	1190	0.0040	0.007	1.620	0.086	0.002	1.398	0.007	0.006	0.4	0.39
121	1200	0.0040	0.007	1.627	0.087	0.002	1.406	0.007	0.006	0.4	0.39
122	1210	0.0040	0.007	1.634	0.089	0.002	1.413	0.007	0.006	0.4	0.39
123	1220	0.0040	0.007	1.642	0.091	0.002	1.420	0.007	0.006	0.4	0.39
124	1230	0.0040	0.007	1.649	0.092	0.002	1.427	0.007	0.006	0.4	0.39
125	1240	0.0040	0.007	1.656	0.094	0.002	1.434	0.007	0.006	0.4	0.39
126	1250	0.0040	0.007	1.663	0.096	0.002	1.441	0.007	0.006	0.4	0.39
127	1260	0.0040	0.007	1.670	0.098	0.002	1.448	0.007	0.006	0.4	0.39
128	1270	0.0040	0.007	1.678	0.100	0.002	1.455	0.007	0.006	0.4	0.39
129	1280	0.0040	0.007	1.685	0.101	0.002	1.462	0.007	0.006	0.4	0.39
130	1290	0.0040	0.007	1.692	0.103	0.002	1.470	0.007	0.006	0.4	0.39
131	1300	0.0040	0.007	1.699	0.105	0.002	1.477	0.007	0.006	0.4	0.39
132	1310	0.0040	0.007	1.706	0.107	0.002	1.484	0.007	0.006	0.4	0.39
133	1320	0.0040	0.007	1.714	0.109	0.002	1.491	0.007	0.006	0.4	0.39
134	1330	0.0040	0.007	1.721	0.111	0.002	1.498	0.007	0.006	0.4	0.39
135	1340	0.0040	0.007	1.728	0.113	0.002	1.505	0.007	0.006	0.4	0.39
136	1350	0.0040	0.007	1.735	0.115	0.002	1.512	0.007	0.006	0.4	0.39
137	1360	0.0040	0.007	1.742	0.117	0.002	1.519	0.007	0.006	0.4	0.39
138	1370	0.0040	0.007	1.750	0.119	0.002	1.526	0.007	0.006	0.4	0.39
139	1380	0.0040	0.007	1.757	0.120	0.002	1.534	0.007	0.006	0.4	0.39
140	1390	0.0040	0.007	1.764	0.122	0.002	1.541	0.007	0.006	0.4	0.39
141	1400	0.0040	0.007	1.771	0.124	0.002	1.548	0.007	0.006	0.4	0.39
142	1410	0.0040	0.007	1.778	0.126	0.002	1.555	0.007	0.006	0.4	0.39
143	1420	0.0040	0.007	1.786	0.128	0.002	1.562	0.007	0.006	0.4	0.39
144	1430	0.0040	0.007	1.793	0.131	0.002	1.569	0.007	0.006	0.4	0.39
145	1440	0.0040	0.007	1.800	0.133	0.002	1.576	0.007	0.006	0.4	0.39

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Headwater Basin**
Design Storm : **10-yr / 24-hr**

Given: Area = 1008.51 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 495.97 Ac. CN = 85.09 S = 1.7523 0.2S = 0.35
IMPERVIOUS AREA: Area = 512.54 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 159.91 cfs ***$T_{(Peak)}$ = 8.67 hrs***
Total Volume = 6,931,306 cf ***$Tc_{(min)}$ = 187 min***

Equations:
Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.5	0.01
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	3.7	0.12
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.001	6.9	0.39
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.002	9.7	0.80
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.002	12.0	1.32
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.002	14.1	1.93
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.003	15.9	2.62
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.004	22.1	3.47
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.004	24.3	4.50
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.004	26.1	5.58
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.005	27.8	6.69

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.005	29.2	7.83
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.005	30.4	8.97
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.006	38.0	10.28
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.006	39.4	11.76
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.007	40.6	13.23
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.007	41.6	14.68
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.007	42.6	16.11
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.007	43.4	17.51
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.008	51.6	19.07
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.009	52.5	20.79
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.009	53.8	22.48
27	260	0.0070	0.020	0.389	0.001	0.001	0.219	0.017	0.009	55.9	24.16
28	270	0.0070	0.020	0.409	0.002	0.001	0.237	0.018	0.009	57.9	25.87
29	280	0.0070	0.020	0.429	0.003	0.002	0.255	0.018	0.010	59.7	27.58
30	290	0.0082	0.024	0.453	0.006	0.002	0.276	0.021	0.012	72.2	29.58
31	300	0.0082	0.024	0.477	0.008	0.003	0.297	0.021	0.012	74.4	31.86
32	310	0.0082	0.024	0.501	0.012	0.003	0.318	0.021	0.013	76.6	34.13
33	320	0.0082	0.024	0.524	0.016	0.004	0.340	0.022	0.013	78.6	36.39
34	330	0.0082	0.024	0.548	0.020	0.004	0.362	0.022	0.013	80.5	38.64
35	340	0.0082	0.024	0.572	0.025	0.005	0.384	0.022	0.013	82.3	40.87
36	350	0.0095	0.028	0.599	0.031	0.006	0.409	0.026	0.016	97.5	43.42
37	360	0.0095	0.028	0.627	0.038	0.007	0.435	0.026	0.016	99.7	46.29
38	370	0.0095	0.028	0.655	0.045	0.007	0.461	0.026	0.017	101.7	49.13
39	380	0.0095	0.028	0.682	0.053	0.008	0.486	0.026	0.017	103.7	51.92
40	390	0.0095	0.028	0.710	0.061	0.008	0.512	0.026	0.017	105.6	54.67
41	400	0.0095	0.028	0.737	0.070	0.009	0.539	0.026	0.018	107.4	57.36
42	410	0.0134	0.039	0.776	0.083	0.013	0.575	0.037	0.025	154.3	61.19
43	420	0.0134	0.039	0.815	0.097	0.014	0.613	0.037	0.026	157.5	66.12
44	430	0.0134	0.039	0.854	0.112	0.015	0.650	0.037	0.026	160.5	70.96
45	440	0.0180	0.052	0.906	0.134	0.021	0.700	0.050	0.036	219.9	77.17
46	450	0.0180	0.052	0.958	0.156	0.023	0.750	0.050	0.037	224.6	84.72
47	460	0.0340	0.099	1.057	0.203	0.046	0.846	0.096	0.071	435.7	97.51
48	470	0.0540	0.157	1.213	0.285	0.082	0.999	0.153	0.118	719.1	122.50
49	480	0.0270	0.078	1.292	0.329	0.044	1.075	0.077	0.061	370.3	144.49
50	490	0.0180	0.052	1.344	0.359	0.031	1.127	0.051	0.041	250.4	153.13
51	500	0.0134	0.039	1.383	0.383	0.023	1.165	0.038	0.031	188.1	156.57
52	510	0.0134	0.039	1.422	0.406	0.024	1.203	0.038	0.031	189.5	158.25
53	520	0.0134	0.039	1.460	0.430	0.024	1.241	0.038	0.031	190.9	159.91
54	530	0.0088	0.026	1.486	0.446	0.016	1.266	0.025	0.021	126.0	159.84
55	540	0.0088	0.026	1.511	0.463	0.016	1.291	0.025	0.021	126.6	158.09
56	550	0.0088	0.026	1.537	0.479	0.016	1.317	0.025	0.021	127.1	156.46
57	560	0.0088	0.026	1.563	0.496	0.017	1.342	0.025	0.021	127.6	154.95
58	570	0.0088	0.026	1.588	0.512	0.017	1.367	0.025	0.021	128.1	153.53
59	580	0.0088	0.026	1.614	0.529	0.017	1.392	0.025	0.021	128.6	152.22
60	590	0.0088	0.026	1.639	0.546	0.017	1.417	0.025	0.021	129.0	151.00
61	600	0.0088	0.026	1.665	0.563	0.017	1.442	0.025	0.021	129.5	149.87
62	610	0.0088	0.026	1.690	0.580	0.017	1.468	0.025	0.021	129.9	148.82
63	620	0.0088	0.026	1.716	0.598	0.017	1.493	0.025	0.021	130.4	147.85
64	630	0.0088	0.026	1.741	0.615	0.018	1.518	0.025	0.021	130.8	146.95
65	640	0.0088	0.026	1.767	0.633	0.018	1.543	0.025	0.022	131.2	146.12

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.648	0.015	1.564	0.021	0.018	107.6	144.73
67	660	0.0072	0.021	1.808	0.662	0.015	1.585	0.021	0.018	107.9	142.80
68	670	0.0072	0.021	1.829	0.677	0.015	1.605	0.021	0.018	108.2	140.99
69	680	0.0072	0.021	1.850	0.692	0.015	1.626	0.021	0.018	108.4	139.29
70	690	0.0072	0.021	1.871	0.707	0.015	1.647	0.021	0.018	108.7	137.69
71	700	0.0072	0.021	1.892	0.721	0.015	1.667	0.021	0.018	108.9	136.18
72	710	0.0072	0.021	1.913	0.736	0.015	1.688	0.021	0.018	109.1	134.77
73	720	0.0072	0.021	1.934	0.752	0.015	1.709	0.021	0.018	109.4	133.44
74	730	0.0072	0.021	1.955	0.767	0.015	1.729	0.021	0.018	109.6	132.19
75	740	0.0072	0.021	1.975	0.782	0.015	1.750	0.021	0.018	109.8	131.02
76	750	0.0072	0.021	1.996	0.797	0.015	1.771	0.021	0.018	110.1	129.92
77	760	0.0072	0.021	2.017	0.813	0.015	1.791	0.021	0.018	110.3	128.90
78	770	0.0057	0.017	2.034	0.825	0.012	1.808	0.016	0.014	87.4	127.33
79	780	0.0057	0.017	2.050	0.837	0.012	1.824	0.016	0.014	87.6	125.26
80	790	0.0057	0.017	2.067	0.849	0.012	1.841	0.016	0.014	87.7	123.30
81	800	0.0057	0.017	2.083	0.862	0.012	1.857	0.016	0.014	87.8	121.45
82	810	0.0057	0.017	2.100	0.874	0.012	1.873	0.016	0.014	88.0	119.70
83	820	0.0057	0.017	2.116	0.886	0.012	1.890	0.016	0.014	88.1	118.05
84	830	0.0057	0.017	2.133	0.899	0.012	1.906	0.016	0.014	88.2	116.49
85	840	0.0057	0.017	2.149	0.911	0.012	1.923	0.016	0.014	88.3	115.02
86	850	0.0057	0.017	2.166	0.924	0.013	1.939	0.016	0.014	88.4	113.63
87	860	0.0057	0.017	2.183	0.936	0.013	1.955	0.016	0.015	88.6	112.33
88	870	0.0057	0.017	2.199	0.949	0.013	1.972	0.016	0.015	88.7	111.09
89	880	0.0057	0.017	2.216	0.962	0.013	1.988	0.016	0.015	88.8	109.93
90	890	0.0050	0.015	2.230	0.973	0.011	2.003	0.014	0.013	78.0	108.54
91	900	0.0050	0.015	2.245	0.984	0.011	2.017	0.014	0.013	78.1	106.95
92	910	0.0050	0.015	2.259	0.995	0.011	2.031	0.014	0.013	78.1	105.45
93	920	0.0050	0.015	2.274	1.006	0.011	2.046	0.014	0.013	78.2	104.03
94	930	0.0050	0.015	2.288	1.017	0.011	2.060	0.014	0.013	78.3	102.69
95	940	0.0050	0.015	2.303	1.029	0.011	2.075	0.014	0.013	78.4	101.42
96	950	0.0050	0.015	2.317	1.040	0.011	2.089	0.014	0.013	78.5	100.22
97	960	0.0050	0.015	2.332	1.051	0.011	2.103	0.014	0.013	78.5	99.09
98	970	0.0050	0.015	2.346	1.063	0.011	2.118	0.014	0.013	78.6	98.02
99	980	0.0050	0.015	2.361	1.074	0.011	2.132	0.014	0.013	78.7	97.02
100	990	0.0050	0.015	2.375	1.085	0.011	2.147	0.014	0.013	78.8	96.06
101	1000	0.0050	0.015	2.390	1.097	0.011	2.161	0.014	0.013	78.9	95.17
102	1010	0.0040	0.012	2.401	1.106	0.009	2.173	0.012	0.010	63.1	93.91
103	1020	0.0040	0.012	2.413	1.115	0.009	2.184	0.012	0.010	63.2	92.31
104	1030	0.0040	0.012	2.424	1.124	0.009	2.196	0.012	0.010	63.2	90.79
105	1040	0.0040	0.012	2.436	1.133	0.009	2.207	0.012	0.010	63.3	89.36
106	1050	0.0040	0.012	2.448	1.143	0.009	2.219	0.012	0.010	63.3	88.00
107	1060	0.0040	0.012	2.459	1.152	0.009	2.230	0.012	0.010	63.4	86.71
108	1070	0.0040	0.012	2.471	1.161	0.009	2.242	0.012	0.010	63.4	85.50
109	1080	0.0040	0.012	2.482	1.170	0.009	2.253	0.012	0.010	63.5	84.35
110	1090	0.0040	0.012	2.494	1.179	0.009	2.265	0.012	0.010	63.5	83.26
111	1100	0.0040	0.012	2.506	1.189	0.009	2.276	0.012	0.010	63.5	82.24
112	1110	0.0040	0.012	2.517	1.198	0.009	2.288	0.012	0.010	63.6	81.26
113	1120	0.0040	0.012	2.529	1.207	0.009	2.299	0.012	0.010	63.6	80.34
114	1130	0.0040	0.012	2.540	1.217	0.009	2.311	0.012	0.010	63.7	79.47
115	1140	0.0040	0.012	2.552	1.226	0.009	2.322	0.012	0.010	63.7	78.65

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	1.235	0.009	2.334	0.012	0.010	63.8	77.88
117	1160	0.0040	0.012	2.575	1.245	0.009	2.346	0.012	0.010	63.8	77.14
118	1170	0.0040	0.012	2.587	1.254	0.009	2.357	0.012	0.010	63.8	76.45
119	1180	0.0040	0.012	2.598	1.263	0.009	2.369	0.012	0.010	63.9	75.79
120	1190	0.0040	0.012	2.610	1.273	0.009	2.380	0.012	0.010	63.9	75.17
121	1200	0.0040	0.012	2.622	1.282	0.009	2.392	0.012	0.010	64.0	74.59
122	1210	0.0040	0.012	2.633	1.291	0.009	2.403	0.012	0.010	64.0	74.04
123	1220	0.0040	0.012	2.645	1.301	0.009	2.415	0.012	0.010	64.0	73.51
124	1230	0.0040	0.012	2.656	1.310	0.009	2.426	0.012	0.011	64.1	73.02
125	1240	0.0040	0.012	2.668	1.320	0.009	2.438	0.012	0.011	64.1	72.56
126	1250	0.0040	0.012	2.680	1.329	0.009	2.449	0.012	0.011	64.2	72.12
127	1260	0.0040	0.012	2.691	1.339	0.009	2.461	0.012	0.011	64.2	71.70
128	1270	0.0040	0.012	2.703	1.348	0.009	2.472	0.012	0.011	64.2	71.31
129	1280	0.0040	0.012	2.714	1.358	0.009	2.484	0.012	0.011	64.3	70.95
130	1290	0.0040	0.012	2.726	1.367	0.010	2.496	0.012	0.011	64.3	70.60
131	1300	0.0040	0.012	2.738	1.377	0.010	2.507	0.012	0.011	64.3	70.27
132	1310	0.0040	0.012	2.749	1.386	0.010	2.519	0.012	0.011	64.4	69.97
133	1320	0.0040	0.012	2.761	1.396	0.010	2.530	0.012	0.011	64.4	69.68
134	1330	0.0040	0.012	2.772	1.405	0.010	2.542	0.012	0.011	64.5	69.40
135	1340	0.0040	0.012	2.784	1.415	0.010	2.553	0.012	0.011	64.5	69.15
136	1350	0.0040	0.012	2.796	1.424	0.010	2.565	0.012	0.011	64.5	68.90
137	1360	0.0040	0.012	2.807	1.434	0.010	2.576	0.012	0.011	64.6	68.68
138	1370	0.0040	0.012	2.819	1.444	0.010	2.588	0.012	0.011	64.6	68.46
139	1380	0.0040	0.012	2.830	1.453	0.010	2.599	0.012	0.011	64.6	68.26
140	1390	0.0040	0.012	2.842	1.463	0.010	2.611	0.012	0.011	64.7	68.07
141	1400	0.0040	0.012	2.854	1.472	0.010	2.623	0.012	0.011	64.7	67.90
142	1410	0.0040	0.012	2.865	1.482	0.010	2.634	0.012	0.011	64.7	67.73
143	1420	0.0040	0.012	2.877	1.492	0.010	2.646	0.012	0.011	64.8	67.58
144	1430	0.0040	0.012	2.888	1.501	0.010	2.657	0.012	0.011	64.8	67.43
145	1440	0.0040	0.012	2.900	1.511	0.010	2.669	0.012	0.011	64.8	67.29

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 74th Ave Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 136.59 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 49.93 Ac. CN = 79.20 S = 2.6263 0.2S = 0.53

IMPERVIOUS AREA: Area = 86.66 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 21.88 cfs ***$T_{(Peak)}$ = 8.67 hrs***

Total Volume = 943,957 cf ***$Tc_{(min)}$ = 187 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.1	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.6	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.001	1.2	0.07
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.002	1.6	0.14
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.002	2.0	0.22
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.003	2.4	0.33
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.003	2.7	0.44
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.005	3.7	0.59
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.005	4.1	0.76
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.005	4.4	0.94
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.006	4.7	1.13

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.006	4.9	1.32
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.006	5.1	1.52
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.008	6.4	1.74
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.008	6.7	1.99
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.008	6.9	2.24
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.009	7.0	2.48
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.009	7.2	2.72
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.009	7.3	2.96
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.011	8.7	3.22
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.011	8.9	3.52
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.011	9.0	3.80
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.011	9.1	4.07
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.011	9.2	4.34
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.011	9.3	4.60
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.013	11.0	4.89
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.013	11.2	5.21
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.014	11.2	5.52
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.014	11.3	5.82
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.014	11.5	6.11
35	340	0.0082	0.024	0.572	0.001	0.001	0.384	0.022	0.014	11.7	6.40
36	350	0.0095	0.028	0.599	0.002	0.001	0.409	0.026	0.017	13.7	6.73
37	360	0.0095	0.028	0.627	0.004	0.002	0.435	0.026	0.017	14.0	7.10
38	370	0.0095	0.028	0.655	0.006	0.002	0.461	0.026	0.017	14.2	7.46
39	380	0.0095	0.028	0.682	0.009	0.003	0.486	0.026	0.017	14.4	7.82
40	390	0.0095	0.028	0.710	0.012	0.003	0.512	0.026	0.018	14.6	8.17
41	400	0.0095	0.028	0.737	0.016	0.004	0.539	0.026	0.018	14.8	8.51
42	410	0.0134	0.039	0.776	0.022	0.006	0.575	0.037	0.026	21.2	9.00
43	420	0.0134	0.039	0.815	0.029	0.007	0.613	0.037	0.026	21.5	9.65
44	430	0.0134	0.039	0.854	0.037	0.008	0.650	0.037	0.026	21.9	10.27
45	440	0.0180	0.052	0.906	0.048	0.012	0.700	0.050	0.036	29.8	11.09
46	450	0.0180	0.052	0.958	0.061	0.013	0.750	0.050	0.037	30.4	12.08
47	460	0.0340	0.099	1.057	0.089	0.028	0.846	0.096	0.071	58.6	13.76
48	470	0.0540	0.157	1.213	0.143	0.053	0.999	0.153	0.116	96.2	17.08
49	480	0.0270	0.078	1.292	0.173	0.030	1.075	0.077	0.060	49.3	19.98
50	490	0.0180	0.052	1.344	0.195	0.021	1.127	0.051	0.040	33.3	21.09
51	500	0.0134	0.039	1.383	0.211	0.017	1.165	0.038	0.030	25.0	21.51
52	510	0.0134	0.039	1.422	0.228	0.017	1.203	0.038	0.030	25.2	21.70
53	520	0.0134	0.039	1.460	0.246	0.017	1.241	0.038	0.031	25.3	21.88
54	530	0.0088	0.026	1.486	0.257	0.012	1.266	0.025	0.020	16.7	21.84
55	540	0.0088	0.026	1.511	0.269	0.012	1.291	0.025	0.020	16.8	21.57
56	550	0.0088	0.026	1.537	0.281	0.012	1.317	0.025	0.020	16.8	21.33
57	560	0.0088	0.026	1.563	0.294	0.012	1.342	0.025	0.020	16.9	21.09
58	570	0.0088	0.026	1.588	0.306	0.012	1.367	0.025	0.021	17.0	20.88
59	580	0.0088	0.026	1.614	0.319	0.013	1.392	0.025	0.021	17.0	20.68
60	590	0.0088	0.026	1.639	0.332	0.013	1.417	0.025	0.021	17.1	20.49
61	600	0.0088	0.026	1.665	0.345	0.013	1.442	0.025	0.021	17.1	20.31
62	610	0.0088	0.026	1.690	0.358	0.013	1.468	0.025	0.021	17.2	20.15
63	620	0.0088	0.026	1.716	0.371	0.013	1.493	0.025	0.021	17.3	20.00
64	630	0.0088	0.026	1.741	0.385	0.014	1.518	0.025	0.021	17.3	19.85
65	640	0.0088	0.026	1.767	0.398	0.014	1.543	0.025	0.021	17.4	19.72

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.410	0.011	1.564	0.021	0.017	14.2	19.52
67	660	0.0072	0.021	1.808	0.421	0.011	1.585	0.021	0.017	14.3	19.25
68	670	0.0072	0.021	1.829	0.433	0.012	1.605	0.021	0.017	14.3	18.99
69	680	0.0072	0.021	1.850	0.444	0.012	1.626	0.021	0.017	14.3	18.74
70	690	0.0072	0.021	1.871	0.456	0.012	1.647	0.021	0.017	14.4	18.52
71	700	0.0072	0.021	1.892	0.468	0.012	1.667	0.021	0.017	14.4	18.30
72	710	0.0072	0.021	1.913	0.480	0.012	1.688	0.021	0.017	14.4	18.10
73	720	0.0072	0.021	1.934	0.492	0.012	1.709	0.021	0.018	14.5	17.91
74	730	0.0072	0.021	1.955	0.504	0.012	1.729	0.021	0.018	14.5	17.73
75	740	0.0072	0.021	1.975	0.516	0.012	1.750	0.021	0.018	14.5	17.56
76	750	0.0072	0.021	1.996	0.528	0.012	1.771	0.021	0.018	14.6	17.40
77	760	0.0072	0.021	2.017	0.541	0.012	1.791	0.021	0.018	14.6	17.26
78	770	0.0057	0.017	2.034	0.550	0.010	1.808	0.016	0.014	11.6	17.04
79	780	0.0057	0.017	2.050	0.560	0.010	1.824	0.016	0.014	11.6	16.75
80	790	0.0057	0.017	2.067	0.570	0.010	1.841	0.016	0.014	11.6	16.48
81	800	0.0057	0.017	2.083	0.580	0.010	1.857	0.016	0.014	11.6	16.23
82	810	0.0057	0.017	2.100	0.590	0.010	1.873	0.016	0.014	11.6	15.99
83	820	0.0057	0.017	2.116	0.600	0.010	1.890	0.016	0.014	11.6	15.76
84	830	0.0057	0.017	2.133	0.610	0.010	1.906	0.016	0.014	11.7	15.55
85	840	0.0057	0.017	2.149	0.621	0.010	1.923	0.016	0.014	11.7	15.35
86	850	0.0057	0.017	2.166	0.631	0.010	1.939	0.016	0.014	11.7	15.16
87	860	0.0057	0.017	2.183	0.641	0.010	1.955	0.016	0.014	11.7	14.98
88	870	0.0057	0.017	2.199	0.652	0.010	1.972	0.016	0.014	11.7	14.81
89	880	0.0057	0.017	2.216	0.662	0.010	1.988	0.016	0.014	11.7	14.65
90	890	0.0050	0.015	2.230	0.671	0.009	2.003	0.014	0.012	10.3	14.46
91	900	0.0050	0.015	2.245	0.680	0.009	2.017	0.014	0.012	10.3	14.24
92	910	0.0050	0.015	2.259	0.689	0.009	2.031	0.014	0.013	10.3	14.04
93	920	0.0050	0.015	2.274	0.699	0.009	2.046	0.014	0.013	10.3	13.85
94	930	0.0050	0.015	2.288	0.708	0.009	2.060	0.014	0.013	10.4	13.66
95	940	0.0050	0.015	2.303	0.717	0.009	2.075	0.014	0.013	10.4	13.49
96	950	0.0050	0.015	2.317	0.727	0.009	2.089	0.014	0.013	10.4	13.33
97	960	0.0050	0.015	2.332	0.736	0.009	2.103	0.014	0.013	10.4	13.18
98	970	0.0050	0.015	2.346	0.746	0.009	2.118	0.014	0.013	10.4	13.03
99	980	0.0050	0.015	2.361	0.755	0.009	2.132	0.014	0.013	10.4	12.89
100	990	0.0050	0.015	2.375	0.764	0.009	2.147	0.014	0.013	10.4	12.77
101	1000	0.0050	0.015	2.390	0.774	0.010	2.161	0.014	0.013	10.4	12.64
102	1010	0.0040	0.012	2.401	0.782	0.008	2.173	0.012	0.010	8.4	12.47
103	1020	0.0040	0.012	2.413	0.789	0.008	2.184	0.012	0.010	8.4	12.26
104	1030	0.0040	0.012	2.424	0.797	0.008	2.196	0.012	0.010	8.4	12.06
105	1040	0.0040	0.012	2.436	0.805	0.008	2.207	0.012	0.010	8.4	11.86
106	1050	0.0040	0.012	2.448	0.812	0.008	2.219	0.012	0.010	8.4	11.68
107	1060	0.0040	0.012	2.459	0.820	0.008	2.230	0.012	0.010	8.4	11.51
108	1070	0.0040	0.012	2.471	0.828	0.008	2.242	0.012	0.010	8.4	11.35
109	1080	0.0040	0.012	2.482	0.836	0.008	2.253	0.012	0.010	8.4	11.19
110	1090	0.0040	0.012	2.494	0.844	0.008	2.265	0.012	0.010	8.4	11.05
111	1100	0.0040	0.012	2.506	0.851	0.008	2.276	0.012	0.010	8.4	10.91
112	1110	0.0040	0.012	2.517	0.859	0.008	2.288	0.012	0.010	8.4	10.78
113	1120	0.0040	0.012	2.529	0.867	0.008	2.299	0.012	0.010	8.4	10.66
114	1130	0.0040	0.012	2.540	0.875	0.008	2.311	0.012	0.010	8.4	10.54
115	1140	0.0040	0.012	2.552	0.883	0.008	2.322	0.012	0.010	8.4	10.43

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.891	0.008	2.334	0.012	0.010	8.4	10.33
117	1160	0.0040	0.012	2.575	0.899	0.008	2.346	0.012	0.010	8.4	10.23
118	1170	0.0040	0.012	2.587	0.907	0.008	2.357	0.012	0.010	8.4	10.14
119	1180	0.0040	0.012	2.598	0.915	0.008	2.369	0.012	0.010	8.5	10.05
120	1190	0.0040	0.012	2.610	0.923	0.008	2.380	0.012	0.010	8.5	9.97
121	1200	0.0040	0.012	2.622	0.931	0.008	2.392	0.012	0.010	8.5	9.89
122	1210	0.0040	0.012	2.633	0.939	0.008	2.403	0.012	0.010	8.5	9.81
123	1220	0.0040	0.012	2.645	0.947	0.008	2.415	0.012	0.010	8.5	9.74
124	1230	0.0040	0.012	2.656	0.955	0.008	2.426	0.012	0.010	8.5	9.68
125	1240	0.0040	0.012	2.668	0.963	0.008	2.438	0.012	0.010	8.5	9.62
126	1250	0.0040	0.012	2.680	0.971	0.008	2.449	0.012	0.010	8.5	9.56
127	1260	0.0040	0.012	2.691	0.979	0.008	2.461	0.012	0.010	8.5	9.50
128	1270	0.0040	0.012	2.703	0.987	0.008	2.472	0.012	0.010	8.5	9.45
129	1280	0.0040	0.012	2.714	0.995	0.008	2.484	0.012	0.010	8.5	9.40
130	1290	0.0040	0.012	2.726	1.003	0.008	2.496	0.012	0.010	8.5	9.35
131	1300	0.0040	0.012	2.738	1.012	0.008	2.507	0.012	0.010	8.5	9.31
132	1310	0.0040	0.012	2.749	1.020	0.008	2.519	0.012	0.010	8.5	9.27
133	1320	0.0040	0.012	2.761	1.028	0.008	2.530	0.012	0.010	8.5	9.23
134	1330	0.0040	0.012	2.772	1.036	0.008	2.542	0.012	0.010	8.5	9.20
135	1340	0.0040	0.012	2.784	1.044	0.008	2.553	0.012	0.010	8.5	9.16
136	1350	0.0040	0.012	2.796	1.053	0.008	2.565	0.012	0.010	8.5	9.13
137	1360	0.0040	0.012	2.807	1.061	0.008	2.576	0.012	0.010	8.6	9.10
138	1370	0.0040	0.012	2.819	1.069	0.008	2.588	0.012	0.010	8.6	9.07
139	1380	0.0040	0.012	2.830	1.078	0.008	2.599	0.012	0.010	8.6	9.04
140	1390	0.0040	0.012	2.842	1.086	0.008	2.611	0.012	0.010	8.6	9.02
141	1400	0.0040	0.012	2.854	1.094	0.008	2.623	0.012	0.010	8.6	9.00
142	1410	0.0040	0.012	2.865	1.103	0.008	2.634	0.012	0.010	8.6	8.97
143	1420	0.0040	0.012	2.877	1.111	0.008	2.646	0.012	0.010	8.6	8.95
144	1430	0.0040	0.012	2.888	1.119	0.008	2.657	0.012	0.010	8.6	8.93
145	1440	0.0040	0.012	2.900	1.128	0.008	2.669	0.012	0.010	8.6	8.92

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 71st Ave Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 38.83 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 3.89 Ac. CN = 79.20 S = 2.6263 0.2S = 0.53

IMPERVIOUS AREA: Area = 34.94 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 63 Min. w = 0.073529

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 13.37 cfs ***$T_{(Peak)}$ = 8.17 hrs***

Total Volume = 344,433 cf ***$Tc_{(min)}$ = 63 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.074

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.3	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.5	0.07
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.003	0.7	0.14
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.8	0.23
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.004	1.0	0.33
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.005	1.1	0.43
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.006	1.5	0.56
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.007	1.7	0.71
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.008	1.8	0.86
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.008	1.9	1.00

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.008	2.0	1.14
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.009	2.1	1.27
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.011	2.6	1.43
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.011	2.7	1.60
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.012	2.8	1.77
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.012	2.8	1.92
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.012	2.9	2.06
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.013	3.0	2.19
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.015	3.5	2.34
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.015	3.6	2.52
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.015	3.6	2.68
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.016	3.7	2.82
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.016	3.7	2.95
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.016	3.8	3.07
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.019	4.5	3.22
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.019	4.5	3.41
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.019	4.5	3.57
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.019	4.6	3.71
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.020	4.6	3.84
35	340	0.0082	0.024	0.572	0.001	0.001	0.384	0.022	0.020	4.6	3.96
36	350	0.0095	0.028	0.599	0.002	0.001	0.409	0.026	0.023	5.4	4.11
37	360	0.0095	0.028	0.627	0.004	0.002	0.435	0.026	0.023	5.5	4.31
38	370	0.0095	0.028	0.655	0.006	0.002	0.461	0.026	0.023	5.5	4.48
39	380	0.0095	0.028	0.682	0.009	0.003	0.486	0.026	0.024	5.5	4.63
40	390	0.0095	0.028	0.710	0.012	0.003	0.512	0.026	0.024	5.6	4.77
41	400	0.0095	0.028	0.737	0.016	0.004	0.539	0.026	0.024	5.6	4.89
42	410	0.0134	0.039	0.776	0.022	0.006	0.575	0.037	0.034	8.0	5.17
43	420	0.0134	0.039	0.815	0.029	0.007	0.613	0.037	0.034	8.0	5.58
44	430	0.0134	0.039	0.854	0.037	0.008	0.650	0.037	0.034	8.1	5.94
45	440	0.0180	0.052	0.906	0.048	0.012	0.700	0.050	0.046	10.9	6.46
46	450	0.0180	0.052	0.958	0.061	0.013	0.750	0.050	0.047	11.0	7.12
47	460	0.0340	0.099	1.057	0.089	0.028	0.846	0.096	0.089	20.9	8.41
48	470	0.0540	0.157	1.213	0.143	0.053	0.999	0.153	0.143	33.5	11.17
49	480	0.0270	0.078	1.292	0.173	0.030	1.075	0.077	0.072	16.9	13.24
50	490	0.0180	0.052	1.344	0.195	0.021	1.127	0.051	0.048	11.3	13.37
51	500	0.0134	0.039	1.383	0.211	0.017	1.165	0.038	0.036	8.5	12.86
52	510	0.0134	0.039	1.422	0.228	0.017	1.203	0.038	0.036	8.5	12.21
53	520	0.0134	0.039	1.460	0.246	0.017	1.241	0.038	0.036	8.5	11.66
54	530	0.0088	0.026	1.486	0.257	0.012	1.266	0.025	0.024	5.6	10.98
55	540	0.0088	0.026	1.511	0.269	0.012	1.291	0.025	0.024	5.6	10.19
56	550	0.0088	0.026	1.537	0.281	0.012	1.317	0.025	0.024	5.6	9.52
57	560	0.0088	0.026	1.563	0.294	0.012	1.342	0.025	0.024	5.6	8.94
58	570	0.0088	0.026	1.588	0.306	0.012	1.367	0.025	0.024	5.6	8.45
59	580	0.0088	0.026	1.614	0.319	0.013	1.392	0.025	0.024	5.6	8.03
60	590	0.0088	0.026	1.639	0.332	0.013	1.417	0.025	0.024	5.6	7.68
61	600	0.0088	0.026	1.665	0.345	0.013	1.442	0.025	0.024	5.6	7.38
62	610	0.0088	0.026	1.690	0.358	0.013	1.468	0.025	0.024	5.6	7.12
63	620	0.0088	0.026	1.716	0.371	0.013	1.493	0.025	0.024	5.6	6.90
64	630	0.0088	0.026	1.741	0.385	0.014	1.518	0.025	0.024	5.6	6.72
65	640	0.0088	0.026	1.767	0.398	0.014	1.543	0.025	0.024	5.7	6.56

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.410	0.011	1.564	0.021	0.020	4.6	6.35
67	660	0.0072	0.021	1.808	0.421	0.011	1.585	0.021	0.020	4.6	6.10
68	670	0.0072	0.021	1.829	0.433	0.012	1.605	0.021	0.020	4.6	5.89
69	680	0.0072	0.021	1.850	0.444	0.012	1.626	0.021	0.020	4.6	5.70
70	690	0.0072	0.021	1.871	0.456	0.012	1.647	0.021	0.020	4.6	5.55
71	700	0.0072	0.021	1.892	0.468	0.012	1.667	0.021	0.020	4.6	5.41
72	710	0.0072	0.021	1.913	0.480	0.012	1.688	0.021	0.020	4.7	5.30
73	720	0.0072	0.021	1.934	0.492	0.012	1.709	0.021	0.020	4.7	5.21
74	730	0.0072	0.021	1.955	0.504	0.012	1.729	0.021	0.020	4.7	5.12
75	740	0.0072	0.021	1.975	0.516	0.012	1.750	0.021	0.020	4.7	5.06
76	750	0.0072	0.021	1.996	0.528	0.012	1.771	0.021	0.020	4.7	5.00
77	760	0.0072	0.021	2.017	0.541	0.012	1.791	0.021	0.020	4.7	4.95
78	770	0.0057	0.017	2.034	0.550	0.010	1.808	0.016	0.016	3.7	4.84
79	780	0.0057	0.017	2.050	0.560	0.010	1.824	0.016	0.016	3.7	4.67
80	790	0.0057	0.017	2.067	0.570	0.010	1.841	0.016	0.016	3.7	4.53
81	800	0.0057	0.017	2.083	0.580	0.010	1.857	0.016	0.016	3.7	4.40
82	810	0.0057	0.017	2.100	0.590	0.010	1.873	0.016	0.016	3.7	4.30
83	820	0.0057	0.017	2.116	0.600	0.010	1.890	0.016	0.016	3.7	4.21
84	830	0.0057	0.017	2.133	0.610	0.010	1.906	0.016	0.016	3.7	4.14
85	840	0.0057	0.017	2.149	0.621	0.010	1.923	0.016	0.016	3.7	4.07
86	850	0.0057	0.017	2.166	0.631	0.010	1.939	0.016	0.016	3.7	4.02
87	860	0.0057	0.017	2.183	0.641	0.010	1.955	0.016	0.016	3.7	3.97
88	870	0.0057	0.017	2.199	0.652	0.010	1.972	0.016	0.016	3.7	3.94
89	880	0.0057	0.017	2.216	0.662	0.010	1.988	0.016	0.016	3.7	3.90
90	890	0.0050	0.015	2.230	0.671	0.009	2.003	0.014	0.014	3.3	3.84
91	900	0.0050	0.015	2.245	0.680	0.009	2.017	0.014	0.014	3.3	3.76
92	910	0.0050	0.015	2.259	0.689	0.009	2.031	0.014	0.014	3.3	3.68
93	920	0.0050	0.015	2.274	0.699	0.009	2.046	0.014	0.014	3.3	3.62
94	930	0.0050	0.015	2.288	0.708	0.009	2.060	0.014	0.014	3.3	3.57
95	940	0.0050	0.015	2.303	0.717	0.009	2.075	0.014	0.014	3.3	3.52
96	950	0.0050	0.015	2.317	0.727	0.009	2.089	0.014	0.014	3.3	3.49
97	960	0.0050	0.015	2.332	0.736	0.009	2.103	0.014	0.014	3.3	3.45
98	970	0.0050	0.015	2.346	0.746	0.009	2.118	0.014	0.014	3.3	3.43
99	980	0.0050	0.015	2.361	0.755	0.009	2.132	0.014	0.014	3.3	3.40
100	990	0.0050	0.015	2.375	0.764	0.009	2.147	0.014	0.014	3.3	3.38
101	1000	0.0050	0.015	2.390	0.774	0.010	2.161	0.014	0.014	3.3	3.37
102	1010	0.0040	0.012	2.401	0.782	0.008	2.173	0.012	0.011	2.6	3.30
103	1020	0.0040	0.012	2.413	0.789	0.008	2.184	0.012	0.011	2.6	3.20
104	1030	0.0040	0.012	2.424	0.797	0.008	2.196	0.012	0.011	2.6	3.12
105	1040	0.0040	0.012	2.436	0.805	0.008	2.207	0.012	0.011	2.6	3.04
106	1050	0.0040	0.012	2.448	0.812	0.008	2.219	0.012	0.011	2.6	2.98
107	1060	0.0040	0.012	2.459	0.820	0.008	2.230	0.012	0.011	2.6	2.93
108	1070	0.0040	0.012	2.471	0.828	0.008	2.242	0.012	0.011	2.6	2.88
109	1080	0.0040	0.012	2.482	0.836	0.008	2.253	0.012	0.011	2.6	2.84
110	1090	0.0040	0.012	2.494	0.844	0.008	2.265	0.012	0.011	2.6	2.81
111	1100	0.0040	0.012	2.506	0.851	0.008	2.276	0.012	0.011	2.6	2.78
112	1110	0.0040	0.012	2.517	0.859	0.008	2.288	0.012	0.011	2.6	2.76
113	1120	0.0040	0.012	2.529	0.867	0.008	2.299	0.012	0.011	2.6	2.74
114	1130	0.0040	0.012	2.540	0.875	0.008	2.311	0.012	0.011	2.6	2.72
115	1140	0.0040	0.012	2.552	0.883	0.008	2.322	0.012	0.011	2.6	2.71

