WASILLA CREEK STORMWATER ANALYSIS

Matanuska-Susitna Borough, Alaska

May 2019

WASILLA CREEK STORMWATER ANALYSIS

Project Report

MSB Contract No. 18-145P

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ACRONYMS

ACWA .... Alaska Clean Water Actions
ADF&G .... Alaska Department of Fish and Game
ATV .... all-terrain vehicle
BMP .... Best Management Practice
DEC .... State of Alaska Department of Environmental Conservation
DEM .... Digital Elevation Model
DOT&PF .... State of Alaska Department of Transportation and Public Facilities
EPA .... Environmental Protection Agency
GIS .... Geographic Information System
HSG .... hydrologic soil group
LiDAR .... Light Detection and Ranging
LF .... linear foot
MOA .... Municipality of Anchorage
MRLC .... Multi-Resolution Land Characteristics Consortium
MSB .... Matanuska-Susitna Borough
NHD .... National Hydrographic Database
NLCD .... National Land Cover Dataset
NOAA .... National Oceanic and Atmospheric Administration
NRCS .... Natural Resources Conservation Service
ROW .... right-of-way
SWMM .... Storm Water Management Model
SWPPP .... Stormwater Pollution Prevention Plan
TNC .... The Nature Conservancy
USGS .... United States Geological Survey
WBD .... Watershed Boundary Dataset

1.0 INTRODUCTION

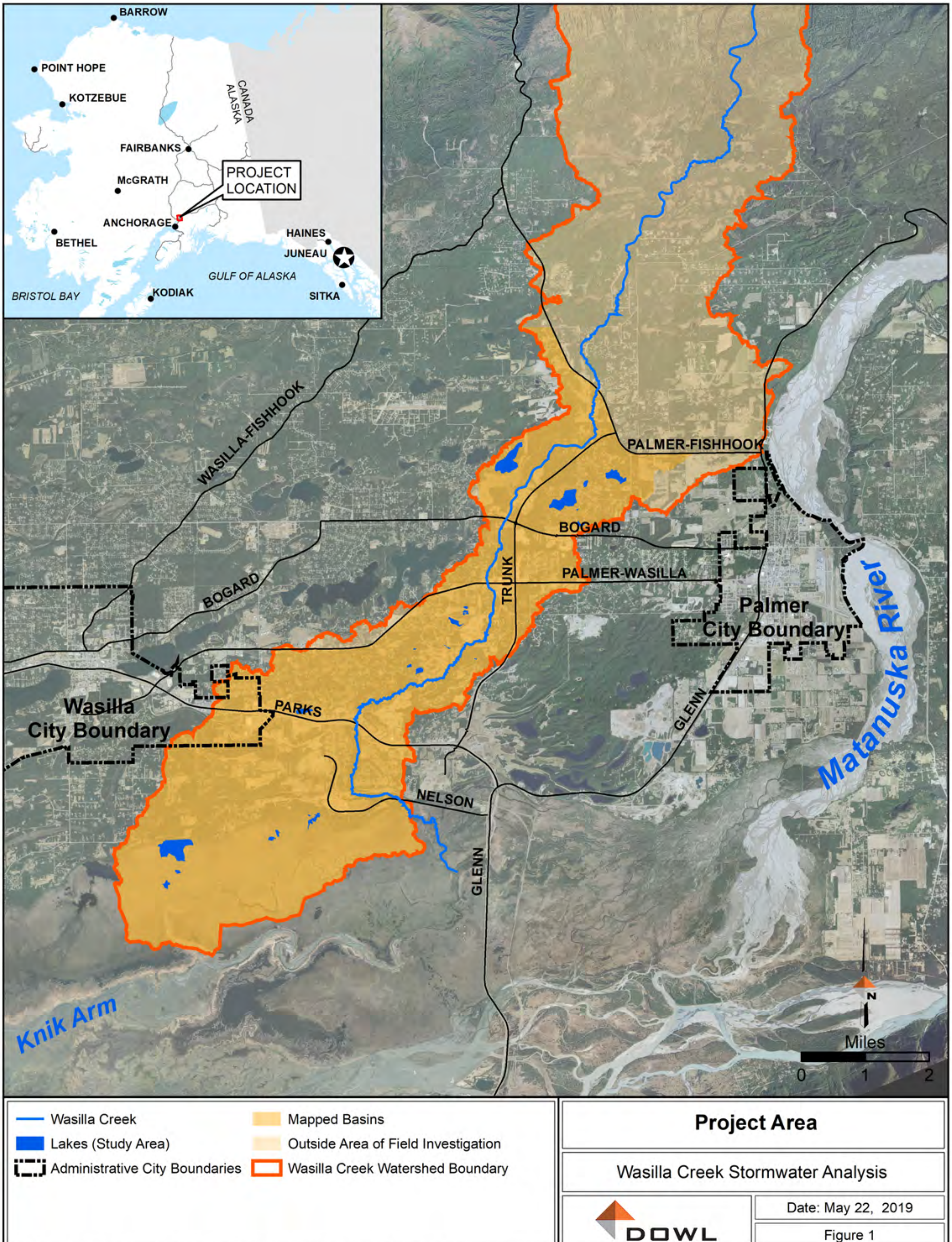
1.1 History/Background

Wasilla Creek originates in the steep mountainside of Arkose Ridge in the Talkeetna Mountains, to the east of Hatcher Pass in the Matanuska-Susitna Borough (MSB) before entering large wetland complexes of the Matanuska Valley Moose Range between Moose Creek and the Little Susitna River (Figure 1). Wasilla Creek's main stem and primary tributary channels are approximately 34 miles, of which, approximately 32 miles are listed as anadromous by Alaska Department of Fish and Game (ADF&G). Wasilla Creek drains approximately 34,000 acres and eventually drains into Knik Arm via the Palmer Slough.

The MSB has experienced rapid growth over the past several decades – an approximately 50 percent growth in Palmer and Wasilla between 1997 and 2017 (U.S. Census Bureau). Residential development in the Mat-Su Valley occurred around the lakes first and spread outward as lakes have provided significantly higher property values and despite rapid development, the MSB remains largely rural compared to other regions of the United States (Berman 2013).

The increase in population and associated development are having a negative effect on several area waterways with loss of naturally vegetated riparian habitat, additional roads and crossings, increase in polluted stormwater runoff volumes, and decreased water quality. In 2011-2012 the State of Alaska Department of Environmental Conservation (DEC) conducted a stormwater assessment of Cottonwood, Meadow, and Wasilla Creeks. The assessment looked at changes in water quality during times of storm runoff. Not surprisingly, water quality decreased in areas receiving urban stormwater runoff. This project will improve the understanding of the current stormwater treatment condition of Wasilla Creek and look for opportunities to intercept stormwater runoff before it reaches the creek.

This rapid population growth has resulted in the need for stormwater infrastructure. In 2010 the DEC listed several waterbodies in the MSB on the Clean Water Act Section 303(d) list (Category 5) as impaired. Despite its lower sections experiencing new roads and development, Wasilla Creek is not identified as an impaired waterbody and has a robust riparian habitat along its banks and flows mostly through rural agricultural lands.



Project Area

Wasilla Creek Stormwater Analysis

Date: May 22, 2019

DOWL

Figure 1

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The upper portions of Moose Creek and Wasilla Creek provide important fish rearing habitat with expansive wetlands and small tributary streams. Unfortunately, some of this area has been severely impacted by illegal off-road activities as shown in Photo Set 1.

Photo Set 1: Impacts to Upper Wasilla Creek Tributaries and Wetlands

A small portion of the City of Wasilla overlays a western section of the watershed near the intersection of the Seward Meridian Parkway and the Parks Highway. Recently-extended Bogard Road and Palmer-Wasilla Highway bisect the watershed in its middle section.

This study focused on the area to the south of Palmer Fishhook Road, which is the main access road to Hatcher Pass from the Glenn Highway. Other arterial roads, including Fairview Loop and Trunk roads, run through the watershed. In addition to the roadway system, development in the watershed includes undeveloped land, medium- to low-density (0.28- to 2.00-acres lots) residential development, and limited commercial development along the highways, and arterials. Approximately 25 percent of the watershed is identified as wetlands, with wetland loss recently estimated at just 3.08 percent (Gracz 2018).

Wasilla Creek provides spawning, rearing, and other habitat for four anadromous fish species (anadromous waters catalog #247-50-10260-2019), serves as the primary drinking water source for a large apartment complex off the Palmer-Wasilla Highway (water system number AK2220154), and supports historic and current small-scale agricultural activities including an operating dairy farm (ADF&G 2018).

1.2 Objectives

The primary purpose of this project is to perform an engineering and hydrologic analysis of the stormwater system contributing to Wasilla Creek drainage. The secondary goal is to identify the extent and functionality of the stormwater system, as well as potential improvements and conservation projects to enhance and protect the water quality of the drainage system and mitigate impacts to Wasilla Creek.

The proposed project is intended to develop and implement a portion of the MSB Stormwater Management Plan along Wasilla Creek by mitigating current and preventing future pollution from public and private stormwater infrastructure and other stormwater sources.

This project is being completed for the MSB and is funded, in part, by an Alaska Clean Water Actions (ACWA) grant from the DEC. This project addresses ACWA Stewardship and Restoration priorities.

> *This project addresses an ACWA Stewardship priority and expands the amount of information the Borough knows about stormwater flows. It will survey and map stormwater infrastructure and flow paths, identifying inadequate storm drain collection and treatment systems in the Wasilla Creek watershed. The survey will identify specific areas which may be contributing to the creek's pollution and make recommendations for the physical stormwater control structures, including green infrastructure, which could be used to improve water quality. A report of design recommendation and a completed Geographic Information Systems hydrography data layer will be created. The information will be used by local planners and engineers as a tool in land use decisions and management.*

1.3 Project Description

The project study area was originally defined as the Wasilla Creek watershed but was focused by MSB to just include the watershed south of Palmer Fishhook Road to East Nelson Road, so that the area of focus is the middle and lower sections of the watershed where most of the development has and is occurring.

This project provides a generalized stormwater infrastructure inventory of the Wasilla Creek watershed south of Palmer Fishhook Road to East Nelson Road. The inventory includes mapping of stormwater infrastructure and flow paths, particularly those that convey water to Wasilla Creek, identifying inadequate storm drain collection and treatment systems, and mapping ditches, pipes, and water quality treatment features.

The results of the mapping are evaluated, and recommendations are included for physical stormwater control structures, primarily using green infrastructure techniques, to protect and improve water quality.

The project has four tasks, listed below.

- Task 1: Conduct a stormwater inventory of the Wasilla Creek watershed using Geographic Information System (GIS) to map the stormwater drainage areas entering Wasilla Creek. Where stormwater is discharged, identify the land area that drains to specific areas of the creek at a catchment level. Maps identify stormwater inflow points and locations of runoff. The GIS layers and metadata are included into one combined figure with various data layers that can be selected for viewing. Mapping includes field verification where data is missing and sources of stormwater runoff that may be occurring.
- Task 2: Estimate stormwater flows at input points.
- Task 3: Identify inadequate storm drain collection and treatment systems and/or areas where new stormwater controls are needed or that exist but needs to be upgraded during spring break up.
- Task 4: Analyze results and develop a draft and final report with recommendations.

1.4 Project Phasing

The project focuses on data collected during both fall storm and spring breakup flows.

- Phase 1 includes field visits during fall 2018 storm flows, updates of the database schema developed by DOWL for Cottonwood Creek (DOWL 2017), and a GIS base map 2017 aerial from the MSB for the project. Using field data and GIS data, runoff estimates for existing and future conditions were calculated, potential stormwater control features identified, and draft findings and recommendations for addressing stormwater runoff were developed into a draft report for MSB and DEC review.
- Phase 2 includes field visits during spring 2019 breakup flow conditions. New data has been added to the GIS data and updates to this report, including recommendations have been completed. The final GIS stormwater data layers for Wasilla Creek are included with the final project report.

1.5 Project Context and Level of Detail

This project, as funded under a DEC grant and administered by the MSB, was not an exhaustive inventory of stormwater infrastructure in the Wasilla Creek drainage. It was targeted at identifying locations where stormwater is discharged to the creek. Since this mapping had not previously been conducted; field investigation, research, and budget were needed to evaluate what portions of the watershed are connected to the creek and which are not. Even when stormwater drainage features were identified, such as ditches or culverts, it was not always apparent that runoff reached the structures or that they were needed for stormwater conveyance. Mapping during runoff events was vital to determine these conditions.

Given the size of the watershed and the extent of the road system, the mapping and runoff calculations performed for this project provide a baseline of current conditions. While the results can serve as a basis for planning, they do not provide adequate detail to evaluate runoff at the parcel level and future site-specific investigation and mapping are likely to be required.

2.0 STORMWATER INFRASTRUCTURE MAPPING

2.1 Existing Available GIS Data

Data from federal and borough agencies and a conservation organization were used to provide a framework for data acquisition. These sources were used to develop field-grade maps for the field investigation.

2.1.1 Primary Data

The overall mapped watershed boundary conforms with the 12-digit Hydrologic Unit Code 190204010808 as defined in the Watershed Boundary Dataset (WBD), compiled by the Federal Geographic Data Committee and the Advisory Committee on Water Information as a coordinated effort between the United States Department of Agriculture Natural Resources Conservation Service (NRCS), the United States Geological Survey (USGS), and the Environmental Protection Agency (EPA). The WBD was created from a variety of sources from each state and aggregated into a standard national layer for use in strategic planning and accountability.

The mapped location of the thread of Wasilla Creek and its tributaries was obtained from the digital vector data sets of the National Hydrographic Dataset (NHD) Plus High-Resolution Dataset (USGS 2018), as compiled by the USGS and cooperating agencies.

Topographic data from a Digital Elevation Model (DEM) developed by MSB in its *Mat-Su LiDAR (Light Detection and Ranging) and Imagery Project 2011-2012* (MSB 2012) was used to develop drainage pathways (see Section 2.1.2) and to aid in catchment delineation.

Aerial imagery from 2017 was obtained from the MSB GIS Division. Building footprints were also obtained from the Mat-Su LiDAR and Imagery Project 2016-2017 (MSB 2012).

2.1.2 Additional Datasets

The National Land Cover Dataset (NLCD) 2011, a raster dataset with 30-meter (100-foot) spatial resolution, was developed by the Multi-Resolution Land Characteristics Consortium (MRLC) (2011). It characterizes land surfaces in the watershed, based on 2011 and previous years' aerial imagery, by the intensity of development, the vegetation type, or other surface features such as lakes and ice. It does not provide quantitative values for impervious surface area, but characterizes developed areas as Open Space, Low Intensity, Medium Intensity, and High Intensity development.

The Nature Conservancy (TNC) generously shared spatial information it has developed for the Wasilla Creek watershed. TNC previously provided DOWL with a conversion of the NLCD 2011 raster data to polygon data. TNC also processed the topographic data (Miller et al. 2015) and provided electronic files of flow accumulation points and a rubric for translating those files using ArcGIS tools so that they could be displayed as geographic features. These geographic features aided in identifying potential outfall points and flow paths and in catchment delineation. DOWL initially used this data to conduct field work, however TNC directed DOWL to an update of the NHD Plus High-Resolution Dataset (USGS 2018) for the Wasilla Creek watershed.

The ADF&G maintains a database of culverts on fish-bearing streams, as documented in Special Publication No. 14-08 (Eisenman et al. 2014). Although stream culverts were not considered part of the stormwater infrastructure inventoried by this project since they don't specifically convey drainage from roads and developed land, the culvert locations are of interest to the MSB. An electronic version of Wasilla Creek database was provided by ADF&G, dated November 26, 2018. It will be necessary for the MSB to obtain periodic downloads of the database to keep the information current.

2.2 Project-Acquired GIS Data

2.2.1 Database Schema

The GIS database adhered to the design of the Cottonwood Creek report (DOWL 2017). It was structured so that individual features of the stormwater infrastructure could be displayed geographically and characterized based on a variety of attributes. Table 1 presents an overview of the database structure. The types of features and their attributes are detailed in the data dictionary in Appendix A.

Table 1: GIS Database Features

GIS Feature Type	Example Structures
Points (nodes)	Outfalls (discharge points to creek), manholes, detention areas
Linear features (lines)	Culverts, pipes, ditches
Closed areas (polygons)	Catchment areas and the watershed boundary

The mapping was intended to identify actual physical features and features that indicated conditions during runoff events. Attribute data were provided for each of the feature types, but not all attribute fields were populated by the field mapping. For instance, the mapping did not include identifying the owner or the party responsible for maintenance of the identified storm drainage features. The database schema provides a field for this information, but that field was not populated.

Ownership information is important because it will provide guidance on which entity is responsible for maintaining, replacing, or retrofitting facilities. In general, ditches, inlets, manholes, pipes, and culverts that handle runoff from the State of Alaska Department of Transportation and Public Facilities (DOT&PF) roads are owned and maintained by DOT&PF, and similarly for City and MSB roads. In some cases, stormwater infrastructure for the city, borough, and state roads also convey runoff from abutting private property. In other cases, runoff from private property may be discharged to the creek, either directly through a single point of discharge or through dispersed flow. Currently, road system ownership is not available. Only DOT&PF and non-DOT&PF roads are identified in publicly available GIS datasets.

2.2.2 Mapped Points and Linear Features

The point features mapped in the field included outfalls, manholes, curb and field inlets, and detention/retention basins. Because the purpose of the project is to identify sources contributing flow to Wasilla Creek, additional data was collected at outfall points. At each of these points, the additional data collected included:

- whether discharge was occurring;
- the condition of the receiving water, including its color, clarity/turbidity, and odor based on visual inspection as no water samples were analyzed;

- whether animals were present in the surrounding area;
- the condition of the discharge point, including its proximity to the flowing water, evidence of scour, whether there were flow obstruction, whether there was erosion (outfall) protection, its general conditions; and
- deficiencies noted in a comment field.

The linear features mapped in the field and from as-built drawings included culverts, constructed ditches, open channels, and storm drain pipe. At each of these features, additional data collected included:

- whether flow was occurring and, if so, its depth and width;
- an estimate of whether flow in the structure was perennial, intermittent, ephemeral, or due primarily to stormwater;
- for culverts and pipes, the material, shape, condition, and diameter, and whether there was rust staining along the flow line;
- for ditches and channels, the substrate or lining material, the top width, and the depth; and
- deficiencies noted in a comment field.

