Biological Resources Technical Report

Basalt Creek Extension: Grahams Ferry Road – Boones Ferry Road

Washington County, Oregon

March 10, 2021

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1 Introduction

The purpose of this report is to provide an assessment of the existing aquatic resources, species listed under the Endangered Species Act (ESA) and their point specific habitat, listed species occupied habitat, and noxious weed populations for the Area of Potential Impact (API) of the Basalt Creek Extension: Grahams Ferry Road – Boones Ferry Road Project (Project). Potential impacts from the Project are also discussed, including direct and indirect impacts to biological resources such as wildlife corridors, secondary and cumulative impacts, and recommended mitigation or conservation measures for unavoidable impacts.

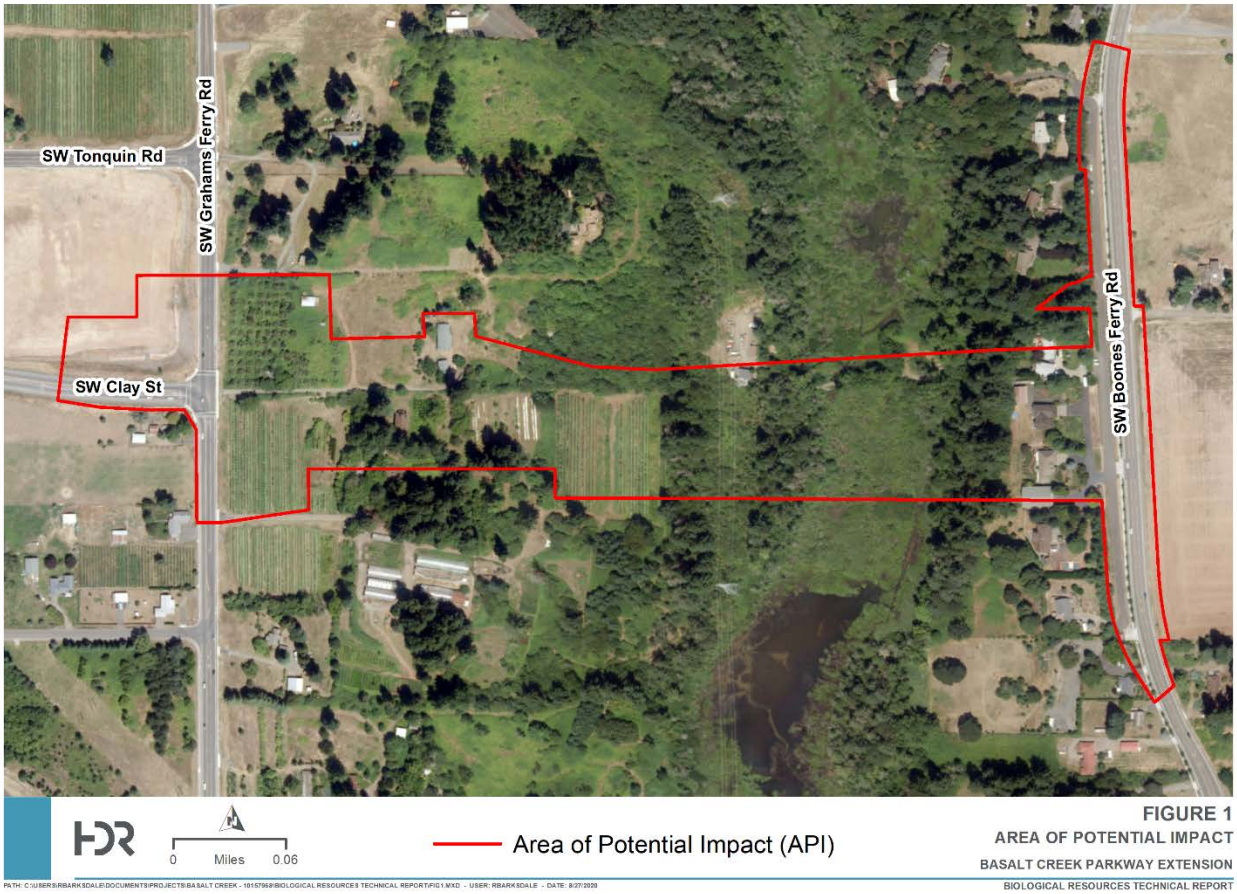
1.1 Project Description

The proposed Project will extend Basalt Creek Parkway from Grahams Ferry Road to Boones Ferry Road in Washington County, Oregon, to improve east-west connectivity. Basalt Creek Parkway will be extended approximately 2,600 feet and would be a five-lane arterial roadway. The proposed roadway will include pedestrian and bicycle facilities and an approximately 800-foot-long bridge over Tapman Creek. Project components include the following:

- Excavation, clearing, and grading
- Building demolition
- Survey work, staking
- Exploratory drilling
- Construction work below ordinary high water
- Fill and excavation within wetlands and waters of the U.S.

The Project API (Figure 1) is located within Oregon Department of Transportation (ODOT) existing road right-of-way (ROW) as well as the following tax lots: 2S135CC00700, 3S102B001400, 3S102B001500, 3S102B000104, 3S102B000105, 3S102B000102, 3S102AB00100, 2S135CD00302, 2S135CD00300, 3S102B000103, 3S102B000107.

Figure 1. Area of Potential Impact



2 Biological Resources

The existing vegetation and habitat types, fish, and wildlife were assessed in the API to determine potential impacts from the Project. A summary of each resource type is described below.

2.1 Habitat Types

The Project API is located in the Willamette Valley Prairie Terrace Level IV Ecoregion. The ecoregion is characterized by nearly level to undulating fluvial terraces with meandering streams and rivers. Seasonal wetlands and ponds were historically common but many streams are now channelized due to urban development.

The API occurs in an area of rural residential and agricultural land uses. One small, intermittent stream (Tapman Creek) flows through the API. The drainage area consists of a canyon with densely vegetated, steep hillsides and a densely vegetated, moderately flat bottom, approximately 230 feet wide. Much of the API is located within an active commercial nursery with row crops.

A general habitat assessment was conducted in May of 2019. Five major vegetative habitats exist in the API including the following:

1. Previously disturbed roadside and transmission ROW: Areas adjacent to the roadway extending to the limits of Washington County ROW consist mainly of graveled or vegetated ditches with communities of herbaceous vegetation typical of previously disturbed roadside habitats. Common species include yarrow, bull thistle, Canada thistle, perennial ryegrass, Himalayan blackberry, tansy ragwort, and a landscape variety of lupine. This habitat type was found in the API along Grahams Ferry Road, Basalt Creek Parkway, and along Boones Ferry Road.
2. Agricultural areas: A large portion of the API is located on an active commercial nursery with several acres of row crops. The cultivated areas are surrounded by open areas with common grasses, tansy ragwort, and Himalayan blackberry patches that transition to mixed forest. The row crops and grassy areas immediately surrounding them are regularly mowed. This habitat type occurs in the western half of the API.
3. Wetland: Tapman Creek runs through the API and is surrounded by an open wetland area which has some portions that appear to be permanently flooded. The scrub shrub wetland is mainly composed of Douglas' spiraea and standing deadwood. Other vegetation in this habitat type includes reed canary grass, sitka willow, Oregon ash, and red alder. The edges of the wetland area transition with increasing elevation to mixed forest with a blackberry understory. The east side of the creek has a steep slope, leading to residential landscaped yards.
4. Mixed forest: Areas of mixed forest are scattered throughout the API, with vegetation including big leaf maple, red alder, cherry, and Douglas fir canopies. Understories are made up of hazelnut and blackberry. The mixed forest areas are likely a second growth forest and were previously deforested during initial settlement and development.
5. Residential/landscaped: Along the western side of Boones Ferry Road is a residential area with several homes and landscaped yards. These developed areas include manicured lawns, paved roads and driveways, and landscaped medians.

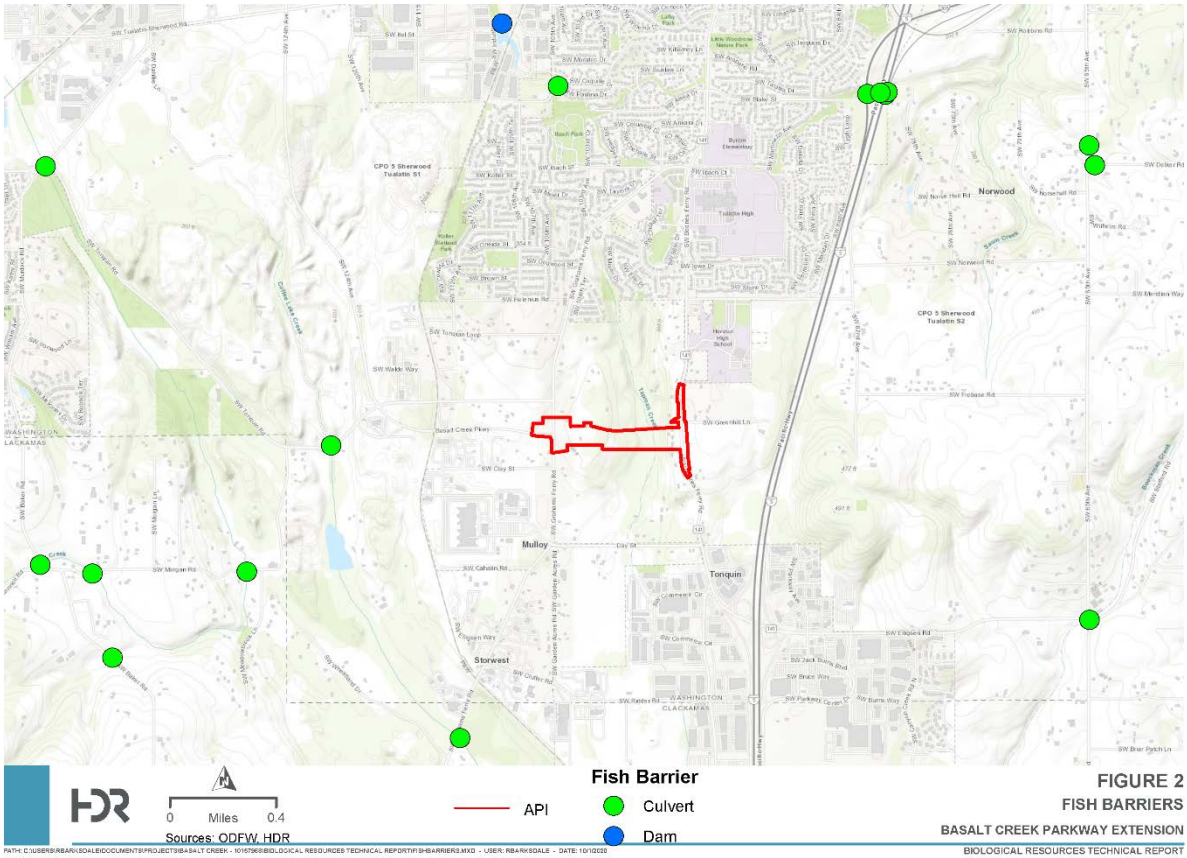
All habitat types found within the Project API provide varying degrees of diversity that would support different species. The wetland habitat and the mixed forest habitat are generally most diverse and support the most diverse wildlife. In addition to pollinators, these habitat types provide foraging opportunities for migratory birds and small mammals, and provide a migratory corridor for wildlife. In contrast, the ROW, agricultural areas, and residential habitat types provide the least diverse habitat, and under existing maintenance practices, provides limited value to wildlife species.