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.891	0.008	2.334	0.012	0.011	2.6	2.70
117	1160	0.0040	0.012	2.575	0.899	0.008	2.346	0.012	0.011	2.6	2.69
118	1170	0.0040	0.012	2.587	0.907	0.008	2.357	0.012	0.011	2.6	2.68
119	1180	0.0040	0.012	2.598	0.915	0.008	2.369	0.012	0.011	2.6	2.67
120	1190	0.0040	0.012	2.610	0.923	0.008	2.380	0.012	0.011	2.6	2.66
121	1200	0.0040	0.012	2.622	0.931	0.008	2.392	0.012	0.011	2.6	2.66
122	1210	0.0040	0.012	2.633	0.939	0.008	2.403	0.012	0.011	2.6	2.65
123	1220	0.0040	0.012	2.645	0.947	0.008	2.415	0.012	0.011	2.6	2.65
124	1230	0.0040	0.012	2.656	0.955	0.008	2.426	0.012	0.011	2.6	2.65
125	1240	0.0040	0.012	2.668	0.963	0.008	2.438	0.012	0.011	2.6	2.64
126	1250	0.0040	0.012	2.680	0.971	0.008	2.449	0.012	0.011	2.6	2.64
127	1260	0.0040	0.012	2.691	0.979	0.008	2.461	0.012	0.011	2.6	2.64
128	1270	0.0040	0.012	2.703	0.987	0.008	2.472	0.012	0.011	2.6	2.64
129	1280	0.0040	0.012	2.714	0.995	0.008	2.484	0.012	0.011	2.6	2.64
130	1290	0.0040	0.012	2.726	1.003	0.008	2.496	0.012	0.011	2.6	2.64
131	1300	0.0040	0.012	2.738	1.012	0.008	2.507	0.012	0.011	2.6	2.64
132	1310	0.0040	0.012	2.749	1.020	0.008	2.519	0.012	0.011	2.6	2.64
133	1320	0.0040	0.012	2.761	1.028	0.008	2.530	0.012	0.011	2.6	2.64
134	1330	0.0040	0.012	2.772	1.036	0.008	2.542	0.012	0.011	2.6	2.63
135	1340	0.0040	0.012	2.784	1.044	0.008	2.553	0.012	0.011	2.6	2.63
136	1350	0.0040	0.012	2.796	1.053	0.008	2.565	0.012	0.011	2.6	2.63
137	1360	0.0040	0.012	2.807	1.061	0.008	2.576	0.012	0.011	2.6	2.63
138	1370	0.0040	0.012	2.819	1.069	0.008	2.588	0.012	0.011	2.6	2.63
139	1380	0.0040	0.012	2.830	1.078	0.008	2.599	0.012	0.011	2.6	2.63
140	1390	0.0040	0.012	2.842	1.086	0.008	2.611	0.012	0.011	2.6	2.64
141	1400	0.0040	0.012	2.854	1.094	0.008	2.623	0.012	0.011	2.6	2.64
142	1410	0.0040	0.012	2.865	1.103	0.008	2.634	0.012	0.011	2.6	2.64
143	1420	0.0040	0.012	2.877	1.111	0.008	2.646	0.012	0.011	2.6	2.64
144	1430	0.0040	0.012	2.888	1.119	0.008	2.657	0.012	0.011	2.6	2.64
145	1440	0.0040	0.012	2.900	1.128	0.008	2.669	0.012	0.011	2.6	2.64

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 204th St Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 17.56 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 1.76 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 15.80 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 33 Min. w = 0.131579

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 7.71 cfs ***$T_{(Peak)}$ = 8.00 hrs***

Total Volume = 154,432 cf ***$Tc_{(min)}$ = 33 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.132

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.1	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.2	0.06
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.003	0.3	0.11
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.4	0.17
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.004	0.4	0.23
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.005	0.5	0.29
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.006	0.7	0.37
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.007	0.7	0.46
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.008	0.8	0.54
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.008	0.9	0.62

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.008	0.9	0.69
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.009	0.9	0.75
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.011	1.2	0.83
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.011	1.2	0.92
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.012	1.3	1.01
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.012	1.3	1.07
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.012	1.3	1.13
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.013	1.3	1.18
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.015	1.6	1.26
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.015	1.6	1.35
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.015	1.6	1.42
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.016	1.7	1.48
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.016	1.7	1.53
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.016	1.7	1.58
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.019	2.0	1.65
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.019	2.0	1.75
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.019	2.1	1.83
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.019	2.1	1.89
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.020	2.1	1.94
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.020	2.1	1.98
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.023	2.4	2.05
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.023	2.5	2.15
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.023	2.5	2.23
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.023	2.5	2.30
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.023	2.5	2.34
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.023	2.5	2.38
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.033	3.5	2.55
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.033	3.5	2.81
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.034	3.6	3.00
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.045	4.8	3.31
46	450	0.0180	0.052	0.958	0.000	0.000	0.750	0.050	0.045	4.8	3.71
47	460	0.0340	0.099	1.057	0.003	0.003	0.846	0.096	0.086	9.2	4.57
48	470	0.0540	0.157	1.213	0.015	0.012	0.999	0.153	0.139	14.7	6.51
49	480	0.0270	0.078	1.292	0.024	0.009	1.075	0.077	0.070	7.4	7.71
50	490	0.0180	0.052	1.344	0.032	0.007	1.127	0.051	0.047	5.0	7.32
51	500	0.0134	0.039	1.383	0.038	0.006	1.165	0.038	0.035	3.7	6.53
52	510	0.0134	0.039	1.422	0.044	0.007	1.203	0.038	0.035	3.7	5.79
53	520	0.0134	0.039	1.460	0.052	0.007	1.241	0.038	0.035	3.7	5.25
54	530	0.0088	0.026	1.486	0.057	0.005	1.266	0.025	0.023	2.5	4.68
55	540	0.0088	0.026	1.511	0.062	0.005	1.291	0.025	0.023	2.5	4.10
56	550	0.0088	0.026	1.537	0.067	0.005	1.317	0.025	0.023	2.5	3.66
57	560	0.0088	0.026	1.563	0.072	0.006	1.342	0.025	0.023	2.5	3.35
58	570	0.0088	0.026	1.588	0.078	0.006	1.367	0.025	0.023	2.5	3.12
59	580	0.0088	0.026	1.614	0.084	0.006	1.392	0.025	0.023	2.5	2.95
60	590	0.0088	0.026	1.639	0.090	0.006	1.417	0.025	0.023	2.5	2.82
61	600	0.0088	0.026	1.665	0.096	0.006	1.442	0.025	0.023	2.5	2.73
62	610	0.0088	0.026	1.690	0.103	0.006	1.468	0.025	0.023	2.5	2.66
63	620	0.0088	0.026	1.716	0.109	0.007	1.493	0.025	0.023	2.5	2.61
64	630	0.0088	0.026	1.741	0.116	0.007	1.518	0.025	0.023	2.5	2.58
65	640	0.0088	0.026	1.767	0.123	0.007	1.543	0.025	0.023	2.5	2.55

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.129	0.006	1.564	0.021	0.019	2.0	2.48
67	660	0.0072	0.021	1.808	0.135	0.006	1.585	0.021	0.019	2.0	2.36
68	670	0.0072	0.021	1.829	0.141	0.006	1.605	0.021	0.019	2.0	2.28
69	680	0.0072	0.021	1.850	0.147	0.006	1.626	0.021	0.019	2.0	2.21
70	690	0.0072	0.021	1.871	0.153	0.006	1.647	0.021	0.019	2.0	2.17
71	700	0.0072	0.021	1.892	0.160	0.006	1.667	0.021	0.019	2.0	2.14
72	710	0.0072	0.021	1.913	0.166	0.006	1.688	0.021	0.019	2.0	2.11
73	720	0.0072	0.021	1.934	0.173	0.007	1.709	0.021	0.019	2.0	2.09
74	730	0.0072	0.021	1.955	0.180	0.007	1.729	0.021	0.019	2.0	2.08
75	740	0.0072	0.021	1.975	0.186	0.007	1.750	0.021	0.019	2.0	2.07
76	750	0.0072	0.021	1.996	0.193	0.007	1.771	0.021	0.019	2.1	2.07
77	760	0.0072	0.021	2.017	0.200	0.007	1.791	0.021	0.019	2.1	2.06
78	770	0.0057	0.017	2.034	0.206	0.006	1.808	0.016	0.015	1.6	2.00
79	780	0.0057	0.017	2.050	0.212	0.006	1.824	0.016	0.015	1.6	1.91
80	790	0.0057	0.017	2.067	0.217	0.006	1.841	0.016	0.015	1.6	1.83
81	800	0.0057	0.017	2.083	0.223	0.006	1.857	0.016	0.015	1.6	1.78
82	810	0.0057	0.017	2.100	0.229	0.006	1.873	0.016	0.015	1.6	1.74
83	820	0.0057	0.017	2.116	0.235	0.006	1.890	0.016	0.015	1.6	1.71
84	830	0.0057	0.017	2.133	0.241	0.006	1.906	0.016	0.015	1.6	1.69
85	840	0.0057	0.017	2.149	0.247	0.006	1.923	0.016	0.015	1.6	1.67
86	850	0.0057	0.017	2.166	0.253	0.006	1.939	0.016	0.015	1.6	1.66
87	860	0.0057	0.017	2.183	0.259	0.006	1.955	0.016	0.015	1.6	1.66
88	870	0.0057	0.017	2.199	0.265	0.006	1.972	0.016	0.015	1.6	1.65
89	880	0.0057	0.017	2.216	0.272	0.006	1.988	0.016	0.015	1.6	1.65
90	890	0.0050	0.015	2.230	0.277	0.006	2.003	0.014	0.014	1.4	1.62
91	900	0.0050	0.015	2.245	0.283	0.006	2.017	0.014	0.014	1.4	1.57
92	910	0.0050	0.015	2.259	0.288	0.006	2.031	0.014	0.014	1.4	1.53
93	920	0.0050	0.015	2.274	0.294	0.006	2.046	0.014	0.014	1.4	1.51
94	930	0.0050	0.015	2.288	0.300	0.006	2.060	0.014	0.014	1.4	1.49
95	940	0.0050	0.015	2.303	0.305	0.006	2.075	0.014	0.014	1.4	1.48
96	950	0.0050	0.015	2.317	0.311	0.006	2.089	0.014	0.014	1.4	1.47
97	960	0.0050	0.015	2.332	0.317	0.006	2.103	0.014	0.014	1.4	1.46
98	970	0.0050	0.015	2.346	0.323	0.006	2.118	0.014	0.014	1.4	1.45
99	980	0.0050	0.015	2.361	0.329	0.006	2.132	0.014	0.014	1.4	1.45
100	990	0.0050	0.015	2.375	0.335	0.006	2.147	0.014	0.014	1.4	1.45
101	1000	0.0050	0.015	2.390	0.341	0.006	2.161	0.014	0.014	1.4	1.45
102	1010	0.0040	0.012	2.401	0.346	0.005	2.173	0.012	0.011	1.2	1.41
103	1020	0.0040	0.012	2.413	0.351	0.005	2.184	0.012	0.011	1.2	1.34
104	1030	0.0040	0.012	2.424	0.355	0.005	2.196	0.012	0.011	1.2	1.29
105	1040	0.0040	0.012	2.436	0.360	0.005	2.207	0.012	0.011	1.2	1.25
106	1050	0.0040	0.012	2.448	0.365	0.005	2.219	0.012	0.011	1.2	1.23
107	1060	0.0040	0.012	2.459	0.370	0.005	2.230	0.012	0.011	1.2	1.21
108	1070	0.0040	0.012	2.471	0.375	0.005	2.242	0.012	0.011	1.2	1.19
109	1080	0.0040	0.012	2.482	0.380	0.005	2.253	0.012	0.011	1.2	1.18
110	1090	0.0040	0.012	2.494	0.385	0.005	2.265	0.012	0.011	1.2	1.18
111	1100	0.0040	0.012	2.506	0.390	0.005	2.276	0.012	0.011	1.2	1.17
112	1110	0.0040	0.012	2.517	0.395	0.005	2.288	0.012	0.011	1.2	1.17
113	1120	0.0040	0.012	2.529	0.400	0.005	2.299	0.012	0.011	1.2	1.16
114	1130	0.0040	0.012	2.540	0.406	0.005	2.311	0.012	0.011	1.2	1.16
115	1140	0.0040	0.012	2.552	0.411	0.005	2.322	0.012	0.011	1.2	1.16

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.416	0.005	2.334	0.012	0.011	1.2	1.16
117	1160	0.0040	0.012	2.575	0.421	0.005	2.346	0.012	0.011	1.2	1.16
118	1170	0.0040	0.012	2.587	0.426	0.005	2.357	0.012	0.011	1.2	1.16
119	1180	0.0040	0.012	2.598	0.432	0.005	2.369	0.012	0.011	1.2	1.16
120	1190	0.0040	0.012	2.610	0.437	0.005	2.380	0.012	0.011	1.2	1.16
121	1200	0.0040	0.012	2.622	0.442	0.005	2.392	0.012	0.011	1.2	1.16
122	1210	0.0040	0.012	2.633	0.447	0.005	2.403	0.012	0.011	1.2	1.16
123	1220	0.0040	0.012	2.645	0.453	0.005	2.415	0.012	0.011	1.2	1.16
124	1230	0.0040	0.012	2.656	0.458	0.005	2.426	0.012	0.011	1.2	1.16
125	1240	0.0040	0.012	2.668	0.464	0.005	2.438	0.012	0.011	1.2	1.16
126	1250	0.0040	0.012	2.680	0.469	0.005	2.449	0.012	0.011	1.2	1.16
127	1260	0.0040	0.012	2.691	0.474	0.005	2.461	0.012	0.011	1.2	1.16
128	1270	0.0040	0.012	2.703	0.480	0.005	2.472	0.012	0.011	1.2	1.16
129	1280	0.0040	0.012	2.714	0.485	0.005	2.484	0.012	0.011	1.2	1.16
130	1290	0.0040	0.012	2.726	0.491	0.005	2.496	0.012	0.011	1.2	1.16
131	1300	0.0040	0.012	2.738	0.496	0.006	2.507	0.012	0.011	1.2	1.16
132	1310	0.0040	0.012	2.749	0.502	0.006	2.519	0.012	0.011	1.2	1.16
133	1320	0.0040	0.012	2.761	0.507	0.006	2.530	0.012	0.011	1.2	1.16
134	1330	0.0040	0.012	2.772	0.513	0.006	2.542	0.012	0.011	1.2	1.16
135	1340	0.0040	0.012	2.784	0.519	0.006	2.553	0.012	0.011	1.2	1.16
136	1350	0.0040	0.012	2.796	0.524	0.006	2.565	0.012	0.011	1.2	1.16
137	1360	0.0040	0.012	2.807	0.530	0.006	2.576	0.012	0.011	1.2	1.16
138	1370	0.0040	0.012	2.819	0.536	0.006	2.588	0.012	0.011	1.2	1.16
139	1380	0.0040	0.012	2.830	0.541	0.006	2.599	0.012	0.011	1.2	1.16
140	1390	0.0040	0.012	2.842	0.547	0.006	2.611	0.012	0.011	1.2	1.16
141	1400	0.0040	0.012	2.854	0.553	0.006	2.623	0.012	0.011	1.2	1.16
142	1410	0.0040	0.012	2.865	0.558	0.006	2.634	0.012	0.011	1.2	1.16
143	1420	0.0040	0.012	2.877	0.564	0.006	2.646	0.012	0.011	1.2	1.16
144	1430	0.0040	0.012	2.888	0.570	0.006	2.657	0.012	0.011	1.2	1.16
145	1440	0.0040	0.012	2.900	0.576	0.006	2.669	0.012	0.011	1.2	1.16

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to BNSF RR Culvert**

Design Storm : **10-yr / 24-hr**

Given: Area = 4.18 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 0.42 Ac. CN = 68.95 S = 4.5033 0.2S = 0.90

IMPERVIOUS AREA: Area = 3.76 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 2.85 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 37,278 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.02
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.1	0.04
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.003	0.1	0.06
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.1	0.08
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.004	0.1	0.10
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.005	0.1	0.11
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.006	0.2	0.14
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.007	0.2	0.17
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.008	0.2	0.18
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.008	0.2	0.20

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.008	0.2	0.21
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.009	0.2	0.22
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.011	0.3	0.25
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.011	0.3	0.28
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.012	0.3	0.29
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.012	0.3	0.30
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.012	0.3	0.31
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.013	0.3	0.32
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.015	0.4	0.35
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.015	0.4	0.38
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.015	0.4	0.39
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.016	0.4	0.39
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.016	0.4	0.40
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.016	0.4	0.40
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.019	0.5	0.44
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.019	0.5	0.48
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.019	0.5	0.49
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.019	0.5	0.49
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.020	0.5	0.49
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.020	0.5	0.50
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.023	0.6	0.54
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.023	0.6	0.58
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.023	0.6	0.58
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.023	0.6	0.59
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.023	0.6	0.59
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.023	0.6	0.59
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.033	0.8	0.72
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.033	0.8	0.84
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.033	0.8	0.85
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.045	1.1	0.99
46	450	0.0180	0.052	0.958	0.001	0.001	0.750	0.050	0.045	1.1	1.15
47	460	0.0340	0.099	1.057	0.005	0.005	0.846	0.096	0.086	2.2	1.67
48	470	0.0540	0.157	1.213	0.020	0.015	0.999	0.153	0.139	3.5	2.85
49	480	0.0270	0.078	1.292	0.031	0.011	1.075	0.077	0.070	1.8	2.64
50	490	0.0180	0.052	1.344	0.040	0.008	1.127	0.051	0.047	1.2	1.48
51	500	0.0134	0.039	1.383	0.047	0.007	1.165	0.038	0.035	0.9	1.04
52	510	0.0134	0.039	1.422	0.054	0.007	1.203	0.038	0.035	0.9	0.89
53	520	0.0134	0.039	1.460	0.062	0.008	1.241	0.038	0.035	0.9	0.89
54	530	0.0088	0.026	1.486	0.067	0.005	1.266	0.025	0.023	0.6	0.74
55	540	0.0088	0.026	1.511	0.073	0.006	1.291	0.025	0.023	0.6	0.59
56	550	0.0088	0.026	1.537	0.079	0.006	1.317	0.025	0.023	0.6	0.59
57	560	0.0088	0.026	1.563	0.085	0.006	1.342	0.025	0.023	0.6	0.59
58	570	0.0088	0.026	1.588	0.091	0.006	1.367	0.025	0.023	0.6	0.59
59	580	0.0088	0.026	1.614	0.097	0.006	1.392	0.025	0.023	0.6	0.59
60	590	0.0088	0.026	1.639	0.104	0.007	1.417	0.025	0.023	0.6	0.59
61	600	0.0088	0.026	1.665	0.111	0.007	1.442	0.025	0.023	0.6	0.59
62	610	0.0088	0.026	1.690	0.118	0.007	1.468	0.025	0.023	0.6	0.59
63	620	0.0088	0.026	1.716	0.125	0.007	1.493	0.025	0.023	0.6	0.59
64	630	0.0088	0.026	1.741	0.132	0.007	1.518	0.025	0.023	0.6	0.59
65	640	0.0088	0.026	1.767	0.140	0.007	1.543	0.025	0.023	0.6	0.59

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.146	0.006	1.564	0.021	0.019	0.5	0.54
67	660	0.0072	0.021	1.808	0.152	0.006	1.585	0.021	0.019	0.5	0.49
68	670	0.0072	0.021	1.829	0.159	0.006	1.605	0.021	0.019	0.5	0.49
69	680	0.0072	0.021	1.850	0.165	0.007	1.626	0.021	0.019	0.5	0.49
70	690	0.0072	0.021	1.871	0.172	0.007	1.647	0.021	0.019	0.5	0.49
71	700	0.0072	0.021	1.892	0.179	0.007	1.667	0.021	0.019	0.5	0.49
72	710	0.0072	0.021	1.913	0.186	0.007	1.688	0.021	0.019	0.5	0.49
73	720	0.0072	0.021	1.934	0.193	0.007	1.709	0.021	0.019	0.5	0.49
74	730	0.0072	0.021	1.955	0.200	0.007	1.729	0.021	0.019	0.5	0.49
75	740	0.0072	0.021	1.975	0.207	0.007	1.750	0.021	0.019	0.5	0.49
76	750	0.0072	0.021	1.996	0.214	0.007	1.771	0.021	0.019	0.5	0.49
77	760	0.0072	0.021	2.017	0.222	0.007	1.791	0.021	0.019	0.5	0.49
78	770	0.0057	0.017	2.034	0.228	0.006	1.808	0.016	0.015	0.4	0.44
79	780	0.0057	0.017	2.050	0.234	0.006	1.824	0.016	0.015	0.4	0.39
80	790	0.0057	0.017	2.067	0.240	0.006	1.841	0.016	0.015	0.4	0.39
81	800	0.0057	0.017	2.083	0.246	0.006	1.857	0.016	0.015	0.4	0.39
82	810	0.0057	0.017	2.100	0.252	0.006	1.873	0.016	0.015	0.4	0.39
83	820	0.0057	0.017	2.116	0.258	0.006	1.890	0.016	0.015	0.4	0.39
84	830	0.0057	0.017	2.133	0.265	0.006	1.906	0.016	0.015	0.4	0.39
85	840	0.0057	0.017	2.149	0.271	0.006	1.923	0.016	0.015	0.4	0.39
86	850	0.0057	0.017	2.166	0.278	0.006	1.939	0.016	0.015	0.4	0.39
87	860	0.0057	0.017	2.183	0.284	0.006	1.955	0.016	0.015	0.4	0.39
88	870	0.0057	0.017	2.199	0.291	0.007	1.972	0.016	0.015	0.4	0.39
89	880	0.0057	0.017	2.216	0.297	0.007	1.988	0.016	0.015	0.4	0.39
90	890	0.0050	0.015	2.230	0.303	0.006	2.003	0.014	0.014	0.3	0.37
91	900	0.0050	0.015	2.245	0.309	0.006	2.017	0.014	0.014	0.3	0.34
92	910	0.0050	0.015	2.259	0.315	0.006	2.031	0.014	0.014	0.3	0.34
93	920	0.0050	0.015	2.274	0.321	0.006	2.046	0.014	0.014	0.3	0.34
94	930	0.0050	0.015	2.288	0.327	0.006	2.060	0.014	0.014	0.3	0.34
95	940	0.0050	0.015	2.303	0.333	0.006	2.075	0.014	0.014	0.3	0.34
96	950	0.0050	0.015	2.317	0.339	0.006	2.089	0.014	0.014	0.3	0.34
97	960	0.0050	0.015	2.332	0.345	0.006	2.103	0.014	0.014	0.3	0.34
98	970	0.0050	0.015	2.346	0.351	0.006	2.118	0.014	0.014	0.3	0.34
99	980	0.0050	0.015	2.361	0.357	0.006	2.132	0.014	0.014	0.3	0.34
100	990	0.0050	0.015	2.375	0.364	0.006	2.147	0.014	0.014	0.3	0.34
101	1000	0.0050	0.015	2.390	0.370	0.006	2.161	0.014	0.014	0.3	0.34
102	1010	0.0040	0.012	2.401	0.375	0.005	2.173	0.012	0.011	0.3	0.31
103	1020	0.0040	0.012	2.413	0.380	0.005	2.184	0.012	0.011	0.3	0.28
104	1030	0.0040	0.012	2.424	0.385	0.005	2.196	0.012	0.011	0.3	0.28
105	1040	0.0040	0.012	2.436	0.390	0.005	2.207	0.012	0.011	0.3	0.28
106	1050	0.0040	0.012	2.448	0.396	0.005	2.219	0.012	0.011	0.3	0.28
107	1060	0.0040	0.012	2.459	0.401	0.005	2.230	0.012	0.011	0.3	0.28
108	1070	0.0040	0.012	2.471	0.406	0.005	2.242	0.012	0.011	0.3	0.28
109	1080	0.0040	0.012	2.482	0.411	0.005	2.253	0.012	0.011	0.3	0.28
110	1090	0.0040	0.012	2.494	0.416	0.005	2.265	0.012	0.011	0.3	0.28
111	1100	0.0040	0.012	2.506	0.422	0.005	2.276	0.012	0.011	0.3	0.28
112	1110	0.0040	0.012	2.517	0.427	0.005	2.288	0.012	0.011	0.3	0.28
113	1120	0.0040	0.012	2.529	0.432	0.005	2.299	0.012	0.011	0.3	0.28
114	1130	0.0040	0.012	2.540	0.438	0.005	2.311	0.012	0.011	0.3	0.28
115	1140	0.0040	0.012	2.552	0.443	0.005	2.322	0.012	0.011	0.3	0.28

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.448	0.005	2.334	0.012	0.011	0.3	0.28
117	1160	0.0040	0.012	2.575	0.454	0.005	2.346	0.012	0.011	0.3	0.28
118	1170	0.0040	0.012	2.587	0.459	0.005	2.357	0.012	0.011	0.3	0.28
119	1180	0.0040	0.012	2.598	0.465	0.005	2.369	0.012	0.011	0.3	0.28
120	1190	0.0040	0.012	2.610	0.470	0.005	2.380	0.012	0.011	0.3	0.28
121	1200	0.0040	0.012	2.622	0.476	0.006	2.392	0.012	0.011	0.3	0.28
122	1210	0.0040	0.012	2.633	0.481	0.006	2.403	0.012	0.011	0.3	0.28
123	1220	0.0040	0.012	2.645	0.487	0.006	2.415	0.012	0.011	0.3	0.28
124	1230	0.0040	0.012	2.656	0.493	0.006	2.426	0.012	0.011	0.3	0.28
125	1240	0.0040	0.012	2.668	0.498	0.006	2.438	0.012	0.011	0.3	0.28
126	1250	0.0040	0.012	2.680	0.504	0.006	2.449	0.012	0.011	0.3	0.28
127	1260	0.0040	0.012	2.691	0.509	0.006	2.461	0.012	0.011	0.3	0.28
128	1270	0.0040	0.012	2.703	0.515	0.006	2.472	0.012	0.011	0.3	0.28
129	1280	0.0040	0.012	2.714	0.521	0.006	2.484	0.012	0.011	0.3	0.28
130	1290	0.0040	0.012	2.726	0.526	0.006	2.496	0.012	0.011	0.3	0.28
131	1300	0.0040	0.012	2.738	0.532	0.006	2.507	0.012	0.011	0.3	0.28
132	1310	0.0040	0.012	2.749	0.538	0.006	2.519	0.012	0.011	0.3	0.28
133	1320	0.0040	0.012	2.761	0.544	0.006	2.530	0.012	0.011	0.3	0.28
134	1330	0.0040	0.012	2.772	0.550	0.006	2.542	0.012	0.011	0.3	0.28
135	1340	0.0040	0.012	2.784	0.555	0.006	2.553	0.012	0.011	0.3	0.28
136	1350	0.0040	0.012	2.796	0.561	0.006	2.565	0.012	0.011	0.3	0.28
137	1360	0.0040	0.012	2.807	0.567	0.006	2.576	0.012	0.011	0.3	0.28
138	1370	0.0040	0.012	2.819	0.573	0.006	2.588	0.012	0.011	0.3	0.28
139	1380	0.0040	0.012	2.830	0.579	0.006	2.599	0.012	0.011	0.3	0.28
140	1390	0.0040	0.012	2.842	0.585	0.006	2.611	0.012	0.011	0.3	0.28
141	1400	0.0040	0.012	2.854	0.591	0.006	2.623	0.012	0.011	0.3	0.28
142	1410	0.0040	0.012	2.865	0.597	0.006	2.634	0.012	0.011	0.3	0.28
143	1420	0.0040	0.012	2.877	0.603	0.006	2.646	0.012	0.011	0.3	0.28
144	1430	0.0040	0.012	2.888	0.609	0.006	2.657	0.012	0.011	0.3	0.28
145	1440	0.0040	0.012	2.900	0.615	0.006	2.669	0.012	0.011	0.3	0.28

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 69th Ave Culvert**

Design Storm : **10-yr / 24-hr**

Given:	Area =	0.76	Ac.	P =	2.90	in.	dt =	10 min.
PERVIOUS AREA:	Area =	0.08	Ac.	CN =	68.00		S = 4.7059	0.2S = 0.94
IMPERVIOUS AREA:	Area =	0.68	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 0.51 cfs
Total Volume = 6,740 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.0	0.00
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.0	0.01
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.003	0.0	0.01
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.0	0.01
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.004	0.0	0.02
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.005	0.0	0.02
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.006	0.0	0.03
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.007	0.0	0.03
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.008	0.0	0.03
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.008	0.0	0.04

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.008	0.0	0.04
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.009	0.0	0.04
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.011	0.1	0.05
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.011	0.1	0.05
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.012	0.1	0.05
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.012	0.1	0.05
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.012	0.1	0.06
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.013	0.1	0.06
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.015	0.1	0.06
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.015	0.1	0.07
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.015	0.1	0.07
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.016	0.1	0.07
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.016	0.1	0.07
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.016	0.1	0.07
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.019	0.1	0.08
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.019	0.1	0.09
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.019	0.1	0.09
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.019	0.1	0.09
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.019	0.1	0.09
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.020	0.1	0.09
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.023	0.1	0.10
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.023	0.1	0.11
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.023	0.1	0.11
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.023	0.1	0.11
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.023	0.1	0.11
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.023	0.1	0.11
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.033	0.2	0.13
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.033	0.2	0.15
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.033	0.2	0.15
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.045	0.2	0.18
46	450	0.0180	0.052	0.958	0.000	0.000	0.750	0.050	0.045	0.2	0.21
47	460	0.0340	0.099	1.057	0.003	0.003	0.846	0.096	0.086	0.4	0.30
48	470	0.0540	0.157	1.213	0.015	0.012	0.999	0.153	0.138	0.6	0.51
49	480	0.0270	0.078	1.292	0.024	0.009	1.075	0.077	0.070	0.3	0.48
50	490	0.0180	0.052	1.344	0.032	0.007	1.127	0.051	0.047	0.2	0.27
51	500	0.0134	0.039	1.383	0.038	0.006	1.165	0.038	0.035	0.2	0.19
52	510	0.0134	0.039	1.422	0.044	0.007	1.203	0.038	0.035	0.2	0.16
53	520	0.0134	0.039	1.460	0.052	0.007	1.241	0.038	0.035	0.2	0.16
54	530	0.0088	0.026	1.486	0.057	0.005	1.266	0.025	0.023	0.1	0.13
55	540	0.0088	0.026	1.511	0.062	0.005	1.291	0.025	0.023	0.1	0.11
56	550	0.0088	0.026	1.537	0.067	0.005	1.317	0.025	0.023	0.1	0.11
57	560	0.0088	0.026	1.563	0.072	0.006	1.342	0.025	0.023	0.1	0.11
58	570	0.0088	0.026	1.588	0.078	0.006	1.367	0.025	0.023	0.1	0.11
59	580	0.0088	0.026	1.614	0.084	0.006	1.392	0.025	0.023	0.1	0.11
60	590	0.0088	0.026	1.639	0.090	0.006	1.417	0.025	0.023	0.1	0.11
61	600	0.0088	0.026	1.665	0.096	0.006	1.442	0.025	0.023	0.1	0.11
62	610	0.0088	0.026	1.690	0.103	0.006	1.468	0.025	0.023	0.1	0.11
63	620	0.0088	0.026	1.716	0.109	0.007	1.493	0.025	0.023	0.1	0.11
64	630	0.0088	0.026	1.741	0.116	0.007	1.518	0.025	0.023	0.1	0.11
65	640	0.0088	0.026	1.767	0.123	0.007	1.543	0.025	0.023	0.1	0.11

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.129	0.006	1.564	0.021	0.019	0.1	0.10
67	660	0.0072	0.021	1.808	0.135	0.006	1.585	0.021	0.019	0.1	0.09
68	670	0.0072	0.021	1.829	0.141	0.006	1.605	0.021	0.019	0.1	0.09
69	680	0.0072	0.021	1.850	0.147	0.006	1.626	0.021	0.019	0.1	0.09
70	690	0.0072	0.021	1.871	0.153	0.006	1.647	0.021	0.019	0.1	0.09
71	700	0.0072	0.021	1.892	0.160	0.006	1.667	0.021	0.019	0.1	0.09
72	710	0.0072	0.021	1.913	0.166	0.006	1.688	0.021	0.019	0.1	0.09
73	720	0.0072	0.021	1.934	0.173	0.007	1.709	0.021	0.019	0.1	0.09
74	730	0.0072	0.021	1.955	0.180	0.007	1.729	0.021	0.019	0.1	0.09
75	740	0.0072	0.021	1.975	0.186	0.007	1.750	0.021	0.019	0.1	0.09
76	750	0.0072	0.021	1.996	0.193	0.007	1.771	0.021	0.019	0.1	0.09
77	760	0.0072	0.021	2.017	0.200	0.007	1.791	0.021	0.019	0.1	0.09
78	770	0.0057	0.017	2.034	0.206	0.006	1.808	0.016	0.015	0.1	0.08
79	780	0.0057	0.017	2.050	0.212	0.006	1.824	0.016	0.015	0.1	0.07
80	790	0.0057	0.017	2.067	0.217	0.006	1.841	0.016	0.015	0.1	0.07
81	800	0.0057	0.017	2.083	0.223	0.006	1.857	0.016	0.015	0.1	0.07
82	810	0.0057	0.017	2.100	0.229	0.006	1.873	0.016	0.015	0.1	0.07
83	820	0.0057	0.017	2.116	0.235	0.006	1.890	0.016	0.015	0.1	0.07
84	830	0.0057	0.017	2.133	0.241	0.006	1.906	0.016	0.015	0.1	0.07
85	840	0.0057	0.017	2.149	0.247	0.006	1.923	0.016	0.015	0.1	0.07
86	850	0.0057	0.017	2.166	0.253	0.006	1.939	0.016	0.015	0.1	0.07
87	860	0.0057	0.017	2.183	0.259	0.006	1.955	0.016	0.015	0.1	0.07
88	870	0.0057	0.017	2.199	0.265	0.006	1.972	0.016	0.015	0.1	0.07
89	880	0.0057	0.017	2.216	0.272	0.006	1.988	0.016	0.015	0.1	0.07
90	890	0.0050	0.015	2.230	0.277	0.006	2.003	0.014	0.013	0.1	0.07
91	900	0.0050	0.015	2.245	0.283	0.006	2.017	0.014	0.013	0.1	0.06
92	910	0.0050	0.015	2.259	0.288	0.006	2.031	0.014	0.013	0.1	0.06
93	920	0.0050	0.015	2.274	0.294	0.006	2.046	0.014	0.013	0.1	0.06
94	930	0.0050	0.015	2.288	0.300	0.006	2.060	0.014	0.013	0.1	0.06
95	940	0.0050	0.015	2.303	0.305	0.006	2.075	0.014	0.013	0.1	0.06
96	950	0.0050	0.015	2.317	0.311	0.006	2.089	0.014	0.013	0.1	0.06
97	960	0.0050	0.015	2.332	0.317	0.006	2.103	0.014	0.014	0.1	0.06
98	970	0.0050	0.015	2.346	0.323	0.006	2.118	0.014	0.014	0.1	0.06
99	980	0.0050	0.015	2.361	0.329	0.006	2.132	0.014	0.014	0.1	0.06
100	990	0.0050	0.015	2.375	0.335	0.006	2.147	0.014	0.014	0.1	0.06
101	1000	0.0050	0.015	2.390	0.341	0.006	2.161	0.014	0.014	0.1	0.06
102	1010	0.0040	0.012	2.401	0.346	0.005	2.173	0.012	0.011	0.0	0.06
103	1020	0.0040	0.012	2.413	0.351	0.005	2.184	0.012	0.011	0.0	0.05
104	1030	0.0040	0.012	2.424	0.355	0.005	2.196	0.012	0.011	0.0	0.05
105	1040	0.0040	0.012	2.436	0.360	0.005	2.207	0.012	0.011	0.0	0.05
106	1050	0.0040	0.012	2.448	0.365	0.005	2.219	0.012	0.011	0.0	0.05
107	1060	0.0040	0.012	2.459	0.370	0.005	2.230	0.012	0.011	0.0	0.05
108	1070	0.0040	0.012	2.471	0.375	0.005	2.242	0.012	0.011	0.0	0.05
109	1080	0.0040	0.012	2.482	0.380	0.005	2.253	0.012	0.011	0.0	0.05
110	1090	0.0040	0.012	2.494	0.385	0.005	2.265	0.012	0.011	0.0	0.05
111	1100	0.0040	0.012	2.506	0.390	0.005	2.276	0.012	0.011	0.0	0.05
112	1110	0.0040	0.012	2.517	0.395	0.005	2.288	0.012	0.011	0.0	0.05
113	1120	0.0040	0.012	2.529	0.400	0.005	2.299	0.012	0.011	0.0	0.05
114	1130	0.0040	0.012	2.540	0.406	0.005	2.311	0.012	0.011	0.0	0.05
115	1140	0.0040	0.012	2.552	0.411	0.005	2.322	0.012	0.011	0.0	0.05

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.416	0.005	2.334	0.012	0.011	0.0	0.05
117	1160	0.0040	0.012	2.575	0.421	0.005	2.346	0.012	0.011	0.0	0.05
118	1170	0.0040	0.012	2.587	0.426	0.005	2.357	0.012	0.011	0.0	0.05
119	1180	0.0040	0.012	2.598	0.432	0.005	2.369	0.012	0.011	0.0	0.05
120	1190	0.0040	0.012	2.610	0.437	0.005	2.380	0.012	0.011	0.1	0.05
121	1200	0.0040	0.012	2.622	0.442	0.005	2.392	0.012	0.011	0.1	0.05
122	1210	0.0040	0.012	2.633	0.447	0.005	2.403	0.012	0.011	0.1	0.05
123	1220	0.0040	0.012	2.645	0.453	0.005	2.415	0.012	0.011	0.1	0.05
124	1230	0.0040	0.012	2.656	0.458	0.005	2.426	0.012	0.011	0.1	0.05
125	1240	0.0040	0.012	2.668	0.464	0.005	2.438	0.012	0.011	0.1	0.05
126	1250	0.0040	0.012	2.680	0.469	0.005	2.449	0.012	0.011	0.1	0.05
127	1260	0.0040	0.012	2.691	0.474	0.005	2.461	0.012	0.011	0.1	0.05
128	1270	0.0040	0.012	2.703	0.480	0.005	2.472	0.012	0.011	0.1	0.05
129	1280	0.0040	0.012	2.714	0.485	0.005	2.484	0.012	0.011	0.1	0.05
130	1290	0.0040	0.012	2.726	0.491	0.005	2.496	0.012	0.011	0.1	0.05
131	1300	0.0040	0.012	2.738	0.496	0.006	2.507	0.012	0.011	0.1	0.05
132	1310	0.0040	0.012	2.749	0.502	0.006	2.519	0.012	0.011	0.1	0.05
133	1320	0.0040	0.012	2.761	0.507	0.006	2.530	0.012	0.011	0.1	0.05
134	1330	0.0040	0.012	2.772	0.513	0.006	2.542	0.012	0.011	0.1	0.05
135	1340	0.0040	0.012	2.784	0.519	0.006	2.553	0.012	0.011	0.1	0.05
136	1350	0.0040	0.012	2.796	0.524	0.006	2.565	0.012	0.011	0.1	0.05
137	1360	0.0040	0.012	2.807	0.530	0.006	2.576	0.012	0.011	0.1	0.05
138	1370	0.0040	0.012	2.819	0.536	0.006	2.588	0.012	0.011	0.1	0.05
139	1380	0.0040	0.012	2.830	0.541	0.006	2.599	0.012	0.011	0.1	0.05
140	1390	0.0040	0.012	2.842	0.547	0.006	2.611	0.012	0.011	0.1	0.05
141	1400	0.0040	0.012	2.854	0.553	0.006	2.623	0.012	0.011	0.1	0.05
142	1410	0.0040	0.012	2.865	0.558	0.006	2.634	0.012	0.011	0.1	0.05
143	1420	0.0040	0.012	2.877	0.564	0.006	2.646	0.012	0.011	0.1	0.05
144	1430	0.0040	0.012	2.888	0.570	0.006	2.657	0.012	0.011	0.1	0.05
145	1440	0.0040	0.012	2.900	0.576	0.006	2.669	0.012	0.011	0.1	0.05

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to Confluence Point**

Design Storm : **10-yr / 24-hr**

Given: Area = 11.29 Ac. P = 2.90 in. dt = 10 min.