2.2.3 Catchment Delineation

Catchments were delineated as areas contributing to a single or general point of discharge by using aerial imagery, field investigation indicators, and topographic information from the DEM. Each catchment was categorized based on the fate of its runoff relative to Wasilla Creek, as follows:

- Outfall – catchment runoff has a direct point of discharge to the creek from ditch, culvert or pipe
- Dispersed – catchment runoff has a general point of discharge to the creek, with dispersed runoff flowing sheetflow from land surfaces contiguous with the streambank or lakeshore
- Sink – catchment runoff does not leave catchment area as surface flow
- Connected – catchment runoff is discharged to connected downstream catchment by sheetflow or as a direct point of discharge. Connected catchments are further characterized by the type of catchment to which they discharge, as follows:
    - Connected – Outfall
    - Connected – Dispersed
    - Connected – Sink

A summary of the delineated catchments in shown in Table 2.

Table 2: Summary of Delineated Catchments

Catchment Type	Number of Catchments	Total Area (acres)	Percent of Total Area	Median Area (acres)
Dispersed	8	698	4.3%	86.5
Sink	26	9268	58.2%	190.5
Outfall	17	2024	12.7%	64.0
Connected-dispersed	5	196	1.2%	45.0
Connected-sink	5	2291	14.4%	345.0
Connected-outfall	16	1442	9.1%	29.5
Total	77	15919		

As indicated by the sink and connected-sink catchments, runoff from 77 percent of the watershed area is restricted from being conveyed to Wasilla Creek by roads with no cross culverts or by natural topographic features.

2.3 Field Mapping

Field mapping was conducted in August, September, and October 2018 and March 2019. Locations for each field visit were identified utilizing GIS. For the first field visit, locations were identified where Wasilla Creek and the roads crossed using the Intersect tool in GIS. Additional locations were identified by the following factors: land proximity to Wasilla Creek, impervious layers, and land accessibility using tax parcels and assuming roadways were public access. Possible locations of deficiencies were further narrowed down identifying where modeled drainage lines intersect the accessible land. Locations were verified or dismissed with field visits. A selection of deficiency photos is included in Appendix B.

2.3.1 Fall 2018 Mapping

Fall mapping occurred after runoff events on August 29, September 4, 2018, and October 18, 2018. Precipitation at rain gauges at the Palmer Municipal Airport for August 19 through 30 totaled 2.17 inches (Perica et al. 2012). This mapping identified locations where discharges and ponded water were occurring, including outfalls to Wasilla Creek. Approximately 60 locations were visited and evaluated.

2.3.2 Spring 2019 Mapping

Additional mapping occurred for spring breakup on March 22 and March 26, 2019. Several identified locations were observed during spring breakup to verify catchment type and size and to identify areas of runoff entering the creek. Additional deficiencies were identified and are included in the results. Results and final recommendations are included in the GIS database and in Sections 4, 5, and 6 of this report.

2.4 Map Production and Quality Control

2.4.1 Map Production

The GIS database was developed using ESRI ArcMAP software to allow interactive mapping and for future updates and database maintenance and enhancements.

Maps were created to be printed in 11-inch by 8.5-inch, hard copy format at 1-inch equals 2 miles (1: 92,000 except Figure 1 1:150,000) except for the Stormwater Analysis Maps (Appendix C). For these maps, 12 figures were created to cover the study area and 1-inch equals 1,500 feet (1: 12000). The maps are preceded by the index sheet in Appendix C.

2.4.2 Quality Control

Quality control procedures were used to:

- enforce topologic rules, for instance to assure that polygons representing catchments are closed and there are no overlaps or gaps;
- assign unique names to catchments and, for outfall catchments, their outfall points;
- ensure all calculations were consistent throughout the dataset by creating a final GIS database; and
- assure consistent terminology in attribute tables.

3.0 STORMWATER RUNOFF

Runoff to the creek was estimated under existing and build-out conditions. The distinguishing factor between the two conditions is the amount of impervious surface. For the existing condition, impervious areas for each catchment were estimated using data interpreted from the NLCD 2011, as described in Section 3.1.3. The build-out scenario was simulated by adjusting the percent impervious from the existing condition by assuming the ultimate development of private, undeveloped, subdivided land will occur, as described in Section 3.1.3.

3.1 Methodology and Hydrologic Parameters

Runoff to the creek was estimated for outfall and dispersed catchments; sink and connected-sink catchments were not modeled. The runoff from 76 catchments was modeled using the United States EPA Storm Water Management Model (SWMM) (Rossman 2010). The SWMM model developed for the project calculated precipitation losses and surface runoff to estimate peak flows for design storms. See Appendix D for model input and output.

The SWMM modeling software requires user-supplied values for precipitation and catchment properties. Catchment properties include total and impervious surface area, roughness factors for flow paths, and rainfall loss parameters including surface depression storage and infiltration parameters related to soils types. These user-supplied values are described below.

3.1.1 Precipitation

The 24-hour precipitation depths for the study area were obtained from National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (Perica et al. 2017) for precipitation gauges Palmer 5NW and Matanuska AG Exp Stn. The rainfall depths from the Palmer 5NW data is higher (16 to 40 percent) than the Matanuska AG Exp Stn data. This might be reflective of higher rainfall at the higher gauge elevation. It might also be because the period of record at Palmer 5NW (1941 to 1977) is different than the period of record at Matanuska AG Exp Stn (1917 to 2010). For this analysis, the Palmer 5NW data as used. The 24-hour depths were distributed temporally using the NRCS Type I Dimensionless 24-hour rainfall distribution, as recommended for Alaska by the NRCS.

The 2-, 10-, 50-, and 100-year 24-hour storms were modeled. The corresponding 24-hour rainfall depths at both gauges for the four recurrence intervals are shown in Table 3 and in Appendix E.

Table 3: Design 24-Hour Rainfall Depths

Rainfall Recurrence Interval (years)	Rainfall Depth (inches)	
	PALMER 5NW	Matanuska AG EXP STA
2	1.5	1.26
10	2.51	1.83
50	3.88	2.43
100	4.61	2.7

3.1.2 Design Flood

According to Chapter 7 of the DOT&PF *Alaska Highway Drainage Manual*, drainage systems must be designed to accommodate specific 24-hour design storms in Table 4.

Table 4: Storm Drain Structure Design Storm Standards

Type of Structure	Return Period (Exceedance Probability)
Culverts in Designated Flood Hazard areas	100 years (1%)
Culverts on Primary Highways	50 years (2%)
Culverts on Secondary Highways with High Design Hourly Volumes	50 years (2%)
Trunk Storm Sewers Lines on Primary Highways	50 years (2%)
Storm Sewer Feeder Lines	10 years (10%)
Side Ditches, Strom Water Inlets and Gutter Flow	10 years (10%)
Side Ditches, Strom Water Inlets and Gutter Flow in Depressed Roadway Sections	50 years (2%)

The Municipality of Anchorage (MOA) *Anchorage Stormwater Manual: Volume One – Management and Design Criteria* identifies the following storm design criteria (Table 5).

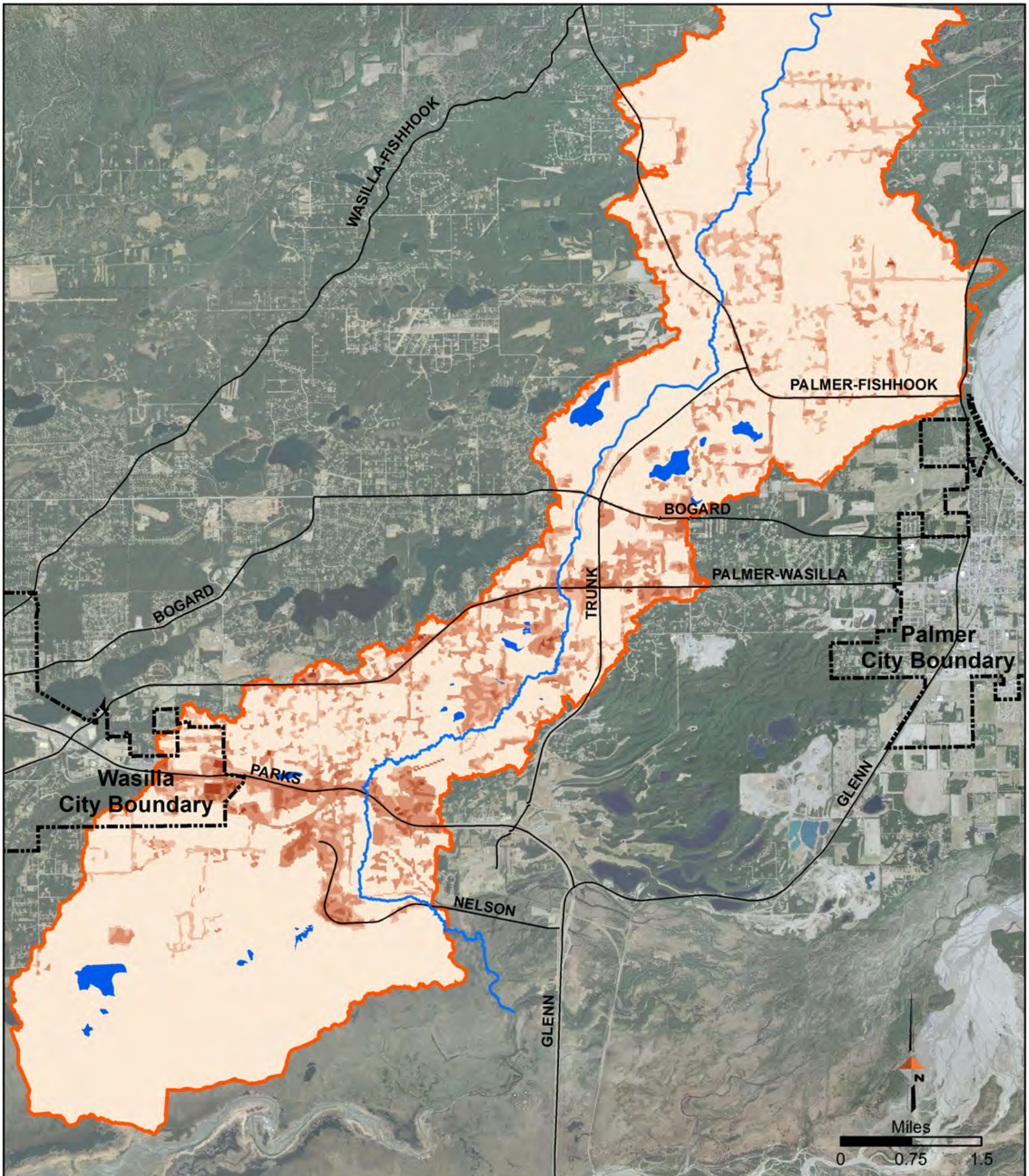
Table 5: MOA Design Storm Depths

Design Requirement	Design Storm	Application
Conveyance Design	10-year, 24-hour	Minor Drainageway and Major Drainageway
	25-year, 24-hour	Non-Regulated Stream
	100-year, 24-hour	Regulated Streams
Water Quality Treatment	90th Percentile, 24-hour	Green Infrastructure Water Quality Treatment
Extended Detention	1-year, 24-hour	Channel Protection
Peak Flow Control	2-year, 24-hour	Peak Control/Channel Protection
	10-year, 24-hour	Peak Control/Channel Protection
	100-year, 24-hour	Peak Control/Channel Protection

3.1.3 Total and Impervious Area

Total area for each catchment was obtained from the GIS database. Impervious data obtained from the NLCD 2011, which provides 100-foot resolution raster values of percent impervious, were rounded to the nearest integer value. The NLCD 2011 percent impervious data for the Wasilla Creek watershed are shown in Figure 2. The raster land cover percent impervious data was intersected with the catchment areas to calculate a weighted catchment impervious percent.

Aerial imagery (MSB 2017) for the watershed was used to compare the NLCD 2011 data with surface features to estimate impervious area at the catchment level. The NLCD 2011 provides the four types of 'developed' land cover: Open Space, Low Intensity, Medium Intensity, and High Intensity rather than values for impervious area. The assigned percent impervious were determined by viewing the NLCD 2011 overlain on the aerial imagery and estimating the percent impervious corresponding to the four types of 'developed' land cover. The raster land cover data was converted to vector (polygon) data and intersected with the catchments to determine the catchment impervious area and to calculate a weighted catchment impervious percent.



Wasilla Creek
Lakes (Study Area)
Administrative City Boundaries
Wasilla Creek Watershed Boundary

NLCD Impervious Percentage

0 - 10%	51 - 60%
11 - 20%	61 - 70%
21 - 30%	71 - 80%
31 - 40%	81 - 90%
41 - 50%	91 - 100%

NLCD 2011 Impervious Percentages

Wasilla Creek Stormwater Analysis

DOWL

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Figure 2

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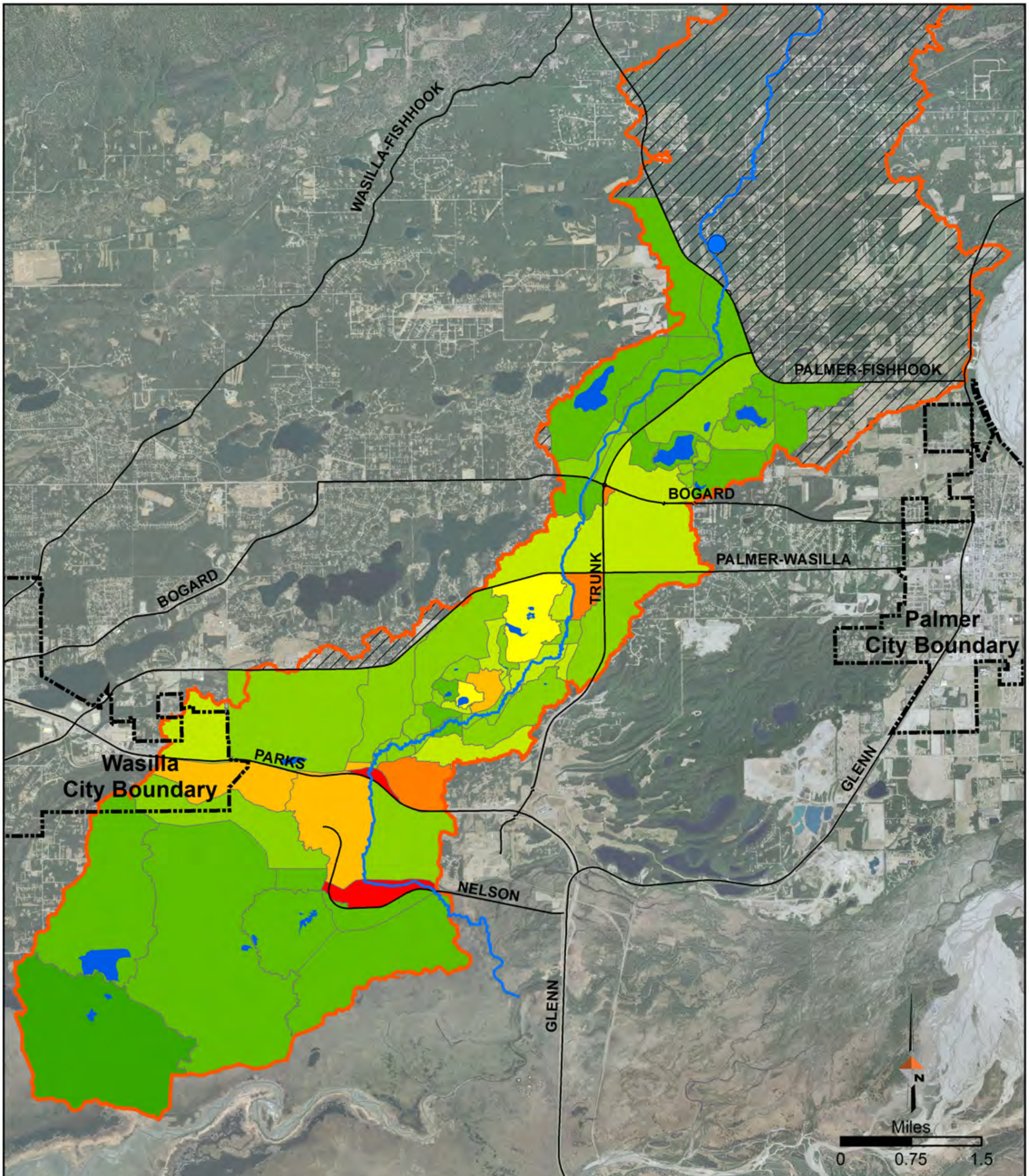
The four NLCD 2011 land types designated ‘developed’ and the assigned percent impervious for each category are shown in Table 6. All other NLCD 2011 land types were characterized as pervious.

Table 6: Land Cover Types and Assigned Percent Impervious

Land Cover Type	Assigned Percent Impervious	Percent of Wasilla Creek Watershed
Developed High Intensity	90	0.2%
Developed Medium Intensity	75	1.4%
Developed Low Intensity	60	9.7%
Developed Open Space	30	8.6%
All others	Pervious surface	80.1%

For build-out conditions, aerial imagery, parcel boundaries, and the LiDAR building footprint layer were used to determine the current level of development (e.g., 70 percent of lots developed in a given subdivision, for instance) within a given catchment. That was associated with the existing percent impervious for the catchment and then prorated to calculate the percent impervious at 100% development.

Visual representations of impervious percentages for the existing and build-out conditions are shown for the modeled catchments in Figures 3 and 4.