2.2 Aquatic Species

Data from the Oregon Biodiversity Information Center (ORBIC) indicates the occurrence of steelhead as the only federally-listed threatened or endangered species within two miles of the project site. According to fish barrier data from the Oregon Department of Fish and Wildlife, there are existing fish barriers downstream of Tapman Creek in Coffee Lake Creek that would prevent steelhead from access, and therefore, are not expected

to be present within the API (Figure 2). A barrier is also present at the terminus of the watershed with the Willamette River for ESA-listed fish species. In addition, the basin is likely thermally inhospitable for salmonids. According to StreamNet Mapper, there may be resident fish such as coastal cutthroat trout (*Oncoryhnchus clarkii clarkii*) present in the API. StreamNet Mapper data is based on Oregon Department of Fish and Wildlife (ODFW) and Oregon Department of Forestry fish presence surveys and fish barriers datasets.

Figure 2. Fish barriers near the API



2.3 Wildlife

According to data retrieved from the Information for Planning and Consultation (IPaC), there is one bird species and one insect species listed on the Endangered Species Act (ESA) that could potentially be present within the API: the streaked horned lark (*Eremophila alpestris strigata*), and the Fender's blue butterfly (*Icaricia icarioides fender*). The streaked horned lark is listed on the ESA as threatened, while the Fender's blue butterfly is listed as endangered. Both species have designated critical habitat which are outside of the API. Data from the Oregon Biodiversity Information Center (ORBIC) indicates no presence of ESA-listed wildlife species. A field survey was completed in May 2019 to determine presence of listed species and suitable habitat in the API (Table 1). No listed species or suitable habitat were present.

Table 1. Federally-listed wildlife species with potential habitat in the API

Scientific Name	Common Name	Federal Status	State Status	Suitable Habitat
Eremophila alpestris strigata	Streaked horned lark	T	-	Open landscapes with no trees and few or no shrubs
Icaricia icarioides fender	Fender's blue butterfly	E	-	Native upland prairies

SOC = Species of Concern; E = endangered; T = threatened. Source: ORBIC, USFWS Oregon Fish and Wildlife Office (OFWO)

Despite the development around the project area, there is wildlife present in the area that is not ESA-listed. Washington County lists several common wildlife species that inhabit various parts of the county, including deer, coyote, beaver, squirrels, raccoons, opossums, bats, and pigeons. The wetland area within the project API likely provides habitat for reptiles and amphibians, while the mixed forest areas provides habitat for birds and mammals.

2.3.1 Migratory Birds

Although not ESA-listed, there are several migratory birds that are protected and may be present in the API or use resources from within it. Table 2 below lists bird species that have been listed as a Bird of Conservation Concern by the US Fish and Wildlife Service or warrant special attention due to the project location.

Table 2. Migratory birds of concern with potential presence in the API

Scientific Name	Common Name
Haliaeetus leucocephalus	Bald eagle
Ardea Herodias fannini	Great blue heron
Tringa flavipes	Lesser yellowlegs
Numenius americanus	Long-billed curlew
Contopus cooperi	Olive-sided flycatcher
Selasphorus rufus	Rufous hummingbird
Calidris pusilla	Semipalmated sandpiper
Limnodromus griseus	Short-billed dowitcher
Megascops kennicottii kennicottii	Western screech-owl
Numenius phaeopus	Whimbrel
Tringa semipalmata	Willet

Source: IPaC 2019

2.4 Plants

A field survey was completed in May of 2019 to investigate the potential presence of threatened, endangered, special status plant species, or designated critical habitat (Table 3). Suitable habitat for white rock larkspur and Nelson's checkermallow were found; however, no listed species were found within the API.

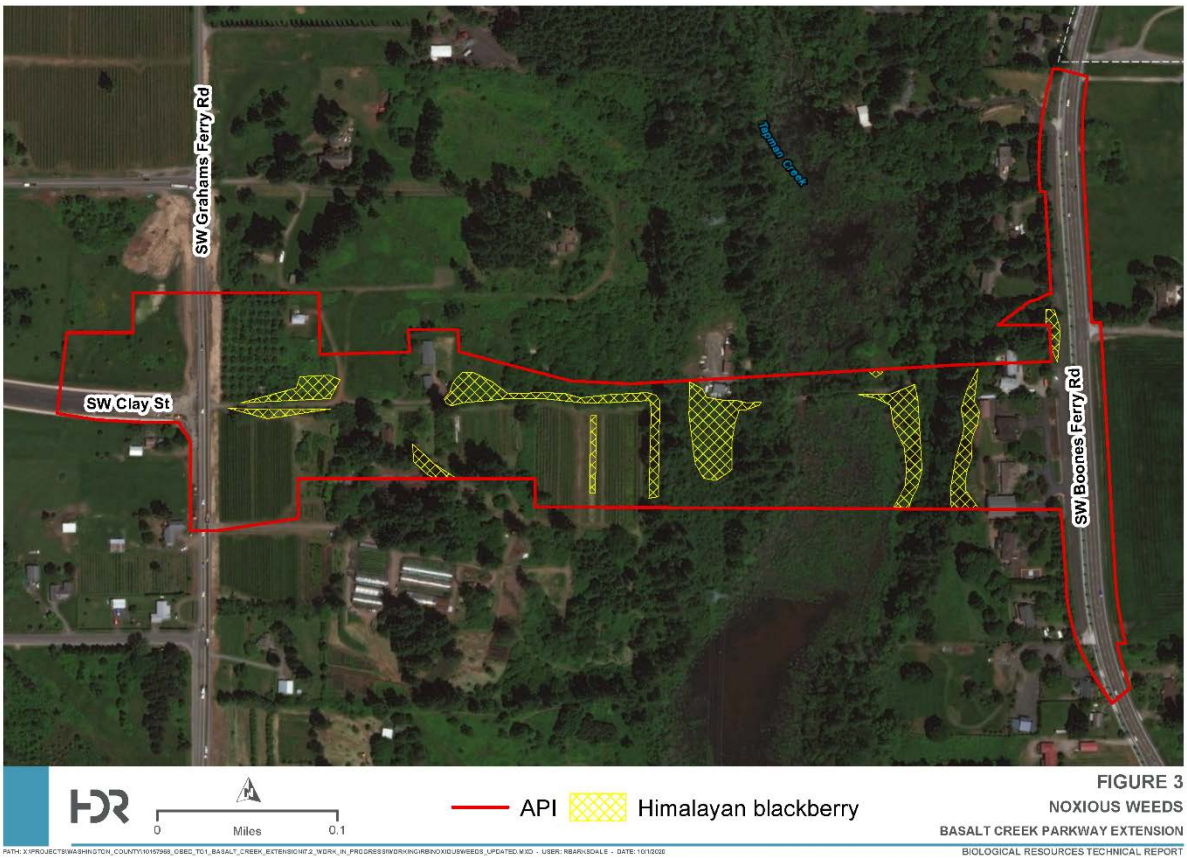
Noxious weeds were present throughout the entire API. Himalayan blackberry was found in extensive patches in each habitat type and had many areas of major concentrations (Figure 3). Tansy ragwort, bull thistle, and Canada thistle were scattered across all habitat types but had no major concentrations. Although not listed as a noxious weed, reed canary grass was present in much of the wetland area.

Table 3. Federally-listed plant species with potential habitat in the API

Scientific Name	Common Name	Federal Status	State Status	Suitable Habitat
Delphinium leucophaeum	White rock larkspur	SOC	E	Well-drained areas within open lowland prairies; dry roadside ditches, open areas atop basaltic shelves
Erigeron decumbens var. decumbens	Willamette daisy	E	E	Alluvial soils in bottomland prairies
Howellia aquatilis	Water howellia	T	T	Small, vernal freshwater wetlands, glacial pothole ponds, former river oxbows
Lomatium bradshawii	Bradshaw's lomatium	E	E	Alluvial soils in seasonally saturated or flooded prairies
Lupinus sulphureus spp. Kincaidii	Kincaid's lupine	T	T	Native grasslands, upland prairies
Sidalcea nelsoniana	Nelson's checkermallow	T	T	Oregon ash swales and meadows, along roadsides at stream crossings, open areas with little or no shade

SOC = Species of Concern; E = endangered; T = threatened. Source: ORBIC, OFWO

Figure 3. Major concentrations of noxious weeds in the API



2.5 Jurisdictional Waters

A wetland delineation was conducted by DOWL environmental staff in May 2019 and identified one waterway, Tapman Creek, and one associated wetland, both of which are regulated by the Oregon Department of State Lands (DSL) and the US Army Corps of Engineers (USACE). Tapman Creek is a small, intermittent stream which flows south into Coffee Lake Creek. The wetland area has been included in the design base files, and the project team has incorporated these boundaries as a regulated work area, avoiding impacts to the extent feasible. Unavoidable impacts within the delineated boundary of the wetland will be documented in a Joint Permit Application (JPA) and will be mitigated through purchase of mitigation bank credits.

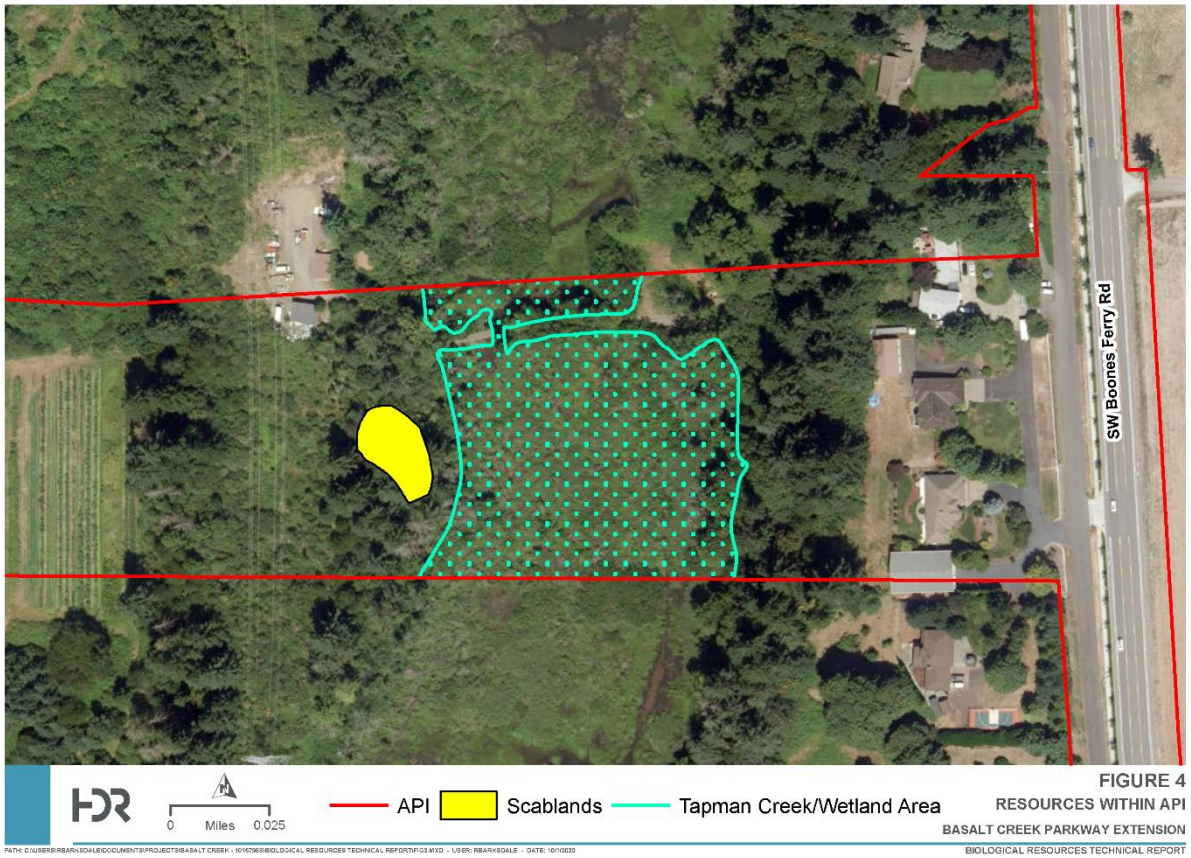
2.6 Tonquin Scablands

The Missoula Floods shaped the geology of the Willamette Valley creating channels, depressions, and scoured bedrock. These geological features within the API that are at or below 300 feet in elevation are known as the Tonquin Scablands, which are a protected resource by Washington County. Typical vegetation associated with scablands includes dominance of Pacific madrone (*Arbutus menziesii*), and plants that are relatively-drought tolerant. Approximately half of the API is at or below 300 feet in elevation. During the site visits, a few individuals of Pacific madrone were observed,

most of which were at elevations greater than 300 feet. No Pacific madrone trees were observed in the wetland area, which is at the lowest elevation. One area where at least one madrone was observed that is at or below 300 feet is towards the center of the API, surrounding an agricultural field. There were no areas observed in which Pacific madrone was dominant.