PERVIOUS AREA: Area = 3.01 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 8.28 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 6.35 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 86,297 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.012	0.023	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.012	0.035	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.012	0.046	0.000	0.000	0.000	0.000	0.000	0.0	0.00
6	50	0.0040	0.012	0.058	0.000	0.000	0.001	0.001	0.001	0.1	0.03
7	60	0.0040	0.012	0.070	0.000	0.000	0.004	0.002	0.002	0.1	0.09
8	70	0.0040	0.012	0.081	0.000	0.000	0.007	0.003	0.002	0.2	0.13
9	80	0.0040	0.012	0.093	0.000	0.000	0.011	0.004	0.003	0.2	0.18
10	90	0.0040	0.012	0.104	0.000	0.000	0.015	0.005	0.003	0.2	0.21
11	100	0.0040	0.012	0.116	0.000	0.000	0.020	0.005	0.004	0.3	0.24
12	110	0.0050	0.015	0.131	0.000	0.000	0.027	0.007	0.005	0.4	0.31
13	120	0.0050	0.015	0.145	0.000	0.000	0.035	0.008	0.006	0.4	0.37
14	130	0.0050	0.015	0.160	0.000	0.000	0.044	0.008	0.006	0.4	0.41
15	140	0.0050	0.015	0.174	0.000	0.000	0.053	0.009	0.007	0.4	0.44

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.015	0.189	0.000	0.000	0.062	0.009	0.007	0.5	0.46
17	160	0.0050	0.015	0.203	0.000	0.000	0.072	0.010	0.007	0.5	0.48
18	170	0.0060	0.017	0.220	0.000	0.000	0.084	0.012	0.009	0.6	0.55
19	180	0.0060	0.017	0.238	0.000	0.000	0.097	0.013	0.009	0.6	0.62
20	190	0.0060	0.017	0.255	0.000	0.000	0.110	0.013	0.010	0.7	0.65
21	200	0.0060	0.017	0.273	0.000	0.000	0.123	0.013	0.010	0.7	0.66
22	210	0.0060	0.017	0.290	0.000	0.000	0.137	0.014	0.010	0.7	0.68
23	220	0.0060	0.017	0.307	0.000	0.000	0.151	0.014	0.010	0.7	0.69
24	230	0.0070	0.020	0.328	0.000	0.000	0.168	0.017	0.012	0.8	0.77
25	240	0.0070	0.020	0.348	0.000	0.000	0.185	0.017	0.012	0.8	0.84
26	250	0.0070	0.020	0.368	0.000	0.000	0.202	0.017	0.013	0.9	0.85
27	260	0.0070	0.020	0.389	0.000	0.000	0.219	0.017	0.013	0.9	0.87
28	270	0.0070	0.020	0.409	0.000	0.000	0.237	0.018	0.013	0.9	0.88
29	280	0.0070	0.020	0.429	0.000	0.000	0.255	0.018	0.013	0.9	0.89
30	290	0.0082	0.024	0.453	0.000	0.000	0.276	0.021	0.015	1.1	0.97
31	300	0.0082	0.024	0.477	0.000	0.000	0.297	0.021	0.016	1.1	1.06
32	310	0.0082	0.024	0.501	0.000	0.000	0.318	0.021	0.016	1.1	1.07
33	320	0.0082	0.024	0.524	0.000	0.000	0.340	0.022	0.016	1.1	1.08
34	330	0.0082	0.024	0.548	0.000	0.000	0.362	0.022	0.016	1.1	1.09
35	340	0.0082	0.024	0.572	0.000	0.000	0.384	0.022	0.016	1.1	1.09
36	350	0.0095	0.028	0.599	0.000	0.000	0.409	0.026	0.019	1.3	1.19
37	360	0.0095	0.028	0.627	0.000	0.000	0.435	0.026	0.019	1.3	1.28
38	370	0.0095	0.028	0.655	0.000	0.000	0.461	0.026	0.019	1.3	1.29
39	380	0.0095	0.028	0.682	0.000	0.000	0.486	0.026	0.019	1.3	1.29
40	390	0.0095	0.028	0.710	0.000	0.000	0.512	0.026	0.019	1.3	1.30
41	400	0.0095	0.028	0.737	0.000	0.000	0.539	0.026	0.019	1.3	1.30
42	410	0.0134	0.039	0.776	0.000	0.000	0.575	0.037	0.027	1.9	1.58
43	420	0.0134	0.039	0.815	0.000	0.000	0.613	0.037	0.027	1.9	1.85
44	430	0.0134	0.039	0.854	0.000	0.000	0.650	0.037	0.027	1.9	1.86
45	440	0.0180	0.052	0.906	0.000	0.000	0.700	0.050	0.037	2.5	2.19
46	450	0.0180	0.052	0.958	0.000	0.000	0.750	0.050	0.037	2.5	2.52
47	460	0.0340	0.099	1.057	0.003	0.003	0.846	0.096	0.071	4.8	3.68
48	470	0.0540	0.157	1.213	0.015	0.012	0.999	0.153	0.115	7.9	6.35
49	480	0.0270	0.078	1.292	0.024	0.009	1.075	0.077	0.059	4.0	5.94
50	490	0.0180	0.052	1.344	0.032	0.007	1.127	0.051	0.040	2.7	3.36
51	500	0.0134	0.039	1.383	0.038	0.006	1.165	0.038	0.030	2.0	2.36
52	510	0.0134	0.039	1.422	0.044	0.007	1.203	0.038	0.030	2.0	2.03
53	520	0.0134	0.039	1.460	0.052	0.007	1.241	0.038	0.030	2.0	2.04
54	530	0.0088	0.026	1.486	0.057	0.005	1.266	0.025	0.020	1.3	1.70
55	540	0.0088	0.026	1.511	0.062	0.005	1.291	0.025	0.020	1.4	1.35
56	550	0.0088	0.026	1.537	0.067	0.005	1.317	0.025	0.020	1.4	1.35
57	560	0.0088	0.026	1.563	0.072	0.006	1.342	0.025	0.020	1.4	1.36
58	570	0.0088	0.026	1.588	0.078	0.006	1.367	0.025	0.020	1.4	1.36
59	580	0.0088	0.026	1.614	0.084	0.006	1.392	0.025	0.020	1.4	1.37
60	590	0.0088	0.026	1.639	0.090	0.006	1.417	0.025	0.020	1.4	1.37
61	600	0.0088	0.026	1.665	0.096	0.006	1.442	0.025	0.020	1.4	1.37
62	610	0.0088	0.026	1.690	0.103	0.006	1.468	0.025	0.020	1.4	1.38
63	620	0.0088	0.026	1.716	0.109	0.007	1.493	0.025	0.020	1.4	1.38
64	630	0.0088	0.026	1.741	0.116	0.007	1.518	0.025	0.020	1.4	1.39
65	640	0.0088	0.026	1.767	0.123	0.007	1.543	0.025	0.020	1.4	1.39

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.021	1.788	0.129	0.006	1.564	0.021	0.017	1.1	1.27
67	660	0.0072	0.021	1.808	0.135	0.006	1.585	0.021	0.017	1.1	1.14
68	670	0.0072	0.021	1.829	0.141	0.006	1.605	0.021	0.017	1.1	1.14
69	680	0.0072	0.021	1.850	0.147	0.006	1.626	0.021	0.017	1.1	1.15
70	690	0.0072	0.021	1.871	0.153	0.006	1.647	0.021	0.017	1.1	1.15
71	700	0.0072	0.021	1.892	0.160	0.006	1.667	0.021	0.017	1.2	1.15
72	710	0.0072	0.021	1.913	0.166	0.006	1.688	0.021	0.017	1.2	1.15
73	720	0.0072	0.021	1.934	0.173	0.007	1.709	0.021	0.017	1.2	1.15
74	730	0.0072	0.021	1.955	0.180	0.007	1.729	0.021	0.017	1.2	1.16
75	740	0.0072	0.021	1.975	0.186	0.007	1.750	0.021	0.017	1.2	1.16
76	750	0.0072	0.021	1.996	0.193	0.007	1.771	0.021	0.017	1.2	1.16
77	760	0.0072	0.021	2.017	0.200	0.007	1.791	0.021	0.017	1.2	1.16
78	770	0.0057	0.017	2.034	0.206	0.006	1.808	0.016	0.014	0.9	1.04
79	780	0.0057	0.017	2.050	0.212	0.006	1.824	0.016	0.014	0.9	0.92
80	790	0.0057	0.017	2.067	0.217	0.006	1.841	0.016	0.014	0.9	0.92
81	800	0.0057	0.017	2.083	0.223	0.006	1.857	0.016	0.014	0.9	0.93
82	810	0.0057	0.017	2.100	0.229	0.006	1.873	0.016	0.014	0.9	0.93
83	820	0.0057	0.017	2.116	0.235	0.006	1.890	0.016	0.014	0.9	0.93
84	830	0.0057	0.017	2.133	0.241	0.006	1.906	0.016	0.014	0.9	0.93
85	840	0.0057	0.017	2.149	0.247	0.006	1.923	0.016	0.014	0.9	0.93
86	850	0.0057	0.017	2.166	0.253	0.006	1.939	0.016	0.014	0.9	0.93
87	860	0.0057	0.017	2.183	0.259	0.006	1.955	0.016	0.014	0.9	0.93
88	870	0.0057	0.017	2.199	0.265	0.006	1.972	0.016	0.014	0.9	0.93
89	880	0.0057	0.017	2.216	0.272	0.006	1.988	0.016	0.014	0.9	0.94
90	890	0.0050	0.015	2.230	0.277	0.006	2.003	0.014	0.012	0.8	0.88
91	900	0.0050	0.015	2.245	0.283	0.006	2.017	0.014	0.012	0.8	0.82
92	910	0.0050	0.015	2.259	0.288	0.006	2.031	0.014	0.012	0.8	0.82
93	920	0.0050	0.015	2.274	0.294	0.006	2.046	0.014	0.012	0.8	0.82
94	930	0.0050	0.015	2.288	0.300	0.006	2.060	0.014	0.012	0.8	0.82
95	940	0.0050	0.015	2.303	0.305	0.006	2.075	0.014	0.012	0.8	0.83
96	950	0.0050	0.015	2.317	0.311	0.006	2.089	0.014	0.012	0.8	0.83
97	960	0.0050	0.015	2.332	0.317	0.006	2.103	0.014	0.012	0.8	0.83
98	970	0.0050	0.015	2.346	0.323	0.006	2.118	0.014	0.012	0.8	0.83
99	980	0.0050	0.015	2.361	0.329	0.006	2.132	0.014	0.012	0.8	0.83
100	990	0.0050	0.015	2.375	0.335	0.006	2.147	0.014	0.012	0.8	0.83
101	1000	0.0050	0.015	2.390	0.341	0.006	2.161	0.014	0.012	0.8	0.83
102	1010	0.0040	0.012	2.401	0.346	0.005	2.173	0.012	0.010	0.7	0.75
103	1020	0.0040	0.012	2.413	0.351	0.005	2.184	0.012	0.010	0.7	0.67
104	1030	0.0040	0.012	2.424	0.355	0.005	2.196	0.012	0.010	0.7	0.67
105	1040	0.0040	0.012	2.436	0.360	0.005	2.207	0.012	0.010	0.7	0.67
106	1050	0.0040	0.012	2.448	0.365	0.005	2.219	0.012	0.010	0.7	0.67
107	1060	0.0040	0.012	2.459	0.370	0.005	2.230	0.012	0.010	0.7	0.67
108	1070	0.0040	0.012	2.471	0.375	0.005	2.242	0.012	0.010	0.7	0.67
109	1080	0.0040	0.012	2.482	0.380	0.005	2.253	0.012	0.010	0.7	0.67
110	1090	0.0040	0.012	2.494	0.385	0.005	2.265	0.012	0.010	0.7	0.67
111	1100	0.0040	0.012	2.506	0.390	0.005	2.276	0.012	0.010	0.7	0.67
112	1110	0.0040	0.012	2.517	0.395	0.005	2.288	0.012	0.010	0.7	0.67
113	1120	0.0040	0.012	2.529	0.400	0.005	2.299	0.012	0.010	0.7	0.67
114	1130	0.0040	0.012	2.540	0.406	0.005	2.311	0.012	0.010	0.7	0.67
115	1140	0.0040	0.012	2.552	0.411	0.005	2.322	0.012	0.010	0.7	0.67

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.012	2.564	0.416	0.005	2.334	0.012	0.010	0.7	0.67
117	1160	0.0040	0.012	2.575	0.421	0.005	2.346	0.012	0.010	0.7	0.67
118	1170	0.0040	0.012	2.587	0.426	0.005	2.357	0.012	0.010	0.7	0.67
119	1180	0.0040	0.012	2.598	0.432	0.005	2.369	0.012	0.010	0.7	0.67
120	1190	0.0040	0.012	2.610	0.437	0.005	2.380	0.012	0.010	0.7	0.67
121	1200	0.0040	0.012	2.622	0.442	0.005	2.392	0.012	0.010	0.7	0.67
122	1210	0.0040	0.012	2.633	0.447	0.005	2.403	0.012	0.010	0.7	0.67
123	1220	0.0040	0.012	2.645	0.453	0.005	2.415	0.012	0.010	0.7	0.67
124	1230	0.0040	0.012	2.656	0.458	0.005	2.426	0.012	0.010	0.7	0.68
125	1240	0.0040	0.012	2.668	0.464	0.005	2.438	0.012	0.010	0.7	0.68
126	1250	0.0040	0.012	2.680	0.469	0.005	2.449	0.012	0.010	0.7	0.68
127	1260	0.0040	0.012	2.691	0.474	0.005	2.461	0.012	0.010	0.7	0.68
128	1270	0.0040	0.012	2.703	0.480	0.005	2.472	0.012	0.010	0.7	0.68
129	1280	0.0040	0.012	2.714	0.485	0.005	2.484	0.012	0.010	0.7	0.68
130	1290	0.0040	0.012	2.726	0.491	0.005	2.496	0.012	0.010	0.7	0.68
131	1300	0.0040	0.012	2.738	0.496	0.006	2.507	0.012	0.010	0.7	0.68
132	1310	0.0040	0.012	2.749	0.502	0.006	2.519	0.012	0.010	0.7	0.68
133	1320	0.0040	0.012	2.761	0.507	0.006	2.530	0.012	0.010	0.7	0.68
134	1330	0.0040	0.012	2.772	0.513	0.006	2.542	0.012	0.010	0.7	0.68
135	1340	0.0040	0.012	2.784	0.519	0.006	2.553	0.012	0.010	0.7	0.68
136	1350	0.0040	0.012	2.796	0.524	0.006	2.565	0.012	0.010	0.7	0.68
137	1360	0.0040	0.012	2.807	0.530	0.006	2.576	0.012	0.010	0.7	0.68
138	1370	0.0040	0.012	2.819	0.536	0.006	2.588	0.012	0.010	0.7	0.68
139	1380	0.0040	0.012	2.830	0.541	0.006	2.599	0.012	0.010	0.7	0.68
140	1390	0.0040	0.012	2.842	0.547	0.006	2.611	0.012	0.010	0.7	0.68
141	1400	0.0040	0.012	2.854	0.553	0.006	2.623	0.012	0.010	0.7	0.68
142	1410	0.0040	0.012	2.865	0.558	0.006	2.634	0.012	0.010	0.7	0.68
143	1420	0.0040	0.012	2.877	0.564	0.006	2.646	0.012	0.010	0.7	0.68
144	1430	0.0040	0.012	2.888	0.570	0.006	2.657	0.012	0.010	0.7	0.68
145	1440	0.0040	0.012	2.900	0.576	0.006	2.669	0.012	0.010	0.7	0.68

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Headwater Basin**
Design Storm : **100-yr / 24-hr**

Given: Area = 1008.51 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 495.97 Ac. CN = 85.09 S = 1.7523 0.2S = 0.35
IMPERVIOUS AREA: Area = 512.54 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 224.71 cfs ***$T_{(Peak)}$ = 8.67 hrs***
Total Volume = 9,572,959 cf ***$Tc_{(min)}$ = 187 min***

Equations:
Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.3	0.01
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	4.9	0.14
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.002	10.1	0.52
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.002	14.4	1.13
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.003	18.0	1.92
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.003	21.0	2.83
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.004	23.6	3.85
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.004	25.8	4.93
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.006	34.9	6.26
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.006	37.3	7.81
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.006	39.5	9.40
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.007	41.3	11.02

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.007	42.8	12.63
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.007	44.2	14.24
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.009	54.5	16.07
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.009	56.0	18.11
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.009	57.3	20.12
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.010	58.4	22.08
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.010	60.3	24.02
23	220	0.0060	0.023	0.398	0.001	0.001	0.227	0.019	0.010	62.8	25.97
24	230	0.0070	0.026	0.424	0.003	0.002	0.250	0.023	0.012	76.2	28.24
25	240	0.0070	0.026	0.450	0.005	0.002	0.273	0.023	0.013	79.2	30.82
26	250	0.0070	0.026	0.476	0.008	0.003	0.296	0.023	0.013	82.0	33.41
27	260	0.0070	0.026	0.503	0.012	0.004	0.320	0.024	0.014	84.6	36.01
28	270	0.0070	0.026	0.529	0.016	0.004	0.344	0.024	0.014	87.0	38.60
29	280	0.0070	0.026	0.555	0.021	0.005	0.368	0.024	0.015	89.3	41.18
30	290	0.0082	0.031	0.586	0.028	0.006	0.396	0.028	0.018	107.4	44.16
31	300	0.0082	0.031	0.617	0.035	0.007	0.425	0.029	0.018	110.2	47.53
32	310	0.0082	0.031	0.647	0.043	0.008	0.454	0.029	0.018	112.8	50.86
33	320	0.0082	0.031	0.678	0.052	0.009	0.483	0.029	0.019	115.3	54.15
34	330	0.0082	0.031	0.709	0.061	0.009	0.512	0.029	0.019	117.7	57.40
35	340	0.0082	0.031	0.740	0.071	0.010	0.541	0.029	0.020	119.9	60.60
36	350	0.0095	0.036	0.775	0.083	0.012	0.575	0.034	0.023	141.5	64.25
37	360	0.0095	0.036	0.811	0.096	0.013	0.609	0.034	0.024	144.2	68.34
38	370	0.0095	0.036	0.846	0.109	0.014	0.643	0.034	0.024	146.7	72.36
39	380	0.0095	0.036	0.882	0.124	0.014	0.677	0.034	0.024	149.1	76.29
40	390	0.0095	0.036	0.918	0.139	0.015	0.711	0.034	0.025	151.3	80.14
41	400	0.0095	0.036	0.953	0.154	0.016	0.746	0.034	0.025	153.5	83.91
42	410	0.0134	0.050	1.004	0.177	0.023	0.794	0.049	0.036	219.9	89.26
43	420	0.0134	0.050	1.054	0.201	0.024	0.843	0.049	0.037	223.6	96.16
44	430	0.0134	0.050	1.104	0.227	0.025	0.892	0.049	0.037	227.2	102.89
45	440	0.0180	0.068	1.172	0.262	0.035	0.958	0.066	0.051	310.3	111.53
46	450	0.0180	0.068	1.239	0.299	0.037	1.024	0.066	0.052	315.7	122.02
47	460	0.0340	0.128	1.367	0.373	0.074	1.149	0.125	0.100	609.6	139.76
48	470	0.0540	0.203	1.569	0.500	0.127	1.348	0.199	0.164	998.8	174.37
49	480	0.0270	0.101	1.670	0.567	0.067	1.448	0.100	0.084	511.4	204.61
50	490	0.0180	0.068	1.738	0.613	0.046	1.515	0.067	0.057	344.9	216.26
51	500	0.0134	0.050	1.788	0.648	0.035	1.564	0.050	0.042	258.6	220.71
52	510	0.0134	0.050	1.838	0.683	0.035	1.614	0.050	0.043	260.1	222.72
53	520	0.0134	0.050	1.889	0.719	0.036	1.664	0.050	0.043	261.6	224.71
54	530	0.0088	0.033	1.922	0.743	0.024	1.697	0.033	0.028	172.5	224.31
55	540	0.0088	0.033	1.955	0.767	0.024	1.729	0.033	0.028	173.1	221.63
56	550	0.0088	0.033	1.988	0.791	0.024	1.762	0.033	0.028	173.7	219.12
57	560	0.0088	0.033	2.021	0.815	0.024	1.795	0.033	0.029	174.2	216.77
58	570	0.0088	0.033	2.054	0.839	0.024	1.827	0.033	0.029	174.8	214.57
59	580	0.0088	0.033	2.087	0.864	0.025	1.860	0.033	0.029	175.3	212.51
60	590	0.0088	0.033	2.120	0.889	0.025	1.893	0.033	0.029	175.8	210.58
61	600	0.0088	0.033	2.153	0.914	0.025	1.926	0.033	0.029	176.3	208.78
62	610	0.0088	0.033	2.186	0.939	0.025	1.958	0.033	0.029	176.7	207.10
63	620	0.0088	0.033	2.219	0.964	0.025	1.991	0.033	0.029	177.2	205.53
64	630	0.0088	0.033	2.252	0.989	0.025	2.024	0.033	0.029	177.6	204.06
65	640	0.0088	0.033	2.285	1.015	0.025	2.057	0.033	0.029	178.1	202.70

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	1.036	0.021	2.083	0.027	0.024	146.0	200.58
67	660	0.0072	0.027	2.339	1.057	0.021	2.110	0.027	0.024	146.3	197.74
68	670	0.0072	0.027	2.366	1.078	0.021	2.137	0.027	0.024	146.5	195.07
69	680	0.0072	0.027	2.393	1.099	0.021	2.164	0.027	0.024	146.8	192.55
70	690	0.0072	0.027	2.420	1.120	0.021	2.191	0.027	0.024	147.1	190.17
71	700	0.0072	0.027	2.447	1.142	0.021	2.218	0.027	0.024	147.3	187.93
72	710	0.0072	0.027	2.474	1.163	0.021	2.244	0.027	0.024	147.6	185.82
73	720	0.0072	0.027	2.501	1.185	0.022	2.271	0.027	0.024	147.8	183.84
74	730	0.0072	0.027	2.528	1.206	0.022	2.298	0.027	0.024	148.0	181.96
75	740	0.0072	0.027	2.555	1.228	0.022	2.325	0.027	0.024	148.3	180.20
76	750	0.0072	0.027	2.582	1.250	0.022	2.352	0.027	0.024	148.5	178.55
77	760	0.0072	0.027	2.609	1.271	0.022	2.379	0.027	0.024	148.7	176.99
78	770	0.0057	0.021	2.630	1.289	0.017	2.400	0.021	0.019	117.9	174.71
79	780	0.0057	0.021	2.651	1.306	0.017	2.421	0.021	0.019	118.0	171.75
80	790	0.0057	0.021	2.673	1.323	0.017	2.442	0.021	0.019	118.1	168.96
81	800	0.0057	0.021	2.694	1.341	0.017	2.464	0.021	0.019	118.3	166.32
82	810	0.0057	0.021	2.715	1.358	0.017	2.485	0.021	0.019	118.4	163.82
83	820	0.0057	0.021	2.737	1.376	0.018	2.506	0.021	0.019	118.5	161.45
84	830	0.0057	0.021	2.758	1.394	0.018	2.527	0.021	0.019	118.7	159.22
85	840	0.0057	0.021	2.780	1.411	0.018	2.549	0.021	0.019	118.8	157.11
86	850	0.0057	0.021	2.801	1.429	0.018	2.570	0.021	0.019	118.9	155.12
87	860	0.0057	0.021	2.822	1.446	0.018	2.591	0.021	0.020	119.0	153.24
88	870	0.0057	0.021	2.844	1.464	0.018	2.613	0.021	0.020	119.1	151.46
89	880	0.0057	0.021	2.865	1.482	0.018	2.634	0.021	0.020	119.2	149.78
90	890	0.0050	0.019	2.884	1.497	0.016	2.653	0.019	0.017	104.7	147.81
91	900	0.0050	0.019	2.903	1.513	0.016	2.671	0.019	0.017	104.8	145.56
92	910	0.0050	0.019	2.921	1.529	0.016	2.690	0.019	0.017	104.9	143.44
93	920	0.0050	0.019	2.940	1.544	0.016	2.709	0.019	0.017	104.9	141.43
94	930	0.0050	0.019	2.959	1.560	0.016	2.727	0.019	0.017	105.0	139.54
95	940	0.0050	0.019	2.978	1.576	0.016	2.746	0.019	0.017	105.1	137.74
96	950	0.0050	0.019	2.996	1.592	0.016	2.765	0.019	0.017	105.2	136.04
97	960	0.0050	0.019	3.015	1.607	0.016	2.783	0.019	0.017	105.3	134.44
98	970	0.0050	0.019	3.034	1.623	0.016	2.802	0.019	0.017	105.3	132.92
99	980	0.0050	0.019	3.053	1.639	0.016	2.821	0.019	0.017	105.4	131.49
100	990	0.0050	0.019	3.071	1.655	0.016	2.839	0.019	0.017	105.5	130.13
101	1000	0.0050	0.019	3.090	1.671	0.016	2.858	0.019	0.017	105.6	128.85
102	1010	0.0040	0.015	3.105	1.684	0.013	2.873	0.015	0.014	84.5	127.09
103	1020	0.0040	0.015	3.120	1.696	0.013	2.888	0.015	0.014	84.6	124.87
104	1030	0.0040	0.015	3.135	1.709	0.013	2.903	0.015	0.014	84.6	122.78
105	1040	0.0040	0.015	3.150	1.722	0.013	2.918	0.015	0.014	84.7	120.79
106	1050	0.0040	0.015	3.165	1.735	0.013	2.933	0.015	0.014	84.7	118.91
107	1060	0.0040	0.015	3.180	1.747	0.013	2.948	0.015	0.014	84.7	117.13
108	1070	0.0040	0.015	3.195	1.760	0.013	2.963	0.015	0.014	84.8	115.44
109	1080	0.0040	0.015	3.210	1.773	0.013	2.977	0.015	0.014	84.8	113.85
110	1090	0.0040	0.015	3.225	1.786	0.013	2.992	0.015	0.014	84.9	112.34
111	1100	0.0040	0.015	3.240	1.799	0.013	3.007	0.015	0.014	84.9	110.91
112	1110	0.0040	0.015	3.255	1.812	0.013	3.022	0.015	0.014	85.0	109.55
113	1120	0.0040	0.015	3.270	1.825	0.013	3.037	0.015	0.014	85.0	108.27
114	1130	0.0040	0.015	3.285	1.837	0.013	3.052	0.015	0.014	85.0	107.06
115	1140	0.0040	0.015	3.300	1.850	0.013	3.067	0.015	0.014	85.1	105.92

SBUH Runoff Hydrograph - Headwater Basin

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	1.863	0.013	3.082	0.015	0.014	85.1	104.83
117	1160	0.0040	0.015	3.330	1.876	0.013	3.097	0.015	0.014	85.2	103.81
118	1170	0.0040	0.015	3.345	1.889	0.013	3.112	0.015	0.014	85.2	102.84
119	1180	0.0040	0.015	3.360	1.902	0.013	3.127	0.015	0.014	85.3	101.92
120	1190	0.0040	0.015	3.375	1.915	0.013	3.142	0.015	0.014	85.3	101.06
121	1200	0.0040	0.015	3.390	1.928	0.013	3.157	0.015	0.014	85.3	100.24
122	1210	0.0040	0.015	3.405	1.941	0.013	3.172	0.015	0.014	85.4	99.46
123	1220	0.0040	0.015	3.420	1.954	0.013	3.187	0.015	0.014	85.4	98.73
124	1230	0.0040	0.015	3.435	1.967	0.013	3.202	0.015	0.014	85.4	98.03
125	1240	0.0040	0.015	3.450	1.980	0.013	3.217	0.015	0.014	85.5	97.38
126	1250	0.0040	0.015	3.465	1.993	0.013	3.232	0.015	0.014	85.5	96.76
127	1260	0.0040	0.015	3.480	2.006	0.013	3.247	0.015	0.014	85.6	96.18
128	1270	0.0040	0.015	3.495	2.019	0.013	3.261	0.015	0.014	85.6	95.62
129	1280	0.0040	0.015	3.510	2.032	0.013	3.276	0.015	0.014	85.6	95.10
130	1290	0.0040	0.015	3.525	2.045	0.013	3.291	0.015	0.014	85.7	94.61
131	1300	0.0040	0.015	3.540	2.059	0.013	3.306	0.015	0.014	85.7	94.15
132	1310	0.0040	0.015	3.555	2.072	0.013	3.321	0.015	0.014	85.7	93.71
133	1320	0.0040	0.015	3.570	2.085	0.013	3.336	0.015	0.014	85.8	93.29
134	1330	0.0040	0.015	3.585	2.098	0.013	3.351	0.015	0.014	85.8	92.90
135	1340	0.0040	0.015	3.600	2.111	0.013	3.366	0.015	0.014	85.8	92.53
136	1350	0.0040	0.015	3.615	2.124	0.013	3.381	0.015	0.014	85.9	92.19
137	1360	0.0040	0.015	3.630	2.137	0.013	3.396	0.015	0.014	85.9	91.86
138	1370	0.0040	0.015	3.645	2.151	0.013	3.411	0.015	0.014	85.9	91.55
139	1380	0.0040	0.015	3.660	2.164	0.013	3.426	0.015	0.014	86.0	91.26
140	1390	0.0040	0.015	3.675	2.177	0.013	3.441	0.015	0.014	86.0	90.99
141	1400	0.0040	0.015	3.690	2.190	0.013	3.456	0.015	0.014	86.0	90.73
142	1410	0.0040	0.015	3.705	2.204	0.013	3.471	0.015	0.014	86.1	90.48
143	1420	0.0040	0.015	3.720	2.217	0.013	3.486	0.015	0.014	86.1	90.26
144	1430	0.0040	0.015	3.735	2.230	0.013	3.501	0.015	0.014	86.1	90.04
145	1440	0.0040	0.015	3.750	2.243	0.013	3.516	0.015	0.014	86.2	89.84

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 74th Ave Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 136.59 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 49.93 Ac. CN = 79.20 S = 2.6263 0.2S = 0.53

IMPERVIOUS AREA: Area = 86.66 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 187 Min. w = 0.026042

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 30.31 cfs ***$T_{(Peak)}$ = 8.67 hrs***

Total Volume = 1,294,331 cf ***$Tc_{(min)}$ = 187 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.026

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.8	0.02
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.002	1.7	0.09
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.003	2.4	0.19
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.004	3.0	0.32
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.004	3.6	0.48
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.005	4.0	0.65
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.005	4.4	0.83
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.007	5.9	1.06
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.008	6.3	1.32
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.008	6.7	1.59
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.008	7.0	1.86