Palmer Precipitation Station
Wasilla Creek
Lakes (Study Area)
Administrative City Boundaries
Wasilla Creek Watershed Boundary
Outside Area of Field Investigation

Impervious Percentage

- 0%
- 0 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 60%
- 60 - 70%
- 70 - 80%

Existing Conditions Catchment

Wasilla Creek Stormwater Analysis

DOWL

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Figure 3

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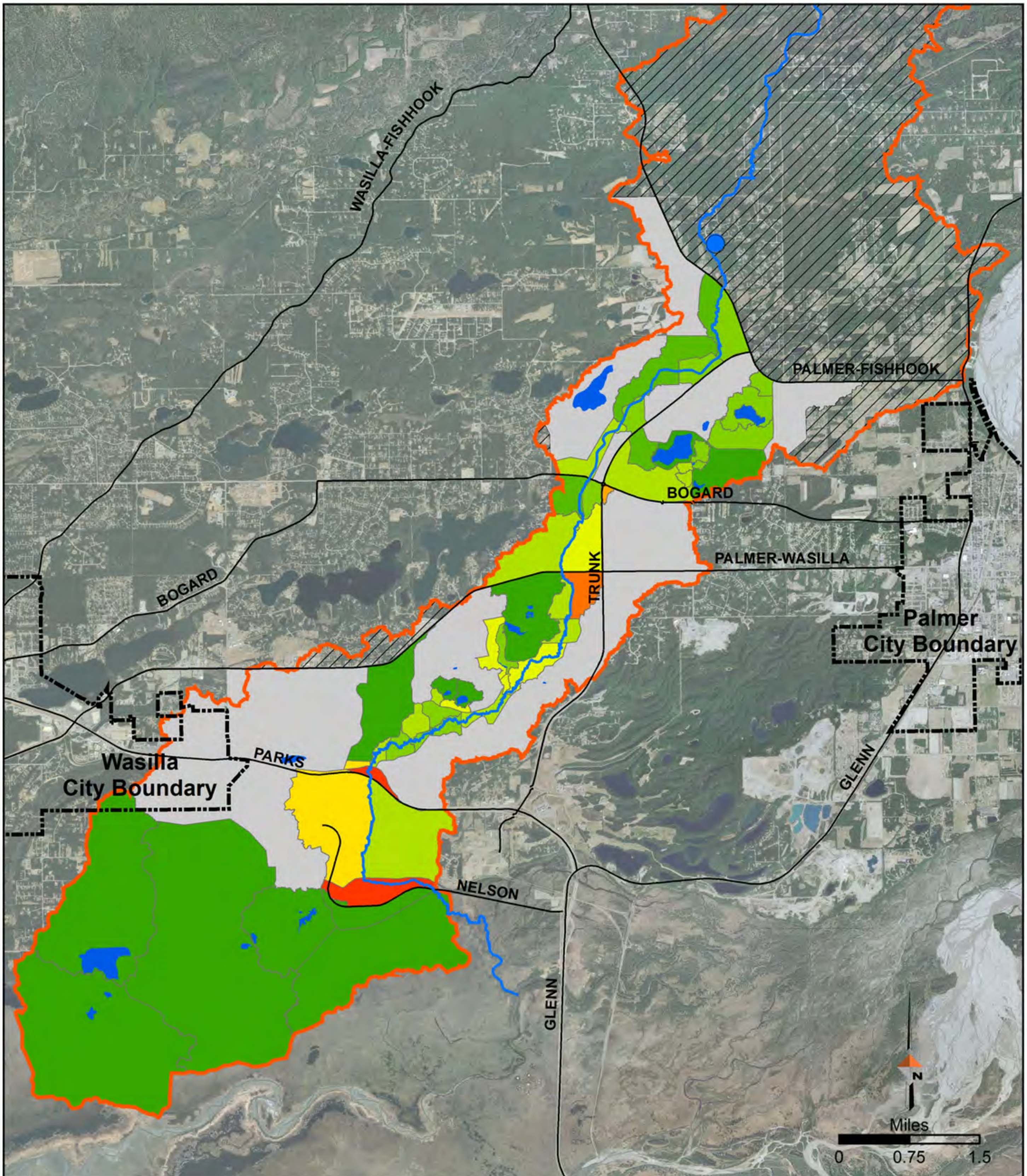

Palmer Precipitation Station
Wasilla Creek
Lakes (Study Area)
Administrative City Boundaries
Wasilla Creek Watershed Boundary
Outside Area of Field Investigation

Impervious Percentage

0%
0 - 10%
10 - 20%
20 - 30%
30 - 40%
40 - 50%
50 - 60%
60 - 70%
70 - 80%
80 - 90%
Not Modeled

Buildout Conditions Catchment

Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 4

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A summary of the existing and build-out percent imperviousness for the modeled catchments is shown in Table 7.

Table 7: Summary of Modeled Percent Imperviousness

Catchment Type	Number of Catchments	Catchment Area, acres, range / median			Existing Percent Impervious		Build-out Percent Impervious	
		min	max	median	median	max	median	max
Dispersed	6	1.9	48	6.8	17%	55%	23%	61%
Outfall	17	1.5	217	8.9	18%	72%	24%	78%
Connected-dispersed	7	1.6	38	3.1	16%	42%	22%	47%
Connected-outfall	14	0.4	48	3.2	12%	52%	18%	58%

3.1.4 Surface Flow

The SWMM kinematic wave method computes overland flow within each drainage basin, using user-supplied basin slope, width, and surface roughness factors.

Surface flow paths were delineated for each catchment and the upper and lower elevation of the flow path determined from the DEM data. Basin slope was computed based on the flow path length and change in elevation. Basin width was computed as the basin area divided by the flow path length.

Surface overland flow roughness factors are shown in Table 8. For drainage basins that had both landscaping and forest land cover, the surface roughness and depression storage were prorated by area.

Table 8: Surface Roughness Parameters

Parameter	Impervious	Pervious	
		Landscape	Light Underbrush
Surface Roughness	0.011	0.24	0.40

3.1.5 *Rainfall Loss Method*

SWMM has the ability to explicitly model rainfall losses as surface depression storage in pervious and impervious surfaces and infiltration on pervious surfaces. Surface depression storage depths for paved, lawn, and naturally vegetated surfaces are shown in Table 9.

Table 9: Depression Storage Parameters

Depression Storage (inches)			
Average Slope	Impervious Surfaces	Pervious Surfaces	
		Landscaped (lawn)	Naturally Vegetated (Forest)
Less than 2 percent	0.10	0.15	1.00
2 percent to 6 percent	0.00	0.10	1.00
Greater than 6 percent	0.00	0.05	0.50

The Green-Ampt equation was used to model infiltration losses. Green-Ampt parameters (suction head, conductivity, and initial deficit) are related to soil types.

Soils data for the study area is available from the NRCS. The NRCS classifies soils into four hydrologic soils groups (HSGs) based on rates of infiltration or hydraulic conductivity, where Group A soils have the most potential for infiltration and Group D soils have the least potential for infiltration. NRCS (2018) soils data for the study area is presented in Appendix E. The primary soil types in the watershed are HSG A (0.1%), HSG B (64%), and HSG D (35%).

The three HSG types were correlated to the soil types listed in Appendix A of the SWMM guidance (Rossman 2010), from which the Green-Ampt parameters were obtained. The parameters used in SWMM modeling for the three HSG types are shown in Table 10.

Table 10: Infiltration Parameters

HSG (from NRCS)	A	B	D
Soil type	Loamy Sand	Silt loam	Silty clay loam
Suction head (inches)	2.4	6.69	10.63
Conductivity (inches/hour)	1.18	0.26	0.04
Initial deficit (fraction)	0.39	0.366	0.261

Values from SWMM User’s Manual Appendix A (Rossman 2010)

3.2 Detention and Retention Modeling

No detention areas or detention basins were found in as-built records or during field mapping.

3.3 Summary of Runoff Estimate Results

The peak discharges are summarized in Table 11. The peak discharges for each catchment and storm event under both existing and build-out conditions are included in Appendix D.

Table 11: Summary of Peak Runoff Flows

Catchment Type	Number	Peak Catchment Runoff, median and maximum (cubic feet per second)							
		2-year		10-year		50-year		100-year	
		Median	Maximum	Median	Maximum	Median	Maximum	Median	Maximum
		Existing							
Dispersed		0.7	0.7	1.4	2.8	1.4	12.9	2.8	20.4
Outfall		1.0	2.3	1.6	9.7	2.5	24.1	4.6	33.1
Connected-dispersed		0.0	0.0	0.6	0.9	0.8	1.3	1.7	2.3
Connected-outfall		0.5	0.5	1.6	8.0	2.3	11.9	4.0	19.9
		Buildout							
Dispersed		1.8	1.8	1.8	4.5	1.9	17.4	3.6	26.5
Outfall		1.4	4.1	1.6	13.9	3.2	31.0	6.0	40.4
Connected-dispersed		0.0	0.0	0.8	1.1	1.1	1.6	1.5	2.8
Connected-outfall		0.5	0.9	2.1	3.8	3.0	15.0	3.9	24.5

1 cubic feet per second = 646,317 gallons per day

See Appendix D for tabulation by catchment.

4.0 RESULTS

Photos of deficient stormwater infrastructure features found during field mapping are included in Appendix B.

4.1 Field Observations of Drainage Infrastructure

In general, where property abuts the creek or its tributaries, flow is towards the creek, but in areas farther from the creek, drainage flows in a northeast to southwest direction in the watershed. Roadside ditches are the primary means of runoff capture and conveyance. Where roads cross Wasilla Creek, ditches may discharge to the creek but in many instances heavy vegetation at the ditch ends indicates that little consistent flow reaches the creek. No piped storm drain systems were found in the area. Inlets with piped outfalls exist along Trunk Road, Bogard Road, and the East Colony School Road roundabout but few pipes or culverts discharge directly to the creek. The outlet ends of the pipes are set back 30 to 300 feet from the creek and discharge to the riparian area along the creek.

Some stormwater infrastructure features, such as culverts, were found but, due to topography or changes in land development conditions, are not actually part of the stormwater conveyance system since no stormwater reaches them. Inferences that this is the case were made based on the degree of overgrown vegetation.

Based on observations from the field mapping, runoff discharged to Wasilla Creek is conveyed through vegetated swales or dispersion across the riparian area along the creek.

Based on observation during field mapping, runoff retention occurs in many instances in existing roadside ditches. The lack of connectivity of these ditches, for instance, few cross culverts across Trunk Road, Palmer-Wasilla Highway, Stringfield Road, and Hyer Road, enables this. In many of the observed locations, this lack of connectivity does not result in drainage problems and is essential for reducing direct stormwater discharges to Wasilla Creek.

4.2 General Deficiencies

The general deficiencies noted for the mapped features are summarized in Table 12.

Table 12: Types of Deficiencies

Deficiency	Number
None	40
Ponding/ATV	17
Undersized/shallow ditches/lack of storage	15
Buried, overgrown, accumulated sediment, submerged	6
Scour or erosion, sediment contamination	14
Other (Lack of SWPPP Management)	3
Total	95

Notes: ATV = all-terrain vehicle; SWPPP = Stormwater Pollution Prevention Plan

In general, the noted deficiencies involved sources of pollutants to the creek (sediment) and conditions that prevented or hindered the flow of drainage (crushed or blocked culverts). As discussed above, some slowing of drainage can promote infiltration, reducing the amount of drainage, and consequently pollutants, reaching Wasilla Creek.

4.3 Specific Deficiency Types

Specific deficiencies noted during the field investigations fell into five general categories. Examples for each category are described below and the locations are shown in Figure 5.

4.3.1 Ditches affected by All-Terrain Vehicle traffic

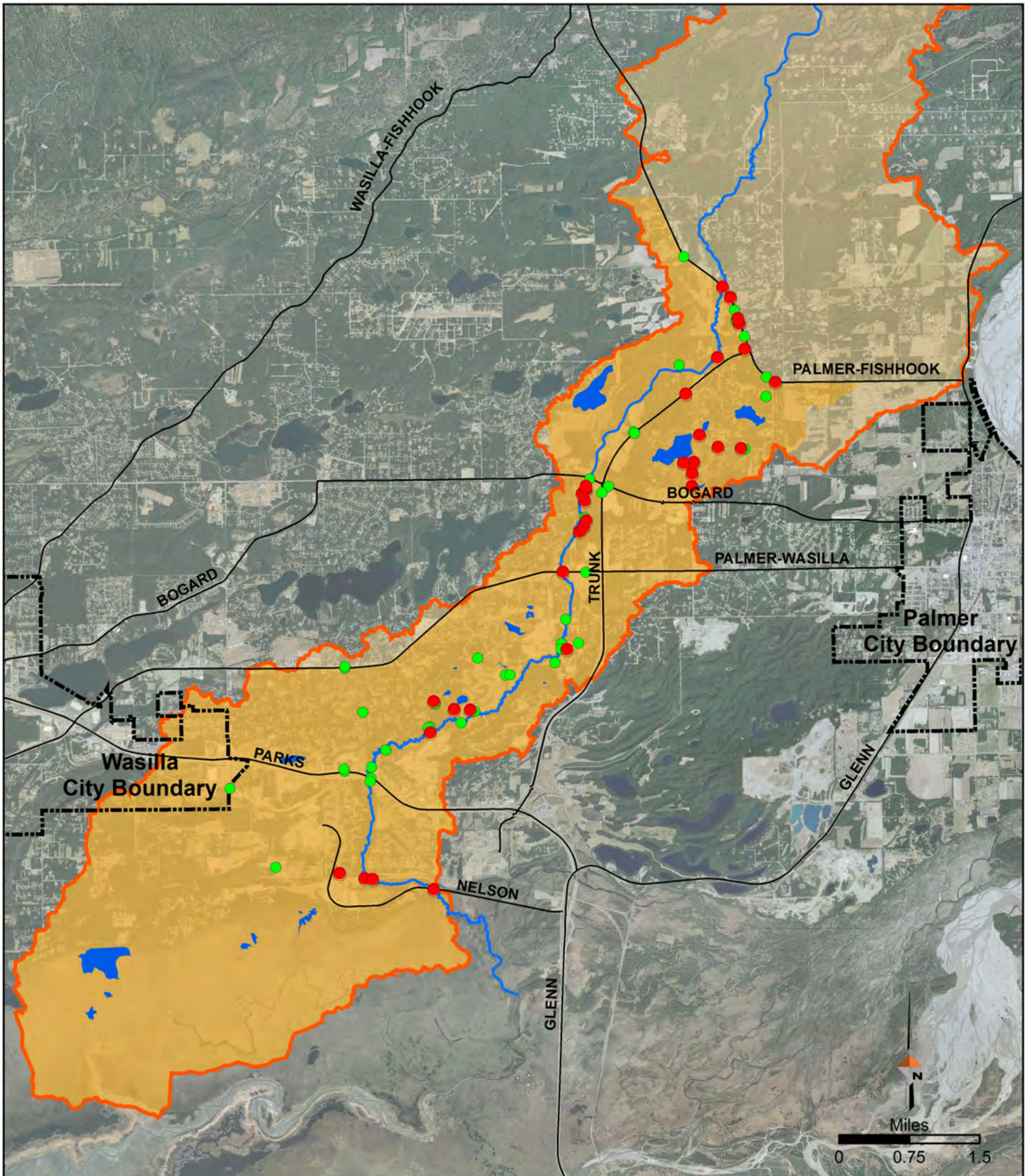
Deficiencies in this category can affect drainage and water quality. Ditches that convey flow affected by all-terrain vehicles (ATVs) are subject to erosion during runoff events. In many cases the runoff does not reach a surface water body, so water quality impacts do not occur. Alterations to ditches due to ATVs can impound runoff and impair drainage away from roads or property, causing drainage impacts.

- Driveways and side streets off Palmer-Fishhook Road. Ponding occurs along roadside ditches during rain events and water collects in ruts created by ATVs. In at least one area, the ATV trail has intercepted a tributary to Wasilla Creek, leading to direct contribution of sediments to the waterbody.
- Palmer-Fishhook Road and Trunk Road. Ponding occurs along roadside ditches during rain events and water collects in ruts created by ATVs. Major ponding in the area.
- Stringfield Road. Ponding occurs along roadside ditches during rain events and water collects in ruts created by ATVs.

4.3.2 Undersized, Shallow Ditches, Lack of Storage

Deficiencies in this category affect drainage and may impact adjacent roadways, paths, or structures.

- Driveways and side streets off Palmer-Fishhook Road. Major ponding occurs along roadside ditches during rain events and water collects in ruts created by ATVs.
- Intersection of Palmer-Fishhook Road and Trunk Road. Major ponding occurs along roadside ditches during rain events and water collects in ruts created by ATVs. Ponding is also occurring near utilities.
- Trunk Road. Ponding occurs along roadside ditches during rain events and water collects in ruts created by ATVs.
- Tern Drive. Ponding occurs in ditches and in many cases spills into the roadway and near utilities.
- North 49th State Street. Ponding occurs in shallow ditches.
- Stringfield Road. Major ponding occurs along roadside ditches during rain events and water collects in ruts created by ATVs.
- Wilderness Drive. Ponding occurs in shallow ditches and in many cases spills into the roadway and near utilities.
- Fetlock Drive. Ponding occurs in ditches and near utilities.



Field Visit Location
Deficiency Location
Wasilla Creek
Lakes (Study Area)
Administrative City Boundaries
Mapped Basins
Outside Area of Field Investigation
Wasilla Creek Watershed Boundary

Locations of Deficiencies

Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 5

4.3.3 *Buried, Overgrown, Accumulated Sediment, Crushed, Submerged Structures*

Deficiencies in this category affect drainage and may impact adjacent roadways, paths, or structures.

- Palmer-Fishhook Road, Wasilla Creek tributary. Perched culvert outfalls into ditch/ATV trail and eventually flows into stream.
- North 49th State Street, Wasilla Creek tributary. Culvert is partially buried and rusted. Overgrown vegetation and inlet are partially submerged.
- Seagull Drive, Walby Lake. Culvert is almost completed submerged, rusted and is overgrown with vegetation.
- Encroachment into road right-of-way (ROW) by homeowners in the suburban development south of the Parks Highway and north of Nelson Road, by filling in swales and reducing stormwater detention.
- Vickie Circle. Culvert is completely submerged.
- Bit Circle. Culvert nearly submerged.
- Fetlock Drive. Several crushed driveway culverts.

4.3.4 *Scour or Erosion and Sediment Contamination*

Deficiencies in this category can affect water quality and may impact adjacent roadways, paths, or structures.

- Palmer-Fishhook Road, Wasilla Creek. Downstream bank erosion at bend.
- Seagull Drive. Roadway sediment is being carried into the stream by road runoff.
- Stringfield Road. Roadway erosion caused by the stream is occurring at multiple locations along Stringfield Road. Roadway sediment is being carried into the stream by road runoff.
- Palmer-Wasilla Highway, Wasilla Creek. ATV traffic has caused embankment erosion at pipe outlet.
- Wilderness Drive. Roadway sediment is being carried into the stream by stormwater.
- Fetlock Drive. Roadway sediment is being carried into the stream by stormwater. Erosion is occurring at the large culvert embankments.
- Nelson Drive. Roadway sediment is being carried into the stream by stormwater.