Another indicator of the Tonquin Scablands is the presence of drought-tolerant plants. The majority of the site was covered with Himalayan blackberry, which is a drought-tolerant, but also invasive. The largest portion of the API that is below 300 feet is the Tapman Creek area and associated surrounding wetland area. With the exception of blackberry, the dominant species present are not drought-tolerant. Most of the API is in degraded condition due to agricultural activities and development, and presence of invasive plant species. The other area with elevation less than or equal to 300 feet is surrounding SW Grahams Ferry Road, which is developed land occupied by roadway. One area in the API was determined to be consistent with Tonquin Scabland descriptions (Figure 4).

Figure 4. Resources within API



3 Impacts to Biological Resources

3.1 Temporary Impacts

Impacts to the existing biological resources within the API are anticipated from Project construction activities, including the following:

- Construction access and staging
- Installation of drilled shafts and steel piles
- Fill and excavation on land and within Tapman Creek and surrounding wetland
- Installation and removal of work bridges
- Installation of retaining walls
- Building demolition
- Vegetation removal

3.1.1 Terrestrial Impacts

The majority of the API is covered in vegetation, much of which will need to be removed in order to provide construction access, staging, and for construction of the proposed roadway and bridge. In addition to impacts resulting from the construction of the bridge, excavation and fill will be required for construction of the roadway and to accommodate the relocation of a PGE transmission tower. Figure 5 shows the proposed Project design.

A temporary work bridge spanning Tapman Creek is proposed to be constructed immediately north of the proposed permanent bridge. The work bridge will be supported by steel piles, which will be driven into the ground. In order to install the work bridge, it is assumed a temporary access road will be constructed to the north for drilling equipment and cranes to access the area. The permanent bridge would be supported by steel piles and drilled shafts. Vegetation removal will be required for both the access road, installation of the work bridge, and installation of the permanent bridge.

Construction of the proposed roadway and two retaining walls will require excavation and fill, as well as vegetation removal. Construction of the proposed temporary work bridge, the permanent bridge over Tapman Creek, permanent roadway, and permanent retaining walls can affect terrestrial species in several ways. A direct loss of vegetation reduces available habitat for birds and wildlife, and reduces habitat connectivity. Installation of drilled shafts and steel pile entails loud machinery, creating undesirable conditions for birds and wildlife. Temporary pile from the work bridge also directly reduces available habitat for both plants and wildlife. A reduction of habitat and an increase in noise could shift birds and wildlife out of the API both temporarily and permanently. Fencing will be placed around a portion of the Tonquin Scablands that will not be impacted, although construction of the proposed bridge may impact a portion of the scablands.

Much of the existing vegetation in the API is invasive. Removal of invasive species would be an overall benefit if replaced with native vegetation after construction is complete. In total, approximately 10 acres within the API would be cleared and grubbed, which includes all areas within the ROW and easements that might be cleared for the work, and

excludes existing impervious areas. The proposed roadway within the API is approximately six acres in area. Wetland areas impacted during construction will be revegetated with the goal of stabilizing slopes, providing habitat, and deterring invasive plant establishment.

3.1.2 Aquatic Impacts

The project elements above can impact aquatic resources in additional to terrestrial resources. Installation of drilled shafts and pile below the OHWM of the creek directly impacts the amount of available habitat for resident fish and other aquatic species.

In order to construct the bridge over Tapman Creek and the existing wetlands, a temporary work bridge will need to be installed, which will entail fill below the ordinary high water mark (OHWM) of Tapman Creek. Temporary piling will be required to support the work bridge. Once the work bridge is in place, construction of the permanent bridge can begin and will also include both excavation and fill below the OHWM and within the wetlands to install the bridge bents. At the time of this report, the exact quantities of fill and removal below OHWM is unknown and will be determined at a later date when a JPA is submitted. The only features affecting the wetland area and Tapman Creek are the temporary work bridge pilings and the permanent bridge bents.

Steel piles supporting the work bridge and permanent bridge will be driven into the ground, causing noise disturbance within the water, known as hydroacoustic impacts. Hydroacoustic impacts can result in fish injury, behavior modification, and death. Fish have swim bladders that help them maintain buoyancy while swimming. The action of pile driving creates changes in pressure within the water, which can rupture the swim bladder and cause other injuries that lead to internal bleeding, hearing damage, or immediate death (National Academies 2011). In-water work will be restricted to the in-water work window (IWWW), which is from July 15 to October 30.

Physical alteration to habitat may create increases in turbidity through sedimentation effects. Temporary, short-term increases in turbidity could occur during construction, potentially reducing the ability for fish to feed. An increase in suspended sediment in the water column can also impact fish through gill abrasion and clogging of filtration and respiratory organs (Kjelland et al. 2015). Best Management Practices (BMPs) to minimize sedimentation impacts will be implemented and are discussed in Section 4 below.

3.2 Permanent Impacts

After construction is complete, the permanent elements from the project that will remain include the proposed roadway and bridge over Tapman Creek, as well as the proposed stormwater facilities and two retaining walls.

3.2.1 Terrestrial Impacts

Several acres of existing vegetation will be permanently displaced by the proposed roadway, unable to be restored in its original location. Although landscaping is proposed to restore native vegetation in several areas, the removal of existing plants that will not be replaced is a direct permanent loss of habitat for birds and wildlife. Vegetation

provides food resources and habitat for a variety of species. Assuming the existing vegetation is fully utilized as habitat, removal could lead to a reduction in populations of birds and wildlife. Since no threatened or endangered terrestrial species were determined to be present within the API, impacts to US Fish and Wildlife Service-listed species will be addressed with a No Effect Memo.

In addition to vegetation, the Tonquin Scablands may be permanently impacted by the permanent bridge supports, reducing the amount of remaining scablands in the Project area. Only a portion of the scablands would be impacted, and the bridge is being designed to have the least amount of impact as possible to the resource.

3.2.2 Aquatic Impacts

The placement of the proposed bridge bents below OHW of Tapman Creek is the only permanent structure that will affect aquatic resources. The structure will permanently displace habitat that could otherwise be used by fish, including resident coastal cutthroat trout that are likely present in the creek.

In addition to impacts from construction activities, impacts from stormwater runoff also have the potential to affect fish and other aquatic species in the API and downstream. The Project will add new contributing impervious surface area (CIA), triggering the need for water quality treatment, as outlined in the Federal Aid Highway Program (FAHP) Programmatic Agreement. Quantity control is not required for the FAHP since the basin lacks ESA-listed fish species, the API includes a large wetland, and the nearest ESA-listed fish are located in the Willamette River. A Stormwater Report was prepared for the Project and is included in Appendix A. The proposed stormwater facilities will outfall to Tapman Creek and an existing stormwater facility in the Coffee Lake Creek system. Proposed increases in CIA are 6.48 acres, from the existing 0.42 acres to 6.90 acres. Stormwater impacts could affect resident fish present in Tapman Creek, as well as downstream, which may include steelhead, a listed species under the ESA. Stormwater can affect fish through changes to water quality, including from an increase in metals, sediment/particulates, and hydrocarbons (oils and greases). Pollutants such as these are commonly found on roadways, and can affect fish through inhibiting growth and development, reducing resistance to infection and disease, and causing direct mortality (Spence et al. 1996). Increases in sediment can result in gill abrasion, reduction in visibility when detecting prey, and reduction in food availability (DEQ 2014; Kjelland et al. 2015). Impacts to National Marine Fisheries Service-listed species will be addressed via the FAHP Programmatic Agreement.

3.3 Indirect Impacts

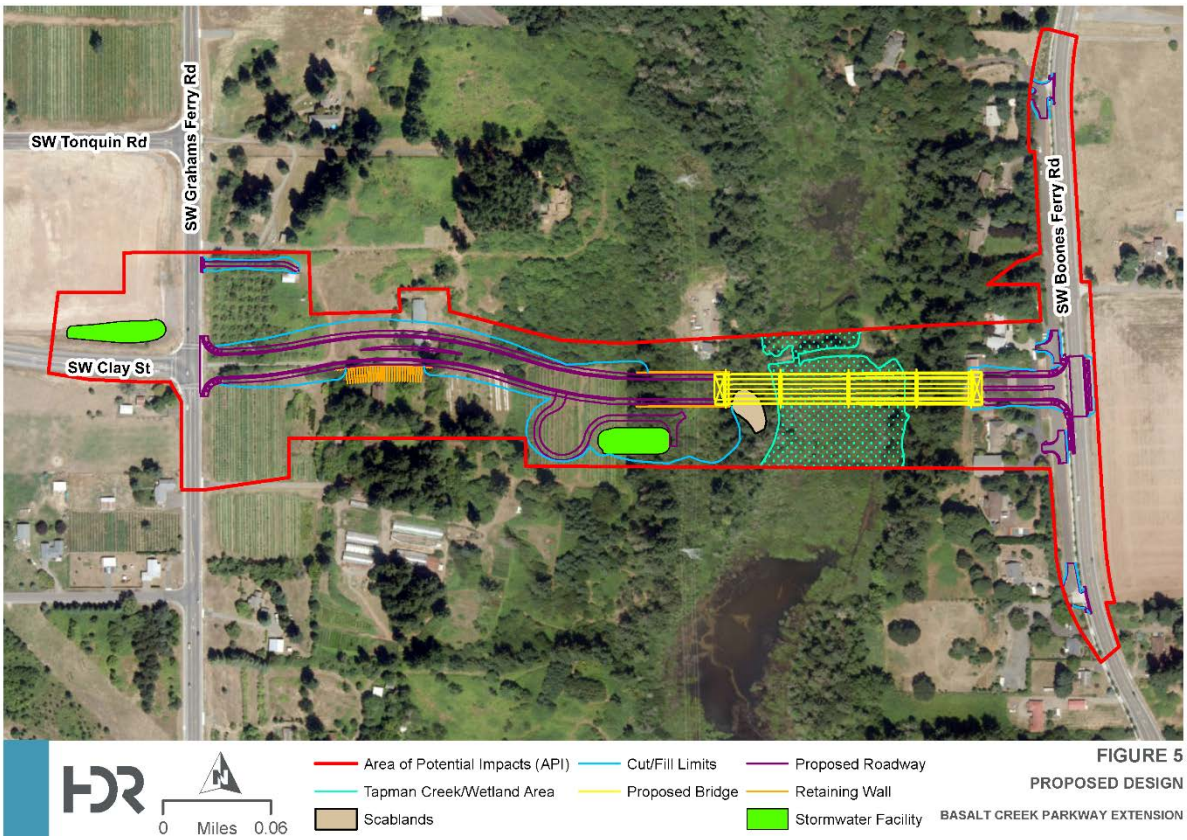
No indirect impacts to terrestrial or aquatic resources are anticipated from the Project.