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.009	7.2	2.14
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.009	7.5	2.41
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.011	9.2	2.72
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.011	9.5	3.06
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.012	9.7	3.40
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.012	9.9	3.73
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.012	10.0	4.06
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.012	10.2	4.37
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.015	12.0	4.72
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.015	12.2	5.11
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.015	12.3	5.48
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.015	12.4	5.84
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.015	12.5	6.18
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.015	12.7	6.52
30	290	0.0082	0.031	0.586	0.001	0.001	0.396	0.028	0.018	15.2	6.90
31	300	0.0082	0.031	0.617	0.003	0.002	0.425	0.029	0.019	15.5	7.34
32	310	0.0082	0.031	0.647	0.005	0.002	0.454	0.029	0.019	15.8	7.77
33	320	0.0082	0.031	0.678	0.008	0.003	0.483	0.029	0.019	16.0	8.20
34	330	0.0082	0.031	0.709	0.012	0.004	0.512	0.029	0.020	16.3	8.61
35	340	0.0082	0.031	0.740	0.016	0.004	0.541	0.029	0.020	16.5	9.02
36	350	0.0095	0.036	0.775	0.022	0.006	0.575	0.034	0.024	19.4	9.49
37	360	0.0095	0.036	0.811	0.028	0.006	0.609	0.034	0.024	19.7	10.01
38	370	0.0095	0.036	0.846	0.035	0.007	0.643	0.034	0.024	20.0	10.52
39	380	0.0095	0.036	0.882	0.043	0.008	0.677	0.034	0.025	20.3	11.02
40	390	0.0095	0.036	0.918	0.051	0.008	0.711	0.034	0.025	20.5	11.51
41	400	0.0095	0.036	0.953	0.060	0.009	0.746	0.034	0.025	20.7	11.99
42	410	0.0134	0.050	1.004	0.074	0.014	0.794	0.049	0.036	29.6	12.67
43	420	0.0134	0.050	1.054	0.089	0.015	0.843	0.049	0.036	30.1	13.57
44	430	0.0134	0.050	1.104	0.105	0.016	0.892	0.049	0.037	30.5	14.44
45	440	0.0180	0.068	1.172	0.128	0.023	0.958	0.066	0.050	41.5	15.56
46	450	0.0180	0.068	1.239	0.153	0.025	1.024	0.066	0.051	42.1	16.93
47	460	0.0340	0.128	1.367	0.204	0.052	1.149	0.125	0.098	81.1	19.26
48	470	0.0540	0.203	1.569	0.297	0.093	1.348	0.199	0.160	132.5	23.82
49	480	0.0270	0.101	1.670	0.348	0.051	1.448	0.100	0.082	67.7	27.79
50	490	0.0180	0.068	1.738	0.383	0.035	1.515	0.067	0.055	45.6	29.30
51	500	0.0134	0.050	1.788	0.410	0.027	1.564	0.050	0.041	34.2	29.85
52	510	0.0134	0.050	1.838	0.438	0.028	1.614	0.050	0.042	34.4	30.08
53	520	0.0134	0.050	1.889	0.466	0.028	1.664	0.050	0.042	34.6	30.31
54	530	0.0088	0.033	1.922	0.485	0.019	1.697	0.033	0.028	22.8	30.23
55	540	0.0088	0.033	1.955	0.504	0.019	1.729	0.033	0.028	22.9	29.84
56	550	0.0088	0.033	1.988	0.523	0.019	1.762	0.033	0.028	23.0	29.48
57	560	0.0088	0.033	2.021	0.542	0.019	1.795	0.033	0.028	23.0	29.15
58	570	0.0088	0.033	2.054	0.562	0.020	1.827	0.033	0.028	23.1	28.83
59	580	0.0088	0.033	2.087	0.582	0.020	1.860	0.033	0.028	23.2	28.53
60	590	0.0088	0.033	2.120	0.602	0.020	1.893	0.033	0.028	23.2	28.26
61	600	0.0088	0.033	2.153	0.623	0.020	1.926	0.033	0.028	23.3	28.00
62	610	0.0088	0.033	2.186	0.643	0.021	1.958	0.033	0.028	23.4	27.75
63	620	0.0088	0.033	2.219	0.664	0.021	1.991	0.033	0.028	23.4	27.53
64	630	0.0088	0.033	2.252	0.685	0.021	2.024	0.033	0.028	23.5	27.32
65	640	0.0088	0.033	2.285	0.706	0.021	2.057	0.033	0.028	23.5	27.12

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.723	0.017	2.083	0.027	0.023	19.3	26.82
67	660	0.0072	0.027	2.339	0.741	0.017	2.110	0.027	0.023	19.3	26.43
68	670	0.0072	0.027	2.366	0.758	0.018	2.137	0.027	0.023	19.4	26.06
69	680	0.0072	0.027	2.393	0.776	0.018	2.164	0.027	0.023	19.4	25.72
70	690	0.0072	0.027	2.420	0.794	0.018	2.191	0.027	0.024	19.5	25.39
71	700	0.0072	0.027	2.447	0.812	0.018	2.218	0.027	0.024	19.5	25.08
72	710	0.0072	0.027	2.474	0.830	0.018	2.244	0.027	0.024	19.5	24.79
73	720	0.0072	0.027	2.501	0.848	0.018	2.271	0.027	0.024	19.6	24.52
74	730	0.0072	0.027	2.528	0.866	0.018	2.298	0.027	0.024	19.6	24.26
75	740	0.0072	0.027	2.555	0.885	0.018	2.325	0.027	0.024	19.6	24.02
76	750	0.0072	0.027	2.582	0.903	0.018	2.352	0.027	0.024	19.7	23.79
77	760	0.0072	0.027	2.609	0.922	0.019	2.379	0.027	0.024	19.7	23.57
78	770	0.0057	0.021	2.630	0.936	0.015	2.400	0.021	0.019	15.6	23.26
79	780	0.0057	0.021	2.651	0.951	0.015	2.421	0.021	0.019	15.6	22.87
80	790	0.0057	0.021	2.673	0.966	0.015	2.442	0.021	0.019	15.6	22.49
81	800	0.0057	0.021	2.694	0.981	0.015	2.464	0.021	0.019	15.7	22.13
82	810	0.0057	0.021	2.715	0.996	0.015	2.485	0.021	0.019	15.7	21.80
83	820	0.0057	0.021	2.737	1.011	0.015	2.506	0.021	0.019	15.7	21.48
84	830	0.0057	0.021	2.758	1.026	0.015	2.527	0.021	0.019	15.7	21.18
85	840	0.0057	0.021	2.780	1.041	0.015	2.549	0.021	0.019	15.7	20.89
86	850	0.0057	0.021	2.801	1.056	0.015	2.570	0.021	0.019	15.7	20.63
87	860	0.0057	0.021	2.822	1.072	0.015	2.591	0.021	0.019	15.8	20.37
88	870	0.0057	0.021	2.844	1.087	0.015	2.613	0.021	0.019	15.8	20.13
89	880	0.0057	0.021	2.865	1.102	0.015	2.634	0.021	0.019	15.8	19.91
90	890	0.0050	0.019	2.884	1.116	0.014	2.653	0.019	0.017	13.9	19.64
91	900	0.0050	0.019	2.903	1.129	0.014	2.671	0.019	0.017	13.9	19.34
92	910	0.0050	0.019	2.921	1.143	0.014	2.690	0.019	0.017	13.9	19.06
93	920	0.0050	0.019	2.940	1.157	0.014	2.709	0.019	0.017	13.9	18.79
94	930	0.0050	0.019	2.959	1.170	0.014	2.727	0.019	0.017	13.9	18.54
95	940	0.0050	0.019	2.978	1.184	0.014	2.746	0.019	0.017	13.9	18.30
96	950	0.0050	0.019	2.996	1.198	0.014	2.765	0.019	0.017	13.9	18.07
97	960	0.0050	0.019	3.015	1.212	0.014	2.783	0.019	0.017	14.0	17.85
98	970	0.0050	0.019	3.034	1.225	0.014	2.802	0.019	0.017	14.0	17.65
99	980	0.0050	0.019	3.053	1.239	0.014	2.821	0.019	0.017	14.0	17.46
100	990	0.0050	0.019	3.071	1.253	0.014	2.839	0.019	0.017	14.0	17.28
101	1000	0.0050	0.019	3.090	1.267	0.014	2.858	0.019	0.017	14.0	17.11
102	1010	0.0040	0.015	3.105	1.278	0.011	2.873	0.015	0.014	11.2	16.87
103	1020	0.0040	0.015	3.120	1.290	0.011	2.888	0.015	0.014	11.2	16.58
104	1030	0.0040	0.015	3.135	1.301	0.011	2.903	0.015	0.014	11.2	16.30
105	1040	0.0040	0.015	3.150	1.312	0.011	2.918	0.015	0.014	11.2	16.03
106	1050	0.0040	0.015	3.165	1.323	0.011	2.933	0.015	0.014	11.2	15.78
107	1060	0.0040	0.015	3.180	1.335	0.011	2.948	0.015	0.014	11.2	15.55
108	1070	0.0040	0.015	3.195	1.346	0.011	2.963	0.015	0.014	11.2	15.32
109	1080	0.0040	0.015	3.210	1.357	0.011	2.977	0.015	0.014	11.3	15.11
110	1090	0.0040	0.015	3.225	1.368	0.011	2.992	0.015	0.014	11.3	14.91
111	1100	0.0040	0.015	3.240	1.380	0.011	3.007	0.015	0.014	11.3	14.72
112	1110	0.0040	0.015	3.255	1.391	0.011	3.022	0.015	0.014	11.3	14.54
113	1120	0.0040	0.015	3.270	1.403	0.011	3.037	0.015	0.014	11.3	14.37
114	1130	0.0040	0.015	3.285	1.414	0.011	3.052	0.015	0.014	11.3	14.21
115	1140	0.0040	0.015	3.300	1.426	0.011	3.067	0.015	0.014	11.3	14.06

SBUH Runoff Hydrograph - Tributary to 74th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	1.437	0.011	3.082	0.015	0.014	11.3	13.91
117	1160	0.0040	0.015	3.330	1.448	0.011	3.097	0.015	0.014	11.3	13.78
118	1170	0.0040	0.015	3.345	1.460	0.012	3.112	0.015	0.014	11.3	13.65
119	1180	0.0040	0.015	3.360	1.471	0.012	3.127	0.015	0.014	11.3	13.53
120	1190	0.0040	0.015	3.375	1.483	0.012	3.142	0.015	0.014	11.3	13.41
121	1200	0.0040	0.015	3.390	1.495	0.012	3.157	0.015	0.014	11.3	13.30
122	1210	0.0040	0.015	3.405	1.506	0.012	3.172	0.015	0.014	11.3	13.20
123	1220	0.0040	0.015	3.420	1.518	0.012	3.187	0.015	0.014	11.3	13.11
124	1230	0.0040	0.015	3.435	1.529	0.012	3.202	0.015	0.014	11.3	13.01
125	1240	0.0040	0.015	3.450	1.541	0.012	3.217	0.015	0.014	11.4	12.93
126	1250	0.0040	0.015	3.465	1.553	0.012	3.232	0.015	0.014	11.4	12.85
127	1260	0.0040	0.015	3.480	1.564	0.012	3.247	0.015	0.014	11.4	12.77
128	1270	0.0040	0.015	3.495	1.576	0.012	3.261	0.015	0.014	11.4	12.69
129	1280	0.0040	0.015	3.510	1.588	0.012	3.276	0.015	0.014	11.4	12.63
130	1290	0.0040	0.015	3.525	1.599	0.012	3.291	0.015	0.014	11.4	12.56
131	1300	0.0040	0.015	3.540	1.611	0.012	3.306	0.015	0.014	11.4	12.50
132	1310	0.0040	0.015	3.555	1.623	0.012	3.321	0.015	0.014	11.4	12.44
133	1320	0.0040	0.015	3.570	1.635	0.012	3.336	0.015	0.014	11.4	12.39
134	1330	0.0040	0.015	3.585	1.647	0.012	3.351	0.015	0.014	11.4	12.34
135	1340	0.0040	0.015	3.600	1.658	0.012	3.366	0.015	0.014	11.4	12.29
136	1350	0.0040	0.015	3.615	1.670	0.012	3.381	0.015	0.014	11.4	12.24
137	1360	0.0040	0.015	3.630	1.682	0.012	3.396	0.015	0.014	11.4	12.20
138	1370	0.0040	0.015	3.645	1.694	0.012	3.411	0.015	0.014	11.4	12.16
139	1380	0.0040	0.015	3.660	1.706	0.012	3.426	0.015	0.014	11.4	12.12
140	1390	0.0040	0.015	3.675	1.718	0.012	3.441	0.015	0.014	11.4	12.08
141	1400	0.0040	0.015	3.690	1.730	0.012	3.456	0.015	0.014	11.4	12.05
142	1410	0.0040	0.015	3.705	1.741	0.012	3.471	0.015	0.014	11.4	12.02
143	1420	0.0040	0.015	3.720	1.753	0.012	3.486	0.015	0.014	11.4	11.99
144	1430	0.0040	0.015	3.735	1.765	0.012	3.501	0.015	0.014	11.5	11.96
145	1440	0.0040	0.015	3.750	1.777	0.012	3.516	0.015	0.014	11.5	11.93

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 71st Ave Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 38.83 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 3.89 Ac. CN = 79.20 S = 2.6263 0.2S = 0.53

IMPERVIOUS AREA: Area = 34.94 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 63 Min. w = 0.073529

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 17.72 cfs ***$T_{(Peak)}$ = 8.17 hrs***

Total Volume = 457,995 cf ***$Tc_{(min)}$ = 63 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.074

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.3	0.03
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.003	0.7	0.10
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.004	1.0	0.21
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.005	1.2	0.34
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.006	1.4	0.48
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.007	1.6	0.64
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.007	1.8	0.79
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.010	2.4	0.98
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.011	2.5	1.20
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.011	2.7	1.41
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.012	2.8	1.60

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.012	2.9	1.79
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.013	3.0	1.96
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.016	3.7	2.17
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.016	3.8	2.40
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.017	3.9	2.62
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.017	4.0	2.81
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.017	4.0	2.99
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.017	4.1	3.15
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.021	4.8	3.34
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.021	4.9	3.57
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.021	5.0	3.77
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.021	5.0	3.95
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.021	5.0	4.11
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.022	5.1	4.25
30	290	0.0082	0.031	0.586	0.001	0.001	0.396	0.028	0.026	6.0	4.44
31	300	0.0082	0.031	0.617	0.003	0.002	0.425	0.029	0.026	6.1	4.68
32	310	0.0082	0.031	0.647	0.005	0.002	0.454	0.029	0.026	6.1	4.89
33	320	0.0082	0.031	0.678	0.008	0.003	0.483	0.029	0.026	6.2	5.07
34	330	0.0082	0.031	0.709	0.012	0.004	0.512	0.029	0.026	6.2	5.24
35	340	0.0082	0.031	0.740	0.016	0.004	0.541	0.029	0.027	6.3	5.38
36	350	0.0095	0.036	0.775	0.022	0.006	0.575	0.034	0.031	7.3	5.59
37	360	0.0095	0.036	0.811	0.028	0.006	0.609	0.034	0.031	7.3	5.84
38	370	0.0095	0.036	0.846	0.035	0.007	0.643	0.034	0.031	7.4	6.06
39	380	0.0095	0.036	0.882	0.043	0.008	0.677	0.034	0.032	7.4	6.26
40	390	0.0095	0.036	0.918	0.051	0.008	0.711	0.034	0.032	7.4	6.43
41	400	0.0095	0.036	0.953	0.060	0.009	0.746	0.034	0.032	7.5	6.58
42	410	0.0134	0.050	1.004	0.074	0.014	0.794	0.049	0.045	10.6	6.95
43	420	0.0134	0.050	1.054	0.089	0.015	0.843	0.049	0.045	10.7	7.49
44	430	0.0134	0.050	1.104	0.105	0.016	0.892	0.049	0.046	10.7	7.96
45	440	0.0180	0.068	1.172	0.128	0.023	0.958	0.066	0.062	14.5	8.64
46	450	0.0180	0.068	1.239	0.153	0.025	1.024	0.066	0.062	14.5	9.50
47	460	0.0340	0.128	1.367	0.204	0.052	1.149	0.125	0.118	27.6	11.21
48	470	0.0540	0.203	1.569	0.297	0.093	1.348	0.199	0.189	44.3	14.85
49	480	0.0270	0.101	1.670	0.348	0.051	1.448	0.100	0.095	22.3	17.56
50	490	0.0180	0.068	1.738	0.383	0.035	1.515	0.067	0.064	14.9	17.72
51	500	0.0134	0.050	1.788	0.410	0.027	1.564	0.050	0.047	11.1	17.03
52	510	0.0134	0.050	1.838	0.438	0.028	1.614	0.050	0.048	11.2	16.17
53	520	0.0134	0.050	1.889	0.466	0.028	1.664	0.050	0.048	11.2	15.43
54	530	0.0088	0.033	1.922	0.485	0.019	1.697	0.033	0.031	7.4	14.52
55	540	0.0088	0.033	1.955	0.504	0.019	1.729	0.033	0.031	7.4	13.47
56	550	0.0088	0.033	1.988	0.523	0.019	1.762	0.033	0.031	7.4	12.57
57	560	0.0088	0.033	2.021	0.542	0.019	1.795	0.033	0.031	7.4	11.81
58	570	0.0088	0.033	2.054	0.562	0.020	1.827	0.033	0.031	7.4	11.16
59	580	0.0088	0.033	2.087	0.582	0.020	1.860	0.033	0.031	7.4	10.60
60	590	0.0088	0.033	2.120	0.602	0.020	1.893	0.033	0.031	7.4	10.13
61	600	0.0088	0.033	2.153	0.623	0.020	1.926	0.033	0.031	7.4	9.73
62	610	0.0088	0.033	2.186	0.643	0.021	1.958	0.033	0.032	7.4	9.38
63	620	0.0088	0.033	2.219	0.664	0.021	1.991	0.033	0.032	7.4	9.09
64	630	0.0088	0.033	2.252	0.685	0.021	2.024	0.033	0.032	7.4	8.85
65	640	0.0088	0.033	2.285	0.706	0.021	2.057	0.033	0.032	7.4	8.64

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.723	0.017	2.083	0.027	0.026	6.1	8.36
67	660	0.0072	0.027	2.339	0.741	0.017	2.110	0.027	0.026	6.1	8.02
68	670	0.0072	0.027	2.366	0.758	0.018	2.137	0.027	0.026	6.1	7.74
69	680	0.0072	0.027	2.393	0.776	0.018	2.164	0.027	0.026	6.1	7.50
70	690	0.0072	0.027	2.420	0.794	0.018	2.191	0.027	0.026	6.1	7.29
71	700	0.0072	0.027	2.447	0.812	0.018	2.218	0.027	0.026	6.1	7.11
72	710	0.0072	0.027	2.474	0.830	0.018	2.244	0.027	0.026	6.1	6.96
73	720	0.0072	0.027	2.501	0.848	0.018	2.271	0.027	0.026	6.1	6.84
74	730	0.0072	0.027	2.528	0.866	0.018	2.298	0.027	0.026	6.1	6.73
75	740	0.0072	0.027	2.555	0.885	0.018	2.325	0.027	0.026	6.1	6.64
76	750	0.0072	0.027	2.582	0.903	0.018	2.352	0.027	0.026	6.1	6.56
77	760	0.0072	0.027	2.609	0.922	0.019	2.379	0.027	0.026	6.1	6.49
78	770	0.0057	0.021	2.630	0.936	0.015	2.400	0.021	0.021	4.8	6.34
79	780	0.0057	0.021	2.651	0.951	0.015	2.421	0.021	0.021	4.8	6.12
80	790	0.0057	0.021	2.673	0.966	0.015	2.442	0.021	0.021	4.8	5.93
81	800	0.0057	0.021	2.694	0.981	0.015	2.464	0.021	0.021	4.8	5.77
82	810	0.0057	0.021	2.715	0.996	0.015	2.485	0.021	0.021	4.8	5.64
83	820	0.0057	0.021	2.737	1.011	0.015	2.506	0.021	0.021	4.8	5.52
84	830	0.0057	0.021	2.758	1.026	0.015	2.527	0.021	0.021	4.9	5.42
85	840	0.0057	0.021	2.780	1.041	0.015	2.549	0.021	0.021	4.9	5.34
86	850	0.0057	0.021	2.801	1.056	0.015	2.570	0.021	0.021	4.9	5.27
87	860	0.0057	0.021	2.822	1.072	0.015	2.591	0.021	0.021	4.9	5.21
88	870	0.0057	0.021	2.844	1.087	0.015	2.613	0.021	0.021	4.9	5.16
89	880	0.0057	0.021	2.865	1.102	0.015	2.634	0.021	0.021	4.9	5.11
90	890	0.0050	0.019	2.884	1.116	0.014	2.653	0.019	0.018	4.3	5.03
91	900	0.0050	0.019	2.903	1.129	0.014	2.671	0.019	0.018	4.3	4.92
92	910	0.0050	0.019	2.921	1.143	0.014	2.690	0.019	0.018	4.3	4.82
93	920	0.0050	0.019	2.940	1.157	0.014	2.709	0.019	0.018	4.3	4.74
94	930	0.0050	0.019	2.959	1.170	0.014	2.727	0.019	0.018	4.3	4.67
95	940	0.0050	0.019	2.978	1.184	0.014	2.746	0.019	0.018	4.3	4.61
96	950	0.0050	0.019	2.996	1.198	0.014	2.765	0.019	0.018	4.3	4.56
97	960	0.0050	0.019	3.015	1.212	0.014	2.783	0.019	0.018	4.3	4.52
98	970	0.0050	0.019	3.034	1.225	0.014	2.802	0.019	0.018	4.3	4.48
99	980	0.0050	0.019	3.053	1.239	0.014	2.821	0.019	0.018	4.3	4.45
100	990	0.0050	0.019	3.071	1.253	0.014	2.839	0.019	0.018	4.3	4.43
101	1000	0.0050	0.019	3.090	1.267	0.014	2.858	0.019	0.018	4.3	4.40
102	1010	0.0040	0.015	3.105	1.278	0.011	2.873	0.015	0.015	3.4	4.32
103	1020	0.0040	0.015	3.120	1.290	0.011	2.888	0.015	0.015	3.4	4.19
104	1030	0.0040	0.015	3.135	1.301	0.011	2.903	0.015	0.015	3.4	4.08
105	1040	0.0040	0.015	3.150	1.312	0.011	2.918	0.015	0.015	3.4	3.98
106	1050	0.0040	0.015	3.165	1.323	0.011	2.933	0.015	0.015	3.4	3.90
107	1060	0.0040	0.015	3.180	1.335	0.011	2.948	0.015	0.015	3.4	3.83
108	1070	0.0040	0.015	3.195	1.346	0.011	2.963	0.015	0.015	3.4	3.77
109	1080	0.0040	0.015	3.210	1.357	0.011	2.977	0.015	0.015	3.4	3.72
110	1090	0.0040	0.015	3.225	1.368	0.011	2.992	0.015	0.015	3.4	3.68
111	1100	0.0040	0.015	3.240	1.380	0.011	3.007	0.015	0.015	3.4	3.64
112	1110	0.0040	0.015	3.255	1.391	0.011	3.022	0.015	0.015	3.4	3.61
113	1120	0.0040	0.015	3.270	1.403	0.011	3.037	0.015	0.015	3.4	3.58
114	1130	0.0040	0.015	3.285	1.414	0.011	3.052	0.015	0.015	3.4	3.56
115	1140	0.0040	0.015	3.300	1.426	0.011	3.067	0.015	0.015	3.4	3.54

SBUH Runoff Hydrograph - Tributary to 71st Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	1.437	0.011	3.082	0.015	0.015	3.4	3.52
117	1160	0.0040	0.015	3.330	1.448	0.011	3.097	0.015	0.015	3.4	3.51
118	1170	0.0040	0.015	3.345	1.460	0.012	3.112	0.015	0.015	3.4	3.50
119	1180	0.0040	0.015	3.360	1.471	0.012	3.127	0.015	0.015	3.4	3.49
120	1190	0.0040	0.015	3.375	1.483	0.012	3.142	0.015	0.015	3.4	3.48
121	1200	0.0040	0.015	3.390	1.495	0.012	3.157	0.015	0.015	3.4	3.47
122	1210	0.0040	0.015	3.405	1.506	0.012	3.172	0.015	0.015	3.4	3.47
123	1220	0.0040	0.015	3.420	1.518	0.012	3.187	0.015	0.015	3.4	3.46
124	1230	0.0040	0.015	3.435	1.529	0.012	3.202	0.015	0.015	3.4	3.46
125	1240	0.0040	0.015	3.450	1.541	0.012	3.217	0.015	0.015	3.4	3.45
126	1250	0.0040	0.015	3.465	1.553	0.012	3.232	0.015	0.015	3.4	3.45
127	1260	0.0040	0.015	3.480	1.564	0.012	3.247	0.015	0.015	3.4	3.45
128	1270	0.0040	0.015	3.495	1.576	0.012	3.261	0.015	0.015	3.4	3.45
129	1280	0.0040	0.015	3.510	1.588	0.012	3.276	0.015	0.015	3.4	3.45
130	1290	0.0040	0.015	3.525	1.599	0.012	3.291	0.015	0.015	3.4	3.44
131	1300	0.0040	0.015	3.540	1.611	0.012	3.306	0.015	0.015	3.4	3.44
132	1310	0.0040	0.015	3.555	1.623	0.012	3.321	0.015	0.015	3.4	3.44
133	1320	0.0040	0.015	3.570	1.635	0.012	3.336	0.015	0.015	3.4	3.44
134	1330	0.0040	0.015	3.585	1.647	0.012	3.351	0.015	0.015	3.4	3.44
135	1340	0.0040	0.015	3.600	1.658	0.012	3.366	0.015	0.015	3.4	3.44
136	1350	0.0040	0.015	3.615	1.670	0.012	3.381	0.015	0.015	3.4	3.44
137	1360	0.0040	0.015	3.630	1.682	0.012	3.396	0.015	0.015	3.4	3.44
138	1370	0.0040	0.015	3.645	1.694	0.012	3.411	0.015	0.015	3.4	3.44
139	1380	0.0040	0.015	3.660	1.706	0.012	3.426	0.015	0.015	3.4	3.44
140	1390	0.0040	0.015	3.675	1.718	0.012	3.441	0.015	0.015	3.4	3.44
141	1400	0.0040	0.015	3.690	1.730	0.012	3.456	0.015	0.015	3.4	3.44
142	1410	0.0040	0.015	3.705	1.741	0.012	3.471	0.015	0.015	3.4	3.44
143	1420	0.0040	0.015	3.720	1.753	0.012	3.486	0.015	0.015	3.4	3.44
144	1430	0.0040	0.015	3.735	1.765	0.012	3.501	0.015	0.015	3.4	3.44
145	1440	0.0040	0.015	3.750	1.777	0.012	3.516	0.015	0.015	3.4	3.44

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 204th St Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 17.56 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 1.76 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 15.80 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 33 Min. w = 0.131579

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 10.20 cfs ***$T_{(Peak)}$ = 8.00 hrs***

Total Volume = 205,328 cf ***$Tc_{(min)}$ = 33 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.132

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.1	0.02
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.003	0.3	0.08
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.004	0.4	0.16
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.005	0.6	0.25
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.006	0.6	0.34
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.007	0.7	0.43
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.007	0.8	0.52
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.010	1.1	0.63
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.011	1.2	0.76
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.011	1.2	0.87
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.012	1.3	0.97

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.012	1.3	1.05
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.013	1.4	1.13
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.016	1.7	1.23
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.016	1.7	1.36
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.017	1.8	1.46
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.017	1.8	1.54
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.017	1.8	1.61
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.017	1.9	1.67
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.021	2.2	1.77
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.021	2.2	1.88
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.021	2.2	1.97
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.021	2.3	2.05
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.021	2.3	2.11
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.022	2.3	2.16
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.026	2.7	2.25
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.026	2.7	2.37
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.026	2.7	2.47
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.026	2.8	2.54
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.026	2.8	2.60
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.026	2.8	2.65
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.030	3.2	2.74
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.031	3.3	2.88
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.031	3.3	2.98
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.031	3.3	3.05
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.031	3.3	3.11
41	400	0.0095	0.036	0.953	0.000	0.000	0.746	0.034	0.031	3.3	3.16
42	410	0.0134	0.050	1.004	0.001	0.001	0.794	0.049	0.044	4.7	3.37
43	420	0.0134	0.050	1.054	0.003	0.002	0.843	0.049	0.044	4.7	3.71
44	430	0.0134	0.050	1.104	0.005	0.003	0.892	0.049	0.044	4.7	3.97
45	440	0.0180	0.068	1.172	0.011	0.005	0.958	0.066	0.060	6.3	4.38
46	450	0.0180	0.068	1.239	0.018	0.007	1.024	0.066	0.060	6.4	4.90
47	460	0.0340	0.128	1.367	0.035	0.018	1.149	0.125	0.114	12.1	6.05
48	470	0.0540	0.203	1.569	0.074	0.039	1.348	0.199	0.183	19.5	8.62
49	480	0.0270	0.101	1.670	0.098	0.024	1.448	0.100	0.092	9.8	10.20
50	490	0.0180	0.068	1.738	0.115	0.018	1.515	0.067	0.062	6.6	9.67
51	500	0.0134	0.050	1.788	0.129	0.014	1.564	0.050	0.046	4.9	8.63
52	510	0.0134	0.050	1.838	0.144	0.014	1.614	0.050	0.046	4.9	7.65
53	520	0.0134	0.050	1.889	0.159	0.015	1.664	0.050	0.046	4.9	6.93
54	530	0.0088	0.033	1.922	0.169	0.010	1.697	0.033	0.030	3.2	6.18
55	540	0.0088	0.033	1.955	0.180	0.011	1.729	0.033	0.030	3.2	5.40
56	550	0.0088	0.033	1.988	0.190	0.011	1.762	0.033	0.031	3.2	4.83
57	560	0.0088	0.033	2.021	0.201	0.011	1.795	0.033	0.031	3.2	4.42
58	570	0.0088	0.033	2.054	0.213	0.011	1.827	0.033	0.031	3.2	4.11
59	580	0.0088	0.033	2.087	0.224	0.012	1.860	0.033	0.031	3.3	3.88
60	590	0.0088	0.033	2.120	0.236	0.012	1.893	0.033	0.031	3.3	3.72
61	600	0.0088	0.033	2.153	0.248	0.012	1.926	0.033	0.031	3.3	3.59
62	610	0.0088	0.033	2.186	0.260	0.012	1.958	0.033	0.031	3.3	3.51
63	620	0.0088	0.033	2.219	0.273	0.012	1.991	0.033	0.031	3.3	3.44
64	630	0.0088	0.033	2.252	0.285	0.013	2.024	0.033	0.031	3.3	3.40
65	640	0.0088	0.033	2.285	0.298	0.013	2.057	0.033	0.031	3.3	3.36

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.309	0.011	2.083	0.027	0.025	2.7	3.26
67	660	0.0072	0.027	2.339	0.320	0.011	2.110	0.027	0.025	2.7	3.11
68	670	0.0072	0.027	2.366	0.331	0.011	2.137	0.027	0.025	2.7	2.99
69	680	0.0072	0.027	2.393	0.342	0.011	2.164	0.027	0.025	2.7	2.91
70	690	0.0072	0.027	2.420	0.353	0.011	2.191	0.027	0.025	2.7	2.85
71	700	0.0072	0.027	2.447	0.365	0.011	2.218	0.027	0.025	2.7	2.81
72	710	0.0072	0.027	2.474	0.376	0.012	2.244	0.027	0.025	2.7	2.78
73	720	0.0072	0.027	2.501	0.388	0.012	2.271	0.027	0.025	2.7	2.75
74	730	0.0072	0.027	2.528	0.400	0.012	2.298	0.027	0.025	2.7	2.74
75	740	0.0072	0.027	2.555	0.412	0.012	2.325	0.027	0.025	2.7	2.73
76	750	0.0072	0.027	2.582	0.424	0.012	2.352	0.027	0.025	2.7	2.72
77	760	0.0072	0.027	2.609	0.436	0.012	2.379	0.027	0.025	2.7	2.71
78	770	0.0057	0.021	2.630	0.446	0.010	2.400	0.021	0.020	2.1	2.63
79	780	0.0057	0.021	2.651	0.456	0.010	2.421	0.021	0.020	2.1	2.50
80	790	0.0057	0.021	2.673	0.466	0.010	2.442	0.021	0.020	2.1	2.41
81	800	0.0057	0.021	2.694	0.476	0.010	2.464	0.021	0.020	2.1	2.34
82	810	0.0057	0.021	2.715	0.486	0.010	2.485	0.021	0.020	2.1	2.28
83	820	0.0057	0.021	2.737	0.496	0.010	2.506	0.021	0.020	2.1	2.25
84	830	0.0057	0.021	2.758	0.506	0.010	2.527	0.021	0.020	2.1	2.22
85	840	0.0057	0.021	2.780	0.516	0.010	2.549	0.021	0.020	2.1	2.20
86	850	0.0057	0.021	2.801	0.527	0.010	2.570	0.021	0.020	2.1	2.18
87	860	0.0057	0.021	2.822	0.537	0.010	2.591	0.021	0.020	2.1	2.17
88	870	0.0057	0.021	2.844	0.548	0.011	2.613	0.021	0.020	2.1	2.17
89	880	0.0057	0.021	2.865	0.558	0.011	2.634	0.021	0.020	2.1	2.16
90	890	0.0050	0.019	2.884	0.568	0.009	2.653	0.019	0.018	1.9	2.12
91	900	0.0050	0.019	2.903	0.577	0.009	2.671	0.019	0.018	1.9	2.06
92	910	0.0050	0.019	2.921	0.586	0.009	2.690	0.019	0.018	1.9	2.01
93	920	0.0050	0.019	2.940	0.596	0.009	2.709	0.019	0.018	1.9	1.98
94	930	0.0050	0.019	2.959	0.605	0.010	2.727	0.019	0.018	1.9	1.96
95	940	0.0050	0.019	2.978	0.615	0.010	2.746	0.019	0.018	1.9	1.94
96	950	0.0050	0.019	2.996	0.625	0.010	2.765	0.019	0.018	1.9	1.92
97	960	0.0050	0.019	3.015	0.634	0.010	2.783	0.019	0.018	1.9	1.91
98	970	0.0050	0.019	3.034	0.644	0.010	2.802	0.019	0.018	1.9	1.91
99	980	0.0050	0.019	3.053	0.654	0.010	2.821	0.019	0.018	1.9	1.90
100	990	0.0050	0.019	3.071	0.664	0.010	2.839	0.019	0.018	1.9	1.90
101	1000	0.0050	0.019	3.090	0.674	0.010	2.858	0.019	0.018	1.9	1.90
102	1010	0.0040	0.015	3.105	0.682	0.008	2.873	0.015	0.014	1.5	1.85
103	1020	0.0040	0.015	3.120	0.690	0.008	2.888	0.015	0.014	1.5	1.76
104	1030	0.0040	0.015	3.135	0.698	0.008	2.903	0.015	0.014	1.5	1.69
105	1040	0.0040	0.015	3.150	0.706	0.008	2.918	0.015	0.014	1.5	1.65
106	1050	0.0040	0.015	3.165	0.714	0.008	2.933	0.015	0.014	1.5	1.61
107	1060	0.0040	0.015	3.180	0.722	0.008	2.948	0.015	0.014	1.5	1.59
108	1070	0.0040	0.015	3.195	0.730	0.008	2.963	0.015	0.014	1.5	1.57
109	1080	0.0040	0.015	3.210	0.738	0.008	2.977	0.015	0.014	1.5	1.55
110	1090	0.0040	0.015	3.225	0.746	0.008	2.992	0.015	0.014	1.5	1.54
111	1100	0.0040	0.015	3.240	0.754	0.008	3.007	0.015	0.014	1.5	1.54
112	1110	0.0040	0.015	3.255	0.763	0.008	3.022	0.015	0.014	1.5	1.53
113	1120	0.0040	0.015	3.270	0.771	0.008	3.037	0.015	0.014	1.5	1.53
114	1130	0.0040	0.015	3.285	0.779	0.008	3.052	0.015	0.014	1.5	1.52
115	1140	0.0040	0.015	3.300	0.788	0.008	3.067	0.015	0.014	1.5	1.52

SBUH Runoff Hydrograph - Tributary to 204th St Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.796	0.008	3.082	0.015	0.014	1.5	1.52
117	1160	0.0040	0.015	3.330	0.804	0.008	3.097	0.015	0.014	1.5	1.52
118	1170	0.0040	0.015	3.345	0.813	0.008	3.112	0.015	0.014	1.5	1.52
119	1180	0.0040	0.015	3.360	0.821	0.008	3.127	0.015	0.014	1.5	1.52
120	1190	0.0040	0.015	3.375	0.830	0.008	3.142	0.015	0.014	1.5	1.52
121	1200	0.0040	0.015	3.390	0.838	0.008	3.157	0.015	0.014	1.5	1.52
122	1210	0.0040	0.015	3.405	0.847	0.009	3.172	0.015	0.014	1.5	1.52
123	1220	0.0040	0.015	3.420	0.855	0.009	3.187	0.015	0.014	1.5	1.52
124	1230	0.0040	0.015	3.435	0.864	0.009	3.202	0.015	0.014	1.5	1.52
125	1240	0.0040	0.015	3.450	0.872	0.009	3.217	0.015	0.014	1.5	1.52
126	1250	0.0040	0.015	3.465	0.881	0.009	3.232	0.015	0.014	1.5	1.52
127	1260	0.0040	0.015	3.480	0.890	0.009	3.247	0.015	0.014	1.5	1.52
128	1270	0.0040	0.015	3.495	0.898	0.009	3.261	0.015	0.014	1.5	1.52
129	1280	0.0040	0.015	3.510	0.907	0.009	3.276	0.015	0.014	1.5	1.52
130	1290	0.0040	0.015	3.525	0.916	0.009	3.291	0.015	0.014	1.5	1.52
131	1300	0.0040	0.015	3.540	0.925	0.009	3.306	0.015	0.014	1.5	1.52
132	1310	0.0040	0.015	3.555	0.933	0.009	3.321	0.015	0.014	1.5	1.52
133	1320	0.0040	0.015	3.570	0.942	0.009	3.336	0.015	0.014	1.5	1.52
134	1330	0.0040	0.015	3.585	0.951	0.009	3.351	0.015	0.014	1.5	1.52
135	1340	0.0040	0.015	3.600	0.960	0.009	3.366	0.015	0.014	1.5	1.52
136	1350	0.0040	0.015	3.615	0.969	0.009	3.381	0.015	0.014	1.5	1.52
137	1360	0.0040	0.015	3.630	0.978	0.009	3.396	0.015	0.014	1.5	1.52
138	1370	0.0040	0.015	3.645	0.987	0.009	3.411	0.015	0.014	1.5	1.52
139	1380	0.0040	0.015	3.660	0.996	0.009	3.426	0.015	0.014	1.5	1.52
140	1390	0.0040	0.015	3.675	1.005	0.009	3.441	0.015	0.014	1.5	1.52
141	1400	0.0040	0.015	3.690	1.014	0.009	3.456	0.015	0.014	1.5	1.52
142	1410	0.0040	0.015	3.705	1.023	0.009	3.471	0.015	0.014	1.5	1.53
143	1420	0.0040	0.015	3.720	1.032	0.009	3.486	0.015	0.014	1.5	1.53
144	1430	0.0040	0.015	3.735	1.041	0.009	3.501	0.015	0.014	1.5	1.53
145	1440	0.0040	0.015	3.750	1.050	0.009	3.516	0.015	0.014	1.5	1.53