4.3.5 *Lack of Stormwater Pollution Prevention Plan Management*

Deficiencies in this category can affect water quality.

- Commons and Tributary Avenue. A residential construction project has a large amount of unstabilized fill surrounded by water near culvert without Best Management Practices (BMPs).
- Nelson Drive. Ineffective BMPs left in place during fall inspection and still in place during spring inspection.

5.0 DESIGN RECOMMENDATIONS

5.1 Drainage Facilities

Because of the current and projected low density of development in the Wasilla Creek watershed, the lack of widespread use of curbs and gutters, the existing use of roadside ditches, and the generally well-draining soil in the watershed, design recommendations focus on retaining and infiltrating runoff as near to its source as possible while preventing property and road damage.

Green infrastructure is a term for stormwater management that reduces and treats stormwater at its source. Green infrastructure uses vegetation, soils, and other elements and practices to restore some of the natural processes required to manage water and create healthier urban environments. At the city or county scale, green infrastructure is a patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the neighborhood or site scale, stormwater management systems that mimic nature soak up and store water (EPA 2017).

Green infrastructure facilities for retaining and infiltrating runoff include vegetated swales and bioretention facilities. These types of drainage infrastructure reduce the peak flow rate and total quantity of water discharges to the creek. By reducing the total quantity of water, the quantity of pollutants is also reduced. They are generally designed to perform for more frequent storm events (1- to 2-year return intervals), which have been shown to constitute most of the annual storm event depths (DEC 2011; USKH 2013). Additional design elements, such as freeboard, are necessary for these facilities to handle runoff from larger, less frequent events.

- Vegetated or dry swales (DEC 2011) are ditches that are stabilized against erosion by turf grass or other vegetation and maintained by mowing. They are optimally designed with a bottom width of 2 feet or more to maintain a shallow flow depth and on a longitudinal slope of less than 2 percent to maintain lower velocities and promote filtration by water flowing through the vegetation. Where slopes are steeper, check dams can be included to slow the velocity, trap sediment and promote infiltration. A typical section of a vegetated swale is shown in Figure 6.

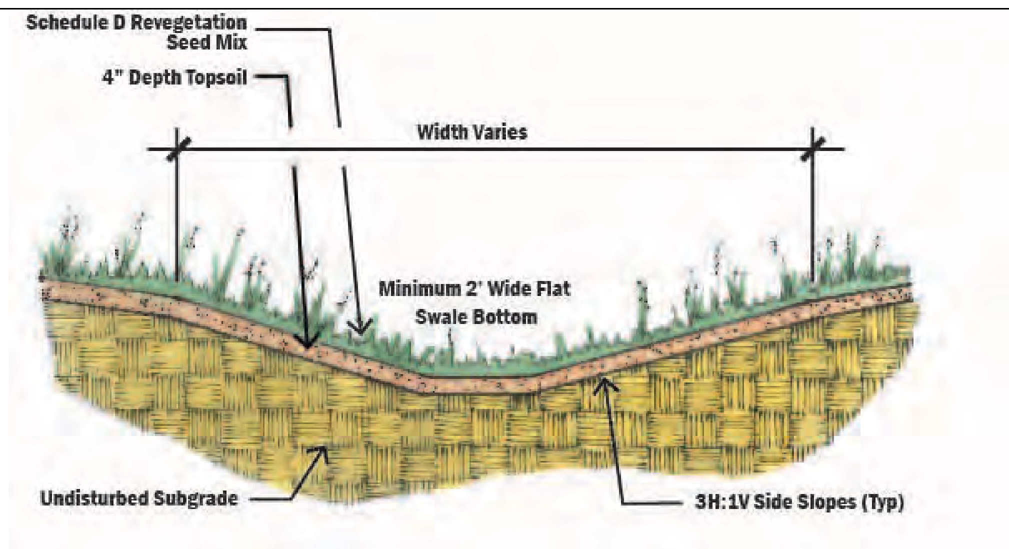


Figure 6: Vegetated Swale Typical Section

- Bioretention facilities are shallow basins or landscaped areas that capture and treat runoff using amended planting soils (a mix of sand and organic soil) and vegetation. Unlike vegetated swales that convey flow, bioretention facilities receive and infiltrate runoff. They are optimally designed with a minimum three-foot depth of amended planting soil on soils that have a minimum infiltration rate of 1 inch per hour. Since they are at low points in the drainage system, adequate freeboard or overflow paths must be provided for larger runoff events. A typical section of a bioretention facility is shown in Figure 7.

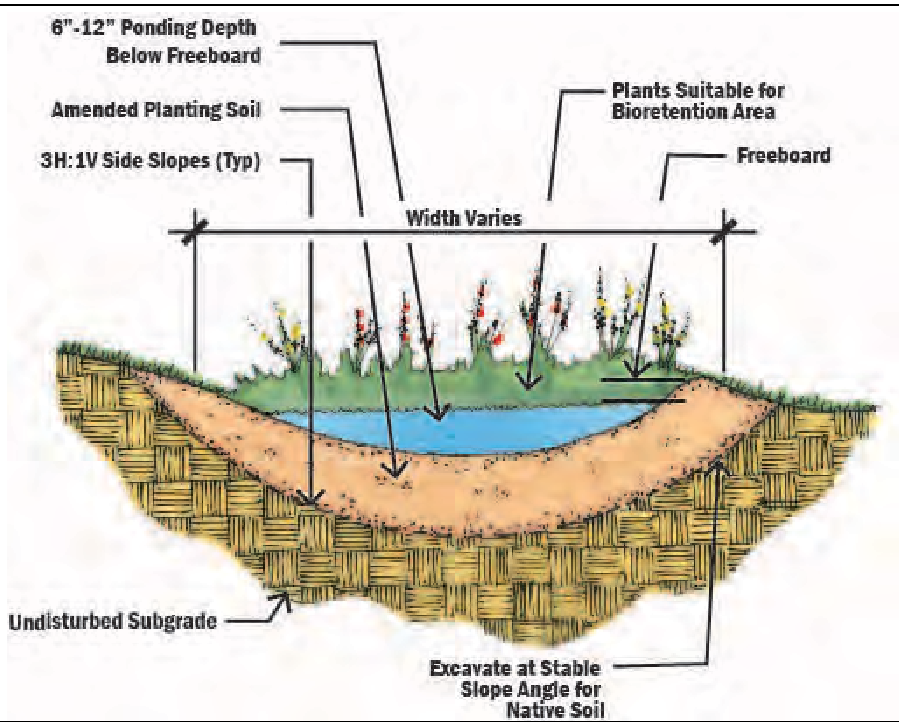


Figure 7: Bioretention Facility Typical Section

Vegetated swales and bioretention facilities must be designed to handle the flow directed towards them, and these flows will vary with the size and imperviousness of the area contributing drainage to them. Therefore, site specific design is required. Further information is provided in the Alaska Storm Water Guide (DEC 2011).

Where limitations to the use of vegetated swales or bioretention facilities occur, the recommendation is to retain or infiltrate runoff from up to the 2-year storm event. If that cannot be achieved, at a minimum treatment should be provided before discharge. The first choice for treatment is the use of green infrastructure. Even if retention or infiltration is not feasible, vegetation and soils can provide treatment.

5.2 Retrofit Opportunities

The project scope of work included identifying potential improvements and conservation projects to enhance the water quality of the drainage system and mitigate impacts to Wasilla Creek. Potential improvement projects are presented in this section.

5.2.1 Shallow or Undersized Ditches

Based on field observations, ditches along several streets including Trunk Road, Tern Drive, North 49th State Street, and various others receive runoff from the road and surrounding property. Depending on the width of the ROW and clear-zone requirements for road safety, ditches could be widened or deepened, lined with amended planting soil and planted with suitable grass species (Wright 2008). Maintenance agreements for these facilities should be considered (see Section 5.4).

5.2.2 Rehabilitate Ditches

Ditches along the length of Stringfield Road, which in several locations contribute to Wasilla Creek, have been eroded by ATV traffic causing major ponding and allowing sediment to be transported into the creek. Reestablishing stabilized (rock or vegetated) channels would reduce the amount of sediment that is picked up and, if the flow is slowed, allow sedimentation to occur prior to the flow entering the creek. Providing alternative routes for ATVs may be necessary.

5.2.3 Significant Ponding

An undersized culvert at Palmer-Fishhook Road conveys a tributary of Wasilla Creek which outfalls into the ditch which is used as ATV trail causing significant ponding (Figure 8). The ponded water flows back into the creek channel with sediment and negatively affects water quality.

An improvement to the Wasilla Creek tributary at Palmer-Fishhook Road would be to extend the culvert to outfall into the actual creek bed and build an ATV friendly embankment over the pipe extension.

Another option would be to build an armored channel section along the ATV trail at the culvert outfall to prevent sediment disturbance and discharge.

Figure 8: Wasilla Creek tributary culvert ponding on ATV trail at Palmer-Fishhook Road

5.2.4 Eroding Banks

Embankment erosion is occurring at multiple locations along Stringfield Road which is causing sediment contamination in Wasilla Creek and threatening the road embankment in the locations shown in Figure 9.

Riprap embankment protection would provide bank stabilization as well as reduce scour and susceptibility to sediment contamination.

Figure 9: Wasilla Creek embankment erosion at Stringfield Road

5.3 Cost Estimates

The costs associated with green infrastructure include ROW, excavation, and material and labor to install amended planting soils and plant materials. Retrofitting sites for green infrastructure may also require utility coordination and/ or relocation to minimize impacts. Cost estimates for several of the identified retrofit projects are included in Table 13. These are preliminary, order-of-magnitude estimates for planning purposes only. The facilities were sized for the different recurrent interval design event based on available area and to accommodate conveyance criteria as well as water quality criteria. The estimates do not include ROW acquisition and/ or utility relocation costs. Cost estimates are included in Appendix F.

Table 13: Potential Retrofit Projects and Estimated Costs

ID	Location	Description	Cost Estimate
9, 11	Tern Drive, North 49th State Street	Ditch grading per linear foot (LF)	$200/LF
12	Stringfield Road	Rock lined ditch per LF	$300/LF
2	Palmer-Fishhook Road	Wasilla Creek tributary culvert ponding on ATV trail – Culvert and embankment extension	$36,000
2	Palmer-Fishhook Road	Wasilla Creek tributary culvert ponding on ATV trail – Armored channel section	$19,000
12	Stringfield Road	Embankment erosion – Riprap embankment protection	$114,000

5.4 Maintenance Considerations

Maintenance of stormwater infrastructure is necessary for proper function. Maintenance considerations are often overlooked or receive inadequate funding (public facilities) or enforcement (private facilities).

Observations during mapping conducted for this project identified locations where culverts and ditches are overgrown, blocked, or have noticeable sediment accumulation that may be obstructing drainage. The condition of some specific drainage facilities, such as private detention and retention basins, are not as visible and were not part of the mapped observations. These facilities, which are prone to, or are specifically designed to, collect sediment, require specific means for inspection and periodic sediment removal.

When water quality treatment devices, including bioretention facilities, are installed on private development, the permitting or approving agency (DEC, City of Wasilla, or MSB) should include mechanisms in the approval process for assuring ongoing maintenance of the facility. The authorizing agencies may not presently have enforcement mechanisms and may need to acquire them. For instance, the DEC issues a letter of non-objection that does not address on-going maintenance.

New facilities that rely on green infrastructure will require similarly periodic maintenance, such as mowing, sediment removal, and vegetation re-establishment. The approving authority should consider a means to guarantee ongoing maintenance of these facilities.

Blocked or overgrown culvert inlets, culverts impacted by deposited sediment, or culverts that are not aligned with ditches, should be maintained to provide unimpeded flow. Not all culverts in the Wasilla Creek drainage actually serve a drainage function, so their maintenance may not be crucial. These could be identified through regular inspections or inspections during flow events. Those that do convey flow should have regular maintenance to prevent blockage.

Eroding ditches, whether due to steep embankments, ATV traffic, or channels inadequately protected for high flows, should be repaired. These may require a case-by-case examination to determine the cause. For instance, mildly sloped unvegetated embankment slopes (for instance, 2 horizontal to 1 vertical or flatter), could be revegetated. Steeper slopes may require rolled erosion control products or other stabilization measures. Control of ATV traffic affecting drainage ditches is an on-going concern. Signage requesting ATV users' help in maintaining vegetation has been successful in some situations. Providing a dedicated gravel alignment outside of the ditch backslope could be considered.

5.5 Future Considerations

Drainage recommendations for the Wasilla Creek watershed as it approaches build-out include:

- continue to handle runoff in ditches and vegetated swales and limit the conversion of ditches and swales to piped storm systems;
- provide design criteria and plan review mechanisms that assure that adequate ROW (for roads) or on-site areas (for commercial, residential, and other development) are included for managing stormwater with green infrastructure;
- for areas of new development in outfall and dispersed catchments, consider a limit on increases in site discharge and additional regulation;
- emphasis on preservation and protection of riparian areas along Wasilla Creek;
- consider ATV trails and access for future drainage design; and
- DEC recommends maintenance of natural hydrography with zero discharge off site for areas being developed. For large developments this is required through permitting process.

6.0 DISCUSSION

Field mapping of stormwater infrastructure was conducted fall of 2018 and spring of 2019 in the Wasilla Creek watershed to identify discharges to Wasilla Creek. Mapped data and noted field conditions were captured in an ArcMap GIS database to display and manipulate watershed and stormwater infrastructure features.

Catchment areas contributing to discharge points were delineated and their land cover, slope, and area features were characterized. Runoff from approximately 77 percent of the Wasilla Creek watershed is not connected by drainage infrastructure to Wasilla Creek. Peak discharges from catchment areas that discharge to Wasilla Creek for existing and build-out conditions were estimated for the 2-, 10-, 50-, and 100-year precipitation events.

Deficiencies noted during the field mapping included ponding and lack of storage, ditches affected by ATV traffic, buried and overgrown structures, scour and erosion.

Recommendations for retrofitting these deficiencies include:

- Improving ditch capacity and ponded areas (Sections 5.2.1, 5.2.2, 5.2.3)
- Improving bank protection to reduce sediment contamination and protect existing infrastructure (Section 5.2.4)

Recommendation for build-out conditions include maintaining the disconnected ditch and vegetated swale system to reduce impacts to Wasilla Creek and incorporating bioretention areas with future land development.

6.1 Data Limitations

Several observations were made, and ideas were developed that were limited by the scope of the project but are important to discuss. The scope of this analysis was limited to specific analysis and deliverables to adhere to grant requirements and this approach requires clarifications regarding data availability, data needs, and related ideas beneficial to future study.

This study did not include:

- a comprehensive survey of all ditches and roadway culverts; nor
- data related to infrastructure or conditions on private property, or within the watershed upstream of Palmer Fishhook Road due to the largely undeveloped nature of the upper watershed, although new development is occurring.

6.2 Recommendations

The following is recommended for further understanding of stormwater in the MSB:

- implement an asset management system to track stormwater facilities' locations and condition and to schedule and track maintenance;
- develop an overall drainage master plan to prioritize problem areas and capital improvement projects;
- develop snow management procedures and identify/pursue funding options for the development of a snow management plan;

- understand the regulatory implications of either creating wetlands or using existing wetlands to treat stormwater;
- understand the data and compliance requirements to obtaining permit under the DEC Alaska Pollutant Discharge Elimination System storm water program and prepare for MS4 permitting;
- unify methods of Stormwater Pollution Prevention Plan (SWPPP) management by different agencies within the MSB. The variation in approach to General Construction Permits and SWPPPs results in inconsistent and inefficient stormwater management;
- develop design criteria to help developers design and install effective stormwater facilities;
- develop permit requirements for developers to ensure runoff is adequately handled; and
- require maintenance of stormwater facilities for developers.

6.3 Other Deficiencies

Encroachment into the roadway ROW with structures (fences, sheds) and by filling retention swales and ditches is occurring by some homeowners in the suburban development south of the Parks Highway and north of Nelson road (e.g., Fetlock Way).

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APPENDIX A: GIS DATA DICTIONARY

STORMWATER INFRASTRUCTURE GEODATABASE

Data Dictionary

Prepared for:

Matanuska Susitna Borough
Capital Projects Department
350 Dahlia Street
Palmer, Alaska 99645

Prepared by:

DOWL
4041 B Street
Anchorage, Alaska 99503

May 2019

1133.62808.01

20190529.D62808.DataDictionary.FINAL.mkr

TABLE OF CONTENTS

TABLES

ACRONYMS

ADF&G .... Alaska Department of Fish and Game
GIS .... Geographic Information System
MSB .... Matanuska Susitna Borough
NHD .... National Hydrographic Dataset
SIGDB .... Stormwater Infrastructure Geodatabase
USGS .... United States Geological Survey

1.0 STORMWATER INFRASTRUCTURE GEODATABASE SUMMARY

The Stormwater Infrastructure Geodatabase (SIGDB) provides a digital container for project information and spatial digital data files, attribute data, and metadata related to stormwater infrastructure and drainage analyses for use by the Matanuska Susitna Borough (MSB).

This data depicts stormwater infrastructure associated with point discharges to Wasilla Creek between Palmer-Fishhook Road and East Nelson Road, with some additional mapping in areas that contribute to Wasilla Creek below Nelson Road. It depicts catchment areas and characterizes them based on the nature of the points of discharge associated with them.

1.1 Data Content and Compilation

The information content of the SIGDB is generated through mapping performed by MSB, its partners, and its contractors.

This data depicts stormwater infrastructure within the Wasilla Creek watershed between Palmer-Fishhook Road and East Nelson Road, it depicts catchment areas and characterizes them based on their points of discharge.

Point (deficiency locations) and Node (discharge points) features were identified using desktop modeling and verified by field work and Global Positioning System camera. Following field work, the collected data was entered into the Geographic Information System (GIS) data base.

The watershed boundary, catchment areas, and mapped location of Wasilla Creek and its tributaries were developed by the United States Geological Survey (USGS) National Hydrographic Dataset (NHD) Plus. Catchment areas were modified in the GIS database through data processing, topological associations, or information obtained from other sources. Data processing produced additional data attributes, such as catchment delineation, area, slope, and lengths of identified linear features, such as drainage pathways.

1.2 Data Administration

The MSB Information Technology department administers and coordinates digital geospatial data for the borough and provides quality assurance to maintain a common data structure, nomenclature, and topology.