3.4 Cumulative Impacts

Cumulative impacts are defined as the changes to the environmental caused by the combined impact of past, present, and future human activities and natural processes. Little area within the API is previously undisturbed. Several structures, including homes and other buildings occupy the area. Dirt and gravel roads have been created to access

these buildings. The commercial nursery has converted the landscape into agricultural row crops. These past development actions have led to degradation of the API. The proposed Project actions will likely cause additional degradation by disrupting wildlife corridors, removing vegetation and habitat for both terrestrial and aquatic species, and by causing temporary hydroacoustic and sedimentation impacts during construction. The API is part of the larger Basalt Creek Planning Area, which is an area that has been identified by Metro for future industrial development. Eventually Basalt Creek Parkway will be extended east of Boones Ferry Road to cross over I-5 (City of Tualatin and City of Wilsonville 2018). The Basalt Creek Concept Plan was created by the Cities of Tualatin and Wilsonville, which guides development in the area over the next 20 years. Future urbanization, transportation, and development projects will continue to impact the API through a reduction in size and quality of remaining habitat.

Figure 5. Proposed Project Design



4 Mitigation

The impacts described above will be minimized during construction with the use of BMPs. Impacts to aquatic resources, such as fish, will be minimized by restricting in-water work to the IWWW, from July 15 to October 30. The IWWW is set based on presence of species during the timing of different life stages (ex. migration, rearing). Although no ESA-listed species are present in the API, the IWWW still applies and will be used to minimize impacts to resident fish that do occur in the API.

An Erosion and Sediment Control Plan will be developed for the Project that will minimize the potential for erosion and increases in sedimentation during construction. Typical measures include sediment trapping and surface roughening to prevent sediment from entering the waterway.

Impacts to the Tonquin Scabland area will be minimized. Areas of the Tonquin Scablands to be designated as no work will be fenced off during construction. The bridge was designed to have the least impact possible to the scablands, however, permanent impacts may occur to the area.

Contributing impervious area from the new roadway will be mitigated with onsite stormwater treatment facilities. Existing impervious area in the API is 0.42 acres, and the Project proposes 6.90 acres of impervious area, an increase of 6.48 acres. Stormwater runoff will be treated both onsite and offsite through bioretention basins and a bioswale facility. The total proposed CIA to be treated is equal to approximately 5.90 acres. The eastern portion of the Project will use a bioretention facility to detain and treat runoff, while the western portion of the Project will utilize existing stormwater facilities, including a bioswale that is anticipated to be modified. The facilities will outfall to Tapman Creek and an existing stormwater treatment facility in the Coffee Lake Creek system. The proposed facilities provide stormwater management for site runoff as required by Washington County, ODOT, and FAHP permitting requirements to the extent practicable.

Vegetation removal required for construction will be replaced at a minimum of 1:1 ratio and will be planted with all native species, rather than a mix of native and invasive species as is currently present. Approximately three acres of native seeding will be planted adjacent to the roadway. Because the API has many existing populations of invasive species, there is potential to spread them during construction. Actions including minimizing disturbance areas and cleaning plant materials from equipment would help to reduce spread. Approximately four acres of treatment for weed control are estimated to occur.

The proposed design was created to minimize impacts to Tapman Creek and the surrounding wetland area to the extent possible. Mitigation will be required for unavoidable impacts to wetlands and waters. Although the exact quantities are unknown at this time, the proposed fill and removal within jurisdictional features are anticipated to be mitigated with the purchase of mitigation banking credits.

5 References

City of Tualatin and City of Wilsonville

2018 Basalt Creek Concept Plan. Exhibit 2 to Ordinance No. 1418-1419. https://www.tualatinoregon.gov/sites/default/files/fileattachments/planning/page/4509/exhibit_2_-_basalt_creek_concept_plan.pdf

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Appendix A. Draft Stormwater Report

BASALT CREEK EXTENTION: GRAHAMS FERRY ROAD – BOONES FERRY ROAD

Draft Stormwater Report

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September 2020

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DISCLOSURES

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APPENDICES

1.0 OVERVIEW

1.1 Introduction

This stormwater management report addresses the storm sewer and stormwater management design for the Basalt Creek Extension project from Grahams Ferry Road to Boones Ferry Road in Washington County, Oregon. The project includes fully constructing a roadway and bridge where there is no existing public roadway. Storm sewer and stormwater management facilities are also proposed to treat and detain stormwater runoff resulting from the proposed construction. The project is located in Section 35, Township 2 South and Section 2, Township 3 South of Range 1 West, in Washington County, Oregon. A vicinity map showing the project location is provided as Figure 1.

1.2 Regulatory Requirements

The project is located within Washington County, Oregon. It falls under the jurisdiction of Washington County and ODOT, and will comply with Federal-aid Highway Program (FAHP) programmatic stormwater requirements. Though the project is within Washington County, it falls outside of Clean Water Services (CWS) juristriction. Washington County utilizes ODOT stormwater requirements and standards when the project is outside of the CWS jurisdiction.The stormwater management design is based on the most stringent of Washington County, ODOT and FAHP stormwater standards. Table 1 lists the various stormwater requirements.

Table 1: Stormwater Management Design Standards

Design Criteria	Jurisdictional Requirement			Controlling Standard
	ODOT	Washington County	FAHP	
Water Quality	50% of 2-year, 24-hour storm	Same as ODOT	50% of 2-year, 24-hour storm	50% of 2-year, 24-hour storm
Water Quantity	Restrict flows to existing conditions for events ranging from 42% of 2-year, 24-hour storm through the 10-year, 24-hour storm	Same as ODOT	Restrict flows to existing conditions for events ranging from 42% of 2-year, 24-hour storm through the 10-year, 24-hour storm	Restrict flows to existing conditions for events ranging from 42% of 2-year, 24-hour storm through the 10-year, 24-hour storm
Storm Sewers & Inlets	On grade: 10-year On sag: 50-year	Same as ODOT	N/A	On grade: 10-year On sag: 50-year

Proposed project stormwater facilities will outfall to Tapman Creek and Coffee Lake Creek. Neither stream is listed in the Oregon Department of Environmental Quality (DEQ) 2012 Integrated Report as being water quality limited.

1.3 Site Investigations & Sources of Data

Information regarding the project site was gathered from several sources including DOWL field surveys of existing features and contours. All elevations provided in this report are in feet and reference to the North American Vertical Datum of 1988 (NAVD88). Additional site information

was gathered from US Department of Agriculture (USDA) National Resource Conservation Service's (NRCS) Soil Surveys of Washington County, a geotechnical exploration performed by Shannon & Wilson, and available aerial imagery. In addition, engineering staff performed a site visit on June 24, 2020 to confirm information provided by the above sources.

According to United States Department of Agriculture Natural Resources Conservation Service (NRCS) soil data, the soils within the project area consist of mostly silt loam, with some silty clay loam. The majority of the project is on soil classified as hydrologic soil group C, meaning the soil has low infiltration rates. Precipitation data for design rainfall events was obtained from available ODOT GIS data. The NRCS soil report and design storm rainfall depths are included in Appendix 1 of this report.

1.4 Utilities

Utility information for this project was obtained from field surveys. DOWL requested that the Oregon Utilities Notification Center mark the locations of existing utilities; DOWL field surveys then provided locations of the features. In the proposed design, the stormwater management infrastructure are situated to prevent conflicts with existing utilities as much as practical.

2.0 WATERSHED CHARACTERISTICS

2.1 Existing Conditions

The proposed extension of Basalt Creek Parkway extends the roadway through a mix of currently undeveloped and low density residential area, in which there is no existing stormwater management infrastructure.

The project area was divided into 4 basins, as shown in Figure 2. Basin 1 drains westward to Grahams Ferry Road and ultimately to Coffee Lake Creek. Basins 2, 3, and 4 drain into Tapman Creek, which eventually joins with Coffee Lake Creek approximately 2.5 miles downstream of the proposed crossing.

Figure 2 provides a schematic of the drainage areas for the project and the outfall locations for runoff. A summary of the Existing Condition hydrologic parameters and supporting calculations are provided in Appendix 1.

2.2 Proposed Conditions

As can be seen in Figure 2, the proposed road profile maintains the location of the watershed divide between Tapman Creek and the headwaters of Coffee Lake Creek. Basin 1 drains westward into the Coffee Lake Creek watershed to the upgraded existing stormwater facility on the west side of Grahams Ferry Road. The existing stormwater facility is intended to be upgraded to meet ODOT standards for a bioswale facility.

The eastern portion of the roadway and proposed bridge crossing of Tapman Creek combine Existing Basin 2 and Basin 3, which are collected and routed through a bioretention basin. Basin 4 will be collected and diverted through the bioretention basin to provide offsetting treatment for two entrances along the frontage road along Boones Ferry Road, located at station "FS" 43+00, and "FN" 29+00. Due to site limitations and their location, runoff from neither entrance will be treated.

A hydrologic parameter summary and supporting calculations for all proposed subbasins are provided in Appendix 2. All times of concentration for impervious subbasins were set to a minimum of 5 minutes. Table 2 presents the existing and proposed contributing impervious area (CIA) for the project, as well as what amount of CIA from each basin will receive treatment.

Table 2: Existing and Proposed Contributing Impervious Area

Subbasin	Total Area (ac)	Existing Impervious Area (ac)	Proposed Impervious Area (ac)	Net Change (ac)	Treated CIA (ac)
E-1 (P-1)	2.77	0.06	1.85	1.79	1.85
E-2 & E-3 (P-2)	4.66	0.49	4.04	3.55	3.80
E-4	0.25	-	-	-	0.25
Total	**7.33**	**0.55**	**5.89**	**5.34**	**5.90**

The anticipated pollutants of concern likely to be found in the stormwater runoff for the completed project and the effectiveness of the proposed treatment methods are provided in Table 3.

Table 3: Anticipated Pollutants and Stormwater Facility Treatment Effectiveness

Reasonably Expected Pollutants	Biofiltration Swale	Bioretention Basin
Sediment/ Particulates	High	High
Nutrients	Moderate	High
Hydrocarbons (oils & greases)	Moderate	Moderate
Polycyclic Aromatic Hydrocarbons	Moderate	High
Metals (Particulate)	High	High
Metals (Dissolved)	High	High

Stormwater facilities treatment effectiveness based upon Table 14-2 Key Pollutant Removal Capabilities for Water Quality Facilities in the ODOT *Hydraulics Manual,* 2014.

3.0 STORMWATER MANAGEMENT DESIGN

3.1 Analysis Methods

The hydrologic and hydraulic analyses for the stormwater design were performed using the Storm and Sanitary Analysis software package developed by Autodesk. using the Santa Barbara Urban Hydrograph (SBUH) method and hydrodynamic routing of the flow using the full St. Venant equations. The full results of the Storm and Sanitary Analysis model are included in this report as Appendix 2.

3.2 Storm Sewers

Stormwater runoff will be conveyed through a new storm sewer system throughout the project. Storm sewer inlets and pipes were sized using the 10-year storm, with the exception of the

portion of the system at the mainline sag near Station 'B' 270+60, which were designed to the 50-year event. The storm sewer analysis shows that all of the proposed inlets and pipes meet ODOT capacity requirements, and that maximum gutter spread limits are not exceeded. The storm sewer analysis results are included in Appendix 2.