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to BNSF RR Culvert**

Design Storm : **100-yr / 24-hr**

Given: Area = 4.18 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 0.42 Ac. CN = 68.95 S = 4.5033 0.2S = 0.90

IMPERVIOUS AREA: Area = 3.76 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 3.77 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 49,560 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.0	0.02
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.003	0.1	0.05
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.004	0.1	0.09
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.005	0.1	0.12
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.006	0.2	0.14
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.007	0.2	0.16
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.007	0.2	0.18
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.010	0.3	0.22
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.011	0.3	0.26
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.011	0.3	0.28
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.012	0.3	0.30

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.012	0.3	0.31
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.013	0.3	0.32
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.016	0.4	0.36
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.016	0.4	0.41
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.017	0.4	0.42
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.017	0.4	0.42
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.017	0.4	0.43
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.017	0.4	0.44
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.021	0.5	0.48
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.021	0.5	0.52
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.021	0.5	0.53
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.021	0.5	0.54
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.021	0.5	0.54
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.022	0.5	0.55
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.026	0.6	0.60
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.026	0.6	0.65
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.026	0.7	0.65
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.026	0.7	0.66
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.026	0.7	0.66
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.026	0.7	0.66
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.030	0.8	0.72
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.031	0.8	0.77
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.031	0.8	0.77
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.031	0.8	0.78
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.031	0.8	0.78
41	400	0.0095	0.036	0.953	0.001	0.001	0.746	0.034	0.031	0.8	0.78
42	410	0.0134	0.050	1.004	0.002	0.002	0.794	0.049	0.044	1.1	0.95
43	420	0.0134	0.050	1.054	0.005	0.003	0.843	0.049	0.044	1.1	1.11
44	430	0.0134	0.050	1.104	0.009	0.004	0.892	0.049	0.044	1.1	1.12
45	440	0.0180	0.068	1.172	0.015	0.007	0.958	0.066	0.060	1.5	1.32
46	450	0.0180	0.068	1.239	0.024	0.008	1.024	0.066	0.060	1.5	1.52
47	460	0.0340	0.128	1.367	0.044	0.020	1.149	0.125	0.114	2.9	2.21
48	470	0.0540	0.203	1.569	0.086	0.043	1.348	0.199	0.184	4.6	3.77
49	480	0.0270	0.101	1.670	0.112	0.026	1.448	0.100	0.092	2.3	3.49
50	490	0.0180	0.068	1.738	0.131	0.019	1.515	0.067	0.062	1.6	1.95
51	500	0.0134	0.050	1.788	0.146	0.015	1.564	0.050	0.046	1.2	1.37
52	510	0.0134	0.050	1.838	0.162	0.016	1.614	0.050	0.046	1.2	1.17
53	520	0.0134	0.050	1.889	0.178	0.016	1.664	0.050	0.046	1.2	1.17
54	530	0.0088	0.033	1.922	0.189	0.011	1.697	0.033	0.030	0.8	0.97
55	540	0.0088	0.033	1.955	0.200	0.011	1.729	0.033	0.031	0.8	0.77
56	550	0.0088	0.033	1.988	0.211	0.011	1.762	0.033	0.031	0.8	0.77
57	560	0.0088	0.033	2.021	0.223	0.012	1.795	0.033	0.031	0.8	0.77
58	570	0.0088	0.033	2.054	0.235	0.012	1.827	0.033	0.031	0.8	0.77
59	580	0.0088	0.033	2.087	0.247	0.012	1.860	0.033	0.031	0.8	0.78
60	590	0.0088	0.033	2.120	0.260	0.012	1.893	0.033	0.031	0.8	0.78
61	600	0.0088	0.033	2.153	0.272	0.013	1.926	0.033	0.031	0.8	0.78
62	610	0.0088	0.033	2.186	0.285	0.013	1.958	0.033	0.031	0.8	0.78
63	620	0.0088	0.033	2.219	0.298	0.013	1.991	0.033	0.031	0.8	0.78
64	630	0.0088	0.033	2.252	0.312	0.013	2.024	0.033	0.031	0.8	0.78
65	640	0.0088	0.033	2.285	0.325	0.014	2.057	0.033	0.031	0.8	0.78

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.337	0.011	2.083	0.027	0.025	0.6	0.71
67	660	0.0072	0.027	2.339	0.348	0.011	2.110	0.027	0.025	0.6	0.64
68	670	0.0072	0.027	2.366	0.360	0.012	2.137	0.027	0.025	0.6	0.64
69	680	0.0072	0.027	2.393	0.371	0.012	2.164	0.027	0.025	0.6	0.64
70	690	0.0072	0.027	2.420	0.383	0.012	2.191	0.027	0.025	0.6	0.64
71	700	0.0072	0.027	2.447	0.395	0.012	2.218	0.027	0.025	0.6	0.64
72	710	0.0072	0.027	2.474	0.407	0.012	2.244	0.027	0.025	0.6	0.64
73	720	0.0072	0.027	2.501	0.419	0.012	2.271	0.027	0.025	0.6	0.64
74	730	0.0072	0.027	2.528	0.432	0.012	2.298	0.027	0.025	0.6	0.64
75	740	0.0072	0.027	2.555	0.444	0.012	2.325	0.027	0.025	0.6	0.64
76	750	0.0072	0.027	2.582	0.457	0.013	2.352	0.027	0.025	0.6	0.64
77	760	0.0072	0.027	2.609	0.470	0.013	2.379	0.027	0.025	0.6	0.64
78	770	0.0057	0.021	2.630	0.480	0.010	2.400	0.021	0.020	0.5	0.58
79	780	0.0057	0.021	2.651	0.490	0.010	2.421	0.021	0.020	0.5	0.51
80	790	0.0057	0.021	2.673	0.500	0.010	2.442	0.021	0.020	0.5	0.51
81	800	0.0057	0.021	2.694	0.511	0.010	2.464	0.021	0.020	0.5	0.51
82	810	0.0057	0.021	2.715	0.521	0.010	2.485	0.021	0.020	0.5	0.51
83	820	0.0057	0.021	2.737	0.532	0.011	2.506	0.021	0.020	0.5	0.51
84	830	0.0057	0.021	2.758	0.542	0.011	2.527	0.021	0.020	0.5	0.51
85	840	0.0057	0.021	2.780	0.553	0.011	2.549	0.021	0.020	0.5	0.51
86	850	0.0057	0.021	2.801	0.564	0.011	2.570	0.021	0.020	0.5	0.51
87	860	0.0057	0.021	2.822	0.575	0.011	2.591	0.021	0.020	0.5	0.51
88	870	0.0057	0.021	2.844	0.586	0.011	2.613	0.021	0.020	0.5	0.51
89	880	0.0057	0.021	2.865	0.597	0.011	2.634	0.021	0.020	0.5	0.51
90	890	0.0050	0.019	2.884	0.606	0.010	2.653	0.019	0.018	0.4	0.48
91	900	0.0050	0.019	2.903	0.616	0.010	2.671	0.019	0.018	0.4	0.45
92	910	0.0050	0.019	2.921	0.626	0.010	2.690	0.019	0.018	0.4	0.45
93	920	0.0050	0.019	2.940	0.636	0.010	2.709	0.019	0.018	0.4	0.45
94	930	0.0050	0.019	2.959	0.646	0.010	2.727	0.019	0.018	0.4	0.45
95	940	0.0050	0.019	2.978	0.656	0.010	2.746	0.019	0.018	0.4	0.45
96	950	0.0050	0.019	2.996	0.665	0.010	2.765	0.019	0.018	0.5	0.45
97	960	0.0050	0.019	3.015	0.676	0.010	2.783	0.019	0.018	0.5	0.45
98	970	0.0050	0.019	3.034	0.686	0.010	2.802	0.019	0.018	0.5	0.45
99	980	0.0050	0.019	3.053	0.696	0.010	2.821	0.019	0.018	0.5	0.45
100	990	0.0050	0.019	3.071	0.706	0.010	2.839	0.019	0.018	0.5	0.45
101	1000	0.0050	0.019	3.090	0.716	0.010	2.858	0.019	0.018	0.5	0.45
102	1010	0.0040	0.015	3.105	0.724	0.008	2.873	0.015	0.014	0.4	0.41
103	1020	0.0040	0.015	3.120	0.733	0.008	2.888	0.015	0.014	0.4	0.36
104	1030	0.0040	0.015	3.135	0.741	0.008	2.903	0.015	0.014	0.4	0.36
105	1040	0.0040	0.015	3.150	0.749	0.008	2.918	0.015	0.014	0.4	0.36
106	1050	0.0040	0.015	3.165	0.758	0.008	2.933	0.015	0.014	0.4	0.36
107	1060	0.0040	0.015	3.180	0.766	0.008	2.948	0.015	0.014	0.4	0.36
108	1070	0.0040	0.015	3.195	0.774	0.008	2.963	0.015	0.014	0.4	0.36
109	1080	0.0040	0.015	3.210	0.783	0.008	2.977	0.015	0.014	0.4	0.36
110	1090	0.0040	0.015	3.225	0.791	0.008	2.992	0.015	0.014	0.4	0.36
111	1100	0.0040	0.015	3.240	0.800	0.008	3.007	0.015	0.014	0.4	0.36
112	1110	0.0040	0.015	3.255	0.808	0.009	3.022	0.015	0.014	0.4	0.36
113	1120	0.0040	0.015	3.270	0.817	0.009	3.037	0.015	0.014	0.4	0.36
114	1130	0.0040	0.015	3.285	0.825	0.009	3.052	0.015	0.014	0.4	0.36
115	1140	0.0040	0.015	3.300	0.834	0.009	3.067	0.015	0.014	0.4	0.36

SBUH Runoff Hydrograph - Tributary to BNSF RR Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.843	0.009	3.082	0.015	0.014	0.4	0.36
117	1160	0.0040	0.015	3.330	0.851	0.009	3.097	0.015	0.014	0.4	0.36
118	1170	0.0040	0.015	3.345	0.860	0.009	3.112	0.015	0.014	0.4	0.36
119	1180	0.0040	0.015	3.360	0.869	0.009	3.127	0.015	0.014	0.4	0.36
120	1190	0.0040	0.015	3.375	0.877	0.009	3.142	0.015	0.014	0.4	0.36
121	1200	0.0040	0.015	3.390	0.886	0.009	3.157	0.015	0.014	0.4	0.36
122	1210	0.0040	0.015	3.405	0.895	0.009	3.172	0.015	0.014	0.4	0.36
123	1220	0.0040	0.015	3.420	0.904	0.009	3.187	0.015	0.014	0.4	0.36
124	1230	0.0040	0.015	3.435	0.913	0.009	3.202	0.015	0.014	0.4	0.36
125	1240	0.0040	0.015	3.450	0.922	0.009	3.217	0.015	0.014	0.4	0.36
126	1250	0.0040	0.015	3.465	0.930	0.009	3.232	0.015	0.014	0.4	0.36
127	1260	0.0040	0.015	3.480	0.939	0.009	3.247	0.015	0.014	0.4	0.36
128	1270	0.0040	0.015	3.495	0.948	0.009	3.261	0.015	0.014	0.4	0.36
129	1280	0.0040	0.015	3.510	0.957	0.009	3.276	0.015	0.014	0.4	0.36
130	1290	0.0040	0.015	3.525	0.966	0.009	3.291	0.015	0.014	0.4	0.36
131	1300	0.0040	0.015	3.540	0.975	0.009	3.306	0.015	0.014	0.4	0.36
132	1310	0.0040	0.015	3.555	0.984	0.009	3.321	0.015	0.014	0.4	0.36
133	1320	0.0040	0.015	3.570	0.993	0.009	3.336	0.015	0.014	0.4	0.36
134	1330	0.0040	0.015	3.585	1.003	0.009	3.351	0.015	0.014	0.4	0.36
135	1340	0.0040	0.015	3.600	1.012	0.009	3.366	0.015	0.014	0.4	0.36
136	1350	0.0040	0.015	3.615	1.021	0.009	3.381	0.015	0.014	0.4	0.36
137	1360	0.0040	0.015	3.630	1.030	0.009	3.396	0.015	0.014	0.4	0.36
138	1370	0.0040	0.015	3.645	1.039	0.009	3.411	0.015	0.014	0.4	0.36
139	1380	0.0040	0.015	3.660	1.048	0.009	3.426	0.015	0.014	0.4	0.36
140	1390	0.0040	0.015	3.675	1.058	0.009	3.441	0.015	0.014	0.4	0.36
141	1400	0.0040	0.015	3.690	1.067	0.009	3.456	0.015	0.014	0.4	0.36
142	1410	0.0040	0.015	3.705	1.076	0.009	3.471	0.015	0.014	0.4	0.36
143	1420	0.0040	0.015	3.720	1.086	0.009	3.486	0.015	0.014	0.4	0.36
144	1430	0.0040	0.015	3.735	1.095	0.009	3.501	0.015	0.014	0.4	0.36
145	1440	0.0040	0.015	3.750	1.104	0.009	3.516	0.015	0.014	0.4	0.36

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to 69th Ave Culvert**

Design Storm : **100-yr / 24-hr**

Given:	Area =	0.76	Ac.	P =	3.75	in.	dt =	10 min.
PERVIOUS AREA:	Area =	0.08	Ac.	CN =	68.00		S = 4.7059	0.2S = 0.94
IMPERVIOUS AREA:	Area =	0.68	Ac.	CN =	98.00		S = 0.2041	0.2S = 0.04
	T_C =	5	Min.	w =	0.5			

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 0.68 cfs
Total Volume = 8,963 cf
$T_{(Peak)}$ = 7.83 hrs
$Tc_{(min)}$ = 5 min

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.0	0.00
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.003	0.0	0.01
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.004	0.0	0.02
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.005	0.0	0.02
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.006	0.0	0.03
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.007	0.0	0.03
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.007	0.0	0.03
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.010	0.0	0.04
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.011	0.0	0.05
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.011	0.1	0.05
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.012	0.1	0.05

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.012	0.1	0.06
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.013	0.1	0.06
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.016	0.1	0.07
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.016	0.1	0.07
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.017	0.1	0.08
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.017	0.1	0.08
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.017	0.1	0.08
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.017	0.1	0.08
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.021	0.1	0.09
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.021	0.1	0.09
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.021	0.1	0.10
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.021	0.1	0.10
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.021	0.1	0.10
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.022	0.1	0.10
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.025	0.1	0.11
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.026	0.1	0.12
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.026	0.1	0.12
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.026	0.1	0.12
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.026	0.1	0.12
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.026	0.1	0.12
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.030	0.1	0.13
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.030	0.1	0.14
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.031	0.1	0.14
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.031	0.1	0.14
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.031	0.1	0.14
41	400	0.0095	0.036	0.953	0.000	0.000	0.746	0.034	0.031	0.1	0.14
42	410	0.0134	0.050	1.004	0.001	0.001	0.794	0.049	0.044	0.2	0.17
43	420	0.0134	0.050	1.054	0.003	0.002	0.843	0.049	0.044	0.2	0.20
44	430	0.0134	0.050	1.104	0.005	0.003	0.892	0.049	0.044	0.2	0.20
45	440	0.0180	0.068	1.172	0.011	0.005	0.958	0.066	0.059	0.3	0.24
46	450	0.0180	0.068	1.239	0.018	0.007	1.024	0.066	0.060	0.3	0.27
47	460	0.0340	0.128	1.367	0.035	0.018	1.149	0.125	0.114	0.5	0.40
48	470	0.0540	0.203	1.569	0.074	0.039	1.348	0.199	0.182	0.8	0.68
49	480	0.0270	0.101	1.670	0.098	0.024	1.448	0.100	0.092	0.4	0.63
50	490	0.0180	0.068	1.738	0.115	0.018	1.515	0.067	0.062	0.3	0.35
51	500	0.0134	0.050	1.788	0.129	0.014	1.564	0.050	0.046	0.2	0.25
52	510	0.0134	0.050	1.838	0.144	0.014	1.614	0.050	0.046	0.2	0.21
53	520	0.0134	0.050	1.889	0.159	0.015	1.664	0.050	0.046	0.2	0.21
54	530	0.0088	0.033	1.922	0.169	0.010	1.697	0.033	0.030	0.1	0.18
55	540	0.0088	0.033	1.955	0.180	0.011	1.729	0.033	0.030	0.1	0.14
56	550	0.0088	0.033	1.988	0.190	0.011	1.762	0.033	0.030	0.1	0.14
57	560	0.0088	0.033	2.021	0.201	0.011	1.795	0.033	0.030	0.1	0.14
58	570	0.0088	0.033	2.054	0.213	0.011	1.827	0.033	0.030	0.1	0.14
59	580	0.0088	0.033	2.087	0.224	0.012	1.860	0.033	0.030	0.1	0.14
60	590	0.0088	0.033	2.120	0.236	0.012	1.893	0.033	0.031	0.1	0.14
61	600	0.0088	0.033	2.153	0.248	0.012	1.926	0.033	0.031	0.1	0.14
62	610	0.0088	0.033	2.186	0.260	0.012	1.958	0.033	0.031	0.1	0.14
63	620	0.0088	0.033	2.219	0.273	0.012	1.991	0.033	0.031	0.1	0.14
64	630	0.0088	0.033	2.252	0.285	0.013	2.024	0.033	0.031	0.1	0.14
65	640	0.0088	0.033	2.285	0.298	0.013	2.057	0.033	0.031	0.1	0.14

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.309	0.011	2.083	0.027	0.025	0.1	0.13
67	660	0.0072	0.027	2.339	0.320	0.011	2.110	0.027	0.025	0.1	0.12
68	670	0.0072	0.027	2.366	0.331	0.011	2.137	0.027	0.025	0.1	0.12
69	680	0.0072	0.027	2.393	0.342	0.011	2.164	0.027	0.025	0.1	0.12
70	690	0.0072	0.027	2.420	0.353	0.011	2.191	0.027	0.025	0.1	0.12
71	700	0.0072	0.027	2.447	0.365	0.011	2.218	0.027	0.025	0.1	0.12
72	710	0.0072	0.027	2.474	0.376	0.012	2.244	0.027	0.025	0.1	0.12
73	720	0.0072	0.027	2.501	0.388	0.012	2.271	0.027	0.025	0.1	0.12
74	730	0.0072	0.027	2.528	0.400	0.012	2.298	0.027	0.025	0.1	0.12
75	740	0.0072	0.027	2.555	0.412	0.012	2.325	0.027	0.025	0.1	0.12
76	750	0.0072	0.027	2.582	0.424	0.012	2.352	0.027	0.025	0.1	0.12
77	760	0.0072	0.027	2.609	0.436	0.012	2.379	0.027	0.025	0.1	0.12
78	770	0.0057	0.021	2.630	0.446	0.010	2.400	0.021	0.020	0.1	0.10
79	780	0.0057	0.021	2.651	0.456	0.010	2.421	0.021	0.020	0.1	0.09
80	790	0.0057	0.021	2.673	0.466	0.010	2.442	0.021	0.020	0.1	0.09
81	800	0.0057	0.021	2.694	0.476	0.010	2.464	0.021	0.020	0.1	0.09
82	810	0.0057	0.021	2.715	0.486	0.010	2.485	0.021	0.020	0.1	0.09
83	820	0.0057	0.021	2.737	0.496	0.010	2.506	0.021	0.020	0.1	0.09
84	830	0.0057	0.021	2.758	0.506	0.010	2.527	0.021	0.020	0.1	0.09
85	840	0.0057	0.021	2.780	0.516	0.010	2.549	0.021	0.020	0.1	0.09
86	850	0.0057	0.021	2.801	0.527	0.010	2.570	0.021	0.020	0.1	0.09
87	860	0.0057	0.021	2.822	0.537	0.010	2.591	0.021	0.020	0.1	0.09
88	870	0.0057	0.021	2.844	0.548	0.011	2.613	0.021	0.020	0.1	0.09
89	880	0.0057	0.021	2.865	0.558	0.011	2.634	0.021	0.020	0.1	0.09
90	890	0.0050	0.019	2.884	0.568	0.009	2.653	0.019	0.018	0.1	0.09
91	900	0.0050	0.019	2.903	0.577	0.009	2.671	0.019	0.018	0.1	0.08
92	910	0.0050	0.019	2.921	0.586	0.009	2.690	0.019	0.018	0.1	0.08
93	920	0.0050	0.019	2.940	0.596	0.009	2.709	0.019	0.018	0.1	0.08
94	930	0.0050	0.019	2.959	0.605	0.010	2.727	0.019	0.018	0.1	0.08
95	940	0.0050	0.019	2.978	0.615	0.010	2.746	0.019	0.018	0.1	0.08
96	950	0.0050	0.019	2.996	0.625	0.010	2.765	0.019	0.018	0.1	0.08
97	960	0.0050	0.019	3.015	0.634	0.010	2.783	0.019	0.018	0.1	0.08
98	970	0.0050	0.019	3.034	0.644	0.010	2.802	0.019	0.018	0.1	0.08
99	980	0.0050	0.019	3.053	0.654	0.010	2.821	0.019	0.018	0.1	0.08
100	990	0.0050	0.019	3.071	0.664	0.010	2.839	0.019	0.018	0.1	0.08
101	1000	0.0050	0.019	3.090	0.674	0.010	2.858	0.019	0.018	0.1	0.08
102	1010	0.0040	0.015	3.105	0.682	0.008	2.873	0.015	0.014	0.1	0.07
103	1020	0.0040	0.015	3.120	0.690	0.008	2.888	0.015	0.014	0.1	0.07
104	1030	0.0040	0.015	3.135	0.698	0.008	2.903	0.015	0.014	0.1	0.07
105	1040	0.0040	0.015	3.150	0.706	0.008	2.918	0.015	0.014	0.1	0.07
106	1050	0.0040	0.015	3.165	0.714	0.008	2.933	0.015	0.014	0.1	0.07
107	1060	0.0040	0.015	3.180	0.722	0.008	2.948	0.015	0.014	0.1	0.07
108	1070	0.0040	0.015	3.195	0.730	0.008	2.963	0.015	0.014	0.1	0.07
109	1080	0.0040	0.015	3.210	0.738	0.008	2.977	0.015	0.014	0.1	0.07
110	1090	0.0040	0.015	3.225	0.746	0.008	2.992	0.015	0.014	0.1	0.07
111	1100	0.0040	0.015	3.240	0.754	0.008	3.007	0.015	0.014	0.1	0.07
112	1110	0.0040	0.015	3.255	0.763	0.008	3.022	0.015	0.014	0.1	0.07
113	1120	0.0040	0.015	3.270	0.771	0.008	3.037	0.015	0.014	0.1	0.07
114	1130	0.0040	0.015	3.285	0.779	0.008	3.052	0.015	0.014	0.1	0.07
115	1140	0.0040	0.015	3.300	0.788	0.008	3.067	0.015	0.014	0.1	0.07

SBUH Runoff Hydrograph - Tributary to 69th Ave Culvert

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.796	0.008	3.082	0.015	0.014	0.1	0.07
117	1160	0.0040	0.015	3.330	0.804	0.008	3.097	0.015	0.014	0.1	0.07
118	1170	0.0040	0.015	3.345	0.813	0.008	3.112	0.015	0.014	0.1	0.07
119	1180	0.0040	0.015	3.360	0.821	0.008	3.127	0.015	0.014	0.1	0.07
120	1190	0.0040	0.015	3.375	0.830	0.008	3.142	0.015	0.014	0.1	0.07
121	1200	0.0040	0.015	3.390	0.838	0.008	3.157	0.015	0.014	0.1	0.07
122	1210	0.0040	0.015	3.405	0.847	0.009	3.172	0.015	0.014	0.1	0.07
123	1220	0.0040	0.015	3.420	0.855	0.009	3.187	0.015	0.014	0.1	0.07
124	1230	0.0040	0.015	3.435	0.864	0.009	3.202	0.015	0.014	0.1	0.07
125	1240	0.0040	0.015	3.450	0.872	0.009	3.217	0.015	0.014	0.1	0.07
126	1250	0.0040	0.015	3.465	0.881	0.009	3.232	0.015	0.014	0.1	0.07
127	1260	0.0040	0.015	3.480	0.890	0.009	3.247	0.015	0.014	0.1	0.07
128	1270	0.0040	0.015	3.495	0.898	0.009	3.261	0.015	0.014	0.1	0.07
129	1280	0.0040	0.015	3.510	0.907	0.009	3.276	0.015	0.014	0.1	0.07
130	1290	0.0040	0.015	3.525	0.916	0.009	3.291	0.015	0.014	0.1	0.07
131	1300	0.0040	0.015	3.540	0.925	0.009	3.306	0.015	0.014	0.1	0.07
132	1310	0.0040	0.015	3.555	0.933	0.009	3.321	0.015	0.014	0.1	0.07
133	1320	0.0040	0.015	3.570	0.942	0.009	3.336	0.015	0.014	0.1	0.07
134	1330	0.0040	0.015	3.585	0.951	0.009	3.351	0.015	0.014	0.1	0.07
135	1340	0.0040	0.015	3.600	0.960	0.009	3.366	0.015	0.014	0.1	0.07
136	1350	0.0040	0.015	3.615	0.969	0.009	3.381	0.015	0.014	0.1	0.07
137	1360	0.0040	0.015	3.630	0.978	0.009	3.396	0.015	0.014	0.1	0.07
138	1370	0.0040	0.015	3.645	0.987	0.009	3.411	0.015	0.014	0.1	0.07
139	1380	0.0040	0.015	3.660	0.996	0.009	3.426	0.015	0.014	0.1	0.07
140	1390	0.0040	0.015	3.675	1.005	0.009	3.441	0.015	0.014	0.1	0.07
141	1400	0.0040	0.015	3.690	1.014	0.009	3.456	0.015	0.014	0.1	0.07
142	1410	0.0040	0.015	3.705	1.023	0.009	3.471	0.015	0.014	0.1	0.07
143	1420	0.0040	0.015	3.720	1.032	0.009	3.486	0.015	0.014	0.1	0.07
144	1430	0.0040	0.015	3.735	1.041	0.009	3.501	0.015	0.014	0.1	0.07
145	1440	0.0040	0.015	3.750	1.050	0.009	3.516	0.015	0.014	0.1	0.07

SBUH Runoff Hydrograph

per 2001 DOE Stormwater Management Manual for Western Washington T. 2.6

Project Name : **Prairie Creek Drainage Improvements - Full Buildout Conditions**

Project Number : 12-1347
Date : 10/26/2012
Calculated by : KJM

Basin Description : **Tributary to Confluence Point**

Design Storm : **100-yr / 24-hr**

Given: Area = 11.29 Ac. P = 3.75 in. dt = 10 min.

PERVIOUS AREA: Area = 3.01 Ac. CN = 68.00 S = 4.7059 0.2S = 0.94

IMPERVIOUS AREA: Area = 8.28 Ac. CN = 98.00 S = 0.2041 0.2S = 0.04

T_C = 5 Min. w = 0.5

where S = potential maximum natural detention (DOE Vol. 3, 2-24)

Results Summary:

Peak Flow (Q) = 8.64 cfs ***$T_{(Peak)}$ = 7.83 hrs***

Total Volume = 116,867 cf ***$Tc_{(min)}$ = 5 min***

Equations:

Col.[1]= Time Increment
Col.[2]= Time (min)
Col.[3]= Type 1A Storm Distribution (From Vol. III, Table 2.1)
Col.[4]= Column (3) * P
Col.[5]= Accumulated sum of Column (4)
Col.[6]= If(P<0.2S)=0, If (P>0.2S)=(Column (5) - 0.2S)^2 (Column (5) + 0.8S) where the Pervious Area 'S' value is used
Col.[7]= Column (6) of the present step - Column 6 por the previous step
Col.[8]= Same as Column (6) except use Impervious Area 'S' value
Col.[9]= Column (8) of the present step - Column (8) of the previous step
Col.[10]= (Pervious Area / Total Area) * Column (7) + (Impervious Area / Total Area) * Column (9)
Col.[11]= (60.5 * Column (10) * Toatl Area) / dt, where dt = 10 or 60 minutes
Col.[12]= Column (12) of previous time step + w * [(Column (11) of previous time step + Column (11) of present time step) - (2 * Column (12) of previous time step)] where w = routing constant = dt / (2Tc + dt) = 0.500

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
					Pervious Area		Impervious Area				
Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Accum-ulated Runoff	Incre-mental Runoff	Accum ulated Runoff	Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
1	0	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0	0.00
2	10	0.0040	0.015	0.015	0.000	0.000	0.000	0.000	0.000	0.0	0.00
3	20	0.0040	0.015	0.030	0.000	0.000	0.000	0.000	0.000	0.0	0.00
4	30	0.0040	0.015	0.045	0.000	0.000	0.000	0.000	0.000	0.0	0.00
5	40	0.0040	0.015	0.060	0.000	0.000	0.002	0.002	0.001	0.1	0.04
6	50	0.0040	0.015	0.075	0.000	0.000	0.005	0.003	0.002	0.2	0.12
7	60	0.0040	0.015	0.090	0.000	0.000	0.010	0.005	0.003	0.2	0.20
8	70	0.0040	0.015	0.105	0.000	0.000	0.015	0.006	0.004	0.3	0.26
9	80	0.0040	0.015	0.120	0.000	0.000	0.022	0.007	0.005	0.3	0.32
10	90	0.0040	0.015	0.135	0.000	0.000	0.030	0.008	0.006	0.4	0.36
11	100	0.0040	0.015	0.150	0.000	0.000	0.038	0.008	0.006	0.4	0.40
12	110	0.0050	0.019	0.169	0.000	0.000	0.049	0.011	0.008	0.6	0.49
13	120	0.0050	0.019	0.188	0.000	0.000	0.061	0.012	0.009	0.6	0.58
14	130	0.0050	0.019	0.206	0.000	0.000	0.074	0.013	0.009	0.6	0.62
15	140	0.0050	0.019	0.225	0.000	0.000	0.087	0.013	0.010	0.7	0.65

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
16	150	0.0050	0.019	0.244	0.000	0.000	0.101	0.014	0.010	0.7	0.68
17	160	0.0050	0.019	0.263	0.000	0.000	0.115	0.014	0.010	0.7	0.70
18	170	0.0060	0.023	0.285	0.000	0.000	0.133	0.018	0.013	0.9	0.80
19	180	0.0060	0.023	0.308	0.000	0.000	0.151	0.018	0.013	0.9	0.89
20	190	0.0060	0.023	0.330	0.000	0.000	0.170	0.018	0.014	0.9	0.91
21	200	0.0060	0.023	0.353	0.000	0.000	0.188	0.019	0.014	0.9	0.93
22	210	0.0060	0.023	0.375	0.000	0.000	0.207	0.019	0.014	1.0	0.95
23	220	0.0060	0.023	0.398	0.000	0.000	0.227	0.019	0.014	1.0	0.96
24	230	0.0070	0.026	0.424	0.000	0.000	0.250	0.023	0.017	1.1	1.06
25	240	0.0070	0.026	0.450	0.000	0.000	0.273	0.023	0.017	1.2	1.16
26	250	0.0070	0.026	0.476	0.000	0.000	0.296	0.023	0.017	1.2	1.17
27	260	0.0070	0.026	0.503	0.000	0.000	0.320	0.024	0.017	1.2	1.18
28	270	0.0070	0.026	0.529	0.000	0.000	0.344	0.024	0.018	1.2	1.19
29	280	0.0070	0.026	0.555	0.000	0.000	0.368	0.024	0.018	1.2	1.20
30	290	0.0082	0.031	0.586	0.000	0.000	0.396	0.028	0.021	1.4	1.31
31	300	0.0082	0.031	0.617	0.000	0.000	0.425	0.029	0.021	1.4	1.43
32	310	0.0082	0.031	0.647	0.000	0.000	0.454	0.029	0.021	1.4	1.43
33	320	0.0082	0.031	0.678	0.000	0.000	0.483	0.029	0.021	1.4	1.44
34	330	0.0082	0.031	0.709	0.000	0.000	0.512	0.029	0.021	1.5	1.45
35	340	0.0082	0.031	0.740	0.000	0.000	0.541	0.029	0.021	1.5	1.46
36	350	0.0095	0.036	0.775	0.000	0.000	0.575	0.034	0.025	1.7	1.58
37	360	0.0095	0.036	0.811	0.000	0.000	0.609	0.034	0.025	1.7	1.70
38	370	0.0095	0.036	0.846	0.000	0.000	0.643	0.034	0.025	1.7	1.71
39	380	0.0095	0.036	0.882	0.000	0.000	0.677	0.034	0.025	1.7	1.71
40	390	0.0095	0.036	0.918	0.000	0.000	0.711	0.034	0.025	1.7	1.72
41	400	0.0095	0.036	0.953	0.000	0.000	0.746	0.034	0.025	1.7	1.72
42	410	0.0134	0.050	1.004	0.001	0.001	0.794	0.049	0.036	2.5	2.09
43	420	0.0134	0.050	1.054	0.003	0.002	0.843	0.049	0.036	2.5	2.46
44	430	0.0134	0.050	1.104	0.005	0.003	0.892	0.049	0.037	2.5	2.49
45	440	0.0180	0.068	1.172	0.011	0.005	0.958	0.066	0.050	3.4	2.95
46	450	0.0180	0.068	1.239	0.018	0.007	1.024	0.066	0.050	3.4	3.41
47	460	0.0340	0.128	1.367	0.035	0.018	1.149	0.125	0.096	6.6	5.01
48	470	0.0540	0.203	1.569	0.074	0.039	1.348	0.199	0.156	10.7	8.64
49	480	0.0270	0.101	1.670	0.098	0.024	1.448	0.100	0.080	5.4	8.06
50	490	0.0180	0.068	1.738	0.115	0.018	1.515	0.067	0.054	3.7	4.55
51	500	0.0134	0.050	1.788	0.129	0.014	1.564	0.050	0.040	2.7	3.20
52	510	0.0134	0.050	1.838	0.144	0.014	1.614	0.050	0.040	2.8	2.75
53	520	0.0134	0.050	1.889	0.159	0.015	1.664	0.050	0.041	2.8	2.76
54	530	0.0088	0.033	1.922	0.169	0.010	1.697	0.033	0.027	1.8	2.30
55	540	0.0088	0.033	1.955	0.180	0.011	1.729	0.033	0.027	1.8	1.83
56	550	0.0088	0.033	1.988	0.190	0.011	1.762	0.033	0.027	1.8	1.83
57	560	0.0088	0.033	2.021	0.201	0.011	1.795	0.033	0.027	1.8	1.84
58	570	0.0088	0.033	2.054	0.213	0.011	1.827	0.033	0.027	1.8	1.84
59	580	0.0088	0.033	2.087	0.224	0.012	1.860	0.033	0.027	1.8	1.85
60	590	0.0088	0.033	2.120	0.236	0.012	1.893	0.033	0.027	1.9	1.85
61	600	0.0088	0.033	2.153	0.248	0.012	1.926	0.033	0.027	1.9	1.86
62	610	0.0088	0.033	2.186	0.260	0.012	1.958	0.033	0.027	1.9	1.86
63	620	0.0088	0.033	2.219	0.273	0.012	1.991	0.033	0.027	1.9	1.87
64	630	0.0088	0.033	2.252	0.285	0.013	2.024	0.033	0.027	1.9	1.87
65	640	0.0088	0.033	2.285	0.298	0.013	2.057	0.033	0.027	1.9	1.87