1.3 Data Use

The SIGDB is intended to support planning-level and preliminary design drainage and water quality analyses. It may be used in the future for asset management and administration of a stormwater discharge permit and for guideline of stormwater discharges in the MSB. The SIGDB is structured, mapped, and attributed at a level of connectivity, resolution, and completeness sufficient for these uses.

All SIGDB digital spatial and attribute data are collected and compiled to be as complete and geographically representative as possible given mapping priorities and resources available at a point-in-time. It may contain errors and omissions.

This SIGDB is expected to be used with associated geospatial datasets, described as follows in Table 1.

Table 1: Associated Geospatial Datasets

Agency	Data	Description
MSB Environmental Planning	Infrastructure Data	Linear and polygonal features
The Nature Conservancy	Hydrographic data	Digital geospatial data associated with an update of the USGS National Hydrographic Dataset for Alaska. Reference: *Creation of a digital flowline network from IfSAR 5-m DEMs for the Matanuska-Susitna Basins: a resource for update of the National Hydrographic Dataset in Alaska*, Dan Miller, et al., July 2015.
USGS	National Land Cover Dataset, National Hydrography Dataset Plus High Resolution	Linear and polygonal features

1.4 Contacts

Contact the MSB GIS Division or Environmental Engineer for information about the SIGDB. Contact the responsible individual mapping agencies or consultants for information about the mapping and data content of specific feature classes.

2.0 GEOSPATIAL FEATURES

The SIGDB is structured to represent surface drainage features as spatially-interconnected systems of runoff surfaces, natural stormwater conveyances, locations of stormwater deficiencies, and locations of discharges to surface receiving waters. To support the intended uses, the SIGDB includes the following feature classes.

Deficiency location features include any deficiency identified in the field. This includes latitude and longitude coordinates, main street, type, and description of the deficiency.

Stormwater infrastructure nodes features include significant point features along a stormwater conveyance system. For the Wasilla Creek watershed that was the initial focus of this database development, nodes typically identify legally-defined points of discharge to surface waters. Nodes may also identify important point features along stormwater conveyance networks.

Two polygonal features classes include the boundaries of watersheds and of stormwater catchments areas. Watersheds conform to the USGS NHD naming and delineation convention. Catchments include land areas that contribute runoff flows to specific point or surface water features. Catchment “types” reflect the nature of these endpoints. Catchments are delineated based on topographic features, flow accumulation lines and points, and aerial imagery.

3.0 DATA ATTRIBUTES

Attribute data for feature classes includes metadata and core attribute data. SIGDB metadata is common to all feature classes. Core attribute data includes data content that is specific to a feature class as well as relational data. Domains may be revised to accommodate changing conditions.

3.1 Metadata

Metadata includes data that describes the quality and nature of the mapping data itself and conforms to Federal Geographic Data Committee-formatted and the MSB Spatial Data Standards. The metadata describes definitions and mapping standards and includes specific information about the source of the data, the date the information content was generated, the relative accuracy or quality of the data, and some references to information about the data published outside the database.

3.2 Deficiency Locations

Deficiency Locations represent any point where a deficiency was observed along the stormwater conveyance system (Table 2).

Table 2: Deficiency Locations

ATTRIBUTE	Type /subtype to which attribute applies	Description	Domain
Type	Any	Type of deficiency	B=Buried, E=Erosion/ Scour/ Sediment Contamination, O=Other, P=Ponding, S=Lack of Storage, B-E = Buried/ Erosion, P-S: Ponding/ Lack of Storage, P-S-E: Ponding/ Lack of Storage/ Erosion
Longitude	Any		Open domain: double
Latitude	Any		Open domain: double
Major_Rd	Any	Major street where deficiency located	Open domain: text
Deficiency Description	Any	Description of deficiency	Open domain: text

3.3 Stormwater Drainage Node Features

Stormwater infrastructure node features represent any significant point along a stormwater conveyance system (Table 3).

Table 2: Stormwater Infrastructure Node Features

ATTRIBUTE	Description	Domain
Type		B = Bridge, C -= Culvert
Longitude		Open domain: double
Latitude		Open domain: double
Major_Rd	Major road outfall located on	Open domain: text
Material	Material of outfall structure	Structural steel plate, corrugated metal
Type_Shape	Shape of outfall structure	Pipe-arch, circular
Diameter	Diameter of outfall structure	Open domain: text
Approx_Length	Length of outfall structure	Open domain: text
Substrate	Substrate type	Open domain: text
Flow Present		Open domain: text
Condition	Condition of pipe	Open domain: text
Invert Stain		Open domain: text
Flow Height in Pipe		Open domain: text
Depth Flow		Open domain: text
Flow Width		Open domain: text
Waterbody		Open domain: text
ADF&G FP	ADF&G fish passage number	Open domain: text
ADF&G Rating	ADF&G fish passage rating	Black, Green, Gray, Red
Pipe End	Pipe end section type	
Inlet Obstruction		Open domain: text
Upstream	Upstream site information	Open domain: text
Outlet Obstruction		Open domain: text
Downstream	Downstream site information	Open domain: text
Water Color	Color of the receiving water at the point of discharge	Tannic, Brown
Water Turbidity	Clarity of the receiving water at the point of discharge	clear, cloudy, opaque.
Odor	as observed on the date of inspection	none, trash, woody debris, leaves, other. NA if Type not outfall

Note: ADF&G = Alaska Department of Fish and Game

3.4 Polygonal Features

3.4.1 Catchment Features

Catchment features represent land areas that contribute runoff flows to individual stormwater conveyance networks, to point discharges, and to diffuse non-point discharges (Table 4).

Table 4: Stormwater Infrastructure Catchment Features

Attribute	Domain	Domain Type
Catchment_ID	Unique assigned to be number	Open: integer
Type	Outfall, dispersed, sink, connected-dispersed, connected-outfall, connected-sink	Closed; text
Watershed	Discrete MSB watershed per NHD	Closed; text
Area	Area in acres	Open; double

The catchment type refers to the nature of discharge from the catchment area, as follows:

- Outfall: generally, follows the federal regulatory definition of outfall and indicates that stormwater runoff from the catchment area enters surface water as a point discharge.
- Dispersed: signifies that stormwater runoff from the catchment area enters surface water as sheet flow or diffuse flow and not as a point discharge.
- Sink: indicates that stormwater runoff from the catchment does not have a connection to receiving water, either directly or through a conveyance system.
- Connected: indicates that the catchment area is connected to a downstream catchment area or conveyance system through a discrete conveyance feature (such as a culvert).
    - Connected-dispersed indicates that the downstream catchment is a dispersed catchment.
    - Connected-outfall indicates that the downstream catchment is an outfall catchment.
    - Connected-sink indicates that the downstream catchment is a sink catchment.
- Outside area of field investigation indicates that the catchment area has been delineated, but its characteristics have not been field verified or calculated.
- Lakes were also delineated to account for the entire area within the watershed.

APPENDIX B: DEFICIENCY PHOTOS

Looking east from Snowgoose Road to Palmer-Fishhook Road. Drainage along ATV trail.

Wasilla Creek Tributary at Palmer-Fishhook Road undersized structure. Stream outfall on ATV trail at outlet.

Roadside ponding at north side of driveway and in ATV trail.

Roadside ponding at south side of driveway in ATV trail

Roadside ponding at south side of road and in ATV trail.

Roadside ponding at north side of road and in ATV trail.

	Ponding in ATV trail.
	Ponding in ATV trail.

Wasilla Creek downstream streambank erosion at bend.

Wasilla Creek downstream streambank erosion at bend.

	Ponding at corner of Trunk Road and Palmer-Fishhook Road.
	Ponding at corner of Trunk Road and Palmer-Fishhook Road.

	Looking north from Trunk Road along Palmer-Fishhook Road.
	Looking south from Palmer-Fishhook Road toward Trunk Road.

Looking east from Trunk Road toward Palmer-Fishhook Road.

Ponding along Trunk Road.

Ponding in ATV trail along east side of Trunk Road looking south.

Ponding in ATV trail on east side of Trunk Road looking north.

Ponding in ditches along Tern Drive near utilities.

Standing water in shallow ditches along Tern Drive.

Standing water in roadway at Tern Drive.

Ponded water in roadway at the corner of Tern Drive and Dove Lane.

Sediment contamination at ponding on south side of Seagull, west of North 49th State Street.

Sediment contamination at sink/channel, north of side of Seagull, east of North 49th State Street.

Ponding in shallow ditches/ATV trails along North 49th State Street.

Shallow ditches along North 49th State Street.

Ponding in ditches/ATV trails along Stringfield Road.

Ponding in ditches/ATV trails along Stringfield Road.

Wasilla Creek encroachment at Stringfield Road.

Sediment contamination at Wasilla Creek and Stringfield Road encroachment.

	Wasilla Creek encroachment and sediment contamination at Stringfield Road.
	Ponding in ditches/ATV trails along Stringfield Road.

Sediment contamination at Wilderness Drive.

Sediment contamination at Wilderness Drive.

	Sediment contamination at Wilderness Drive.
	Roadway ponding at Wilderness Drive.

	Blocked driveway culvert at Vickie Circle.
	Blocked driveway culvert at Vickie Circle.

Wasilla Creek Stormwater Analysis	**Site #15** **Commons and Tributary Avenue**	**Site Photos (3/26/19)**

	Corner of Commons and Tributary Avenue – looking east. Residential storage of large amount of material without BMPs.
	Corner of Commons and Tributary Avenue – looking west. Residential storage of large amount of material without BMPs near culvert.

Submerged culvert at Bit Circle.

Submerged culvert at Bit Circle.

	Crushed driveway culvert along Fetlock Drive.
	Ponded water at fire hydrant along Fetlock Drive.

Sediment contamination and erosion at Wasilla Creek culvert on Fetlock Drive.

Evidence of sediment contamination at Fetlock Drive.

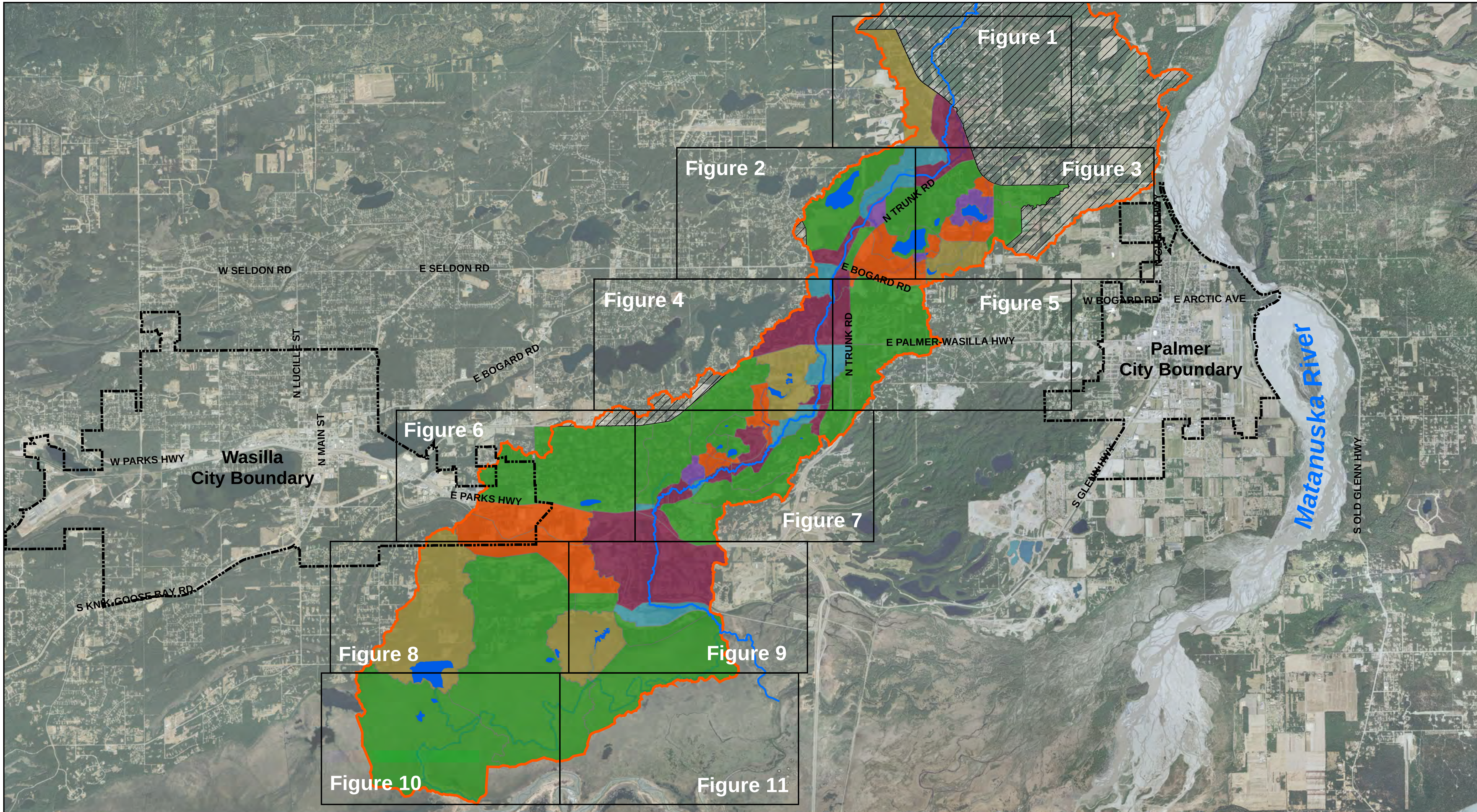
Ineffective BMPs at Nelson Drive.

Ineffective BMPs at Nelson Drive.

Sediment contamination at Wasilla Creek crossing at Nelson Drive.

Sediment contamination at Wasilla Creek crossing at Nelson Drive.

APPENDIX C: MAPS



Study Area

- Wasilla Creek
- Lakes (Study Area)
- Administrative City Boundaries
- Outside Area of Field Investigation
- Wasilla Creek Watershed Boundary

Catchment Type

- Dispersed
- Connected Dispersed
- Outfall
- Connected Outfall
- Sink
- Connected Sink

Miles

0 0.5 1

N

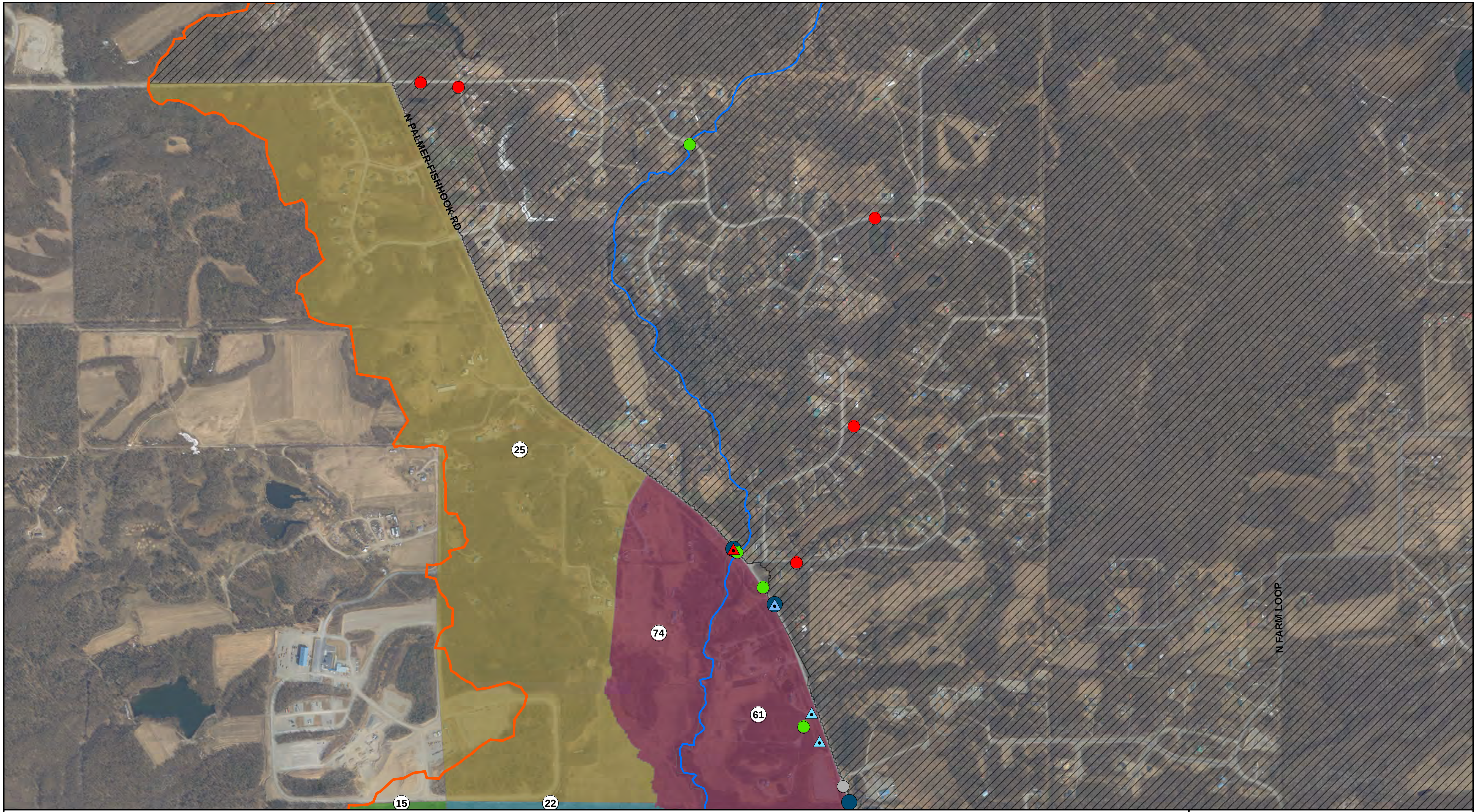
Stormwater Analysis [Index Map]

Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Index Figure



Study Area
- Outfall
- Wasilla Creek
- Wasilla Creek Watershed Boundary
- Outside Area of Field Investigation

ADF & G Fish Passage

RGG Rating
- Gray
- Green
- Red

Catchment Type
- # Catchment ID
- Dispersed
- Outfall
- Sink
- Connected Sink

Deficiency Type
- Ponding/ ATV Trail
- Scour or Erosion, Sediment Contamination
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage

Feet
0 750 1,500

N

Stormwater Analysis

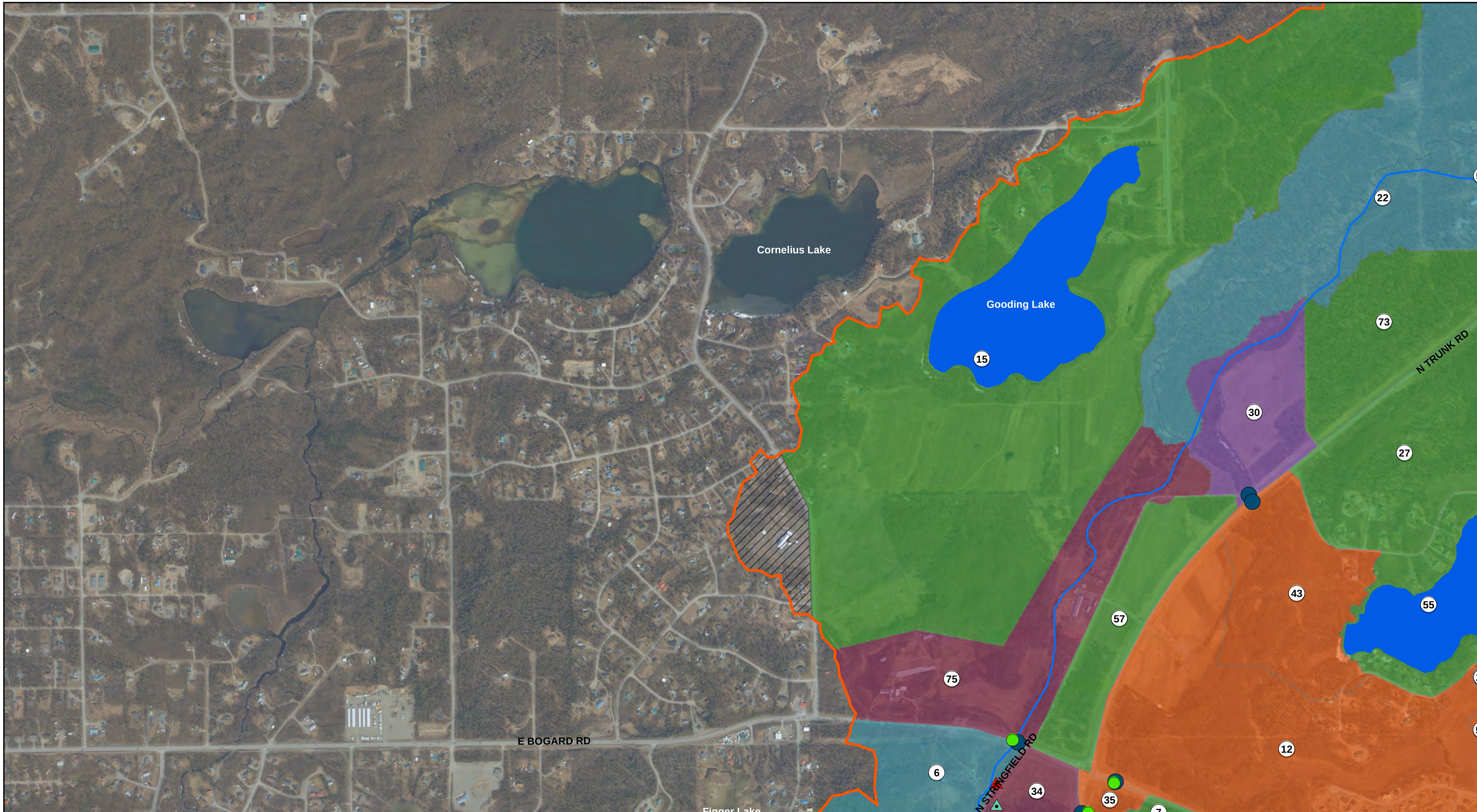
Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 1 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:15:45 PM User: tjameson



Study Area

- Outfall
- Wasilla Creek
- Lakes (Study Area)
- Wasilla Creek Watershed Boundary
- Outside Area of Field Investigation

ADF & G Fish Passage

RGG Rating

- Green

Catchment Type

- # Catchment ID
- Dispersed
- Connected Dispersed
- Outfall
- Connected Outfall
- Sink

Deficiency Type

- Scour or Erosion, Sediment Contamination
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage, Scour or Erosion, Sediment Contamination

Feet
0 750 1,500

N

Stormwater Analysis

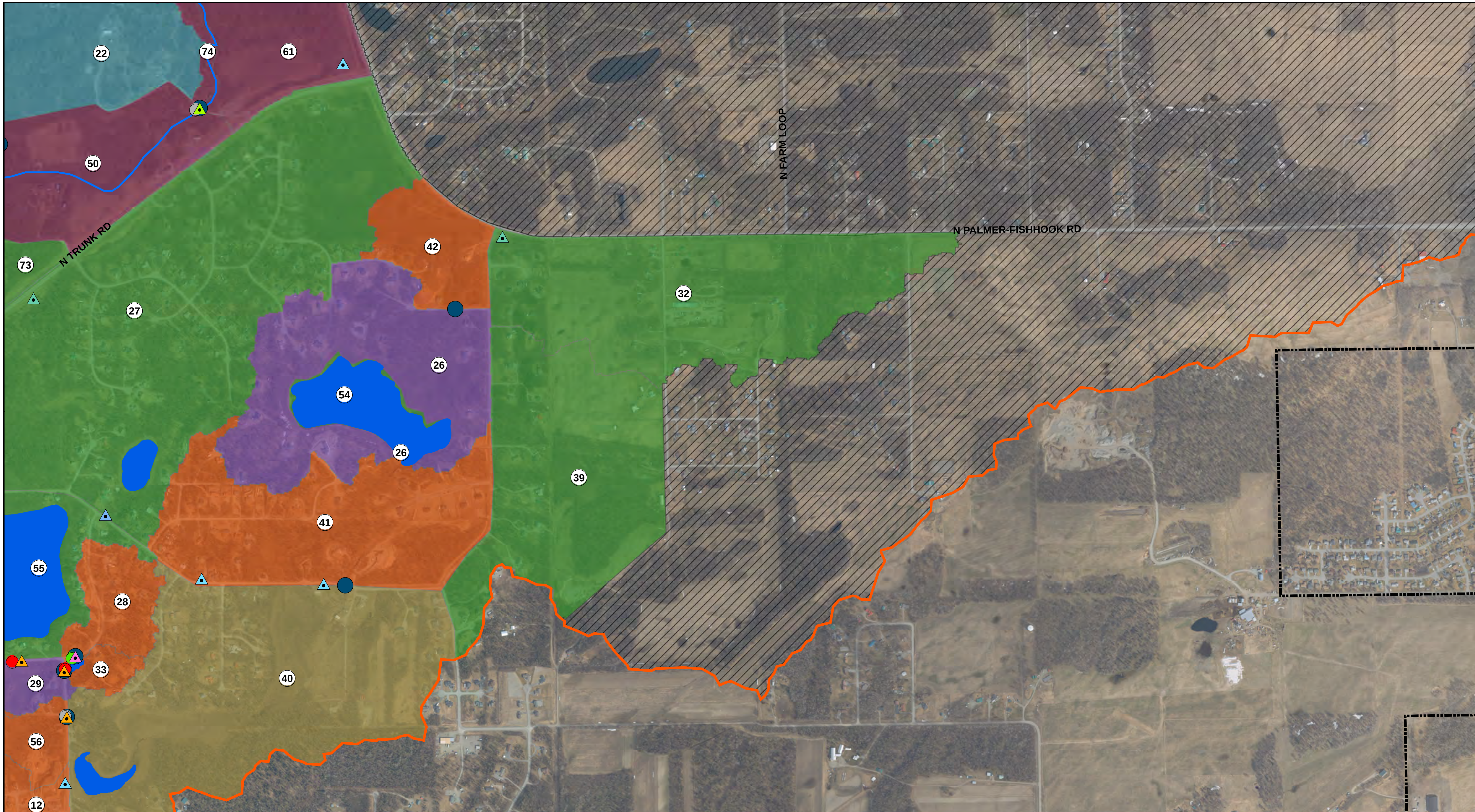
Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 2 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:15:57 PM User: tjameson



Study Area
- Outfall
- Wasilla Creek
- Lakes (Study Area)
- City of Palmer
- Wasilla Creek Watershed Boundary
- Outside Area of Field Investigation

ADF & G Fish Passage

RGG Rating
- Gray
- Green
- Red

Catchment Type
- Catchment ID
- Dispersed
- Connected Dispersed
- Outfall
- Connected Outfall
- Sink
- Connected Sink

Deficiency Type
- Buried, Overgrown, Accumulated Sediment, Submerged
- Other (Lack of SWPPP mgmt., etc.)
- Ponding/ ATV Trail
- Buried, Overgrown, Accumulated Sediment, Submerged, Scour or Erosion, Sediment Contamination
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage, Scour or Erosion, Sediment Contamination

Feet
0 750 1,500

N

Stormwater Analysis

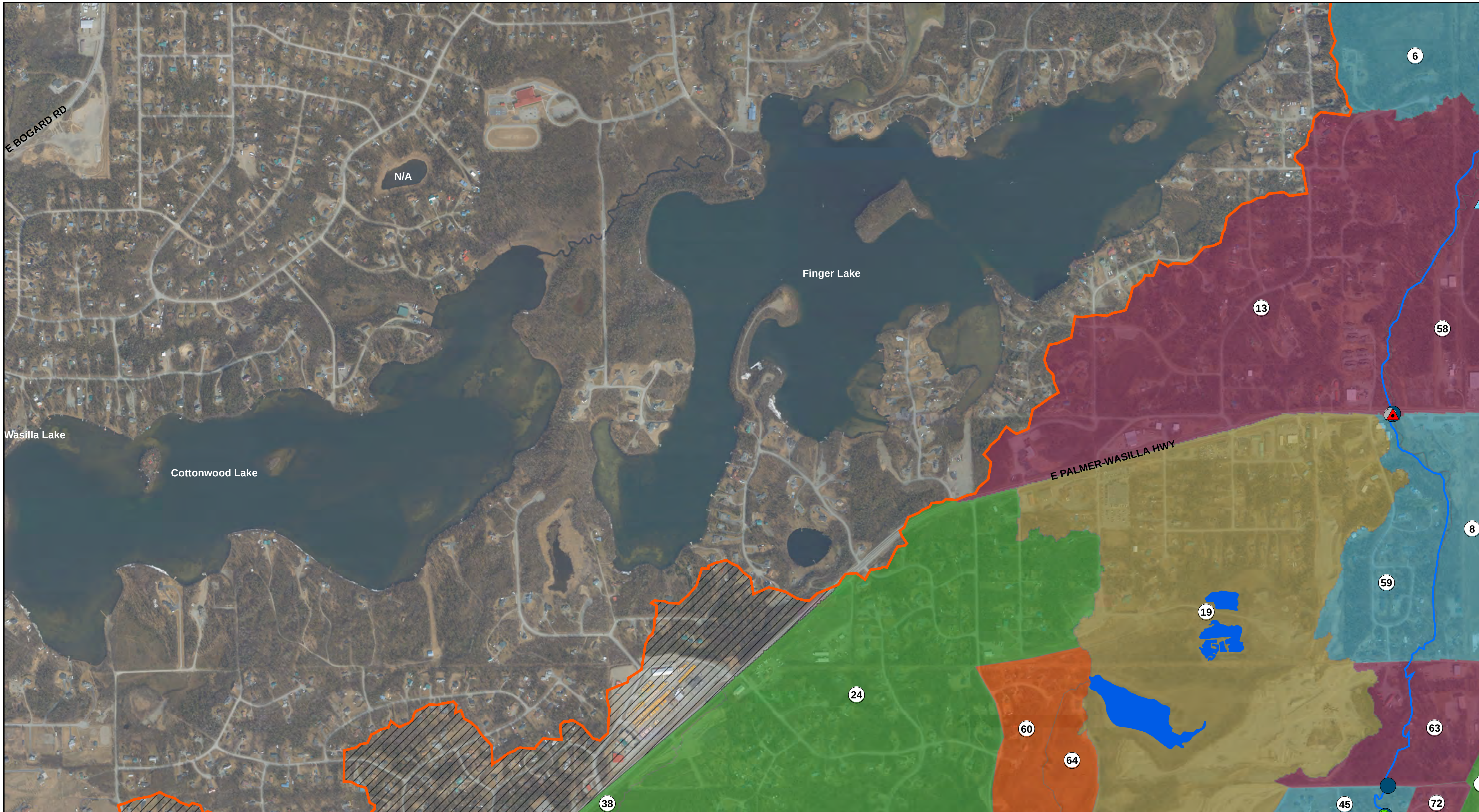
Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 3 of 11

\\ANC-FS\anc-projects\8\62808-01\60GIS\ESM\Stormwater Analysis 11x17.mxd May 28, 2019 4:16:11 PM User: tjameson



Study Area
- Outfall
- Wasilla Creek
- Lakes (Study Area)
- Wasilla Creek Watershed Boundary
- Outside Area of Field Investigation

ADF & G Fish Passage

RGG Rating
- Gray
- Green

Catchment Type
- # Catchment ID
- Dispersed
- Outfall
- Connected Outfall
- Sink
- Connected Sink

Deficiency Type
- Other (Lack of SWPPP mgmt., etc.)
- Scour or Erosion, Sediment Contamination
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage

Feet
0 750 1,500

N

Stormwater Analysis

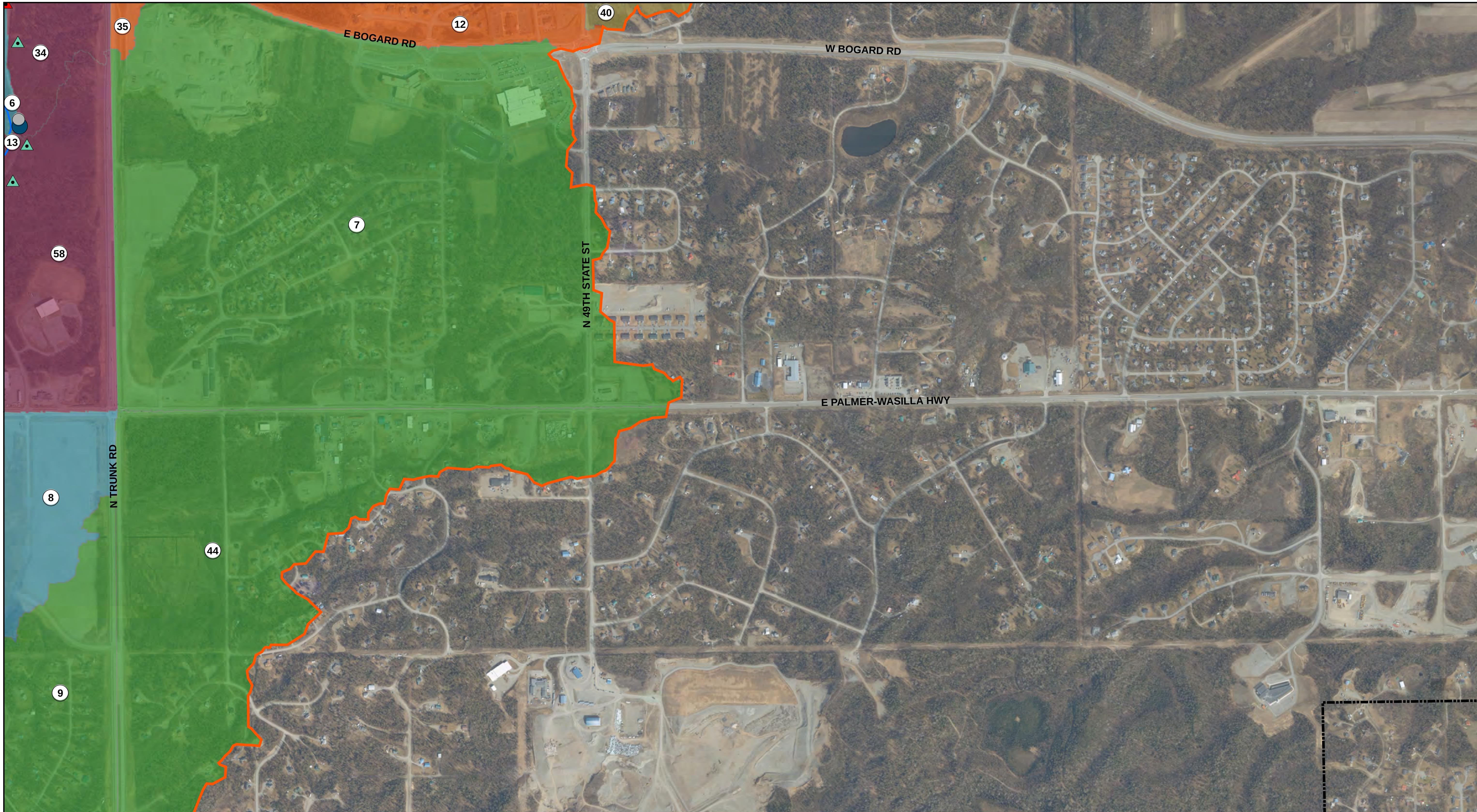
Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 4 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:16:23 PM User: tjameson



Study Area
- Outfall
- Wasilla Creek
- City of Palmer
- Wasilla Creek Watershed Boundary

ADF & G Fish Passage

RGG Rating
- Gray

Catchment Type
- Catchment ID
- Dispersed
- Outfall
- Connected Outfall
- Sink
- Connected Sink

Deficiency Type
- Scour or Erosion, Sediment Contamination
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage, Scour or Erosion, Sediment Contamination