3.3 Stormwater Facility Design

The stormwater BMPs are designed to address typical roadway runoff pollutants. The target pollutants are metals (both dissolved and particulate), polycyclic aromatic hydrocarbon (PAHs), sediment, and hydrocarbons (oils and greases, etc.) in the roadway runoff. The following is a summary of each stormwater BMP included in the project.

3.3.1 Stormwater Quality Treatment

The proposed bioretention pond located at approximately 'B' 269+20 is sized to treat 5.90 acres of impervious area, as shown in Table 2. The facility is approximately 210 feet long, 73 feet wide, and has a maximum design water depth of 3.46 feet with interior side slopes of 4H:1V. The water quality volume of 356,878 ft^3 is treated by settlement in a stilling basin, pollutant uptake from the vegetation in the facility, as well as the runoff infiltrating through 18 inches of water quality soil mix. The water quality soil mix infiltrates the runoff at a rate of 3 inches per hour; however, the underlying soils have low infiltration rates. An underdrain system will be incorporated beneath the water quality soil mix to collect and convey the treated water through the facility outfall. The maximum depth in the pond during the water quality design storm is 2.36 feet, with a maximum water surface elevation of 267.36. The bioretention facility will also provide detention for the runoff from the eastern portion of the project. The facility adequately reduces the peak outflow to levels at or below the existing condition for the design storms, as discussed in Section 3.3.2

The design of the retrofit of the existing stormwater site, which provides treatment for 1.85 acres of impervious area from Basin E-1, has not been completed. The anticipated modifications to the facility include widening the existing swale and improvements to the swale substrate and vegetation to meet ODOT standards for a bioswale. Details of the design and documentation of the anticipated adequacy of the facility will be provided in the Final Stormwater Report.

3.3.2 Stormwater Quantity

The existing facility west of Grahams Ferry Road was designed to provide only water quality treatment and was not required to provide detention due to the discharge into a large water body (Coffee Creek wetland complex). Due to the fact that Basin 1 previously drained to this area, and to maintain consistency with the previous project, runoff from Basin 1 will only receive water quality treatment; no detention will be provided.

Stormwater discharging from basin P-2 is required to be detained to existing peak flow rates for the 42% of the 2-year, 24-hour storm, through the 10-year, 24-hour storm. Storms that exceed the water quality storm are controlled by the underdrain system and two orifices: a 3-inch orifice with an invert elevation of 267.36, and a 6-inch orifice with in invert elevation of 268.00. Storms that exceed the 10-year, 24-hour event will be detained through the use of additional storage provided by the required freeboard. Events that exhaust the additional storage provided by the freeboard will be conveyed through the auxiliary outlet, which discharges down the bank of Tapman Creek. The existing and proposed peak flow rates for basin P-2 are presented in taTable 4.

Table 4 : Existing and Proposed Peak Flows

Event	Existing Condition (cfs)	Proposed Condition (cfs)	Max. Proposed Depth (ft)
42% 2-yr	0.02	0.02	0.96
2-yr	0.30	0.25	3.02
5-yr	0.48	0.44	3.28
10-yr	0.81	0.69	3.46

4.0 FACILITY MAINTENANCE

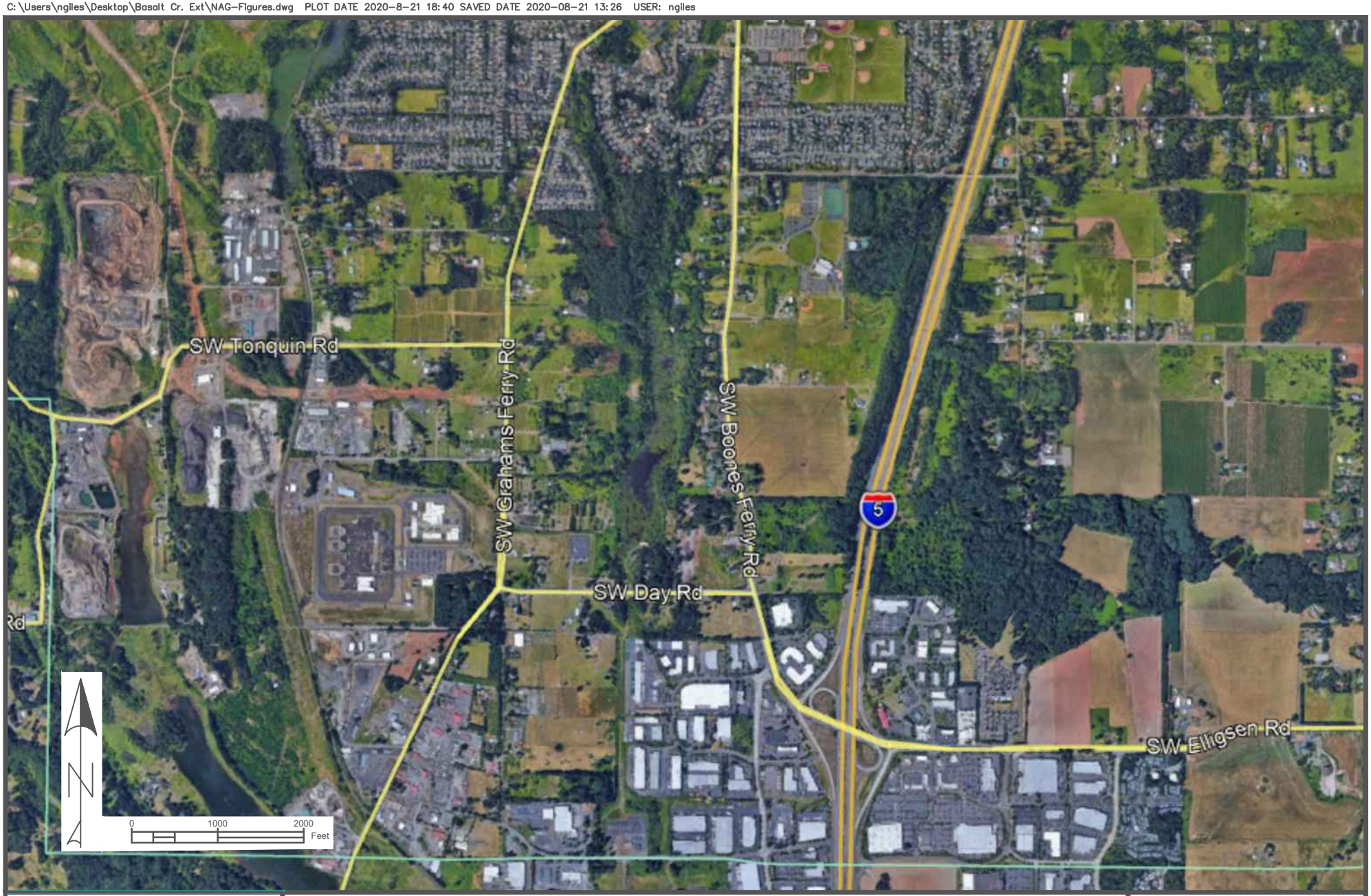
Maintenance of the stormwater facilities will be performed regularly as recommended by the agencies and the Operations and Maintenance Manuals. Washington County will be responsible for maintaining all facilities. Annual inspection of the facilities should occur to ensure their proper function. Maintenance guidance is provided in Appendix 4. Operation and Maintenance Manuals will be submitted under separate cover with the Final Stormwater Report.

5.0 CONCLUSION

The proposed facilities provide stormwater management for site runoff as required by Washington County, ODOT, and FAHP permitting requirements to the maximum extent practicable. The proposed facilities provide treatment of reasonably expected pollutants and contaminants from roadway runoff. Therefore, it is demonstrated that the stormwater management provided for the project meets the regulatory requirements.

6.0 FIGURES

C:\Users\ngiles\Desktop\Basalt Cr. Ext\NAG-Figures.dwg PLOT DATE 2020-8-21 18:40 SAVED DATE 2020-08-21 13:26 USER: ngiles

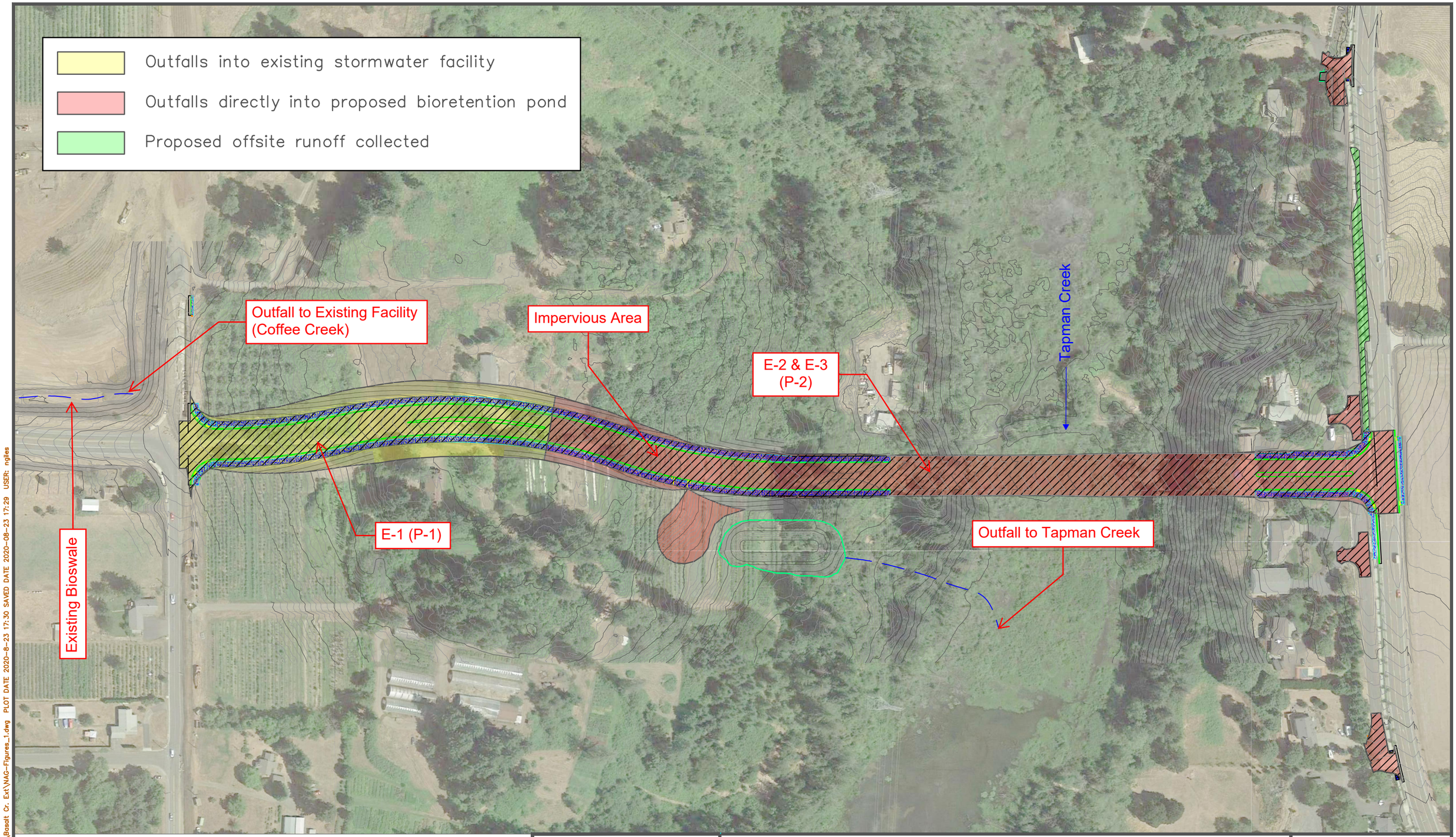


DOWL
WWW.DOWL.COM

Basalt Creek Extension: Grahams Ferry Road - Boones Ferry Road
Vicinity Map

PROJECT	0019-0471
DATE	06/18/2020

FIGURE 1



N

0 250 500 Feet

DOWL
WWW.DOWL.COM

Basalt Creek Parkway Extension: Grahams Ferry Rd. - Boones Ferry Rd.
Stormwater Drainage