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
66	650	0.0072	0.027	2.312	0.309	0.011	2.083	0.027	0.023	1.5	1.71
67	660	0.0072	0.027	2.339	0.320	0.011	2.110	0.027	0.023	1.5	1.54
68	670	0.0072	0.027	2.366	0.331	0.011	2.137	0.027	0.023	1.5	1.54
69	680	0.0072	0.027	2.393	0.342	0.011	2.164	0.027	0.023	1.5	1.55
70	690	0.0072	0.027	2.420	0.353	0.011	2.191	0.027	0.023	1.5	1.55
71	700	0.0072	0.027	2.447	0.365	0.011	2.218	0.027	0.023	1.6	1.55
72	710	0.0072	0.027	2.474	0.376	0.012	2.244	0.027	0.023	1.6	1.55
73	720	0.0072	0.027	2.501	0.388	0.012	2.271	0.027	0.023	1.6	1.56
74	730	0.0072	0.027	2.528	0.400	0.012	2.298	0.027	0.023	1.6	1.56
75	740	0.0072	0.027	2.555	0.412	0.012	2.325	0.027	0.023	1.6	1.56
76	750	0.0072	0.027	2.582	0.424	0.012	2.352	0.027	0.023	1.6	1.56
77	760	0.0072	0.027	2.609	0.436	0.012	2.379	0.027	0.023	1.6	1.57
78	770	0.0057	0.021	2.630	0.446	0.010	2.400	0.021	0.018	1.2	1.41
79	780	0.0057	0.021	2.651	0.456	0.010	2.421	0.021	0.018	1.2	1.24
80	790	0.0057	0.021	2.673	0.466	0.010	2.442	0.021	0.018	1.2	1.24
81	800	0.0057	0.021	2.694	0.476	0.010	2.464	0.021	0.018	1.2	1.25
82	810	0.0057	0.021	2.715	0.486	0.010	2.485	0.021	0.018	1.2	1.25
83	820	0.0057	0.021	2.737	0.496	0.010	2.506	0.021	0.018	1.3	1.25
84	830	0.0057	0.021	2.758	0.506	0.010	2.527	0.021	0.018	1.3	1.25
85	840	0.0057	0.021	2.780	0.516	0.010	2.549	0.021	0.018	1.3	1.25
86	850	0.0057	0.021	2.801	0.527	0.010	2.570	0.021	0.018	1.3	1.25
87	860	0.0057	0.021	2.822	0.537	0.010	2.591	0.021	0.018	1.3	1.25
88	870	0.0057	0.021	2.844	0.548	0.011	2.613	0.021	0.018	1.3	1.26
89	880	0.0057	0.021	2.865	0.558	0.011	2.634	0.021	0.018	1.3	1.26
90	890	0.0050	0.019	2.884	0.568	0.009	2.653	0.019	0.016	1.1	1.18
91	900	0.0050	0.019	2.903	0.577	0.009	2.671	0.019	0.016	1.1	1.11
92	910	0.0050	0.019	2.921	0.586	0.009	2.690	0.019	0.016	1.1	1.11
93	920	0.0050	0.019	2.940	0.596	0.009	2.709	0.019	0.016	1.1	1.11
94	930	0.0050	0.019	2.959	0.605	0.010	2.727	0.019	0.016	1.1	1.11
95	940	0.0050	0.019	2.978	0.615	0.010	2.746	0.019	0.016	1.1	1.11
96	950	0.0050	0.019	2.996	0.625	0.010	2.765	0.019	0.016	1.1	1.11
97	960	0.0050	0.019	3.015	0.634	0.010	2.783	0.019	0.016	1.1	1.11
98	970	0.0050	0.019	3.034	0.644	0.010	2.802	0.019	0.016	1.1	1.11
99	980	0.0050	0.019	3.053	0.654	0.010	2.821	0.019	0.016	1.1	1.11
100	990	0.0050	0.019	3.071	0.664	0.010	2.839	0.019	0.016	1.1	1.11
101	1000	0.0050	0.019	3.090	0.674	0.010	2.858	0.019	0.016	1.1	1.12
102	1010	0.0040	0.015	3.105	0.682	0.008	2.873	0.015	0.013	0.9	1.00
103	1020	0.0040	0.015	3.120	0.690	0.008	2.888	0.015	0.013	0.9	0.89
104	1030	0.0040	0.015	3.135	0.698	0.008	2.903	0.015	0.013	0.9	0.89
105	1040	0.0040	0.015	3.150	0.706	0.008	2.918	0.015	0.013	0.9	0.89
106	1050	0.0040	0.015	3.165	0.714	0.008	2.933	0.015	0.013	0.9	0.90
107	1060	0.0040	0.015	3.180	0.722	0.008	2.948	0.015	0.013	0.9	0.90
108	1070	0.0040	0.015	3.195	0.730	0.008	2.963	0.015	0.013	0.9	0.90
109	1080	0.0040	0.015	3.210	0.738	0.008	2.977	0.015	0.013	0.9	0.90
110	1090	0.0040	0.015	3.225	0.746	0.008	2.992	0.015	0.013	0.9	0.90
111	1100	0.0040	0.015	3.240	0.754	0.008	3.007	0.015	0.013	0.9	0.90
112	1110	0.0040	0.015	3.255	0.763	0.008	3.022	0.015	0.013	0.9	0.90
113	1120	0.0040	0.015	3.270	0.771	0.008	3.037	0.015	0.013	0.9	0.90
114	1130	0.0040	0.015	3.285	0.779	0.008	3.052	0.015	0.013	0.9	0.90
115	1140	0.0040	0.015	3.300	0.788	0.008	3.067	0.015	0.013	0.9	0.90

SBUH Runoff Hydrograph - Tributary to Confluence Point

Time Increment	Time	Rainfall Distri-bution	Incre-mental Rainfall	Accum-ulated Rainfall	Pervious Area Accum-ulated Runoff	Pervious Area Incre-mental Runoff	Impervious Area Accum ulated Runoff	Impervious Area Incre-mental Runoff	Total Runoff	Instant Flowrate	Design Flowrate
#	min.	(fraction)	(inches)	(inches)	(Inches)	(Inches)	(Inches)	(Inches)	(Inches)	(cfs)	(cfs)
116	1150	0.0040	0.015	3.315	0.796	0.008	3.082	0.015	0.013	0.9	0.90
117	1160	0.0040	0.015	3.330	0.804	0.008	3.097	0.015	0.013	0.9	0.90
118	1170	0.0040	0.015	3.345	0.813	0.008	3.112	0.015	0.013	0.9	0.90
119	1180	0.0040	0.015	3.360	0.821	0.008	3.127	0.015	0.013	0.9	0.90
120	1190	0.0040	0.015	3.375	0.830	0.008	3.142	0.015	0.013	0.9	0.90
121	1200	0.0040	0.015	3.390	0.838	0.008	3.157	0.015	0.013	0.9	0.90
122	1210	0.0040	0.015	3.405	0.847	0.009	3.172	0.015	0.013	0.9	0.90
123	1220	0.0040	0.015	3.420	0.855	0.009	3.187	0.015	0.013	0.9	0.90
124	1230	0.0040	0.015	3.435	0.864	0.009	3.202	0.015	0.013	0.9	0.90
125	1240	0.0040	0.015	3.450	0.872	0.009	3.217	0.015	0.013	0.9	0.91
126	1250	0.0040	0.015	3.465	0.881	0.009	3.232	0.015	0.013	0.9	0.91
127	1260	0.0040	0.015	3.480	0.890	0.009	3.247	0.015	0.013	0.9	0.91
128	1270	0.0040	0.015	3.495	0.898	0.009	3.261	0.015	0.013	0.9	0.91
129	1280	0.0040	0.015	3.510	0.907	0.009	3.276	0.015	0.013	0.9	0.91
130	1290	0.0040	0.015	3.525	0.916	0.009	3.291	0.015	0.013	0.9	0.91
131	1300	0.0040	0.015	3.540	0.925	0.009	3.306	0.015	0.013	0.9	0.91
132	1310	0.0040	0.015	3.555	0.933	0.009	3.321	0.015	0.013	0.9	0.91
133	1320	0.0040	0.015	3.570	0.942	0.009	3.336	0.015	0.013	0.9	0.91
134	1330	0.0040	0.015	3.585	0.951	0.009	3.351	0.015	0.013	0.9	0.91
135	1340	0.0040	0.015	3.600	0.960	0.009	3.366	0.015	0.013	0.9	0.91
136	1350	0.0040	0.015	3.615	0.969	0.009	3.381	0.015	0.013	0.9	0.91
137	1360	0.0040	0.015	3.630	0.978	0.009	3.396	0.015	0.013	0.9	0.91
138	1370	0.0040	0.015	3.645	0.987	0.009	3.411	0.015	0.013	0.9	0.91
139	1380	0.0040	0.015	3.660	0.996	0.009	3.426	0.015	0.013	0.9	0.91
140	1390	0.0040	0.015	3.675	1.005	0.009	3.441	0.015	0.013	0.9	0.91
141	1400	0.0040	0.015	3.690	1.014	0.009	3.456	0.015	0.013	0.9	0.91
142	1410	0.0040	0.015	3.705	1.023	0.009	3.471	0.015	0.013	0.9	0.91
143	1420	0.0040	0.015	3.720	1.032	0.009	3.486	0.015	0.013	0.9	0.91
144	1430	0.0040	0.015	3.735	1.041	0.009	3.501	0.015	0.013	0.9	0.91
145	1440	0.0040	0.015	3.750	1.050	0.009	3.516	0.015	0.013	0.9	0.91

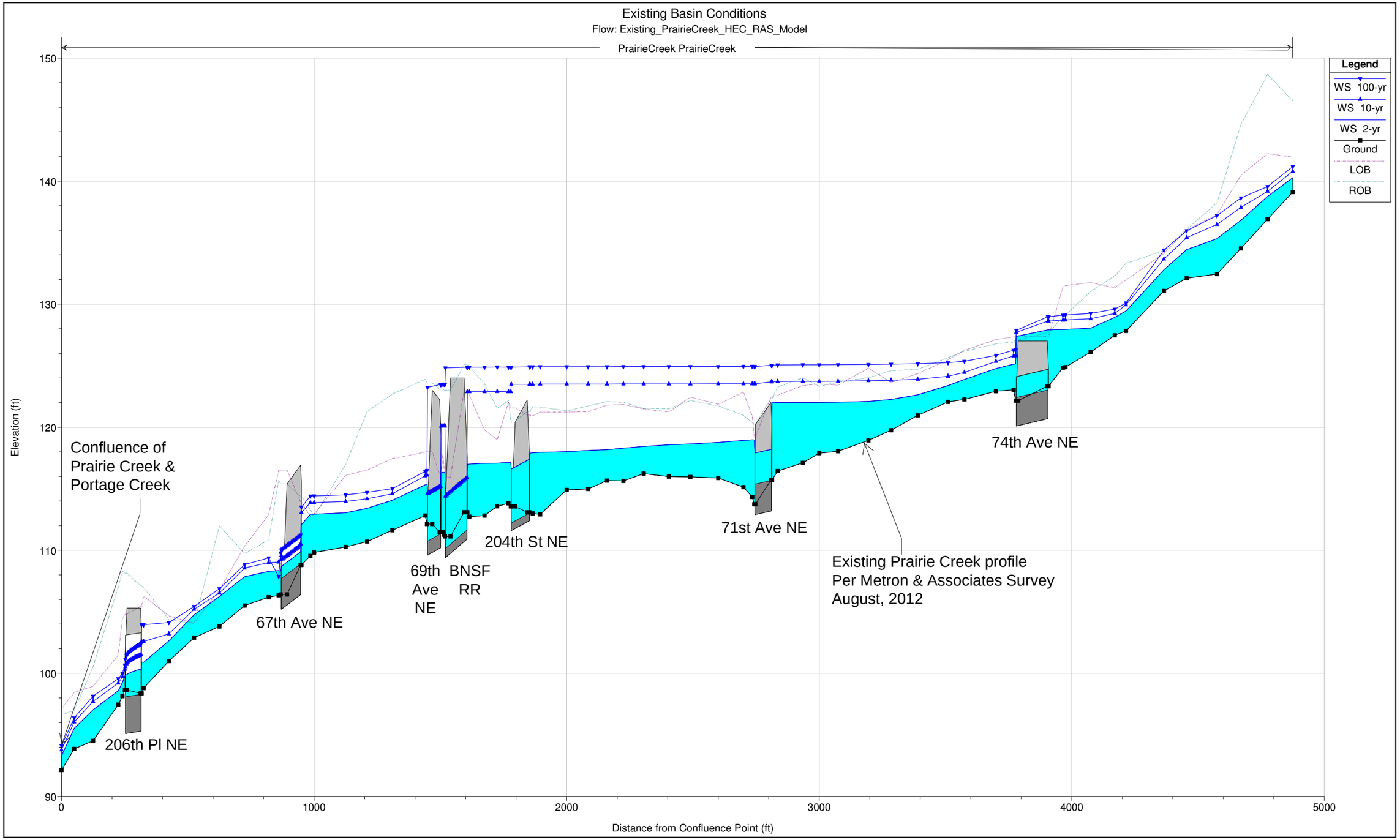
Existing Basin Conditions
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012

Exhibit C7.1

HEC-RAS Plan: Exist Build-Out River: PrairieCreek Reach: PrairieCreek

Reach	River Sta		Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
				(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981	74th Ave	2-yr	127.93	127.91	127.73	127.93	127.01	25.50	47.30	2.77	5.09	5.09
PrairieCreek	3981	74th Ave	10-yr	128.68	128.62	128.49	128.68	127.01	25.85	124.52	2.81	5.16	5.16
PrairieCreek	3981	74th Ave	100-yr	129.08	128.98	128.96	129.08	127.01	25.52	191.77	2.70	5.09	5.09
PrairieCreek	2886	71st Ave	2-yr	122.00	121.99	119.83	122.00	122.01	79.69		3.03	8.00	8.00
PrairieCreek	2886	71st Ave	10-yr	123.72	123.69	123.54	123.72	122.01	20.22	142.48	0.17	2.03	2.03
PrairieCreek	2886	71st Ave	100-yr	125.07	125.03	124.96	125.07	122.01	16.40	218.02	0.10	1.65	1.65
PrairieCreek	1928	204th St	2-yr	117.94	117.90	116.46	117.94	122.23	84.27		0.77	4.62	4.62
PrairieCreek	1928	204th St	10-yr	123.49	123.49	119.33	123.49	122.23	72.88	97.53	0.61	4.00	4.00
PrairieCreek	1928	204th St	100-yr	124.91	124.91	122.84	124.91	122.23	15.35	229.27	0.03	0.84	0.84
PrairieCreek	1680	BNSF RR	2-yr	117.03	116.98	115.01	117.03	124.01	85.96		0.63	4.82	4.82
PrairieCreek	1680	BNSF RR	10-yr	122.89	122.88	117.54	122.89	124.01	173.26		2.78	9.72	9.72
PrairieCreek	1680	BNSF RR	100-yr	124.89	124.88	120.70	124.89	124.01	122.88	125.51	1.39	6.89	6.89
PrairieCreek	1576	69th Ave	2-yr	116.36	116.27	114.76	116.36	123.01	86.27		0.90	5.29	5.29
PrairieCreek	1576	69th Ave	10-yr	120.12	120.08	118.28	120.12	123.01	173.77		3.97	10.66	10.66
PrairieCreek	1576	69th Ave	100-yr	123.51	123.47	122.82	123.51	123.01	229.81	19.26	6.99	14.09	14.09
PrairieCreek	1022	67th Ave	2-yr	110.63	112.10	110.51	110.63	116.93	86.27		3.70	5.72	5.97
PrairieCreek	1022	67th Ave	10-yr	111.66	113.05	111.51	111.66	116.93	173.77		3.84	7.23	6.24
PrairieCreek	1022	67th Ave	100-yr	112.40	113.51	112.69	112.40	116.93	249.07		3.73	7.21	7.21
PrairieCreek	0390	206th Pl	2-yr	101.00	100.93	100.65	101.00	105.31	86.27		1.11	5.28	6.31
PrairieCreek	0390	206th Pl	10-yr	102.66	102.60	102.21	102.66	105.31	173.77		2.27	7.03	9.08
PrairieCreek	0390	206th Pl	100-yr	104.01	103.95	103.51	104.01	105.31	249.07		3.29	8.29	10.53

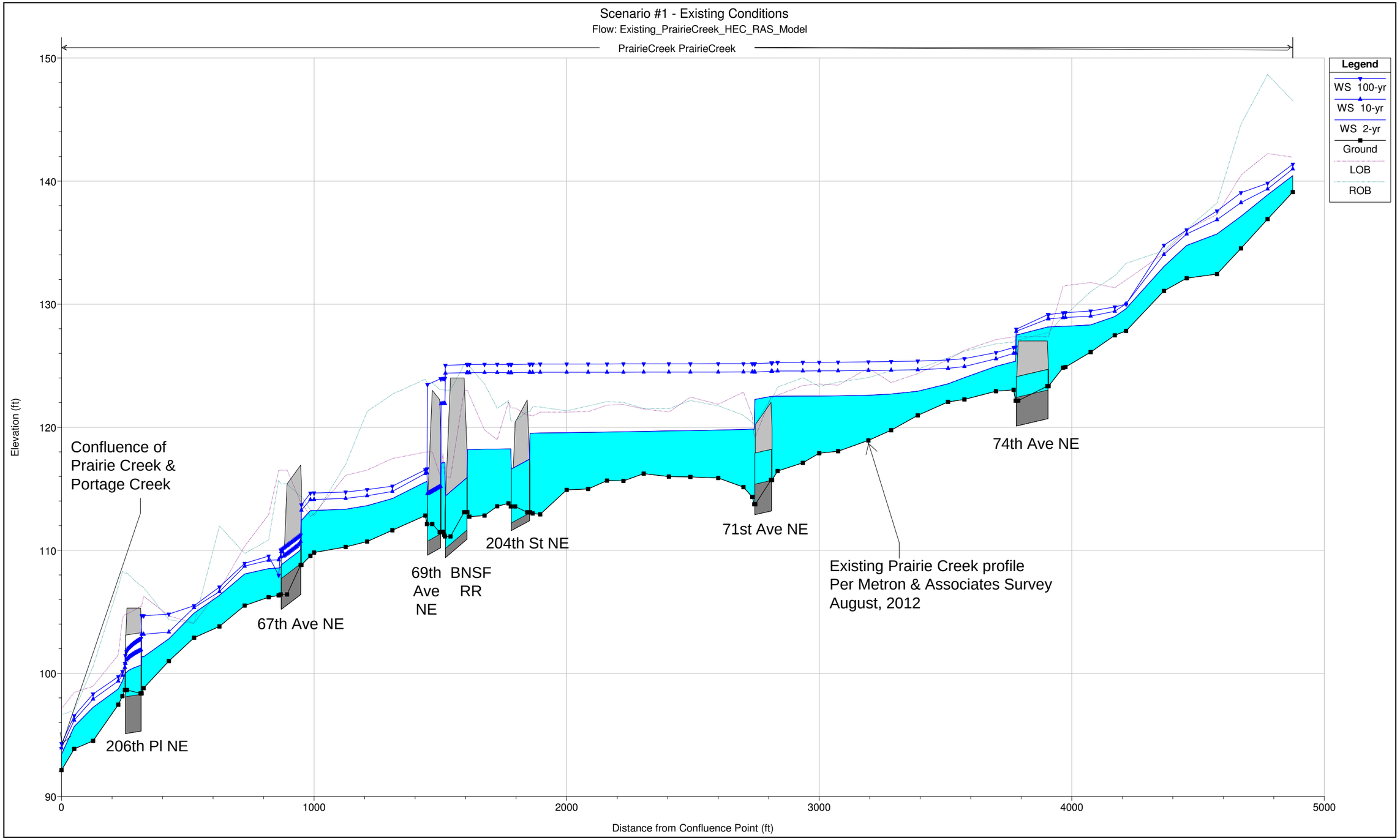
Scenario #1 - Existing Conditions
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012

Exhibit C7.2

HEC-RAS Plan: Scenario #1 River: PrairieCreek Reach: PrairieCreek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981 74th Ave	2-yr	128.18	128.15	127.98	128.18	127.01	25.68	67.98	2.80	5.13	5.13
PrairieCreek	3981 74th Ave	10-yr	128.84	128.76	128.75	128.84	127.01	25.59	156.20	2.73	5.11	5.11
PrairieCreek	3981 74th Ave	100-yr	129.26	129.15	129.12	129.26	127.01	25.35	229.67	2.64	5.06	5.06
PrairieCreek	2886 71st Ave	2-yr	122.53	122.52	121.34	122.53	122.01	75.10	26.35	2.69	7.53	7.53
PrairieCreek	2886 71st Ave	10-yr	124.57	124.55	124.50	124.57	122.01	13.66	181.50	0.06	1.37	1.37
PrairieCreek	2886 71st Ave	100-yr	125.27	125.23	125.20	125.27	122.01	14.66	258.08	0.06	1.47	1.47
PrairieCreek	1928 204th St	2-yr	119.53	119.51	117.08	119.53	122.23	106.03		1.27	5.81	5.81
PrairieCreek	1928 204th St	10-yr	124.46	124.46	120.71	124.46	122.23	15.34	187.53	0.03	0.84	0.84
PrairieCreek	1928 204th St	100-yr	125.14	125.13	125.11	125.14	122.23	16.57	266.37	0.04	0.91	0.91
PrairieCreek	1680 BNSF RR	2-yr	118.21	118.18	115.59	118.21	124.01	107.72		1.05	6.04	6.04
PrairieCreek	1680 BNSF RR	10-yr	124.44	124.43	118.76	124.44	124.01	164.41	41.31	2.50	9.22	9.22
PrairieCreek	1680 BNSF RR	100-yr	125.11	125.10	122.74	125.11	124.01	110.98	175.73	1.13	6.23	6.23
PrairieCreek	1576 69th Ave	2-yr	117.15	117.08	115.42	117.15	123.01	108.03		1.48	6.62	6.62
PrairieCreek	1576 69th Ave	10-yr	121.95	121.91	120.04	121.95	123.01	206.23		5.62	12.65	12.65
PrairieCreek	1576 69th Ave	100-yr	123.98	123.94	123.62	123.98	123.01	235.37	52.02	7.33	14.43	14.43
PrairieCreek	1022 67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022 67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022 67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390 206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390 206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390 206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

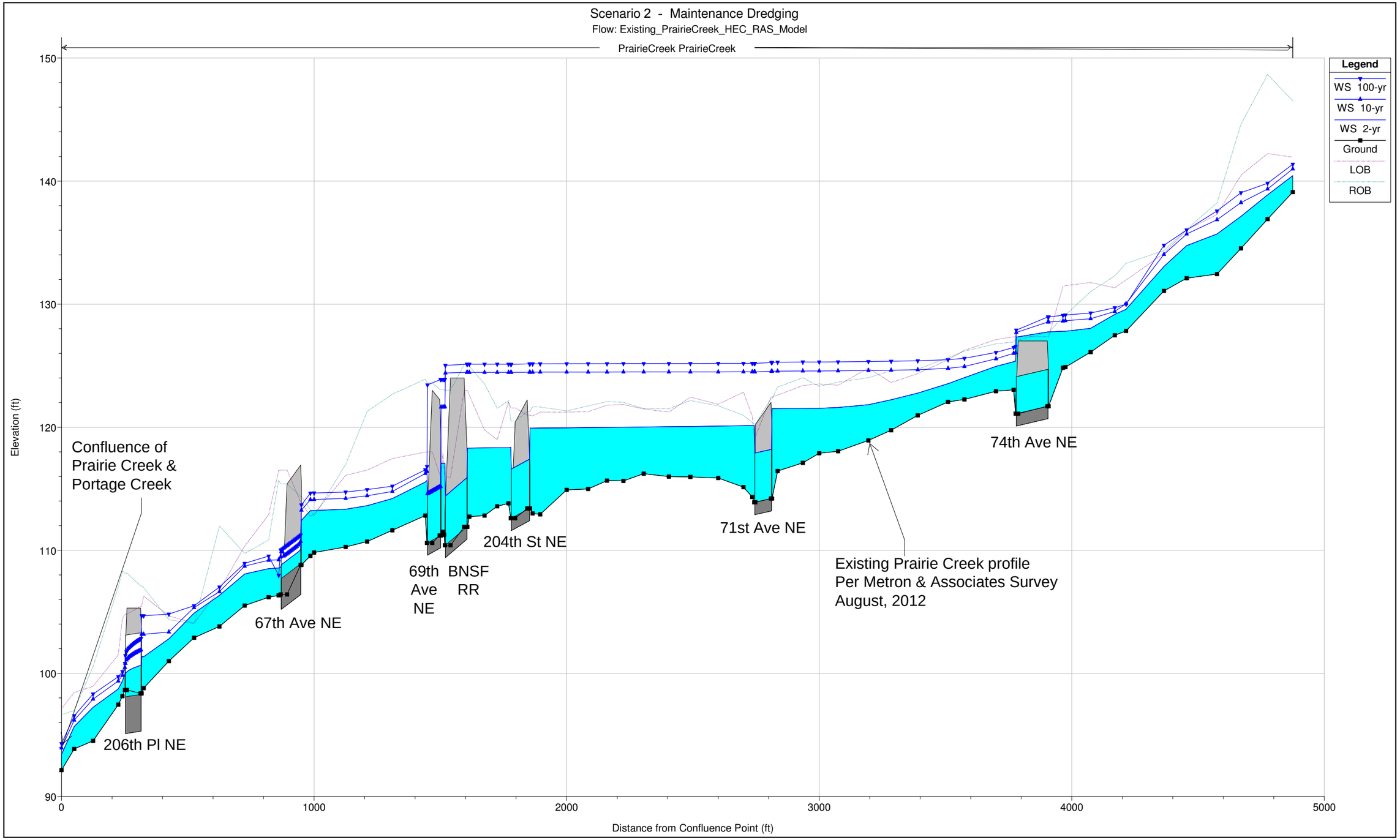
Scenario 2 - Maintenance Dredging
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012

Exhibit C7.2

HEC-RAS Plan: Scenario 2 River: PrairieCreek Reach: PrairieCreek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981 74th Ave	2-yr	127.78	127.75	127.31	127.78	127.01	59.23	34.43	2.38	5.86	5.86
PrairieCreek	3981 74th Ave	10-yr	128.62	128.55	128.36	128.62	127.01	61.00	120.79	2.48	6.03	6.03
PrairieCreek	3981 74th Ave	100-yr	129.07	128.97	128.85	129.07	127.01	60.65	194.37	2.42	6.00	6.00
PrairieCreek	2886 71st Ave	2-yr	121.52	121.50	118.10	121.52	122.01	101.45		1.36	6.02	6.02
PrairieCreek	2886 71st Ave	10-yr	124.57	124.54	122.04	124.57	122.01	22.51	172.65	0.05	1.34	1.34
PrairieCreek	2886 71st Ave	100-yr	125.29	125.26	125.20	125.29	122.01	29.10	243.64	0.08	1.73	1.73
PrairieCreek	1928 204th St	2-yr	119.93	119.92	117.42	119.93	122.23	106.03		1.55	6.30	6.30
PrairieCreek	1928 204th St	10-yr	124.48	124.47	121.64	124.48	122.23	13.55	189.32	0.02	0.80	0.80
PrairieCreek	1928 204th St	100-yr	125.15	125.14	125.13	125.15	122.23	14.43	268.51	0.03	0.86	0.86
PrairieCreek	1680 BNSF RR	2-yr	118.31	118.30	115.82	118.31	124.01	107.72		1.20	6.40	6.40
PrairieCreek	1680 BNSF RR	10-yr	124.45	124.45	119.36	124.45	124.01	163.33	42.39	2.80	9.70	9.70
PrairieCreek	1680 BNSF RR	100-yr	125.12	125.12	123.81	125.12	124.01	108.38	178.33	1.23	6.44	6.44
PrairieCreek	1576 69th Ave	2-yr	117.11	117.07	115.28	117.11	123.01	108.03		1.40	6.42	6.42
PrairieCreek	1576 69th Ave	10-yr	121.67	121.64	119.62	121.67	123.01	206.23		5.22	12.25	12.25
PrairieCreek	1576 69th Ave	100-yr	123.91	123.87	123.52	123.91	123.01	239.90	47.49	7.07	14.25	14.25
PrairieCreek	1022 67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022 67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022 67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390 206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390 206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390 206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

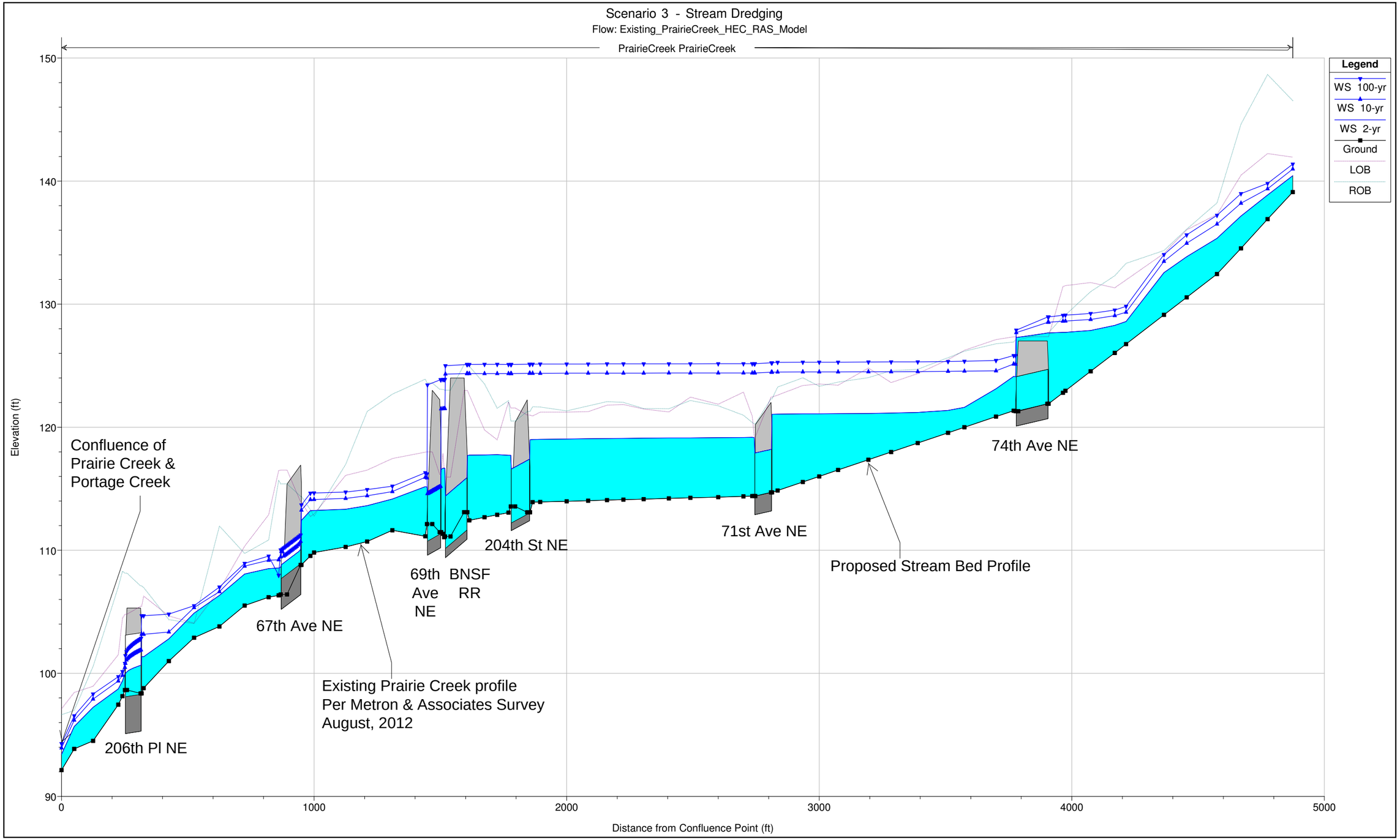
Scenario 3 - Stream Dredging
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012
Proposed Stream Bed Profile

Exhibit C7.2

HEC-RAS Plan: Scenario 3 River: PrairieCreek Reach: PrairieCreek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981 74th Ave	2-yr	127.69	127.66	127.43	127.69	127.01	65.87	27.79	3.56	7.01	7.01
PrairieCreek	3981 74th Ave	10-yr	128.60	128.53	128.39	128.60	127.01	64.88	116.91	3.41	6.90	6.90
PrairieCreek	3981 74th Ave	100-yr	129.08	128.97	128.93	129.08	127.01	62.86	192.16	3.16	6.69	6.69
PrairieCreek	2886 71st Ave	2-yr	121.07	121.04	118.77	121.07	122.01	101.45		1.89	6.91	6.91
PrairieCreek	2886 71st Ave	10-yr	124.49	124.46	123.80	124.49	122.01	21.36	173.80	0.06	1.45	1.45
PrairieCreek	2886 71st Ave	100-yr	125.27	125.24	125.18	125.27	122.01	25.52	247.22	0.09	1.74	1.74
PrairieCreek	1928 204th St	2-yr	119.01	118.98	117.08	119.01	122.23	106.03		1.26	5.81	5.81
PrairieCreek	1928 204th St	10-yr	124.39	124.38	120.71	124.39	122.23	17.20	185.67	0.03	0.94	0.94
PrairieCreek	1928 204th St	100-yr	125.13	125.12	125.11	125.13	122.23	14.18	268.76	0.03	0.78	0.78
PrairieCreek	1680 BNSF RR	2-yr	117.74	117.70	115.59	117.74	124.01	107.72		1.03	6.04	6.04
PrairieCreek	1680 BNSF RR	10-yr	124.36	124.35	118.76	124.36	124.01	175.13	30.59	2.84	9.83	9.83
PrairieCreek	1680 BNSF RR	100-yr	125.10	125.10	122.74	125.10	124.01	114.96	171.75	1.22	6.45	6.45
PrairieCreek	1576 69th Ave	2-yr	116.69	116.58	115.42	116.69	123.01	108.03		1.44	6.62	6.62
PrairieCreek	1576 69th Ave	10-yr	121.53	121.49	120.04	121.53	123.01	206.23		5.62	12.65	12.65
PrairieCreek	1576 69th Ave	100-yr	123.90	123.86	123.62	123.90	123.01	240.49	46.90	7.65	14.75	14.75
PrairieCreek	1022 67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022 67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022 67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390 206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390 206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390 206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

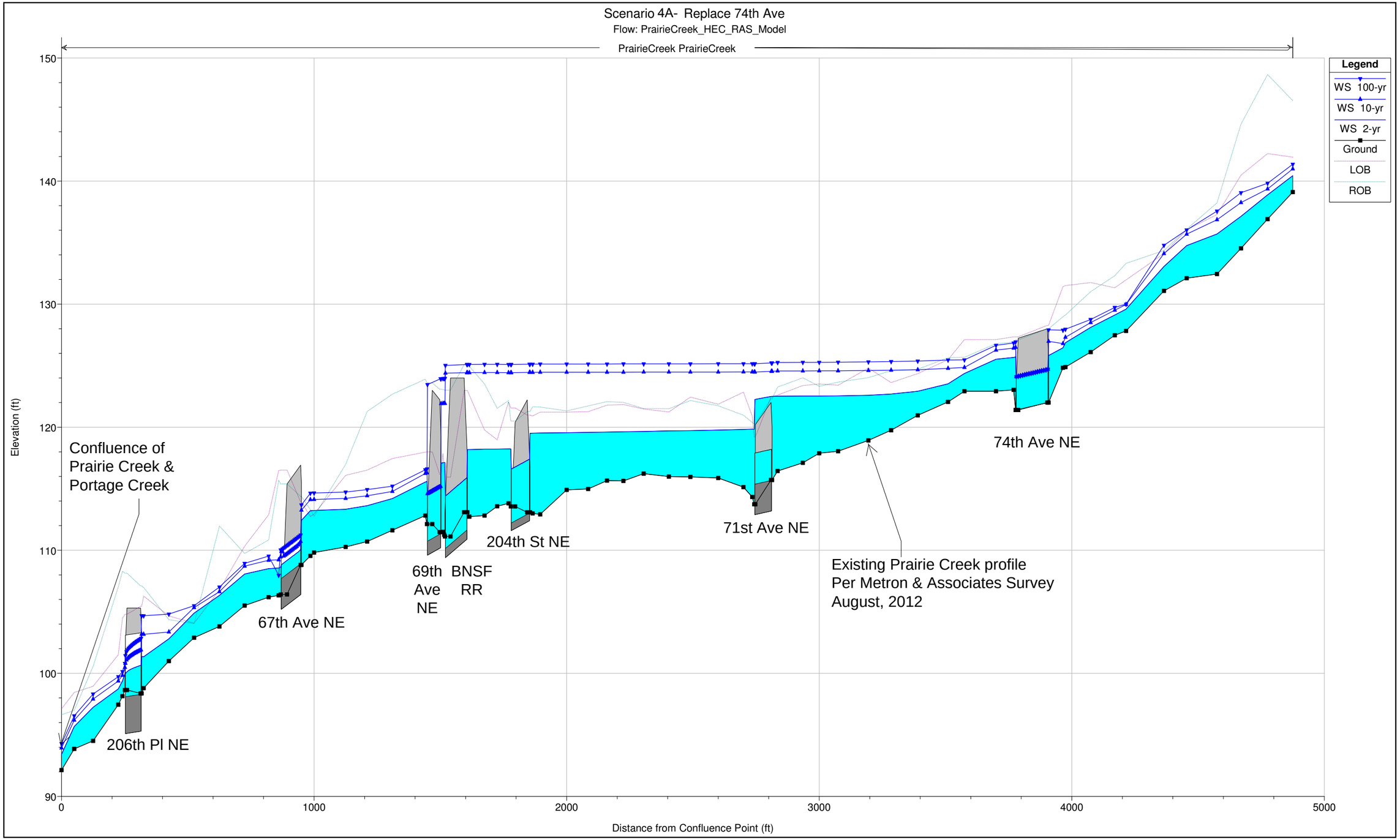
Scenario 4A- Replace 74th Ave
Flow: PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012

Exhibit C7.2

HEC-RAS Plan: Scenario 4A River: PrairieCreek Reach: PrairieCreek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981 74th Ave	2-yr	125.85	125.83	123.38	125.85	128.01	93.66		0.12	1.83	1.83
PrairieCreek	3981 74th Ave	10-yr	127.02	126.98	124.14	127.02	128.01	181.79		0.49	3.54	3.54
PrairieCreek	3981 74th Ave	100-yr	127.96	127.91	124.68	127.96	128.01	255.02		0.98	4.97	4.97
PrairieCreek	2886 71st Ave	2-yr	122.52	122.51	121.34	122.52	122.01	74.99	26.46	2.68	7.52	7.52
PrairieCreek	2886 71st Ave	10-yr	124.57	124.54	124.50	124.57	122.01	13.40	181.76	0.06	1.34	1.34
PrairieCreek	2886 71st Ave	100-yr	125.26	125.23	125.20	125.26	122.01	15.21	257.53	0.07	1.53	1.53
PrairieCreek	1928 204th St	2-yr	119.53	119.51	117.08	119.53	122.23	106.03		1.27	5.81	5.81
PrairieCreek	1928 204th St	10-yr	124.46	124.46	120.71	124.46	122.23	15.64	187.23	0.03	0.86	0.86
PrairieCreek	1928 204th St	100-yr	125.13	125.12	125.11	125.13	122.23	11.88	277.09	0.03	0.65	0.65
PrairieCreek	1680 BNSF RR	2-yr	118.21	118.18	115.59	118.21	124.01	107.72		1.05	6.04	6.04
PrairieCreek	1680 BNSF RR	10-yr	124.44	124.43	118.76	124.44	124.01	164.41	41.31	2.50	9.22	9.22
PrairieCreek	1680 BNSF RR	100-yr	125.11	125.10	122.74	125.11	124.01	110.98	175.73	1.13	6.23	6.23
PrairieCreek	1576 69th Ave	2-yr	117.15	117.08	115.42	117.15	123.01	108.03		1.48	6.62	6.62
PrairieCreek	1576 69th Ave	10-yr	121.95	121.91	120.04	121.95	123.01	206.23		5.62	12.65	12.65
PrairieCreek	1576 69th Ave	100-yr	123.98	123.94	123.62	123.98	123.01	235.37	52.02	7.33	14.43	14.43
PrairieCreek	1022 67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022 67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022 67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390 206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390 206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390 206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