Feet
0 750 1,500

N

Stormwater Analysis

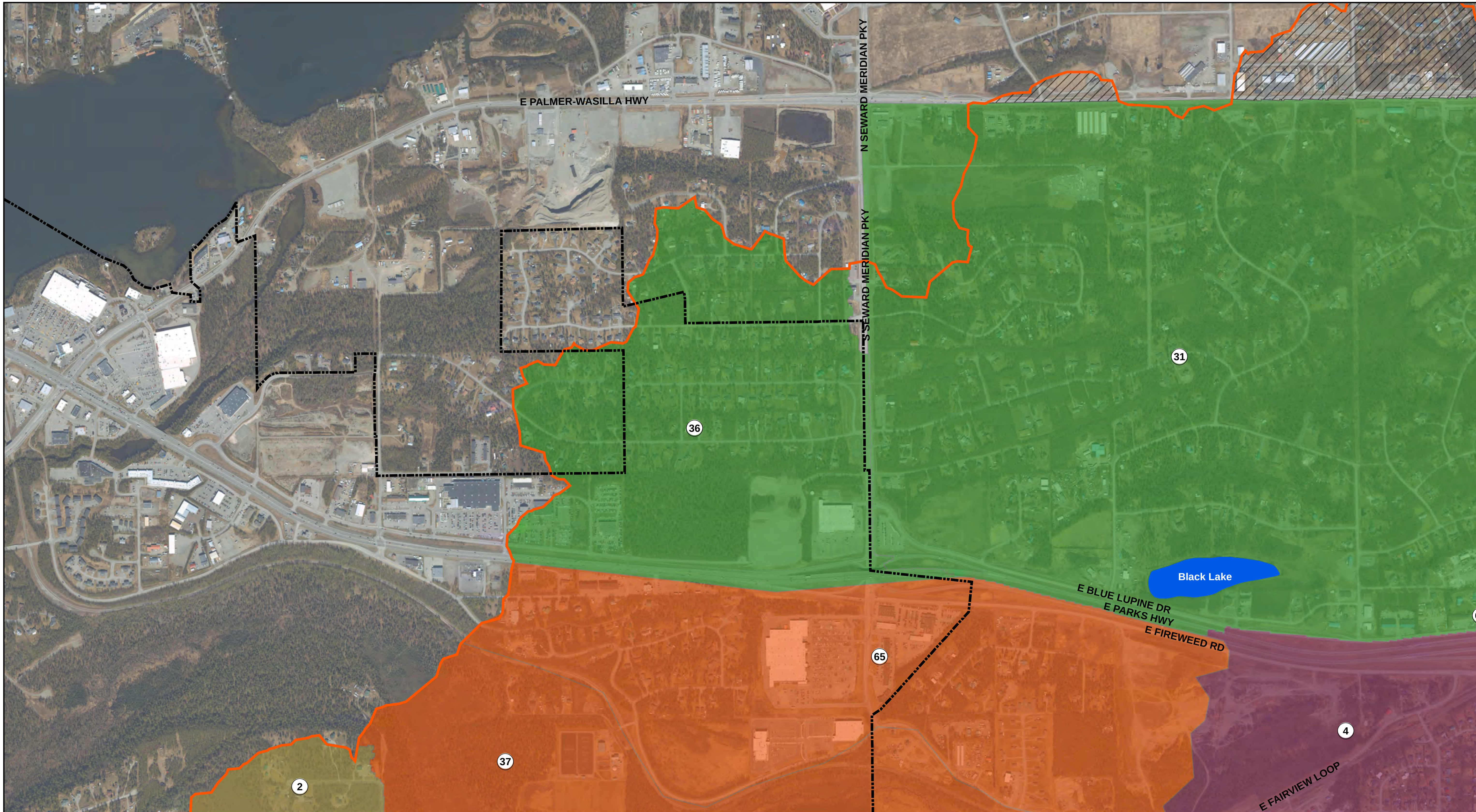
Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 5 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:16:35 PM User: tjameson



Study Area
- Lakes (Study Area)
- City Of Wasilla
- Wasilla Creek Watershed Boundary
- Outside Area of Field Investigation

ADF & G Fish Passage

Catchment Type
- # Catchment ID
- Dispersed
- Outfall
- Connected Outfall
- Sink
- Connected Sink

Deficiency Type

Stormwater Analysis

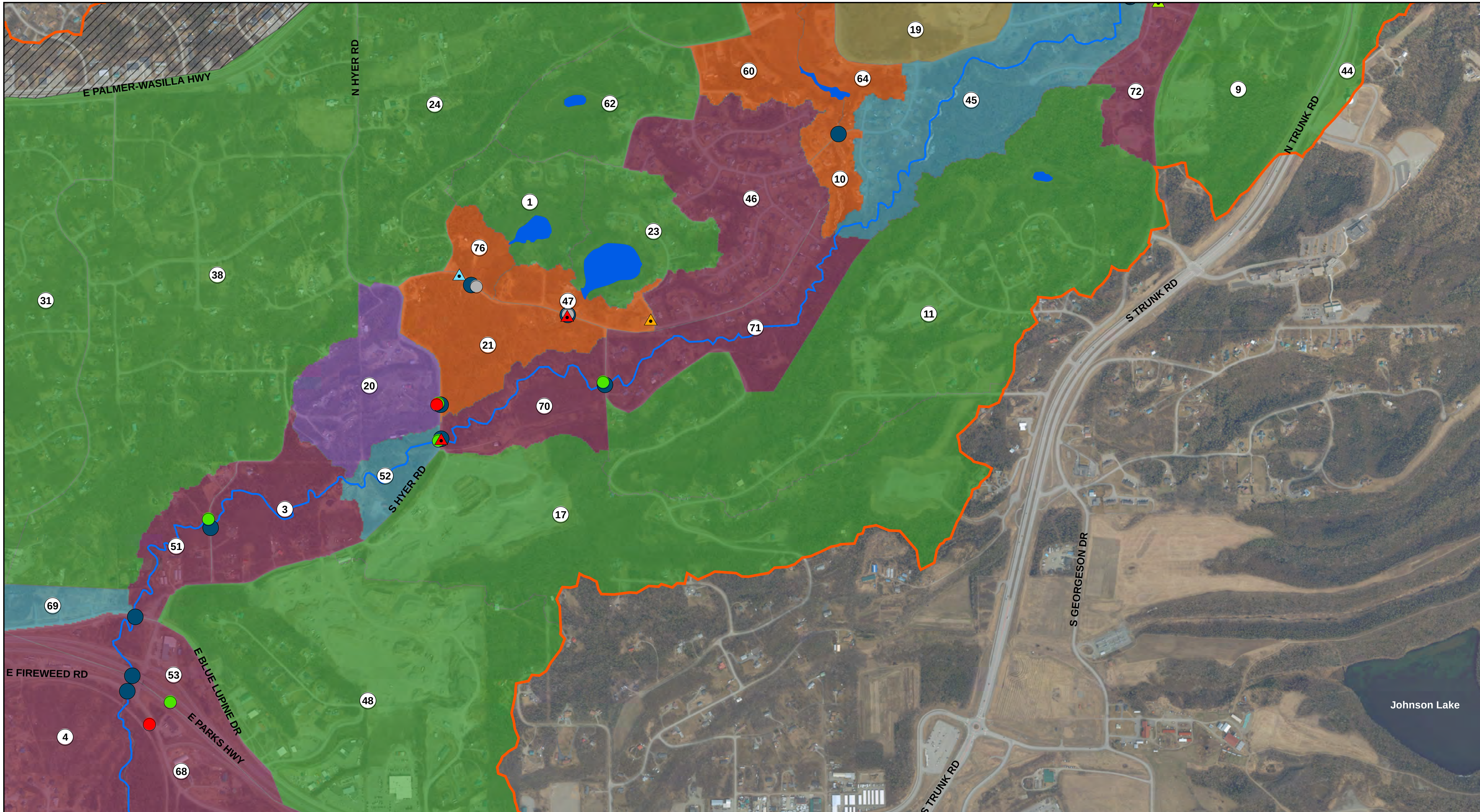
Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 6 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:16:45 PM User: tjameson



Study Area
- Outfall
- Wasilla Creek
- Lakes (Study Area)
- Wasilla Creek Watershed Boundary
- Outside Area of Field Investigation

ADF & G Fish Passage

RGG Rating
- Gray
- Green
- Red

Catchment Type
- # Catchment ID
- Dispersed
- Connected Dispersed
- Outfall
- Connected Outfall
- Sink
- Connected Sink

Deficiency Type
- Buried, Overgrown, Accumulated Sediment, Submerged
- Other (Lack of SWPPP mgmt., etc.)
- Scour or Erosion, Sediment Contamination
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage

Feet
0 750 1,500

N

Stormwater Analysis

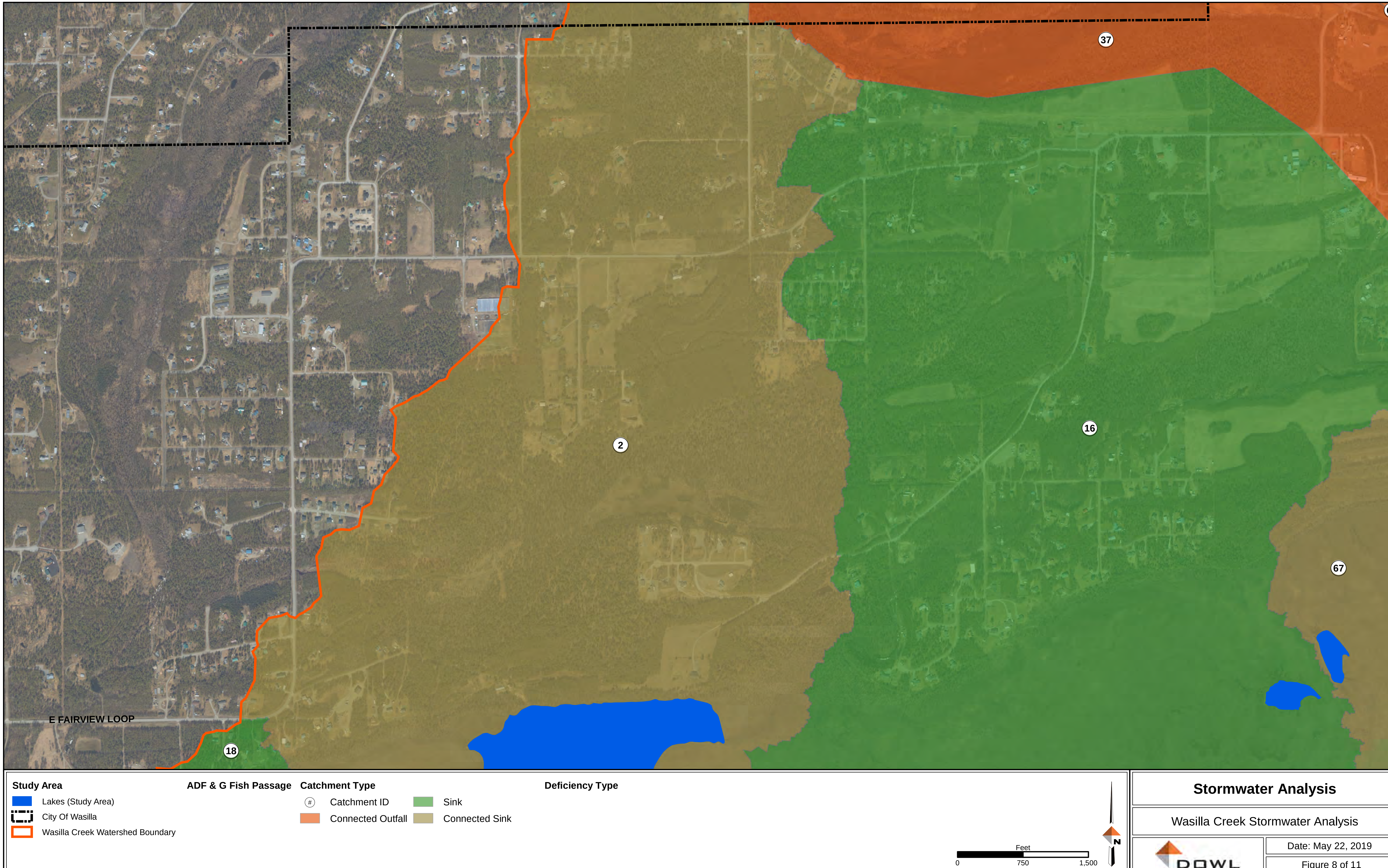
Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 7 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:16:57 PM User: tjameson



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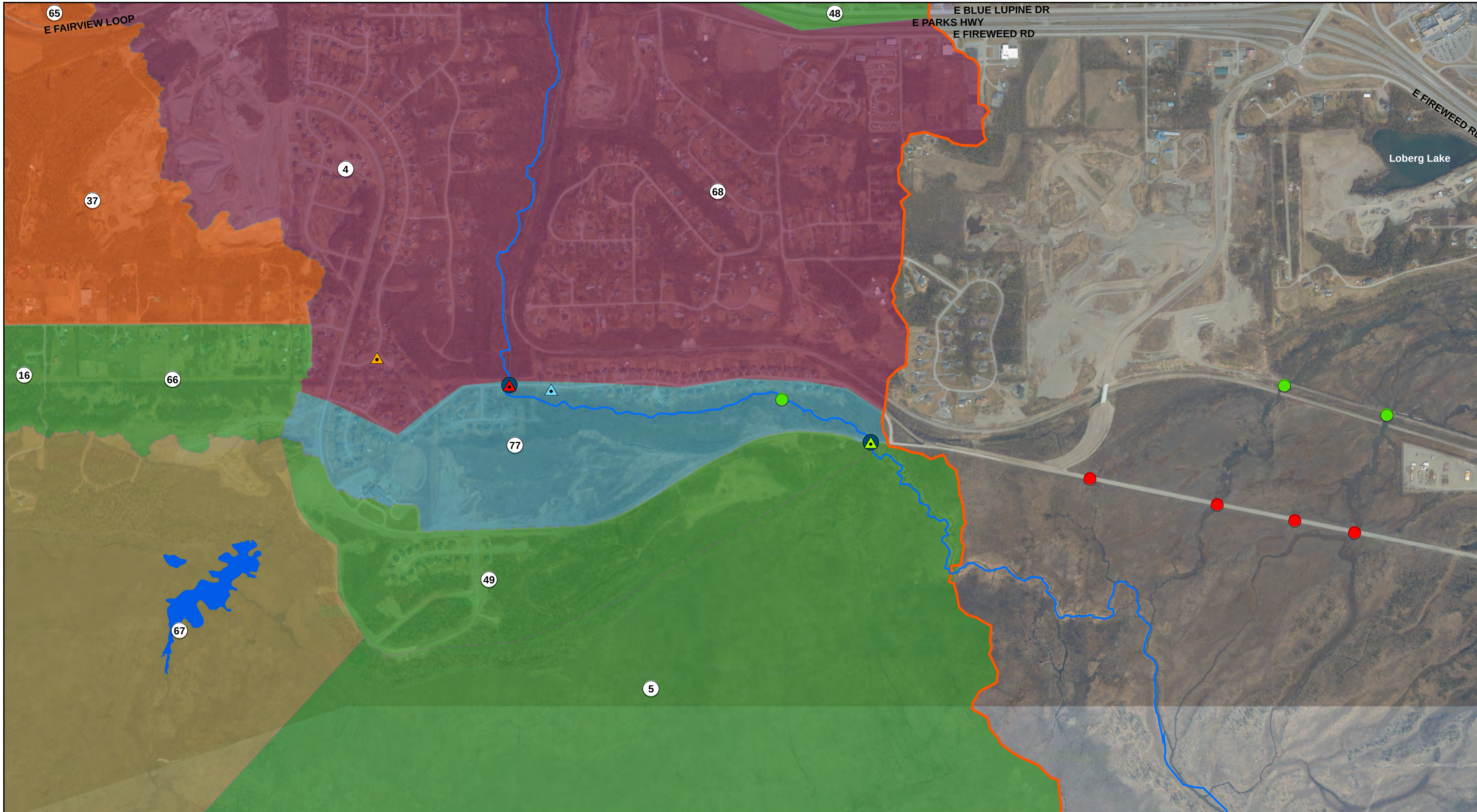

Study Area
- Outfall
- Wasilla Creek
- Lakes (Study Area)
- Wasilla Creek Watershed Boundary

ADF & G Fish Passage

RGG Rating
- Green
- Red

Catchment Type
- Catchment ID
- Dispersed
- Outfall
- Connected Outfall
- Sink
- Connected Sink

Deficiency Type
- Buried, Overgrown, Accumulated Sediment, Submerged
- Other (Lack of SWPPP mgmt., etc.)
- Scour or Erosion, Sediment Contamination
- Ponding/ ATV, Undersized/ Shallow ditches, Lack of Storage

Feet
0 750 1,500

N

Stormwater Analysis

Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 9 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:17:22 PM User: tjameson

Study Area

Lakes (Study Area)

Wasilla Creek Watershed Boundary

ADF & G Fish Passage

Catchment Type

Catchment ID

Connected Sink

Sink

Deficiency Type

Feet

0 750 1,500

N

Stormwater Analysis

Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 10 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:17:35 PM User: tjameson

Study Area
Wasilla Creek
Wasilla Creek Watershed Boundary

ADF & G Fish Passage

Catchment Type
Catchment ID
Connected Sink
Sink

Deficiency Type

Feet
0 750 1,500

N

Stormwater Analysis

Wasilla Creek Stormwater Analysis

DOWL

Date: May 22, 2019

Figure 11 of 11

\\ANC-FS\anc-projects\33\62808-01\60GIS\ENV\Stormwater Analysis 11x17.mxd May 28, 2019 4:17:45 PM User: tjameson

APPENDIX D: SWMM INPUT AND OUTPUT

Wasilla Creek Watershed

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... NO
  Water Quality .... NO
Infiltration Method ...... GREEN_AMPT
Starting Date NOV-14-2018 00:00:00
Ending Date NOV-16-2018 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

Wasilla Creek Watershed

**************************	Volume	Depth
Runoff Quantity Continuity	acre-feet	inches
**************************	---------	-------
Total Precipitation	462.272	1.500
Evaporation Loss	0.000	0.000
Infiltration Loss	456.564	1.482
Surface Runoff	1.020	0.003
Final Storage	4.757	0.015
Continuity Error (%)	-0.015	

**************************	Volume	Volume
Flow Routing Continuity	acre-feet	10^6 gal
**************************	---------	---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	1.020	0.333
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	1.020	0.333
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Subcatchment Runoff Summary
****