PROJECT	0019-0471
DATE	08/23/2020

FIGURE 2

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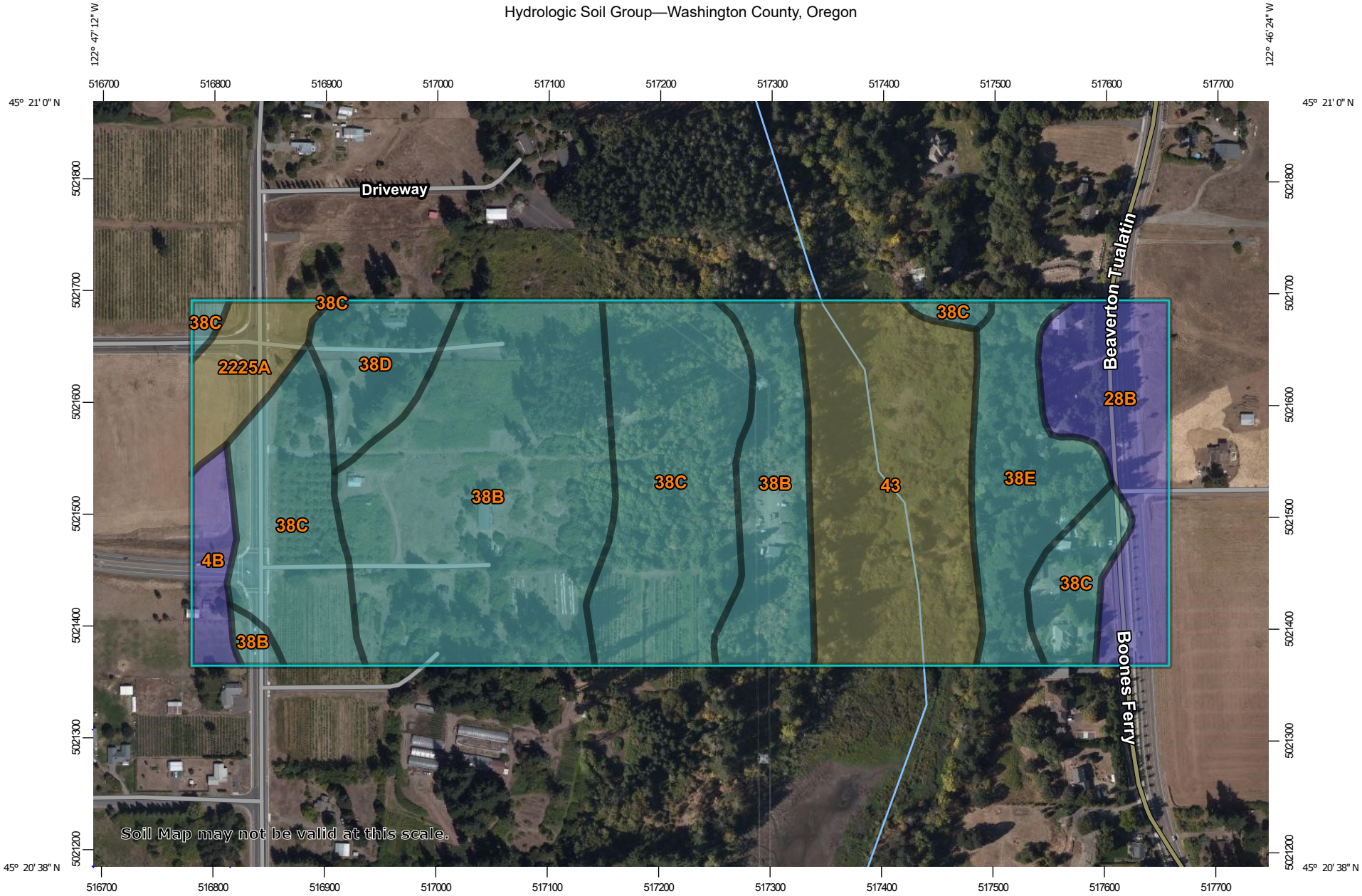
APPENDIX 1: WATERSHED CHARACTERISTICS



Map Scale: 1:4,820 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Washington County, Oregon
Survey Area Data: Version 17, Sep 10, 2019

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

Date(s) aerial images were photographed: Aug 1, 2019—Sep 12, 2019

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
4B	Briedwell silt loam, 0 to 7 percent slopes	B	1.7	2.4%
28B	Laurelwood silt loam, 3 to 7 percent slopes	B	6.1	8.6%
38B	Saum silt loam, 2 to 7 percent slopes	C	21.9	30.8%
38C	Saum silt loam, 7 to 12 percent slopes	C	18.3	25.7%
38D	Saum silt loam, 12 to 20 percent slopes	C	3.1	4.3%
38E	Saum silt loam, 20 to 30 percent slopes	C	5.7	8.0%
43	Wapato silty clay loam	C/D	11.9	16.7%
2225A	Huberly silt loam, 0 to 3 percent slopes	C/D	2.4	3.4%
Totals for Area of Interest			**71.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX 2: STORMWATER ANALYSIS RESULTS

Storm and Sanitary Analysis Output

Model: *Existing*
Event: *42% 2-Year*

Element ID	Basin ID	Area (ac)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
E-1	E-1	2.77	Extg-W	98.00	76.00	0.00	1.01	0.04	0.01	0 00:28:00
E-2	E-2	3.32	64	98.00	76.00	0.00	1.01	0.04	0.01	0 00:40:33
E-3	E-3	1.24	64	98.00	76.00	0.00	1.01	0.04	0.01	0 00:21:16

Model: *Existing*
Event: *2-Year*

Element ID	Basin ID	Area (ac)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
E-1	E-1	2.77	Extg-W	98.00	76.00	0.00	2.40	0.62	0.17	0 00:28:00
E-2	E-2	3.32	64	98.00	76.00	0.00	2.40	0.62	0.18	0 00:40:33
E-3	E-3	1.24	64	98.00	76.00	0.00	2.40	0.62	0.09	0 00:21:16

Model: *Existing*
Event: *5-Year*

Element ID	Basin ID	Area (ac)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
E-1	E-1	2.77	Extg-W	98.00	76.00	0.00	2.80	0.87	0.29	0 00:28:00
E-2	E-2	3.32	64	98.00	76.00	0.00	2.80	0.86	0.30	0 00:40:33
E-3	E-3	1.24	64	98.00	76.00	0.00	2.80	0.87	0.14	0 00:21:16

Model: *Existing*
Event: *10-Year*

Element ID	Basin ID	Area (ac)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
E-1	E-1	2.77	Extg-W	98.00	76.00	0.00	3.39	1.27	0.49	0 00:28:00
E-2	E-2	3.32	64	98.00	76.00	0.00	3.39	1.26	0.51	0 00:40:33
E-3	E-3	1.24	64	98.00	76.00	0.00	3.39	1.27	0.25	0 00:21:16

Model: *Existing*
Event: *50-Year*

Element ID	Basin ID	Area (ac)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
E-1	E-1	2.77	Extg-W	98.00	76.00	0.00	4.29	1.94	0.85	0 00:28:00
E-2	E-2	3.32	64	98.00	76.00	0.00	4.29	1.92	0.87	0 00:40:33
E-3	E-3	1.24	64	98.00	76.00	0.00	4.29	1.95	0.42	0 00:21:16