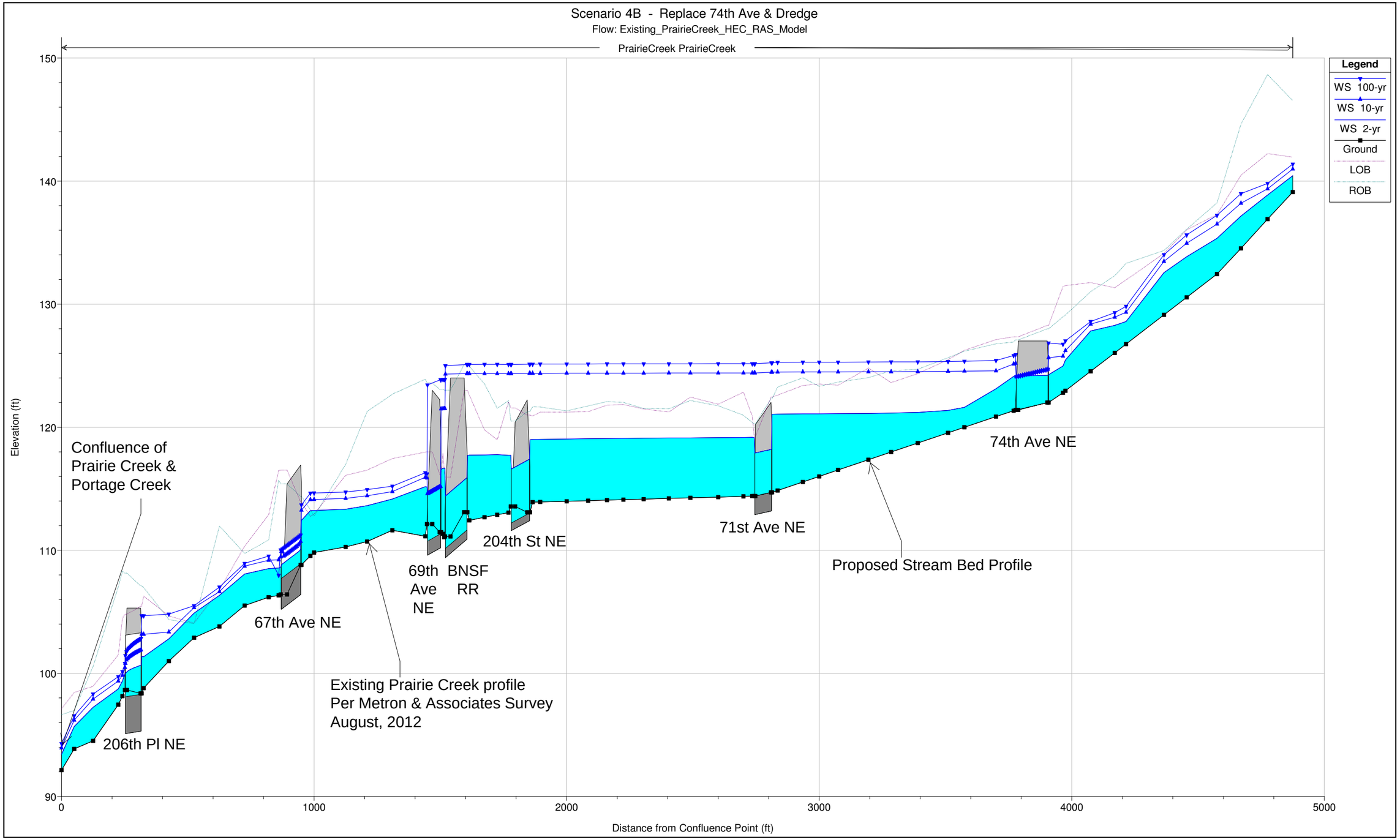
Scenario 4B - Replace 74th Ave & Dredge
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
Distance from Confluence Point (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012
Proposed Stream Bed Profile

Exhibit C7.2

HEC-RAS Plan: Scenario 4B River: PrairieCreek Reach: PrairieCreek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981 74th Ave	2-yr	124.32	124.26	123.38	124.32	127.01	93.66		0.09	2.22	1.83
PrairieCreek	3981 74th Ave	10-yr	125.72	125.65	124.14	125.72	127.01	181.79		0.45	3.54	3.54
PrairieCreek	3981 74th Ave	100-yr	126.92	126.85	124.68	126.92	127.01	255.02		0.95	4.97	4.97
PrairieCreek	2886 71st Ave	2-yr	121.07	121.04	118.77	121.07	122.01	101.45		1.89	6.91	6.91
PrairieCreek	2886 71st Ave	10-yr	124.49	124.46	123.80	124.49	122.01	21.36	173.80	0.06	1.45	1.45
PrairieCreek	2886 71st Ave	100-yr	125.27	125.24	125.18	125.27	122.01	25.52	247.22	0.09	1.74	1.74
PrairieCreek	1928 204th Ave	2-yr	119.01	118.98	117.08	119.01	122.23	106.03		1.26	5.81	5.81
PrairieCreek	1928 204th Ave	10-yr	124.39	124.38	120.71	124.39	122.23	17.20	185.67	0.03	0.94	0.94
PrairieCreek	1928 204th Ave	100-yr	125.13	125.12	125.11	125.13	122.23	14.18	268.76	0.03	0.78	0.78
PrairieCreek	1680 BNSF RR	2-yr	117.74	117.70	115.59	117.74	124.01	107.72		1.03	6.04	6.04
PrairieCreek	1680 BNSF RR	10-yr	124.36	124.35	118.76	124.36	124.01	175.13	30.59	2.84	9.83	9.83
PrairieCreek	1680 BNSF RR	100-yr	125.10	125.10	122.74	125.10	124.01	114.96	171.75	1.22	6.45	6.45
PrairieCreek	1576 69th Ave	2-yr	116.69	116.58	115.42	116.69	123.01	108.03		1.44	6.62	6.62
PrairieCreek	1576 69th Ave	10-yr	121.53	121.49	120.04	121.53	123.01	206.23		5.62	12.65	12.65
PrairieCreek	1576 69th Ave	100-yr	123.90	123.86	123.62	123.90	123.01	240.49	46.90	7.65	14.75	14.75
PrairieCreek	1022 67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022 67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022 67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390 206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390 206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390 206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

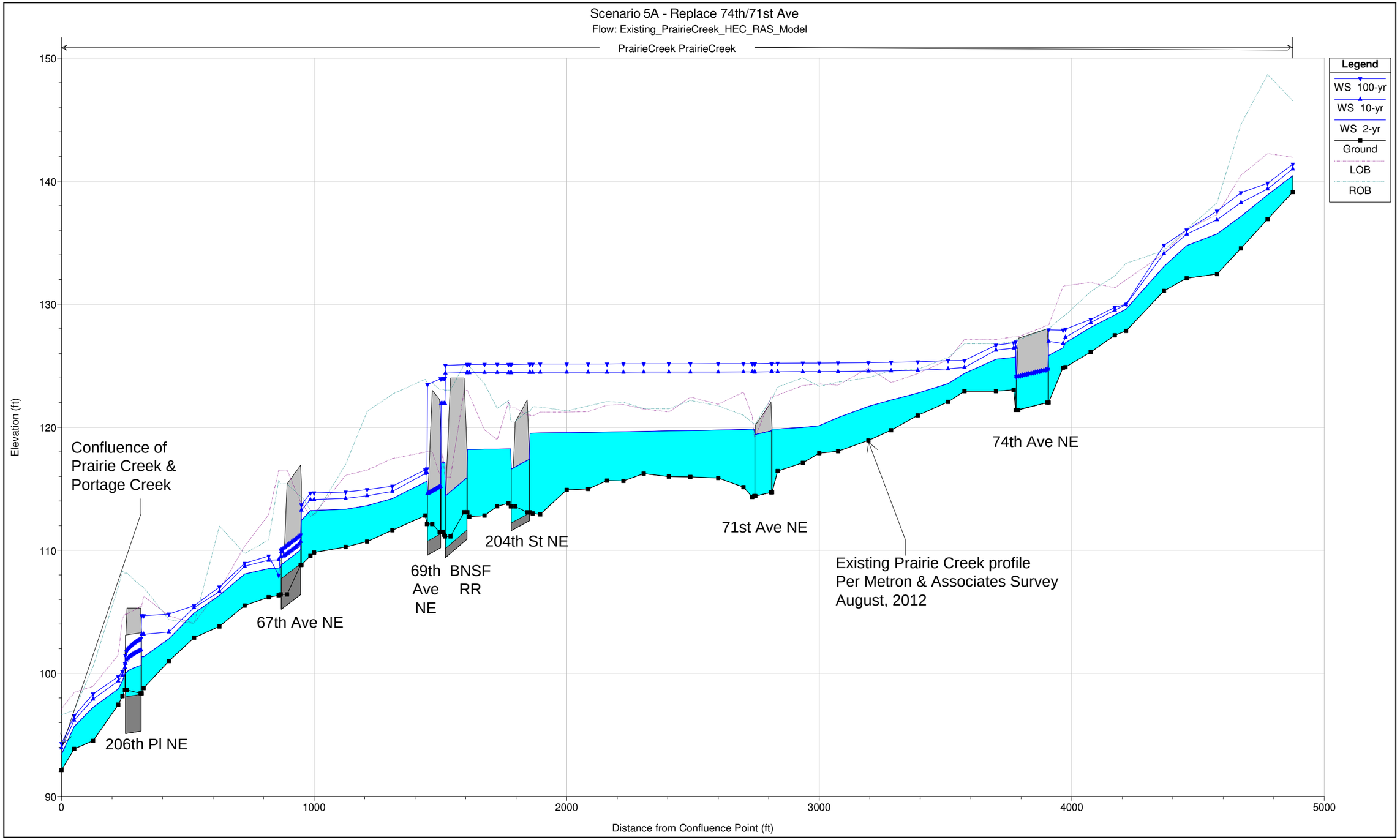
Scenario 5A - Replace 74th/71st Ave
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012

Exhibit C7.2

HEC-RAS Plan: Scenario 5A River: PrairieCreek Reach: PrairieCreek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981 74th Ave	2-yr	125.85	125.83	123.38	125.85	128.01	93.66		0.12	1.83	1.83
PrairieCreek	3981 74th Ave	10-yr	127.02	126.98	124.14	127.02	128.01	181.79		0.49	3.54	3.54
PrairieCreek	3981 74th Ave	100-yr	127.96	127.91	124.68	127.96	128.01	255.02		0.98	4.97	4.97
PrairieCreek	2886 71st Ave	2-yr	119.88	119.87	116.33	119.88	122.01	101.45		0.03	1.27	1.27
PrairieCreek	2886 71st Ave	10-yr	124.51	124.50	117.22	124.51	122.01	85.33	109.83	0.02	1.07	1.07
PrairieCreek	2886 71st Ave	100-yr	125.20	125.18	117.85	125.20	122.01	105.36	167.38	0.03	1.32	1.32
PrairieCreek	1928 204th St	2-yr	119.53	119.51	117.08	119.53	122.23	106.03		1.27	5.81	5.81
PrairieCreek	1928 204th St	10-yr	124.46	124.46	120.71	124.46	122.23	15.64	187.23	0.03	0.86	0.86
PrairieCreek	1928 204th St	100-yr	125.13	125.12	125.11	125.13	122.23	11.88	277.09	0.03	0.65	0.65
PrairieCreek	1680 BNSF RR	2-yr	118.21	118.18	115.59	118.21	124.01	107.72		1.05	6.04	6.04
PrairieCreek	1680 BNSF RR	10-yr	124.44	124.43	118.76	124.44	124.01	164.41	41.31	2.50	9.22	9.22
PrairieCreek	1680 BNSF RR	100-yr	125.11	125.10	122.74	125.11	124.01	110.98	175.73	1.13	6.23	6.23
PrairieCreek	1576 69th Ave	2-yr	117.15	117.08	115.42	117.15	123.01	108.03		1.48	6.62	6.62
PrairieCreek	1576 69th Ave	10-yr	121.95	121.91	120.04	121.95	123.01	206.23		5.62	12.65	12.65
PrairieCreek	1576 69th Ave	100-yr	123.98	123.94	123.62	123.98	123.01	235.37	52.02	7.33	14.43	14.43
PrairieCreek	1022 67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022 67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022 67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390 206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390 206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390 206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

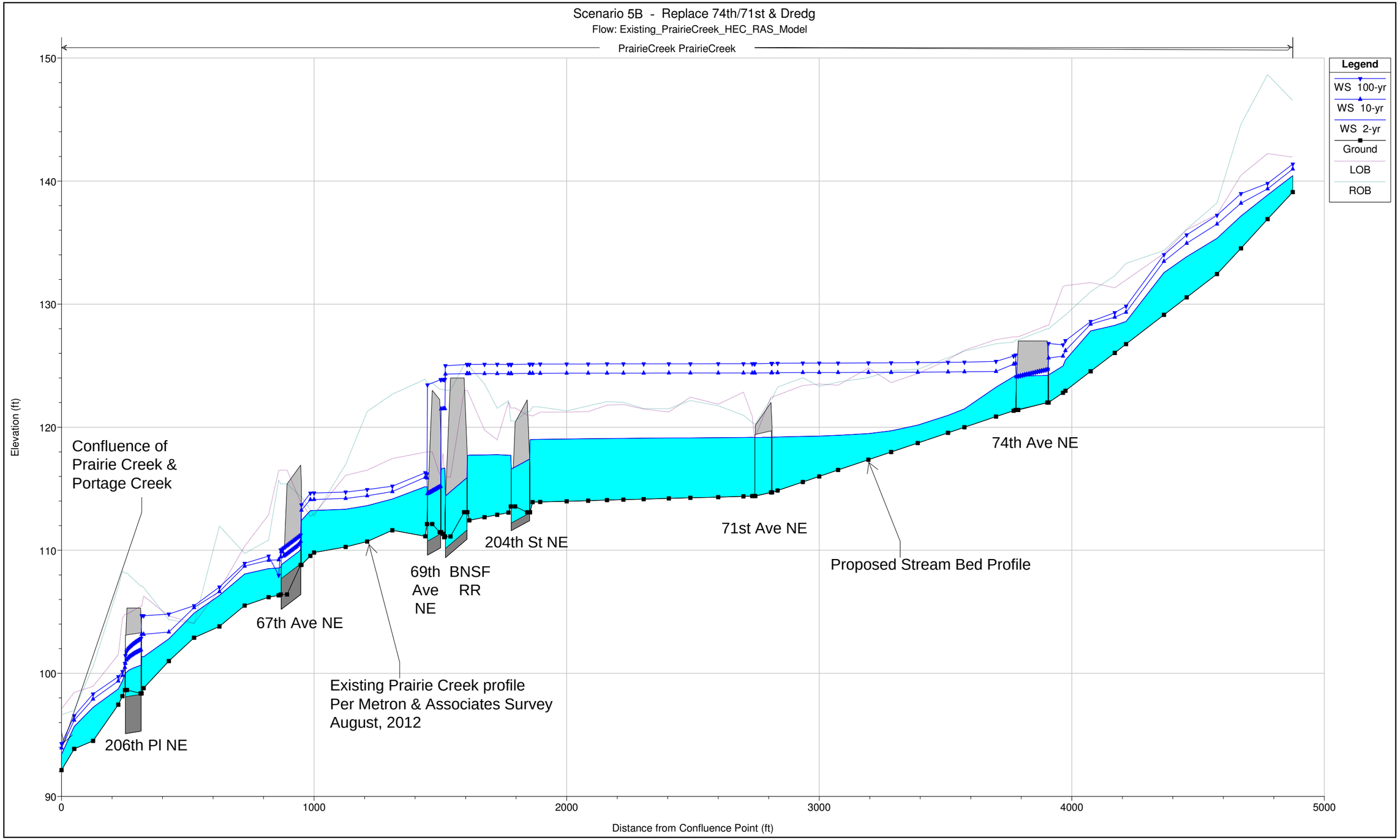
Scenario 5B - Replace 74th/71st & Dredg
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
Distance from Confluence Point (ft)
Confluence of Prairie Creek & Portage Creek
206th Pl NE
67th Ave NE
69th Ave NE
BNSF RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile Per Metron & Associates Survey August, 2012
Proposed Stream Bed Profile

Exhibit C7.2

HEC-RAS Plan: Scenario 5B River: PrairieCreek Reach: PrairieCreek

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981 74th Ave	2-yr	124.31	124.25	123.38	124.31	127.01	93.66		0.09	2.24	1.83
PrairieCreek	3981 74th Ave	10-yr	125.70	125.63	124.14	125.70	127.01	181.79		0.45	3.54	3.54
PrairieCreek	3981 74th Ave	100-yr	126.89	126.81	124.68	126.89	127.01	255.02		0.95	4.97	4.97
PrairieCreek	2886 71st Ave	2-yr	119.22	119.19	116.33	119.22	122.01	101.45		0.03	1.42	1.33
PrairieCreek	2886 71st Ave	10-yr	124.43	124.42	117.22	124.43	122.01	87.44	107.72	0.02	1.09	1.09
PrairieCreek	2886 71st Ave	100-yr	125.20	125.18	117.85	125.20	122.01	105.46	167.28	0.03	1.32	1.32
PrairieCreek	1928 204th St	2-yr	119.01	118.98	117.08	119.01	122.23	106.03		1.26	5.81	5.81
PrairieCreek	1928 204th St	10-yr	124.39	124.38	120.71	124.39	122.23	17.20	185.67	0.03	0.94	0.94
PrairieCreek	1928 204th St	100-yr	125.13	125.12	125.11	125.13	122.23	14.18	268.76	0.03	0.78	0.78
PrairieCreek	1680 BNSF RR	2-yr	117.74	117.70	115.59	117.74	124.01	107.72		1.03	6.04	6.04
PrairieCreek	1680 BNSF RR	10-yr	124.36	124.35	118.76	124.36	124.01	175.13	30.59	2.84	9.83	9.83
PrairieCreek	1680 BNSF RR	100-yr	125.10	125.10	122.74	125.10	124.01	114.96	171.75	1.22	6.45	6.45
PrairieCreek	1576 69th Ave	2-yr	116.69	116.58	115.42	116.69	123.01	108.03		1.44	6.62	6.62
PrairieCreek	1576 69th Ave	10-yr	121.53	121.49	120.04	121.53	123.01	206.23		5.62	12.65	12.65
PrairieCreek	1576 69th Ave	100-yr	123.90	123.86	123.62	123.90	123.01	240.49	46.90	7.65	14.75	14.75
PrairieCreek	1022 67th Ave	2-yr	110.97	112.44	110.78	110.97	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022 67th Ave	10-yr	112.08	113.25	112.07	112.08	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022 67th Ave	100-yr	112.87	113.69	113.29	112.87	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390 206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390 206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390 206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

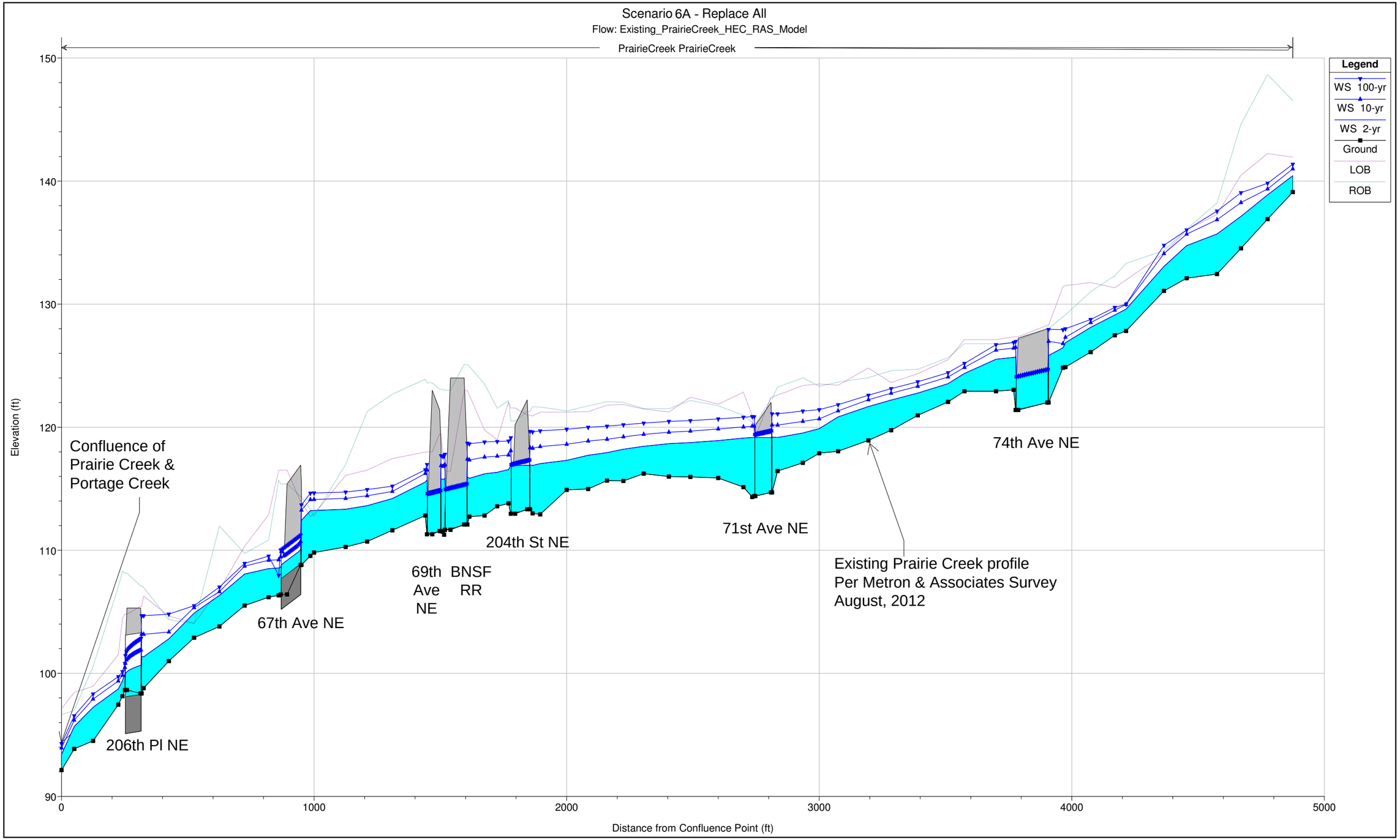
Scenario 6A - Replace All
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012

Exhibit C7.2

HEC-RAS Plan: Scenario 6A River: PrairieCreek Reach: PrairieCreek

Reach	River Sta		Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
				(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981	74th Ave	2-yr	125.85	125.83	123.38	125.85	128.01	93.66		0.12	1.83	1.83
PrairieCreek	3981	74th Ave	10-yr	127.02	126.98	124.14	127.02	128.01	181.79		0.49	3.54	3.54
PrairieCreek	3981	74th Ave	100-yr	127.99	127.95	124.68	127.99	128.01	255.02		0.98	4.97	4.97
PrairieCreek	2886	71st Ave	2-yr	119.21	119.19	116.33	119.21	122.01	101.45		0.03	1.42	1.33
PrairieCreek	2886	71st Ave	10-yr	120.24	120.19	117.22	120.24	122.01	195.16		0.11	2.44	2.44
PrairieCreek	2886	71st Ave	100-yr	121.16	121.09	117.85	121.16	122.01	272.74		0.24	3.41	3.41
PrairieCreek	1928	204th Street	2-yr	116.97	116.94	115.01	116.97	122.23	106.03		0.05	1.86	1.69
PrairieCreek	1928	204th Street	10-yr	118.39	118.34	115.91	118.39	122.23	202.87		0.24	3.17	3.17
PrairieCreek	1928	204th Street	100-yr	119.71	119.65	116.56	119.71	122.23	282.94		0.51	4.42	4.42
PrairieCreek	1680	BNSF RR	2-yr	115.98	115.95	113.78	115.98	124.01	107.72		0.11	2.04	2.04
PrairieCreek	1680	BNSF RR	10-yr	117.45	117.41	114.70	117.45	124.01	205.72		0.45	3.90	3.90
PrairieCreek	1680	BNSF RR	100-yr	118.74	118.70	115.34	118.74	124.01	286.71		0.91	5.43	5.43
PrairieCreek	1576	69th Ave	2-yr	115.83	115.80	113.26	115.83	123.01	108.03		0.08	2.05	2.05
PrairieCreek	1576	69th Ave	10-yr	116.95	116.87	114.17	116.95	123.01	206.23		0.35	3.91	3.91
PrairieCreek	1576	69th Ave	100-yr	117.80	117.69	114.82	117.80	123.01	287.39		0.72	5.44	5.44
PrairieCreek	1022	67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022	67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022	67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390	206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390	206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390	206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

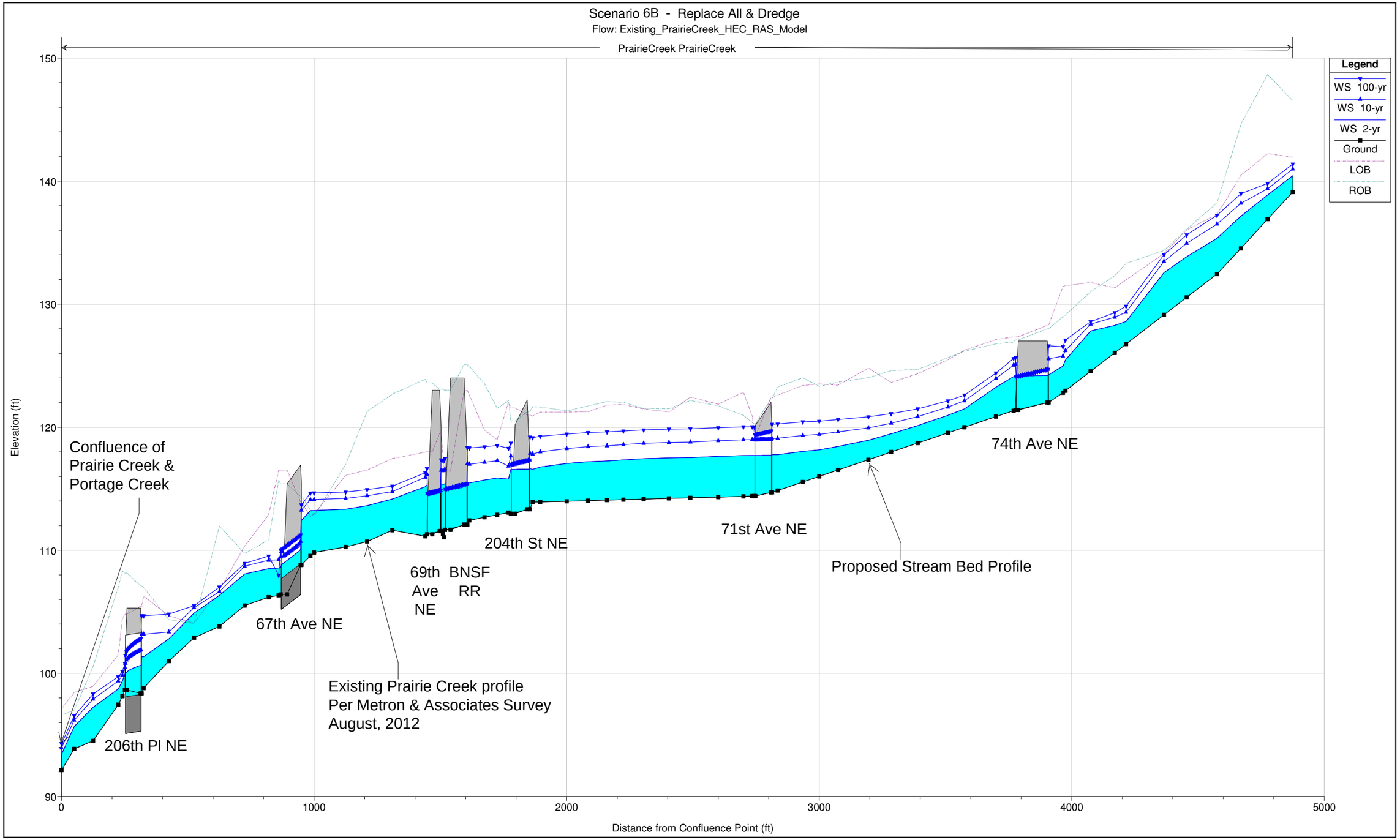
Scenario 6B - Replace All & Dredge
Flow: Existing_PrairieCreek_HEC_RAS_Model
PrairieCreek PrairieCreek
Legend
WS 100-yr
WS 10-yr
WS 2-yr
Ground
LOB
ROB
Elevation (ft)
150
140
130
120
110
100
90
0
1000
2000
3000
4000
5000
Distance from Confluence Point (ft)
Confluence of
Prairie Creek &
Portage Creek
206th Pl NE
67th Ave NE
69th
Ave
NE
BNSF
RR
204th St NE
71st Ave NE
74th Ave NE
Existing Prairie Creek profile
Per Metron & Associates Survey
August, 2012
Proposed Stream Bed Profile

Exhibit C7.2

HEC-RAS Plan: Scenario 6B River: PrairieCreek Reach: PrairieCreek

Reach	River Sta		Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
				(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PrairieCreek	3981	74th Ave	2-yr	124.31	124.25	123.38	124.31	127.01	93.66		0.09	2.24	1.83
PrairieCreek	3981	74th Ave	10-yr	125.64	125.56	124.14	125.64	127.01	181.79		0.44	3.54	3.54
PrairieCreek	3981	74th Ave	100-yr	126.70	126.61	124.68	126.70	127.01	255.02		0.94	4.97	4.97
PrairieCreek	2886	71st Ave	2-yr	117.82	117.77	116.33	117.82	122.01	101.45		0.06	2.10	1.92
PrairieCreek	2886	71st Ave	10-yr	119.17	119.08	117.22	119.17	122.01	195.16		0.11	2.84	2.67
PrairieCreek	2886	71st Ave	100-yr	120.33	120.23	117.85	120.33	122.01	272.74		0.21	3.41	3.41
PrairieCreek	1928	204th St	2-yr	116.68	116.64	115.01	116.68	122.23	106.03		0.06	2.03	1.84
PrairieCreek	1928	204th St	10-yr	117.95	117.89	115.91	117.95	122.23	202.87		0.22	3.17	3.17
PrairieCreek	1928	204th St	100-yr	119.27	119.20	116.56	119.27	122.23	282.94		0.50	4.42	4.42
PrairieCreek	1680	BNSF RR	2-yr	115.56	115.52	113.78	115.56	124.01	107.72		0.10	2.04	2.04
PrairieCreek	1680	BNSF RR	10-yr	117.07	117.03	114.70	117.07	124.01	205.72		0.44	3.90	3.90
PrairieCreek	1680	BNSF RR	100-yr	118.39	118.35	115.34	118.39	124.01	286.71		0.91	5.43	5.43
PrairieCreek	1576	69th Ave	2-yr	115.42	115.38	113.26	115.42	123.01	108.03		0.07	2.05	2.05
PrairieCreek	1576	69th Ave	10-yr	116.60	116.51	114.17	116.60	123.01	206.23		0.34	3.91	3.91
PrairieCreek	1576	69th Ave	100-yr	117.47	117.34	114.82	117.47	123.01	287.39		0.71	5.44	5.44
PrairieCreek	1022	67th Ave	2-yr	110.91	112.44	110.78	110.91	116.93	108.03		3.81	6.17	6.51
PrairieCreek	1022	67th Ave	10-yr	112.07	113.25	112.07	111.99	116.93	206.23		3.79	7.65	6.30
PrairieCreek	1022	67th Ave	100-yr	112.76	113.69	113.29	112.76	116.93	287.39		3.65	8.32	8.32
PrairieCreek	0390	206th Pl	2-yr	101.44	101.36	101.05	101.44	105.31	108.03		1.40	5.79	7.27
PrairieCreek	0390	206th Pl	10-yr	103.24	103.18	102.77	103.24	105.31	206.23		2.70	7.57	9.72
PrairieCreek	0390	206th Pl	100-yr	104.72	104.68	104.49	104.72	105.31	287.39		3.87	8.99	11.25

APPENDIX D

INTERIM DRAINAGE IMPROVEMENTS MEMORANDUM

Murray, Smith & Associates, Inc.
Engineers/Planners

2707 Colby Avenue, Suite 1110 ■ Everett, WA 98201-3566 ■ PHONE 425.252.9003 ■ FAX 425.252.8853

TECHNICAL MEMORANDUM

DATE: October 24, 2012

TO: James Kelly, P.E. - Public Works Director, City of Arlington

FROM: Nathan Hardy, P.E. - Murray, Smith & Associates, Inc.
Ken McIntyre, P.E. - Murray, Smith & Associates, Inc.
Jenna Thelen, EIT - Murray, Smith & Associates, Inc.

RE: City of Arlington, Prairie Creek Drainage Improvement Project
Interim Drainage Improvements

Introduction and Background

The City of Arlington (City) has authorized Murray, Smith & Associates, Inc. (MSA) to provide engineering services for a two phase work program to reduce the risk of local flooding impacts and improve the function of Prairie Creek. The first phase of engineering services include development of a hydrologic basin model, a hydraulic stream routing model and preparation of a preliminary design memorandum to document recommended improvements for up to five undersized culverts. The second phase of engineering services will include final design of recommended improvements.

During the first phase of engineering services, the City has requested that MSA evaluate potential options for interim drainage improvements to Prairie Creek that could be implemented in the fall of 2012. These options could potentially improve the hydraulic capacity and function of Prairie Creek while reducing (not eliminating) the risk of local flooding impacts to key businesses within the City prior to the implementation of culvert replacements which will occur no earlier than the summer of 2013.

Purpose

The purpose of this memorandum is to describe potential options for interim drainage improvements to Prairie Creek that could be implemented in the fall of 2012.

Interim Drainage Improvement Options

The following options were developed based on conversations with the City during the project kickoff meeting and site visits with City staff, design survey information, proposed improvements associated with the 67th Ave Phase III Reconstruction project and preliminary hydraulic modeling results. These potential options are listed below, followed by descriptions starting at the most downstream locations.

- Option 1: Drainage ditch improvements between Portage and Prairie Creeks adjacent to BNSF and 69th Ave NE (Haskins Rd).
- Option 2: Raising berms adjacent to Prairie Creek.
- Option 3: Installing a temporary headwall on the inlet of the 74th Ave NE culvert and providing a backwater route upstream.

Option 1

Option 1 involves grading modifications to the existing ditch along the BNSF railroad to the north of Prairie Creek and 204th Street NE. The objective of this option is to provide backwater storage and/or overflow from Prairie Creek north to Portage Creek during high flow events that cannot be adequately passed by the culvert at 69th Ave NE (Haskins Road).

Constructability – A significant amount of grading work will be required to create a channel north of Prairie Creek. The stream channel upstream of the 69th Ave NE (Haskins Rd) culvert is at elevation 111.3' with an observed summertime low flow water surface at approximately 113.8'. The proposed grade for the Centennial Trail improvements adjacent to this section will have a low point of approximately 115.0' at six-hundred feet north of Prairie Creek. The elevation of the business parking lot also located to the north is also at approximately 116.0'.

The existing rock headwall located on the north side of the channel is at elevation 115.0' and would need to be lowered to approximately elevation 113.5' (below the ordinary high water mark) in order to maximize the benefits of this backwater storage/overflow channel so as not to overtop the proposed Centennial Trail improvements or the business parking lot. A simple channel could be constructed at a relatively flat slope that would slope southwards towards Prairie Creek.

Ability to Reduce Local Flooding Impacts – Preliminary modeling results indicate that the grading modifications to the existing ditch along the BNSF railroad may likely help reduce the magnitude of local flooding impacts to the businesses located adjacent to Prairie Creek, but only during larger storm events. This is largely due to the hydraulic restrictions upstream at the 74th Ave NE culvert. These modifications are not likely to reduce the overtopping that will still occur at 74th Ave NE culvert even at lower frequency storm events and will likely continue to cause localized flooding.

Permitting - Working within the ordinary high water mark would require a Nationwide Permit through the US Army Corps of Engineers and potentially a Hydraulic Project Approval (HPA) through the Washington Department of Fish and Wildlife (WDFW). Additionally, this option requires grading work within BNSF right of way and therefore requires a permit from BNSF for the work.

Due to the proposed improvements likely requiring a great deal of permitting and agency coordination, as well as the fact that they are unlikely to greatly reduce the local flooding impacts, implementing this option in the fall of 2012 does not appear to be feasible.

Option 2

This option includes raising the berms on Prairie Creek between the 204th St NE and 74th Ave NE culverts. The objective of Option 2 is to raise the top of berm elevations to increase the bank full storage capacity of Prairie Creek.

Constructability – This option would be difficult to construct due to the large amount of fill required to raise the elevation of the berms and limited access from the adjacent businesses. Additionally, in order to maintain a consistent higher berm elevation between these culverts, modifications would have to be made to the access bridge and driveway for Absolute Manufacturing.

Ability to Reduce Local Flooding Impacts – Preliminary modeling results indicate that raising the top berm elevations may help reduce the magnitude of local flooding impacts to the businesses located adjacent to Prairie Creek, but only during larger storm events. This is largely due to the hydraulic restrictions upstream at the 74th Ave NE culvert. These modifications are not likely to reduce the overtopping that will still occur at 74th Ave NE culvert even at lower frequency storm events and will likely to continue to cause localized flooding.

Permitting – The construction associated with this option would occur outside of the ordinary high water mark and other critical areas, therefore federal and state permitting would not be required.

Due to the proposed improvements being disruptive to local businesses and the fact that they are unlikely to greatly reduce the frequency of local flooding impacts, implementing this option in the fall of 2012 does not appear to be feasible.