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *42% 2-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (inches)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-01	P-2	0.14	Structure - (5)	98.00	76.00	100.00	1.20	0.98	0.04	0 00:05:00
Sub-02	P-2	0.18	Structure - (6)	98.00	76.00	100.00	1.20	0.98	0.05	0 00:05:00
Sub-03	P-2	0.25	Structure - (6)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-04	P-2	0.25	Structure - (5)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-05	P-2	0.26	Structure - (5)	98.00	76.00	100.00	1.20	0.98	0.07	0 00:05:00
Sub-06	P-2	0.24	Structure - (6)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-07	P-2	0.25	Structure - (10)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-08	P-2	0.24	Structure - (40)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-09	P-2	0.22	Structure - (40)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-10	P-2	0.22	Structure - (10)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-11	P-2	0.24	Structure - (31)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-12	P-2	0.23	Structure - (28)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-13	P-2	0.20	Structure - (11)	98.00	76.00	100.00	1.20	0.98	0.05	0 00:05:00
Sub-14	P-2	0.23	Structure - (12)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-15	P-2	0.23	Structure - (14)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-16	P-2	0.26	Structure - (13)	98.00	76.00	100.00	1.20	0.98	0.07	0 00:05:00
Sub-17	P-2	0.25	Structure - (15)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-18	P-2	0.25	Structure - (16)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-19	P-1	0.25	Structure - (18)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-20	P-1	0.21	Structure - (17)	98.00	76.00	100.00	1.20	0.98	0.05	0 00:05:00
Sub-21	P-1	0.23	Structure - (19)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-22	P-1	0.25	Structure - (20)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-23	P-1	0.23	Structure - (22)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-24	P-1	0.20	Structure - (21)	98.00	76.00	100.00	1.20	0.98	0.05	0 00:05:00
Sub-25	P-1	0.22	Structure - (23)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-26	P-1	0.24	Structure - (24)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-27	P-1	0.22	Structure - (26)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-28	P-1	0.22	Structure - (25)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-29	P-1	0.26	Structure - (25)	98.00	76.00	100.00	1.20	0.98	0.07	0 00:05:00
Sub-30	P-1	0.24	Structure - (26)	98.00	76.00	100.00	1.20	0.98	0.06	0 00:05:00
Sub-31	P-2	0.13	Structure - (128)	98.00	76.00	100.00	1.20	0.98	0.03	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *42% 2-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (inches)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-32	P-2	0.08	Structure - (126)	98.00	76.00	100.00	1.20	0.98	0.02	0 00:05:00
Sub-33	P-2	0.08	Structure - (124)	98.00	76.00	100.00	1.20	0.98	0.02	0 00:05:00
Sub-34	P-2	0.13	Structure - (131)	98.00	76.00	100.00	1.20	0.98	0.03	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *2-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (inches)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-01	P-2	0.14	Structure - (5)	98.00	76.00	100.00	2.40	2.17	0.08	0 00:05:00
Sub-02	P-2	0.18	Structure - (6)	98.00	76.00	100.00	2.40	2.17	0.10	0 00:05:00
Sub-03	P-2	0.25	Structure - (6)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-04	P-2	0.25	Structure - (5)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-05	P-2	0.26	Structure - (5)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-06	P-2	0.24	Structure - (6)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-07	P-2	0.25	tructure - (10)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-08	P-2	0.24	tructure - (40)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-09	P-2	0.22	tructure - (40)	98.00	76.00	100.00	2.40	2.17	0.12	0 00:05:00
Sub-10	P-2	0.22	tructure - (10)	98.00	76.00	100.00	2.40	2.17	0.12	0 00:05:00
Sub-11	P-2	0.24	tructure - (31)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-12	P-2	0.23	tructure - (28)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-13	P-2	0.20	tructure - (11)	98.00	76.00	100.00	2.40	2.17	0.11	0 00:05:00
Sub-14	P-2	0.23	tructure - (12)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-15	P-2	0.23	tructure - (14)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-16	P-2	0.26	tructure - (13)	98.00	76.00	100.00	2.40	2.17	0.15	0 00:05:00
Sub-17	P-2	0.25	tructure - (15)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-18	P-2	0.25	tructure - (16)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-19	P-1	0.25	tructure - (18)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-20	P-1	0.21	tructure - (17)	98.00	76.00	100.00	2.40	2.17	0.11	0 00:05:00
Sub-21	P-1	0.23	tructure - (19)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-22	P-1	0.25	tructure - (20)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-23	P-1	0.23	tructure - (22)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-24	P-1	0.20	tructure - (21)	98.00	76.00	100.00	2.40	2.17	0.11	0 00:05:00
Sub-25	P-1	0.22	tructure - (23)	98.00	76.00	100.00	2.40	2.17	0.12	0 00:05:00
Sub-26	P-1	0.24	tructure - (24)	98.00	76.00	100.00	2.40	2.17	0.13	0 00:05:00
Sub-27	P-1	0.22	tructure - (26)	98.00	76.00	100.00	2.40	2.17	0.12	0 00:05:00
Sub-28	P-1	0.22	tructure - (25)	98.00	76.00	100.00	2.40	2.17	0.12	0 00:05:00
Sub-29	P-1	0.26	tructure - (25)	98.00	76.00	100.00	2.40	2.17	0.15	0 00:05:00
Sub-30	P-1	0.24	tructure - (26)	98.00	76.00	100.00	2.40	2.17	0.14	0 00:05:00
Sub-31	P-2	0.13	ucture - (128)	98.00	76.00	100.00	2.40	2.17	0.07	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *2-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (inches)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-32	P-2	0.08	ucture - (126)	98.00	76.00	100.00	2.40	2.17	0.05	0 00:05:00
Sub-33	P-2	0.08	ucture - (124)	98.00	76.00	100.00	2.40	2.17	0.04	0 00:05:00
Sub-34	P-2	0.13	ucture - (131)	98.00	76.00	100.00	2.40	2.17	0.07	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *5-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (inches)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-01	P-2	0.14	Structure - (5)	98.00	76.00	100.00	2.80	2.56	0.09	0 00:05:00
Sub-02	P-2	0.18	Structure - (6)	98.00	76.00	100.00	2.80	2.56	0.11	0 00:05:00
Sub-03	P-2	0.25	Structure - (6)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-04	P-2	0.25	Structure - (5)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-05	P-2	0.26	Structure - (5)	98.00	76.00	100.00	2.80	2.56	0.17	0 00:05:00
Sub-06	P-2	0.24	Structure - (6)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-07	P-2	0.25	Structure - (10)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-08	P-2	0.24	Structure - (40)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-09	P-2	0.22	Structure - (40)	98.00	76.00	100.00	2.80	2.56	0.14	0 00:05:00
Sub-10	P-2	0.22	Structure - (10)	98.00	76.00	100.00	2.80	2.56	0.14	0 00:05:00
Sub-11	P-2	0.24	Structure - (31)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-12	P-2	0.23	Structure - (28)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-13	P-2	0.20	Structure - (11)	98.00	76.00	100.00	2.80	2.56	0.13	0 00:05:00
Sub-14	P-2	0.23	Structure - (12)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-15	P-2	0.23	Structure - (14)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-16	P-2	0.26	Structure - (13)	98.00	76.00	100.00	2.80	2.56	0.17	0 00:05:00
Sub-17	P-2	0.25	Structure - (15)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-18	P-2	0.25	Structure - (16)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-19	P-1	0.25	Structure - (18)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-20	P-1	0.21	Structure - (17)	98.00	76.00	100.00	2.80	2.56	0.13	0 00:05:00
Sub-21	P-1	0.23	Structure - (19)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-22	P-1	0.25	Structure - (20)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-23	P-1	0.23	Structure - (22)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-24	P-1	0.20	Structure - (21)	98.00	76.00	100.00	2.80	2.56	0.13	0 00:05:00
Sub-25	P-1	0.22	Structure - (23)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-26	P-1	0.24	Structure - (24)	98.00	76.00	100.00	2.80	2.56	0.15	0 00:05:00
Sub-27	P-1	0.22	Structure - (26)	98.00	76.00	100.00	2.80	2.56	0.14	0 00:05:00
Sub-28	P-1	0.22	Structure - (25)	98.00	76.00	100.00	2.80	2.56	0.14	0 00:05:00
Sub-29	P-1	0.26	Structure - (25)	98.00	76.00	100.00	2.80	2.56	0.17	0 00:05:00
Sub-30	P-1	0.24	Structure - (26)	98.00	76.00	100.00	2.80	2.56	0.16	0 00:05:00
Sub-31	P-2	0.13	Structure - (128)	98.00	76.00	100.00	2.80	2.56	0.08	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *5-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (inches)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-32	P-2	0.08	Structure - (126)	98.00	76.00	100.00	2.80	2.56	0.06	0 00:05:00
Sub-33	P-2	0.08	Structure - (124)	98.00	76.00	100.00	2.80	2.56	0.05	0 00:05:00
Sub-34	P-2	0.13	Structure - (131)	98.00	76.00	100.00	2.80	2.56	0.08	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *10-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-01	P-2	0.14	Structure - (5)	98.00	76.00	100.00	3.15	2.92	0.10	0 00:05:00
Sub-02	P-2	0.18	Structure - (6)	98.00	76.00	100.00	3.15	2.92	0.13	0 00:05:00
Sub-03	P-2	0.25	Structure - (6)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-04	P-2	0.25	Structure - (5)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-05	P-2	0.26	Structure - (5)	98.00	76.00	100.00	3.15	2.92	0.19	0 00:05:00
Sub-06	P-2	0.24	Structure - (6)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-07	P-2	0.25	Structure - (10)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-08	P-2	0.24	Structure - (40)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-09	P-2	0.22	Structure - (40)	98.00	76.00	100.00	3.15	2.92	0.16	0 00:05:00
Sub-10	P-2	0.22	Structure - (10)	98.00	76.00	100.00	3.15	2.92	0.16	0 00:05:00
Sub-11	P-2	0.24	Structure - (31)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-12	P-2	0.23	Structure - (28)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-13	P-2	0.20	Structure - (11)	98.00	76.00	100.00	3.15	2.92	0.15	0 00:05:00
Sub-14	P-2	0.23	Structure - (12)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-15	P-2	0.23	Structure - (14)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-16	P-2	0.26	Structure - (13)	98.00	76.00	100.00	3.15	2.92	0.19	0 00:05:00
Sub-17	P-2	0.25	Structure - (15)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-18	P-2	0.25	Structure - (16)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-19	P-1	0.25	Structure - (18)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-20	P-1	0.21	Structure - (17)	98.00	76.00	100.00	3.15	2.92	0.15	0 00:05:00
Sub-21	P-1	0.23	Structure - (19)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-22	P-1	0.25	Structure - (20)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-23	P-1	0.23	Structure - (22)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-24	P-1	0.20	Structure - (21)	98.00	76.00	100.00	3.15	2.92	0.15	0 00:05:00
Sub-25	P-1	0.22	Structure - (23)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-26	P-1	0.24	Structure - (24)	98.00	76.00	100.00	3.15	2.92	0.17	0 00:05:00
Sub-27	P-1	0.22	Structure - (26)	98.00	76.00	100.00	3.15	2.92	0.16	0 00:05:00
Sub-28	P-1	0.22	Structure - (25)	98.00	76.00	100.00	3.15	2.92	0.16	0 00:05:00
Sub-29	P-1	0.26	Structure - (25)	98.00	76.00	100.00	3.15	2.92	0.19	0 00:05:00
Sub-30	P-1	0.24	Structure - (26)	98.00	76.00	100.00	3.15	2.92	0.18	0 00:05:00
Sub-31	P-2	0.13	ructure - (128)	98.00	76.00	100.00	3.15	2.92	0.09	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *10-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-32	P-2	0.08	ructure - (126)	98.00	76.00	100.00	3.15	2.92	0.06	0 00:05:00
Sub-33	P-2	0.08	ructure - (124)	98.00	76.00	100.00	3.15	2.92	0.06	0 00:05:00
Sub-34	P-2	0.13	ructure - (131)	98.00	76.00	100.00	3.15	2.92	0.10	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *50-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-01	P-2	0.14	Structure - (5)	98.00	76.00	100.00	4.29	4.05	0.14	0 00:05:00
Sub-02	P-2	0.18	Structure - (6)	98.00	76.00	100.00	4.29	4.05	0.18	0 00:05:00
Sub-03	P-2	0.25	Structure - (6)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-04	P-2	0.25	Structure - (5)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-05	P-2	0.26	Structure - (5)	98.00	76.00	100.00	4.29	4.05	0.27	0 00:05:00
Sub-06	P-2	0.24	Structure - (6)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-07	P-2	0.25	Structure - (10)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-08	P-2	0.24	Structure - (40)	98.00	76.00	100.00	4.29	4.05	0.24	0 00:05:00
Sub-09	P-2	0.22	Structure - (40)	98.00	76.00	100.00	4.29	4.05	0.22	0 00:05:00
Sub-10	P-2	0.22	Structure - (10)	98.00	76.00	100.00	4.29	4.05	0.23	0 00:05:00
Sub-11	P-2	0.24	Structure - (31)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-12	P-2	0.23	Structure - (28)	98.00	76.00	100.00	4.29	4.05	0.23	0 00:05:00
Sub-13	P-2	0.20	Structure - (11)	98.00	76.00	100.00	4.29	4.05	0.20	0 00:05:00
Sub-14	P-2	0.23	Structure - (12)	98.00	76.00	100.00	4.29	4.05	0.23	0 00:05:00
Sub-15	P-2	0.23	Structure - (14)	98.00	76.00	100.00	4.29	4.05	0.23	0 00:05:00
Sub-16	P-2	0.26	Structure - (13)	98.00	76.00	100.00	4.29	4.05	0.27	0 00:05:00
Sub-17	P-2	0.25	Structure - (15)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-18	P-2	0.25	Structure - (16)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-19	P-1	0.25	Structure - (18)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-20	P-1	0.21	Structure - (17)	98.00	76.00	100.00	4.29	4.05	0.21	0 00:05:00
Sub-21	P-1	0.23	Structure - (19)	98.00	76.00	100.00	4.29	4.05	0.23	0 00:05:00
Sub-22	P-1	0.25	Structure - (20)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00
Sub-23	P-1	0.23	Structure - (22)	98.00	76.00	100.00	4.29	4.05	0.23	0 00:05:00
Sub-24	P-1	0.20	Structure - (21)	98.00	76.00	100.00	4.29	4.05	0.21	0 00:05:00
Sub-25	P-1	0.22	Structure - (23)	98.00	76.00	100.00	4.29	4.05	0.23	0 00:05:00
Sub-26	P-1	0.24	Structure - (24)	98.00	76.00	100.00	4.29	4.05	0.24	0 00:05:00
Sub-27	P-1	0.22	Structure - (26)	98.00	76.00	100.00	4.29	4.05	0.22	0 00:05:00
Sub-28	P-1	0.22	Structure - (25)	98.00	76.00	100.00	4.29	4.05	0.22	0 00:05:00
Sub-29	P-1	0.26	Structure - (25)	98.00	76.00	100.00	4.29	4.05	0.27	0 00:05:00
Sub-30	P-1	0.24	Structure - (26)	98.00	76.00	100.00	4.29	4.05	0.25	0 00:05:00

Storm and Sanitary Analysis Output

Model: *Proposed*
Event: *50-Year*

Element ID	Basin ID	Area (ac.)	Drainage Node ID	Impervious Area Curve Number	Pervious Area Curve Number	Impervious Area (%)	Total Precipitation (in)	Total Runoff (in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
Sub-31	P-2	0.13	:ructure - (128)	98.00	76.00	100.00	4.29	4.05	0.13	0 00:05:00
Sub-32	P-2	0.08	:ructure - (126)	98.00	76.00	100.00	4.29	4.05	0.09	0 00:05:00
Sub-33	P-2	0.08	:ructure - (124)	98.00	76.00	100.00	4.29	4.05	0.08	0 00:05:00
Sub-34	P-2	0.13	:ructure - (131)	98.00	76.00	100.00	4.29	4.05	0.13	0 00:05:00

STORM AND SANITARY ANALYSIS PIPE CONVEYANCE RESULTS

Project: *Basalt Creek Extension: Grahams Ferry Rd. - Boones Ferry Rd.*
Project #: *0019-0471*
Designer: *NAG*
Date: *8/21/2020*

Design Storm: 10-yr.

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter (inches)	Peak Flow (cfs)	Max Flow Velocity (ft/sec)	Design Flow Capacity (cfs)	Max Flow Depth (ft)
1	Link-01	49.64	273.00	0.00	549.9600	CIRCULAR	18.000	2.03	7.88	22.38	0.31
2	Pipe - (12)	57.97	280.63	279.87	1.3100	CIRCULAR	12.000	0.84	4.08	4.07	0.31
3	Pipe - (13)	58.51	280.33	279.25	1.8500	CIRCULAR	12.000	0.17	2.89	4.84	0.13
4	Pipe - (137)	23.25	310.83	310.60	1.0000	CIRCULAR	12.000	0.16	2.29	3.56	0.14
5	Pipe - (138)	135.08	310.50	309.01	1.1000	CIRCULAR	12.000	0.15	2.36	3.74	0.14
6	Pipe - (139)	28.54	315.83	314.56	4.4400	CIRCULAR	12.000	0.06	2.85	7.51	0.06
7	Pipe - (14)	59.15	286.83	286.23	1.0100	CIRCULAR	12.000	0.17	2.34	3.59	0.15
8	Pipe - (140)	157.16	308.83	307.26	1.0000	CIRCULAR	12.000	0.15	2.30	3.56	0.14
9	Pipe - (141)	515.05	307.16	297.72	1.8300	CIRCULAR	12.000	0.31	3.46	4.82	0.17
10	Pipe - (142)	134.22	315.07	313.73	1.0000	CIRCULAR	12.000	0.10	2.01	3.56	0.11
11	Pipe - (143)	336.96	313.63	310.93	0.8000	CIRCULAR	12.000	0.10	1.88	3.19	0.12
12	Pipe - (144)	19.07	329.14	328.94	1.0200	CIRCULAR	12.000	0.10	1.99	3.60	0.11
13	Pipe - (145)	18.03	327.56	326.13	7.9300	CIRCULAR	12.000	0.10	4.02	10.03	0.07
14	Pipe - (146)	15.40	323.03	322.87	1.0800	CIRCULAR	12.000	0.10	2.04	3.70	0.11
15	Pipe - (147)	57.95	322.77	322.18	1.0100	CIRCULAR	12.000	0.10	2.00	3.57	0.11
16	Pipe - (148)	51.52	330.22	329.46	1.4800	CIRCULAR	12.000	0.00	0.00	4.33	0.00
17	Pipe - (149)	51.87	329.36	328.84	1.0100	CIRCULAR	12.000	0.00	0.00	3.59	0.00
18	Pipe - (15)	59.46	294.83	294.22	1.0300	CIRCULAR	12.000	0.18	2.25	3.27	0.16
19	Pipe - (150)	18.47	328.74	328.55	1.0000	CIRCULAR	12.000	0.00	0.00	3.56	0.00
20	Pipe - (151)	627.21	322.08	309.54	2.0000	CIRCULAR	12.000	0.10	2.62	5.04	0.10
21	Pipe - (152)	50.78	309.44	308.93	1.0000	CIRCULAR	12.000	0.15	2.30	3.56	0.14
22	Pipe - (25)	74.14	279.77	278.90	1.1700	CIRCULAR	12.000	1.95	4.92	3.86	0.50
23	Pipe - (30)	24.97	279.70	279.45	1.0000	CIRCULAR	12.000	0.00	0.00	3.56	0.00

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter (inches)	Peak Flow (cfs)	Max Flow Velocity (ft/sec)	Design Flow Capacity (cfs)	Max Flow Depth (ft)
24	Pipe - (31)	24.98	279.71	279.46	1.0000	CIRCULAR	12.000	0.00	0.00	3.56	0.00
25	Pipe - (32)	58.34	279.35	278.75	1.0300	CIRCULAR	12.000	0.18	2.40	3.61	0.15
26	Pipe - (37)	129.47	295.20	290.83	3.3800	CIRCULAR	12.000	0.33	4.38	6.55	0.15
27	Pipe - (38)	118.52	290.73	286.33	3.7100	CIRCULAR	12.000	0.69	5.59	6.86	0.21
28	Pipe - (39)	126.42	286.23	280.76	4.3300	CIRCULAR	12.000	1.01	6.60	7.41	0.25
29	Pipe - (40)	126.79	280.66	275.81	3.8200	CIRCULAR	12.000	1.34	6.85	6.97	0.30
30	Pipe - (41)	67.75	295.33	294.70	0.9400	CIRCULAR	12.000	0.15	1.28	1.59	0.21
31	Pipe - (42)	65.98	291.04	290.37	1.0200	CIRCULAR	12.000	0.17	1.78	2.46	0.18
32	Pipe - (43)	65.57	286.33	285.16	1.7900	CIRCULAR	12.000	0.15	1.28	1.59	0.21
33	Pipe - (44)	65.81	281.34	280.66	1.0200	CIRCULAR	12.000	0.17	2.34	3.61	0.15
34	Pipe - (46)	446.58	297.82	280.54	3.8700	CIRCULAR	12.000	0.49	5.13	6.99	0.18
35	Pipe - (47)	36.98	274.05	270.95	8.3900	CIRCULAR	12.000	3.34	11.72	10.32	0.39
36	Pipe - (48)	128.87	270.85	265.75	3.9500	CIRCULAR	12.000	3.34	8.82	7.02	0.49
37	Pipe - (49)	67.38	265.84	265.00	1.2500	CIRCULAR	18.000	3.34	5.72	11.74	0.55
38	Pipe - (5)	214.72	294.33	284.94	4.3700	CIRCULAR	12.000	0.37	4.93	7.45	0.15
39	Pipe - (50)	41.34	275.56	275.15	0.9800	CIRCULAR	12.000	2.03	4.65	3.53	0.54
40	Pipe - (51)	71.45	275.05	274.34	1.0000	CIRCULAR	12.000	2.03	4.68	3.56	0.54
41	Pipe - (54)	66.11	276.36	275.69	1.0200	CIRCULAR	12.000	0.35	2.92	3.60	0.21
42	Pipe - (55)	444.02	297.62	279.72	4.0300	CIRCULAR	12.000	0.78	6.00	7.14	0.22
43	Pipe - (57)	25.17	278.80	278.55	1.0000	CIRCULAR	12.000	1.95	4.64	3.57	0.53
44	Pipe - (58)	25.05	278.45	278.20	1.0000	CIRCULAR	12.000	2.30	4.82	3.56	0.58
45	Pipe - (59)	60.74	278.10	277.49	1.0000	CIRCULAR	12.000	2.30	4.82	3.56	0.58
46	Pipe - (6)	181.52	284.84	280.33	2.4900	CIRCULAR	12.000	0.73	4.94	5.62	0.24

STORM SEWER RESULTS

Inlet	Grade/Sag	Clogging Factor (%)	10-yr Max Spread (ft)	50-yr Max Spread (ft)	Allowable Spread (ft)	50-yr Max Depth (ft)
Structure - (10)	On Grade	30.00	1.52	1.93	8.00	0.04
Structure - (11)	On Grade	30.00	0.64	0.81	8.00	0.02
Structure - (12)	On Grade	30.00	0.73	0.93	8.00	0.02
Structure - (123)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (124)	On Grade	30.00	0.26	0.33	8.00	0.01
Structure - (125)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (126)	On Grade	30.00	0.27	0.35	8.00	0.01
Structure - (128)	On Grade	30.00	0.41	0.52	8.00	0.01
Structure - (13)	On Grade	30.00	0.85	1.08	8.00	0.02
Structure - (131)	On Sag	50.00	0.30	0.39	8.00	0.04
Structure - (132)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (133)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (134)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (135)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (136)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (137)	On Grade	30.00	0.00	0.00	8.00	0.00
Structure - (138)	On Sag	50.00	0.00	0.00	8.00	0.00
Structure - (14)	On Grade	30.00	0.74	0.94	8.00	0.02
Structure - (15)	On Grade	30.00	0.80	1.02	8.00	0.02
Structure - (16)	On Grade	30.00	0.81	1.03	8.00	0.02
Structure - (17)	On Grade	30.00	0.67	0.85	8.00	0.02
Structure - (18)	On Grade	30.00	0.80	1.02	8.00	0.02
Structure - (19)	On Grade	30.00	0.74	0.94	8.00	0.02
Structure - (20)	On Grade	30.00	0.81	1.03	8.00	0.02
Structure - (21)	On Grade	30.00	0.66	0.84	8.00	0.02
Structure - (22)	On Grade	30.00	0.74	0.95	8.00	0.02
Structure - (23)	On Grade	30.00	0.72	0.92	8.00	0.02
Structure - (24)	On Grade	30.00	0.76	0.97	8.00	0.02
Structure - (25)	On Sag	30.00	1.09	1.38	8.00	0.15
Structure - (26)	On Sag	50.00	1.08	1.37	8.00	0.14
Structure - (28)	On Sag	50.00	0.54	0.69	8.00	0.07
Structure - (29)	On Grade	30.00	0.00	0.00	8.00	0.00
Structure - (30)	On Grade	30.00	0.00	0.00	8.00	0.00
Structure - (31)	On Sag	50.00	0.57	0.72	8.00	0.08
Structure - (32)	On Grade	30.00	0.00	0.00	8.00	0.00
Structure - (33)	On Grade	30.00	0.00	0.00	8.00	0.00
Structure - (40)	On Grade	30.00	1.47	1.87	8.00	0.04
Structure - (5)	On Grade	30.00	2.05	2.18	8.00	0.08
Structure - (6)	On Grade	30.00	2.06	2.19	8.00	0.09

BIORETENTION POND TREATMENT

Project: *Basalt Creek Extension: Grahams Ferry Rd. - Boones Ferry Rd.*
Project #: *0019-0471*
Designer: *NAG*
Date: *8/21/2020*

Inputs

Design Storm:	50% 2-yr, 24 hr.	
$P_{50\%\ 2\text{-yr}}$ =	1.2	in
Bottom El. =	265	ft
Bottom W =	26.39	ft
Infiltration Rate =	3	in/hr
Treatment L =	11	ft
Treatment Area =	290.29	ft
Treatment Q =	0.02016	cfs
Allowed Depth =	3	ft

Storm and Sanitary Analysis Output

Prop. Depth	***2.36***	***ft***
Min. Bypass El.	***267.36***	***ft***

BIORETENTION POND DETENTION

Project: *Basalt Creek Extension: Grahams Ferry Rd. - Boones Ferry Rd.*
Project #: *0019-0471*
Designer: *NAG*
Date: *8/21/2020*

Storm	Req. (cfs)	Prop. (cfs)	Prop. Max Depth (ft)
42% 2-yr	0.02	0.02	0.96
2-yr	0.3	0.25	3.02
5-yr	0.48	0.44	3.28
10-yr	0.81	0.69	3.46
50-yr	1.28	1.05	3.85