Option 3

Option 3 involves installing a temporary headwall on the inlet of the 74th Ave NE culvert and raising the elevation of the berms within the vicinity, as presented in Figure 1 (attached). The objective of this option is to provide backwater storage upstream of the 74th Ave NE culvert and increase the elevation in which backwater overtops the roadway.

Constructability - A moderate amount of fill or other temporary berm material such as sand construction bags will be required in order to impound additional water without causing supplementary flooding impacts to the surrounding area. The temporary headwall could be built to an elevation of 129'. The surrounding berms would be built up to an elevation of approximately 130' to ensure the water would overtop the roadway in the same area as it currently overtops. The existing low point near the sidewalk on the upstream side of the culvert is at elevation 127.0', therefore an additional two feet of storage would be possible. Refer to the attached figure for more information on the estimated construction impacts and water inundation area.

To construct this option, Haggen Food and Pharmacy would have to provide their consent and allow a berm to be constructed on their property.

Ability to Reduce Local Flooding Impacts - Field investigations and preliminary modeling results indicate the existing culvert at 74th Ave NE has the least available hydraulic capacity and will overtop the roadway during a 2-year storm event. Currently there is approximately 2.3' of storage from the vertical separation between the roadway surface and the top of the culvert. The temporary headwall and increased berm height will provide approximately 4.3' of storage, prior to overtopping the roadway. These modifications are likely to reduce the risk of flooding to the local businesses without adversely impacting Haggen Food and Pharmacy or the existing residence upstream of the culvert. Final modeling and analysis (which will be completed and presented to the City in the next few weeks) will be necessary to determine the increased volume of storage.

Permitting - Additional field investigations would be necessary to ensure that wetlands don't exist in the proposed fill areas and that work would occur outside the ordinary high water mark (City staff may be able to confirm this). Depending on the outcome of these additional field investigations, a Nationwide Permit and potentially a HPA may be required. The initial investigations suggest all construction activity would occur outside of critical areas and would not require federal and state permitting.

Based on the results of our preliminary work to date and the factors described above, this option appears to be better than the prior two options in providing interim drainage improvements to reduce the risk of flooding impacts to Prairie Creek prior to implementing proposed culvert replacements starting in 2013.

NPH:jlt

Attachment

FIGURE 1

CITY OF ARLINGTON

PRAIRIE CREEK DRAINAGE IMPROVEMENTS

OCTOBER 2012

MSA Murray, Smith & Associates, Inc. Engineers/Planners
2707 Colby Avenue, Suite 1110 PHONE 425.252.9033
Everett, Washington 98201-3566 FAX 425.252.8853

12-1347.104

H:\EVT_Projects\12\1347\CAD\GIS\12-1347-104-WA-DRAINAGE-FIGURE 1.mxd 10/23/2012 2:01:30 PM PSW

FIGURE 2

CITY OF ARLINGTON

PRAIRIE CREEK DRAINAGE IMPROVEMENTS

INTERIM DRAINAGE IMPROVEMENTS - 74TH AVE NE

OCTOBER 2012

MSA Murray, Smith & Associates, Inc.
Engineers/Planners
2707 Colby Avenue, Suite 1110
Everett, Washington 98201-3566
PHONE 425.252.9003
FAX 425.252.8053

H:\EVT_Projects\12\1347\CAD\Figures\INTERIM DR IMPVTS.dwg FIGURE 2 10/24/2012 8:32 AM ENGCAD 18.1s (LMS Tech)

APPENDIX E

DETAILED CONCEPTUAL LEVEL SCENARIO COST ESTIMATES

CITY OF ARLINGTON, WASHINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS
ENGINEER'S OPINION OF CONCEPTUAL LEVEL CONSTRUCTION COST
November 2012

Scenario 2: Maintenance Dredging

No.	Item Description	Estimated		Unit Cost	Total Cost
1	Mobilization, Bonds, Insurance and Demobilization (10%)	LS	1	$7,200	$7,200
2	Temporary Sedimentation & Erosion Control	LS	1	$2,200	$2,200
3	Temporary Traffic Control	LS	1	$5,000	$5,000
4	Excavation & Disposal	CY	500	$40	$20,000
5	Temporary Dewatering	LS	1	$50,000	$50,000
6	Misc. Landscaping	LS	1	$2,000	$2,000
				Subtotal	$86,400
				Contingency (30%)	$25,920
				Construction Subtotal	**$112,320**
				Sales Tax (8.6%)	$9,660
				TOTAL ESTIMATED CONSTRUCTION COST	**$120,000**

CITY OF ARLINGTON, WASHINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS
ENGINEER'S OPINION OF CONCEPTUAL LEVEL CONSTRUCTION COST
November 2012

Scenario 3: Maintenance Dredging and Additional Accumulated Sediment Removal Between Culverts

No.	Item Description	Estimated		Unit Cost	Total Cost
1	Mobilization, Bonds, Insurance and Demobilization (10%)	LS	1	$25,200	$25,200
2	Temporary Sedimentation & Erosion Control	LS	1	$5,000	$5,000
3	Temporary Traffic Control	LS	1	$2,500	$2,500
4	Excavation & Disposal	CY	5000	$35	$175,000
5	Temporary Dewatering	LS	1	$75,000	$75,000
6	Misc. Landscaping	LS	1	$2,000	$2,000
				Subtotal	$284,700
				Contingency (30%)	$85,410
				Construction Subtotal	**$370,110**
				Sales Tax (8.6%)	$31,829
				TOTAL ESTIMATED CONSTRUCTION COST	**$400,000**

CITY OF ARLINGTON, WASHINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS
ENGINEER'S OPINION OF CONCEPTUAL LEVEL CONSTRUCTION COST
November 2012

Scenario 4A: Replacing 74th Ave NE Culvert

No.	Item Description	Estimated		Unit Cost	Total Cost
1	Mobilization, Bonds, Insurance and Demobilization (10%)	LS	1	$32,800	$32,800
2	Temporary Sedimentation & Erosion Control	LS	1	$6,600	$6,600
3	Temporary Traffic Control	LS	1	$5,000	$5,000
4	Excavation & Disposal	LF	130	$500	$65,000
5	Dewatering During Construction	LS	1	$10,000	$10,000
6	Road Restoration	LS	1	$25,000	$25,000
7	Culvert Replacement - Fish Passable Culverts	LF	130	$1,600	$208,000
8	Stream Restoration - 100 ft up & downstream of culvert	LS	1	$18,000	$18,000
9	Misc. Landscaping	LS	1	$2,000	$2,000
				Subtotal	$372,400
				Contingency (25%)	$93,100
				Construction Subtotal	**$465,500**
				Sales Tax (8.6%)	$40,033
				TOTAL ESTIMATED CONSTRUCTION COST (ROUNDED)	**$500,000**

CITY OF ARLINGTON, WASHINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS
ENGINEER'S OPINION OF CONCEPTUAL LEVEL CONSTRUCTION COST
November 2012

Scenario 5A: Replacing 74th Ave NE & 71st Ave NE Culverts

No.	Item Description	Estimated		Unit Cost	Total Cost
1	Mobilization, Bonds, Insurance and Demobilization (10%)	LS	1	$56,600	$56,600
2	Temporary Sedimentation & Erosion Control	LS	1	$11,300	$11,300
3	Temporary Traffic Control	LS	1	$10,000	$10,000
4	Excavation & Disposal	LF	205	$500	$102,500
5	Dewatering During Construction	LS	1	$35,000	$35,000
6	Road Restoration	LS	1	$60,000	$60,000
7	Culvert Replacement - Fish Passable Culverts (2 total)	LF	205	$1,600	$328,000
8	Stream Restoration - 100 ft up & downstream of culvert	LS	1	$36,000	$36,000
9	Misc. Landscaping	LS	1	$4,000	$4,000
				Subtotal	$643,400
				Contingency (25%)	$160,850
				Construction Subtotal	**$804,250**
				Sales Tax (8.6%)	$69,166
				TOTAL ESTIMATED CONSTRUCTION COST	**$900,000**

CITY OF ARLINGTON, WASHINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS
ENGINEER'S OPINION OF CONCEPTUAL LEVEL CONSTRUCTION COST
November 2012

Scenario 6A: Replacing All Culverts

No.	Item Description	Estimated		Unit Cost	Total Cost
1	Mobilization, Bonds, Insurance and Demobilization (10%)	LS	1	$191,400	$191,400
2	Temporary Sedimentation & Erosion Control	LS	1	$38,300	$38,300
3	Temporary Traffic Control	LS	1	$29,000	$29,000
4	Existing Utility Coordination	LS	1	$12,000	$12,000
5	Excavation & Disposal	LF	335	$500	$167,500
6	Dewatering During Construction	LS	1	$50,000	$50,000
7	Road Restoration	LF	400	$300	$120,000
8	Culvert Replacement - Fish Passable Culverts (3 total)	LF	335	$1,600	$536,000
9	Culvert Replacement - BNSF RR (Trenchless Installation)	LF	100	$9,400	$940,000
10	Stream Restoration - 100 ft up & downstream of culvert	LS	1	$90,000	$90,000
11	Misc. Landscaping	LS	1	$10,000	$10,000
				Subtotal	$2,184,200
				Contingency (25%)	$546,050
				Construction Subtotal	**$2,730,250**
				Sales Tax (8.6%)	$234,802
				TOTAL ESTIMATED CONSTRUCTION COST	**$3,000,000**

APPENDIX F

CONCEPTUAL LEVEL DESIGN PLANS

CITY OF ARLINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS

NOVEMBER 2012

PRELIMINARY
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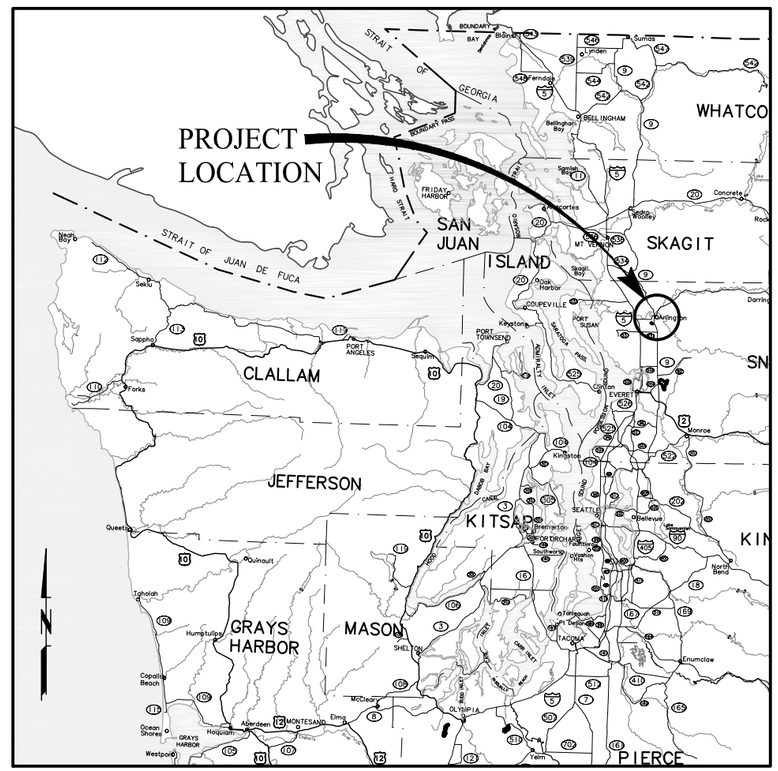
DRAWING INDEX

GENERAL

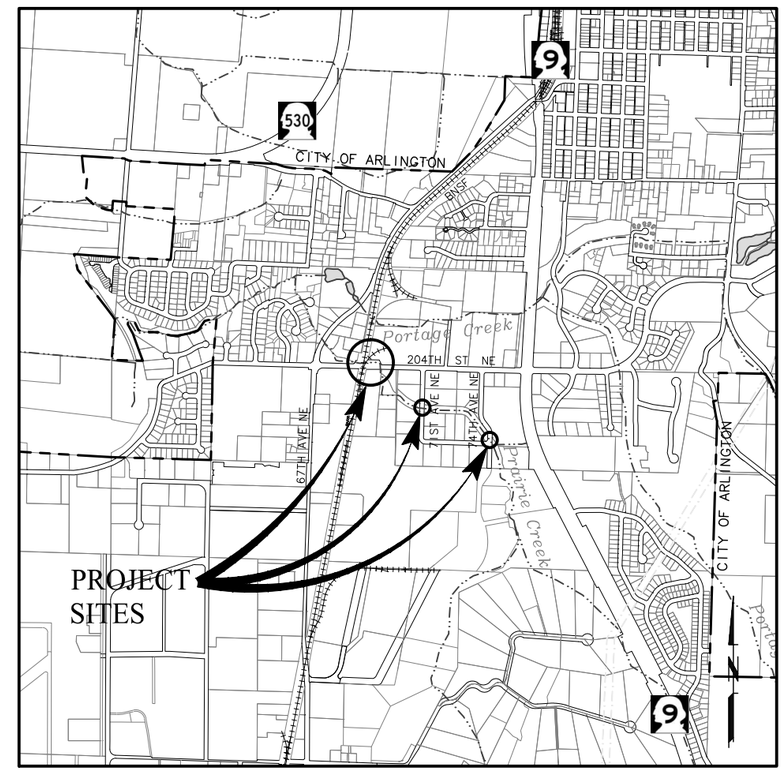
1	G-1	VICINITY MAP, LOCATION MAP AND INDEX OF DRAWINGS
2	G-2	ABBREVIATIONS, SYMBOLS AND LEGEND, AND GENERAL NOTES

CIVIL

3	C-1	74TH AVE CULVERT PLAN AND PROFILE
4	C-2	71ST AVE CULVERT PLAN AND PROFILE
5	C-3	69TH AVE, BNSF, 204TH ST CULVERTS PLAN AND PROFILE



VICINITY MAP
SCALE: 1"=80,000'



LOCATION MAP
SCALE: 1"=500'

811
Know what's **below.**
Call before you dig.

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MSA
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Engineers/Planners
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Everett, Washington 98201-3566 FAX 425-252-8853

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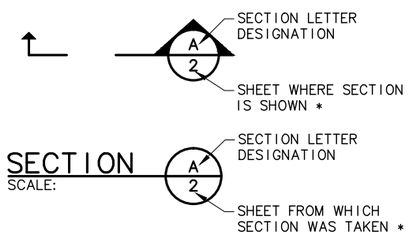
ABBREVIATIONS

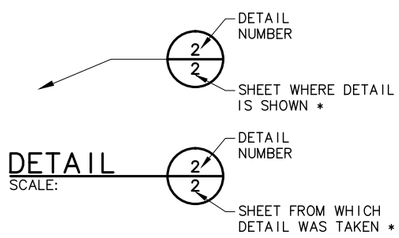
ABAND	ABANDONED
AC	ASPHALTIC CONCRETE
AWWA	AMERICAN WATER WORKS ASSOCIATION
BLDG	BUILDING
BTM	BOTTOM
C	CENTERLINE
CB	CATCH BASIN
CDF	CONTROLLED DENSITY FILL
CL	CLASS
CLR	CLEARANCE
CMP	CORRUGATED METAL PIPE
COORD	COORDINATE
CONC	CONCRETE
CPLG	COUPLING
CY	CUBIC YARD
DET	DETAIL
DI	DUCTILE IRON
DIA	DIAMETER
DR	DRIVEWAY
DWG	DRAWING
E	EAST
EA	EACH
EL	ELEVATION
EQ	EQUAL
ESC	EROSION AND SEDIMENT CONTROL
EX	EXISTING
EXIST	EXISTING
FLG	FLANGE
FM	FORCE MAIN
FT	FEET
G	GAS
GALV	GALVANIZED
GEN	GENERAL
HORIZ	HORIZONTAL(LY)
ID	INSIDE DIAMETER
IE	INVERT ELEVATION
INSTL	INSTALL
INV	INVERT
L	LENGTH
LF	LINEAR FOOT
LT	LEFT
LTF	LENGTH TO FIT
MFR	MANUFACTURER
MH	MANHOLE
MJ	MECHANICAL JOINT
MIN	MINIMUM
N	NORTH
NIC	NOT IN CONTRACT
NOM	NOMINAL
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PL	PLASTIC
PVC	POLYVINYL CHLORIDE
PWR	POWER
RESTR	RESTRAIN(ED)
RJ	RESTRAINED JOINT PIPE
RT	RIGHT
R/W	RIGHT OF WAY
S	SOUTH
SCHED	SCHEDULE
SD	STORM DRAIN
SDMH	STORM MANHOLE
SERV	SERVICE
SHT(S)	SHEET(S)
SL	SLOPE
SPECS	SPECIFICATIONS
SQ	SQUARE
SS	SANITARY SEWER
SSCO	SANITARY SEWER CLEANOUT
SSMH	SANITARY SEWER MANHOLE
STA	STATION
STD	STANDARD
STL	STEEL
S/W	SIDEWALK
T, TEL	TELEPHONE
TB	THRUST BLOCK
TEMP	TEMPORARY
TRANS	TRANSITION
TYP	TYPICAL
VERT	VERTICAL(LY)
UGP	UNDERGROUND POWER LINE
UGT	UNDERGROUND TELEPHONE
W	WATER, WEST
WSDOT	WASHINGTON DEPARTMENT OF TRANSPORTATION
WV	WATER VALVE

SECTION AND DETAIL DESIGNATIONS

SECTION DESIGNATIONS



DETAIL DESIGNATIONS



* NOTE: IF PLAN AND SECTION FOR DETAIL CALL-OUT AND DETAIL ARE SHOWN ON THE SAME DRAWING, DRAWING NUMBER IS REPLACED WITH A DASH.

LEGEND

	EXISTING	PROPOSED
WATERLINE	12"W	20"DI W
ELECTRICITY	UGP/OHD	
GAS	4"G	
TELEPHONE/TELEMETRY	T T	
SANITARY SEWER LINE	8"SS	
SANITARY SEWER FORCE MAIN	4"FM	
STORM DRAIN	8"SD	8"SD
CULVERT		8"D
ABANDON PIPE		
DRAINAGE DITCH		
TOP OF BANK		
FENCE	X X X	X X X
CHAIN LINK FENCE		
TEMPORARY SILT FENCE		
STRAW WATTLE		
TREE/BUSH LINE		
RETAINING WALL		
CENTERLINE		
EASEMENT/PROPERTY LINE		
RIGHT-OF-WAY		
EDGE OF PAVEMENT/AC		
EDGE OF GRAVEL		
CURB		
SIDEWALK	S/W	S/W
STRUCTURE OR FACILITY		
CONTOUR MINOR		
CONTOUR MAJOR	200	200

	EXISTING	PROPOSED
MANHOLE		
CLEAN-OUT		
CATCH BASIN/FIELD INLET		
FITTING		
CAP		
THRUST BLOCK		
VALVE		
BLOW-OFF ASSEMBLY		
AIR RELEASE ASSEMBLY		
AIR/VAC ASSEMBLY		
FIRE HYDRANT ASSEMBLY		
WATER METER		
PULL BOX/JUNCTION BOX		
UTILITY POLE		
GUY WIRE		
LIGHT POST		
MAIL BOX		
SIGN		
BENCH MARK		
TREE DECIDUOUS		
TREE CONIFEROUS		
TREE TO BE REMOVED		
SURFACE ELEVATION	+ 176.63	+ 176.63
CATCH BASIN INSERT		
INLET PROTECTION BIOBAG		

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NO.	DATE	BY	REVISION

NOTICE
0 ½ 1
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NPH CHECKED

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November 14, 2012
MURRAY, SMITH & ASSOCIATES, INC.
PROFESSIONAL ENGINEERS

MSA Murray, Smith & Associates, Inc. Engineers/Planners
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Everett, Washington 98201-3566 FAX 425.252.8853

CITY OF ARLINGTON
PRAIRIE CREEK DRAINAGE IMPROVEMENTS

ABBREVIATIONS, SYMBOLS AND LEGEND, AND GENERAL NOTES

PROJECT NO.: 12-1347.104 | SCALE: AS SHOWN | DATE: November 2012

SHEET G-2

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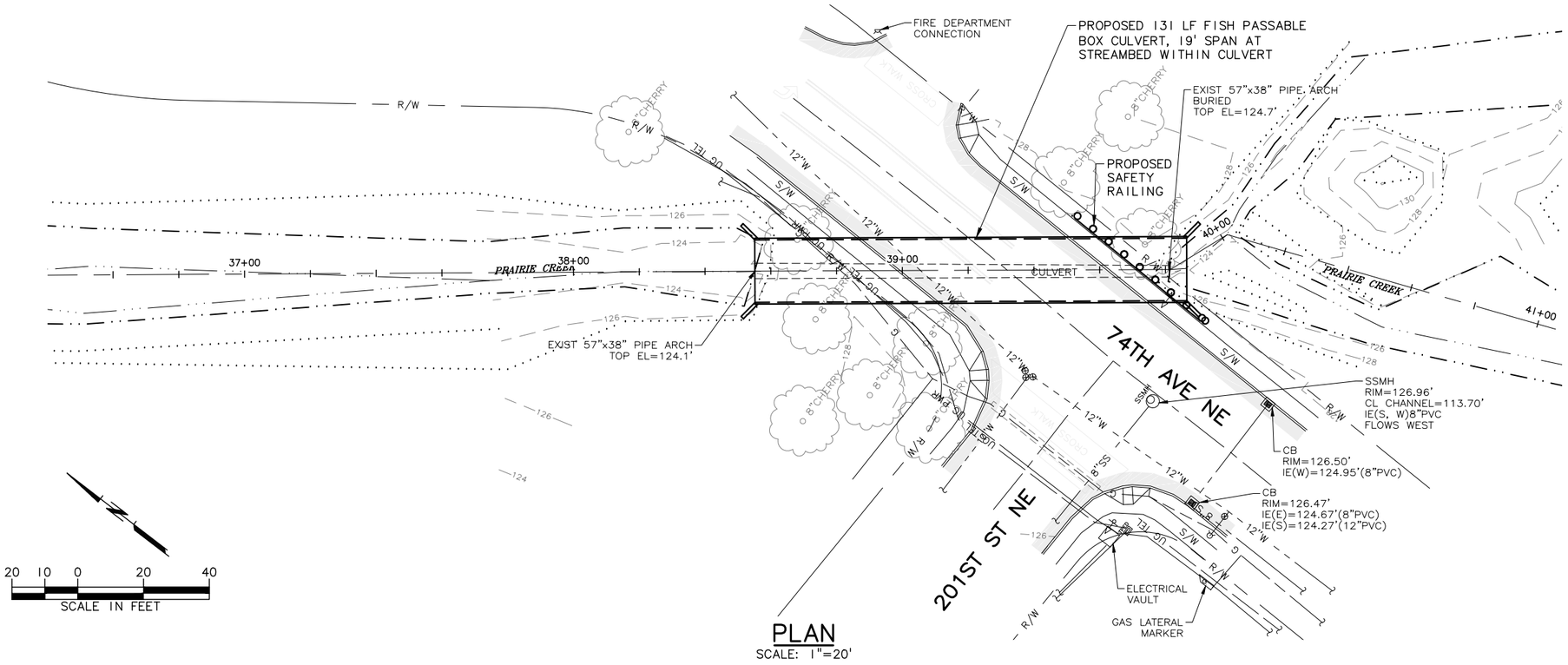
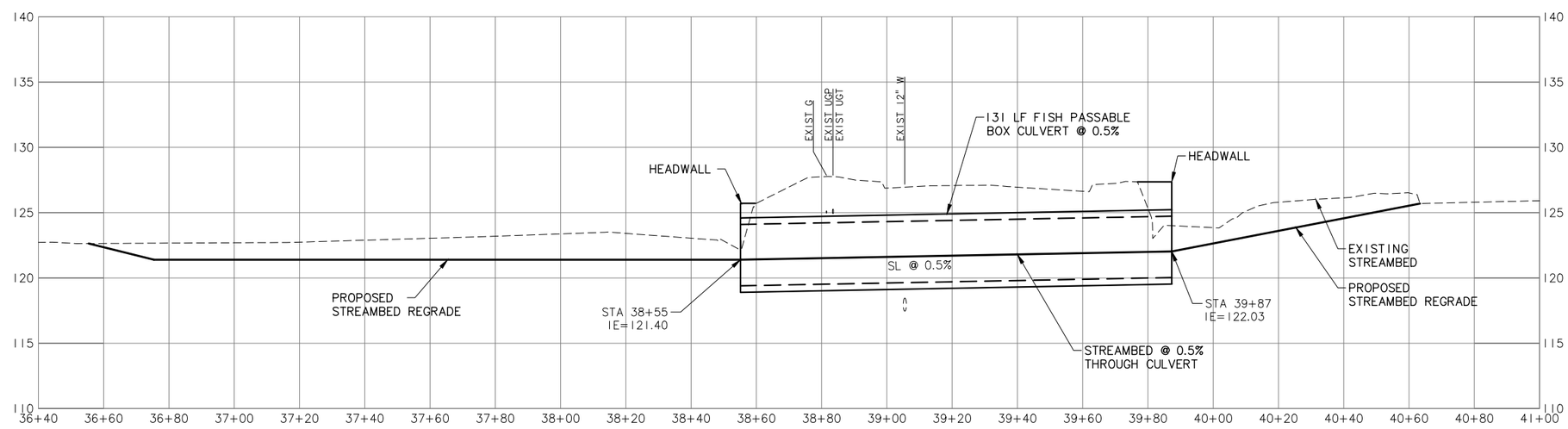


PLAN

SCALE: 1"=20'



PROFILE – 74TH AVE CULVERT

SCALE: 1"=20' HORIZ, 1"=5' VERT

NOTES:

1. VERTICAL LOCATION OF EXISTING UTILITIES HAS NOT YET BEEN VERIFIED. VERTICAL LOCATIONS SHOWN IN THE PROFILE ARE ASSUMED.

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CITY OF ARLINGTON

CITY OF ARLINGTON PRAIRIE CREEK DRAINAGE IMPROVEMENTS

74TH AVE CULVERT PLAN & PROFILE

PROJECT NO.: 12-1347.104 | SCALE: AS SHOWN | DATE: November 2012

SHEET C-1

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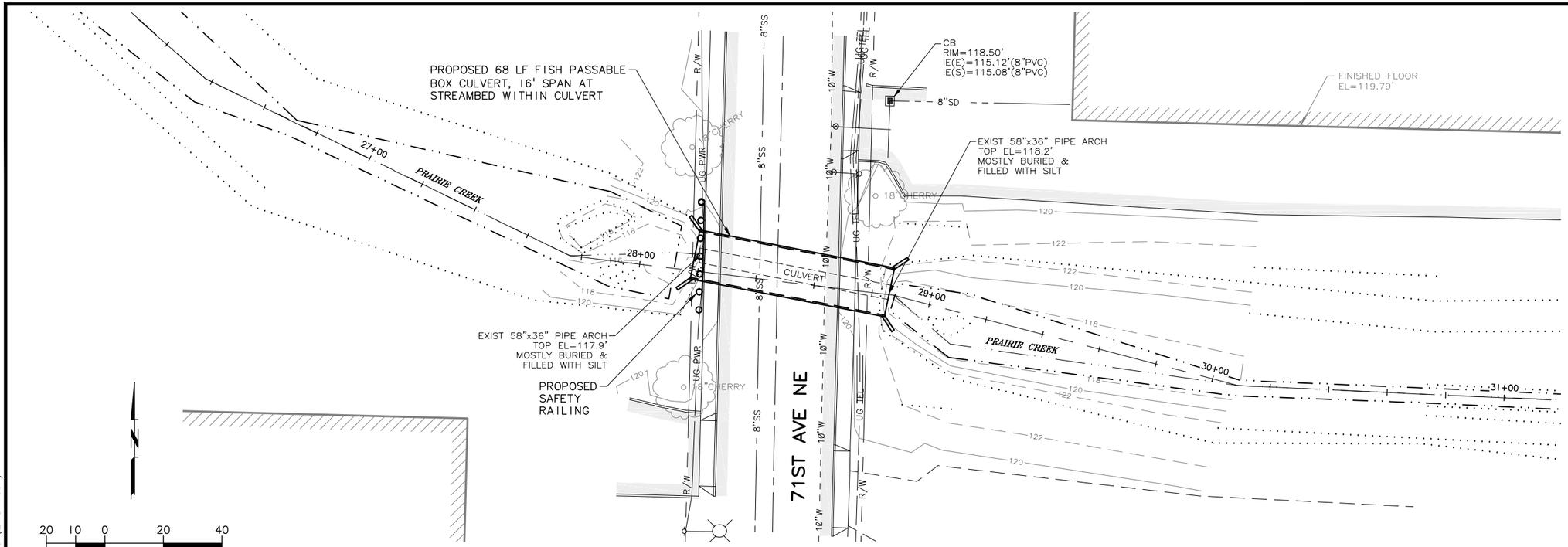
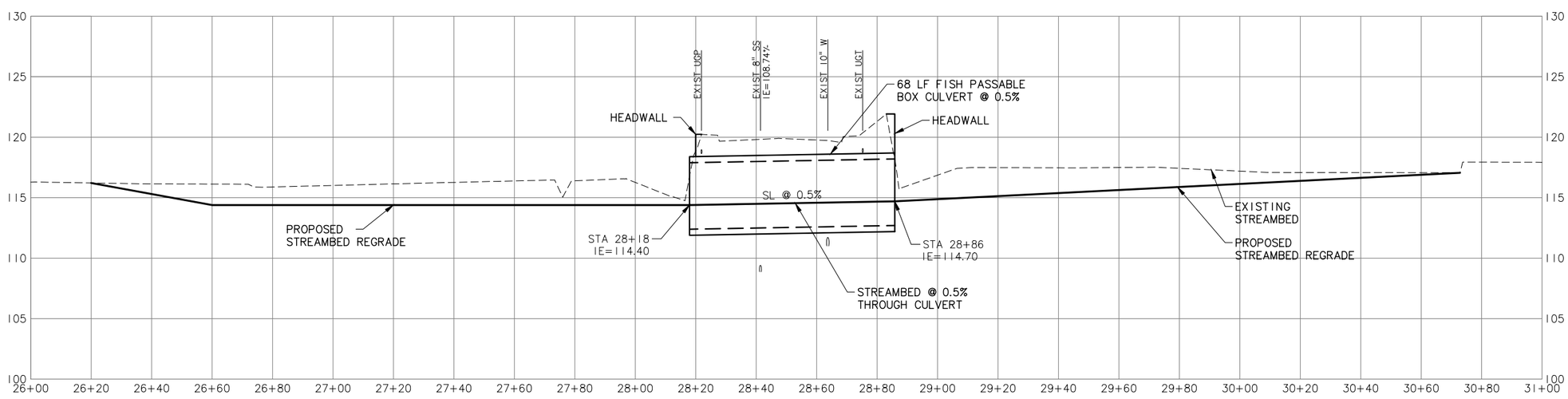


PLAN

SCALE: 1"=20'



PROFILE – 71ST AVE CULVERT

SCALE: 1"=20' HORIZ, 1"=5' VERT

NOTES:

1. VERTICAL LOCATION OF EXISTING UTILITIES HAS NOT YET BEEN VERIFIED. VERTICAL LOCATIONS SHOWN IN THE PROFILE ARE ASSUMED.

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NO.	DATE	BY	REVISION

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CITY OF ARLINGTON

CITY OF ARLINGTON
PRAIRIE CREEK
DRAINAGE
IMPROVEMENTS

71ST AVE CULVERT
PLAN & PROFILE

PROJECT NO.: 12-1347.104 | SCALE: AS SHOWN | DATE: November 2012

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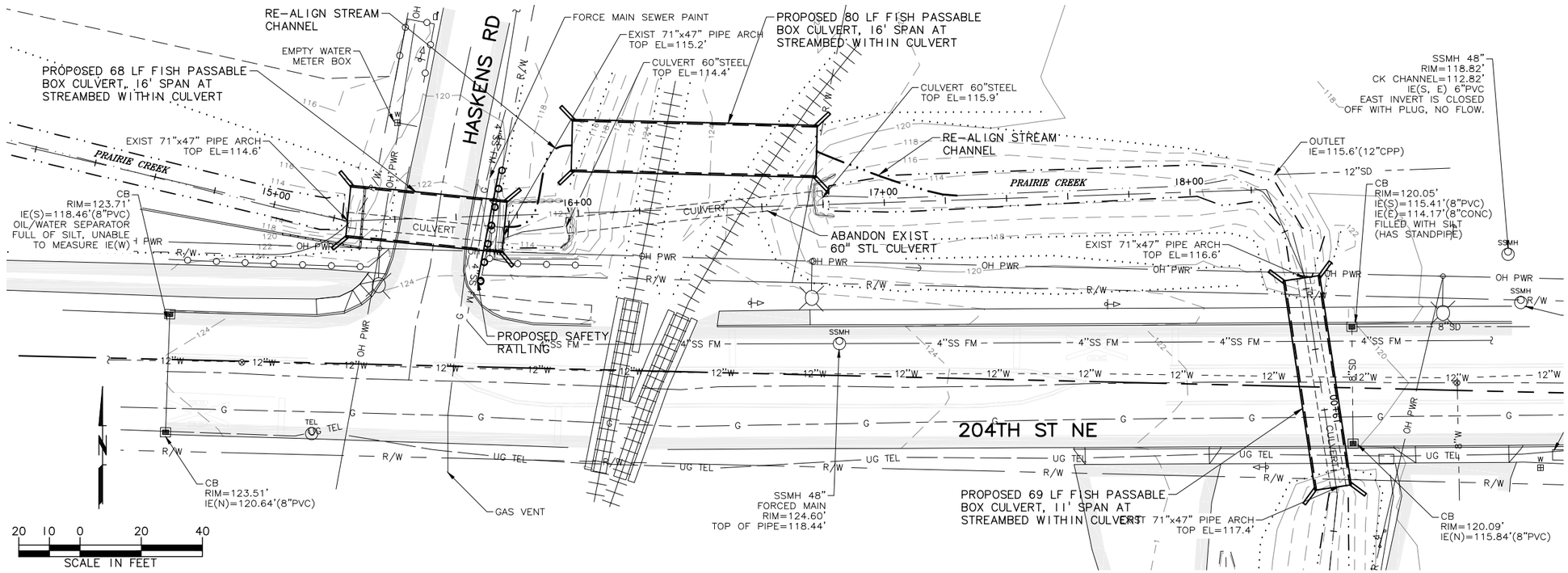
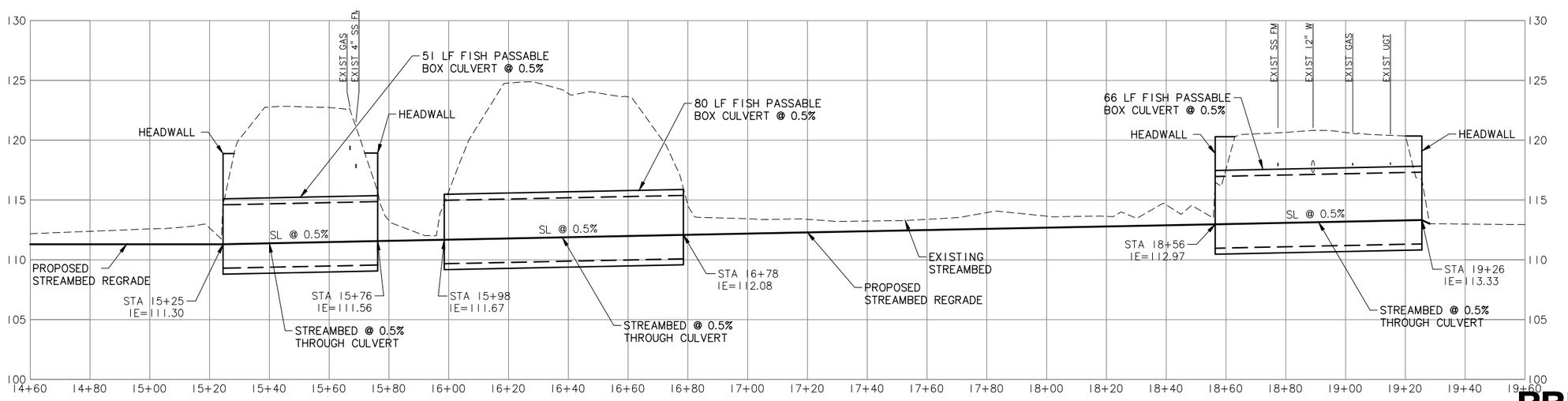


NOTES:

1. ONLY EXISTING CONDITIONS AR SHOWN IN VICINITY OF 69TH AVE CULVERT. PROPOSED TRAIL AND PEDESTRIAN IMPROVEMENTS ASSOCIATED WITH THE 67TH AVE PHASE III RECONSTRUCTION ARE NOT SHOWN AT THIS TIME – WILL BE SHOWN ON NEXT DESIGN SUBMITTAL.

2. VERTICAL LOCATION OF EXISTING UTILITIES HAS NOT YET BEEN VERIFIED. VERTICAL LOCATIONS SHOWN IN THE PROFILE ARE ASSUMED.



PROFILE – 69TH AVE, BNSF, 204TH ST CULVERTS

SCALE: 1"=20' HORIZ, 1"=5' VERT

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CITY OF ARLINGTON

CITY OF ARLINGTON PRAIRIE CREEK DRAINAGE IMPROVEMENTS

69TH AVE, BNSF, 204TH ST CULVERTS PLAN & PROFILE

PROJECT NO.: 12-1347.104 | SCALE: AS SHOWN | DATE: November 2012

SHEET C-3

5 of 5

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Spokane, WA 99201
Phone: 509.321.0340
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Portland, OR 97204
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Fax: 503.225.9022

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Springfield, OR 97477
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Fax: 541.744.3875

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Boise, ID 83702
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