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
4	1.50	0.00	0.00	1.47	0.00	0.00	0.00	0.000
6	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
8	1.50	0.00	0.00	1.44	0.01	0.03	0.68	0.010
10	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
12	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
13	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
20	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
21	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
22	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
26	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
28	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
29	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
30	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
33	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
34	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
35	1.50	0.00	0.00	1.40	0.07	0.02	0.48	0.044
40	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
41	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
42	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
43	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
45	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
46	1.50	0.00	0.00	1.37	0.09	0.19	0.95	0.063
47	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
50	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
51	1.50	0.00	0.00	1.49	0.00	0.00	0.06	0.003
52	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
53	1.50	0.00	0.00	1.40	0.10	0.09	2.30	0.068

Wasilla Creek Watershed

56	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
58	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
59	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
60	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
61	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
63	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
64	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
68	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
69	1.50	0.00	0.00	1.47	0.00	0.00	0.00	0.000
70	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
71	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
72	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
74	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
75	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
76	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
77	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000

Analysis begun on: Wed Dec 12 14:00:55 2018
Analysis ended on: Wed Dec 12 14:00:55 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	1.50	0.00	0.00	1.40	0.10	0.09	2.30	0.068
46	1.50	0.00	0.00	1.37	0.09	0.19	0.95	0.063
8	1.50	0.00	0.00	1.44	0.01	0.03	0.68	0.010
35	1.50	0.00	0.00	1.40	0.07	0.02	0.48	0.044
51	1.50	0.00	0.00	1.49	0.00	0.00	0.06	0.003
4	1.50	0.00	0.00	1.47	0.00	0.00	0.00	0.000
13	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
6	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
3	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
22	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
20	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
26	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
28	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
12	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
29	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
34	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
33	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
30	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
42	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
10	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
40	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
41	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
50	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
45	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
56	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
74	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
52	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
47	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
58	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
59	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
60	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
61	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
63	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
71	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
69	1.50	0.00	0.00	1.47	0.00	0.00	0.00	0.000
70	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
21	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
43	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
64	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
75	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
72	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
77	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
68	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
76	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... NO
  Water Quality .... NO
Infiltration Method ...... GREEN_AMPT
Starting Date NOV-14-2018 00:00:00
Ending Date NOV-16-2018 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

Wasilla Creek Watershed

```
***************************     Volume      Depth
Runoff Quantity Continuity    acre-feet     inches
***************************   ---------    -------
Total Precipitation ......      773.439      2.510
Evaporation Loss .........        0.000      0.000
Infiltration Loss ........      755.099      2.450
Surface Runoff ...........       13.719      0.045
Final Storage ............        4.761      0.015
Continuity Error (%) .....       -0.018


***************************     Volume     Volume
Flow Routing Continuity       acre-feet   10^6 gal
***************************   ---------  ---------
Dry Weather Inflow .......        0.000      0.000
Wet Weather Inflow .......       13.722      4.472
Groundwater Inflow .......        0.000      0.000
RDII Inflow ..............        0.000      0.000
External Inflow ..........        0.000      0.000
External Outflow .........       13.722      4.472
Flooding Loss ............        0.000      0.000
Evaporation Loss .........        0.000      0.000
Exfiltration Loss ........        0.000      0.000
Initial Stored Volume ....        0.000      0.000
Final Stored Volume ......        0.000      0.000
Continuity Error (%) .....        0.000


***************************
Subcatchment Runoff Summary
***************************
```

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
4	2.51	0.00	0.00	2.48	0.00	0.02	0.65	0.000
6	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
8	2.51	0.00	0.00	2.40	0.06	0.15	2.82	0.026
10	2.51	0.00	0.00	2.28	0.21	0.05	0.91	0.083
12	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
13	2.51	0.00	0.00	2.48	0.02	0.12	1.58	0.007
20	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
21	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
22	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
26	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
28	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
29	2.51	0.00	0.00	2.40	0.10	0.03	0.49	0.039
30	2.51	0.00	0.00	2.48	0.02	0.03	0.69	0.010
33	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
34	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
35	2.51	0.00	0.00	2.32	0.15	0.04	1.28	0.059
40	2.51	0.00	0.00	2.50	0.00	0.02	0.49	0.002
41	2.51	0.00	0.00	2.46	0.04	0.11	1.88	0.016
42	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
43	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
45	2.51	0.00	0.00	2.46	0.03	0.07	0.81	0.012
46	2.51	0.00	0.00	1.76	0.71	1.44	4.98	0.284
47	2.51	0.00	0.00	2.48	0.01	0.00	0.03	0.004
50	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
51	2.51	0.00	0.00	2.25	0.25	0.14	0.82	0.101
52	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
53	2.51	0.00	0.00	1.95	0.56	0.49	9.73	0.225

Wasilla Creek Watershed

56	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
58	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
59	2.51	0.00	0.00	2.42	0.07	0.10	1.44	0.030
60	2.51	0.00	0.00	2.23	0.26	0.41	8.04	0.104
61	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
63	2.51	0.00	0.00	2.42	0.07	0.08	1.28	0.029
64	2.51	0.00	0.00	2.35	0.15	0.12	3.11	0.060
68	2.51	0.00	0.00	2.45	0.04	0.51	7.51	0.017
69	2.51	0.00	0.00	2.48	0.00	0.00	0.01	0.000
70	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
71	2.51	0.00	0.00	2.44	0.06	0.08	1.36	0.025
72	2.51	0.00	0.00	2.33	0.16	0.11	1.70	0.062
74	2.51	0.00	0.00	2.49	0.02	0.04	1.36	0.009
75	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
76	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
77	2.51	0.00	0.00	2.42	0.07	0.29	3.27	0.028

Analysis begun on: Wed Dec 12 14:01:51 2018
Analysis ended on: Wed Dec 12 14:01:51 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	2.51	0.00	0.00	1.95	0.56	0.49	9.73	0.225
60	2.51	0.00	0.00	2.23	0.26	0.41	8.04	0.104
68	2.51	0.00	0.00	2.45	0.04	0.51	7.51	0.017
46	2.51	0.00	0.00	1.76	0.71	1.44	4.98	0.284
77	2.51	0.00	0.00	2.42	0.07	0.29	3.27	0.028
64	2.51	0.00	0.00	2.35	0.15	0.12	3.11	0.060
8	2.51	0.00	0.00	2.40	0.06	0.15	2.82	0.026
41	2.51	0.00	0.00	2.46	0.04	0.11	1.88	0.016
72	2.51	0.00	0.00	2.33	0.16	0.11	1.70	0.062
13	2.51	0.00	0.00	2.48	0.02	0.12	1.58	0.007
59	2.51	0.00	0.00	2.42	0.07	0.10	1.44	0.030
71	2.51	0.00	0.00	2.44	0.06	0.08	1.36	0.025
74	2.51	0.00	0.00	2.49	0.02	0.04	1.36	0.009
63	2.51	0.00	0.00	2.42	0.07	0.08	1.28	0.029
35	2.51	0.00	0.00	2.32	0.15	0.04	1.28	0.059
10	2.51	0.00	0.00	2.28	0.21	0.05	0.91	0.083

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
51	2.51	0.00	0.00	2.25	0.25	0.14	0.82	0.101
45	2.51	0.00	0.00	2.46	0.03	0.07	0.81	0.012
30	2.51	0.00	0.00	2.48	0.02	0.03	0.69	0.010
4	2.51	0.00	0.00	2.48	0.00	0.02	0.65	0.000
29	2.51	0.00	0.00	2.40	0.10	0.03	0.49	0.039
40	2.51	0.00	0.00	2.50	0.00	0.02	0.49	0.002
47	2.51	0.00	0.00	2.48	0.01	0.00	0.03	0.004
69	2.51	0.00	0.00	2.48	0.00	0.00	0.01	0.000
58	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
43	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
42	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
61	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
56	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
34	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
33	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
50	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
28	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
26	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
20	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
12	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
21	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
70	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
22	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
75	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
76	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
6	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
52	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
3	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... NO
  Water Quality .... NO
Infiltration Method ...... GREEN_AMPT
Starting Date NOV-14-2018 00:00:00
Ending Date NOV-16-2018 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

Wasilla Creek Watershed

**************************	Volume	Depth
Runoff Quantity Continuity	acre-feet	inches
**************************	---------	-------
Total Precipitation	1195.602	3.880
Evaporation Loss	0.000	0.000
Infiltration Loss	1156.120	3.752
Surface Runoff	34.958	0.113
Final Storage	4.764	0.015
Continuity Error (%)	-0.020	

**************************	Volume	Volume
Flow Routing Continuity	acre-feet	10^6 gal
**************************	---------	---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	34.967	11.394
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	34.967	11.394
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Subcatchment Runoff Summary
****

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	3.88	0.00	0.00	3.36	0.51	0.57	2.29	0.130
4	3.88	0.00	0.00	3.78	0.07	0.95	9.73	0.017
6	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
8	3.88	0.00	0.00	3.32	0.52	1.25	12.86	0.135
10	3.88	0.00	0.00	3.67	0.19	0.04	1.30	0.049
12	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
13	3.88	0.00	0.00	3.85	0.01	0.08	1.91	0.003
20	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
21	3.88	0.00	0.00	3.58	0.30	0.31	1.30	0.076
22	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
26	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
28	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
29	3.88	0.00	0.00	3.80	0.07	0.02	0.63	0.018
30	3.88	0.00	0.00	3.86	0.02	0.02	1.02	0.005
33	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
34	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
35	3.88	0.00	0.00	3.13	0.71	0.19	4.58	0.184
40	3.88	0.00	0.00	3.87	0.00	0.02	0.70	0.001
41	3.88	0.00	0.00	3.84	0.03	0.07	2.31	0.007
42	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
43	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
45	3.88	0.00	0.00	3.84	0.02	0.05	1.00	0.006
46	3.88	0.00	0.00	2.00	1.84	3.72	13.20	0.474
47	3.88	0.00	0.00	2.92	0.94	0.37	1.62	0.243
50	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
51	3.88	0.00	0.00	2.71	1.16	0.66	2.90	0.300
52	3.88	0.00	0.00	3.33	0.54	0.20	0.85	0.139
53	3.88	0.00	0.00	2.41	1.47	1.28	24.06	0.379

Wasilla Creek Watershed

56	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
58	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
59	3.88	0.00	0.00	3.81	0.06	0.07	1.89	0.014
60	3.88	0.00	0.00	3.60	0.26	0.41	11.93	0.067
61	3.88	0.00	0.00	3.88	0.00	0.00	0.28	0.000
63	3.88	0.00	0.00	3.81	0.06	0.06	1.67	0.014
64	3.88	0.00	0.00	3.76	0.11	0.09	4.22	0.029
68	3.88	0.00	0.00	3.84	0.03	0.35	9.49	0.008
69	3.88	0.00	0.00	3.79	0.06	0.02	0.19	0.015
70	3.88	0.00	0.00	3.75	0.13	0.11	0.36	0.033
71	3.88	0.00	0.00	3.83	0.04	0.05	1.71	0.011
72	3.88	0.00	0.00	3.72	0.14	0.10	2.37	0.036
74	3.88	0.00	0.00	3.85	0.03	0.06	2.66	0.007
75	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
76	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
77	3.88	0.00	0.00	3.80	0.06	0.24	4.36	0.015

Analysis begun on: Wed Dec 12 14:02:35 2018
Analysis ended on: Wed Dec 12 14:02:35 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	3.88	0.00	0.00	2.41	1.47	1.28	24.06	0.379
46	3.88	0.00	0.00	2.00	1.84	3.72	13.20	0.474
8	3.88	0.00	0.00	3.32	0.52	1.25	12.86	0.135
60	3.88	0.00	0.00	3.60	0.26	0.41	11.93	0.067
4	3.88	0.00	0.00	3.78	0.07	0.95	9.73	0.017
68	3.88	0.00	0.00	3.84	0.03	0.35	9.49	0.008
35	3.88	0.00	0.00	3.13	0.71	0.19	4.58	0.184
77	3.88	0.00	0.00	3.80	0.06	0.24	4.36	0.015
64	3.88	0.00	0.00	3.76	0.11	0.09	4.22	0.029
51	3.88	0.00	0.00	2.71	1.16	0.66	2.90	0.300
74	3.88	0.00	0.00	3.85	0.03	0.06	2.66	0.007
72	3.88	0.00	0.00	3.72	0.14	0.10	2.37	0.036
41	3.88	0.00	0.00	3.84	0.03	0.07	2.31	0.007
3	3.88	0.00	0.00	3.36	0.51	0.57	2.29	0.130
13	3.88	0.00	0.00	3.85	0.01	0.08	1.91	0.003
59	3.88	0.00	0.00	3.81	0.06	0.07	1.89	0.014

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
71	3.88	0.00	0.00	3.83	0.04	0.05	1.71	0.011
63	3.88	0.00	0.00	3.81	0.06	0.06	1.67	0.014
47	3.88	0.00	0.00	2.92	0.94	0.37	1.62	0.243
10	3.88	0.00	0.00	3.67	0.19	0.04	1.30	0.049
21	3.88	0.00	0.00	3.58	0.30	0.31	1.30	0.076
30	3.88	0.00	0.00	3.86	0.02	0.02	1.02	0.005
45	3.88	0.00	0.00	3.84	0.02	0.05	1.00	0.006
52	3.88	0.00	0.00	3.33	0.54	0.20	0.85	0.139
40	3.88	0.00	0.00	3.87	0.00	0.02	0.70	0.001
29	3.88	0.00	0.00	3.80	0.07	0.02	0.63	0.018
70	3.88	0.00	0.00	3.75	0.13	0.11	0.36	0.033
61	3.88	0.00	0.00	3.88	0.00	0.00	0.28	0.000
69	3.88	0.00	0.00	3.79	0.06	0.02	0.19	0.015
33	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
42	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
43	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
26	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
28	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
56	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
22	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
34	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
58	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
20	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
76	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
6	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
50	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
75	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
12	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... NO
  Water Quality .... NO
Infiltration Method ...... GREEN_AMPT
Starting Date NOV-14-2018 00:00:00
Ending Date NOV-16-2018 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

Wasilla Creek Watershed

```
**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......      1420.545         4.610
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........      1350.872         4.384
Surface Runoff ...........        65.207         0.212
Final Storage ............         4.765         0.015
Continuity Error (%) .....        -0.021


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        65.222        21.253
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........        65.222        21.253
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.000


***************************
Subcatchment Runoff Summary
***************************
```

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	4.61	0.00	0.00	3.53	1.07	1.20	4.85	0.232
4	4.61	0.00	0.00	4.40	0.18	2.59	18.99	0.039
6	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
8	4.61	0.00	0.00	3.65	0.92	2.19	20.39	0.200
10	4.61	0.00	0.00	4.18	0.41	0.10	2.25	0.089
12	4.61	0.00	0.00	4.59	0.00	0.00	0.02	0.000
13	4.61	0.00	0.00	4.55	0.04	0.27	3.95	0.009
20	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
21	4.61	0.00	0.00	3.80	0.81	0.86	3.36	0.175
22	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
26	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
28	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
29	4.61	0.00	0.00	4.41	0.19	0.05	1.21	0.042
30	4.61	0.00	0.00	4.54	0.07	0.08	2.15	0.014
33	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
34	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
35	4.61	0.00	0.00	3.46	1.12	0.30	6.94	0.242
40	4.61	0.00	0.00	4.59	0.01	0.06	1.54	0.003
41	4.61	0.00	0.00	4.52	0.08	0.23	4.71	0.018
42	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
43	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
45	4.61	0.00	0.00	4.52	0.07	0.17	2.02	0.015
46	4.61	0.00	0.00	2.08	2.49	5.04	18.58	0.540
47	4.61	0.00	0.00	3.03	1.57	0.61	2.89	0.340
50	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
51	4.61	0.00	0.00	2.85	1.75	0.99	4.37	0.379
52	4.61	0.00	0.00	3.49	1.11	0.42	1.78	0.242
53	4.61	0.00	0.00	2.56	2.05	1.78	33.07	0.446

Wasilla Creek Watershed

56	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
58	4.61	0.00	0.00	4.59	0.00	0.01	0.33	0.001
59	4.61	0.00	0.00	4.44	0.16	0.20	3.60	0.034
60	4.61	0.00	0.00	4.08	0.52	0.81	19.92	0.112
61	4.61	0.00	0.00	4.57	0.04	0.11	4.58	0.008
63	4.61	0.00	0.00	4.44	0.15	0.18	3.20	0.034
64	4.61	0.00	0.00	4.32	0.28	0.22	7.96	0.061
68	4.61	0.00	0.00	4.51	0.09	1.07	18.87	0.020
69	4.61	0.00	0.00	4.42	0.16	0.06	0.39	0.035
70	4.61	0.00	0.00	4.16	0.44	0.39	1.06	0.096
71	4.61	0.00	0.00	4.47	0.13	0.16	3.39	0.028
72	4.61	0.00	0.00	4.27	0.32	0.24	4.24	0.070
74	4.61	0.00	0.00	4.52	0.09	0.19	5.59	0.020
75	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
76	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
77	4.61	0.00	0.00	4.43	0.16	0.66	8.18	0.035

Analysis begun on: Wed Dec 12 14:03:20 2018
Analysis ended on: Wed Dec 12 14:03:20 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	4.61	0.00	0.00	2.56	2.05	1.78	33.07	0.446
8	4.61	0.00	0.00	3.65	0.92	2.19	20.39	0.200
60	4.61	0.00	0.00	4.08	0.52	0.81	19.92	0.112
4	4.61	0.00	0.00	4.40	0.18	2.59	18.99	0.039
68	4.61	0.00	0.00	4.51	0.09	1.07	18.87	0.020
46	4.61	0.00	0.00	2.08	2.49	5.04	18.58	0.540
77	4.61	0.00	0.00	4.43	0.16	0.66	8.18	0.035
64	4.61	0.00	0.00	4.32	0.28	0.22	7.96	0.061
35	4.61	0.00	0.00	3.46	1.12	0.30	6.94	0.242
74	4.61	0.00	0.00	4.52	0.09	0.19	5.59	0.020
3	4.61	0.00	0.00	3.53	1.07	1.20	4.85	0.232
41	4.61	0.00	0.00	4.52	0.08	0.23	4.71	0.018
61	4.61	0.00	0.00	4.57	0.04	0.11	4.58	0.008
51	4.61	0.00	0.00	2.85	1.75	0.99	4.37	0.379
72	4.61	0.00	0.00	4.27	0.32	0.24	4.24	0.070
13	4.61	0.00	0.00	4.55	0.04	0.27	3.95	0.009

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
59	4.61	0.00	0.00	4.44	0.16	0.20	3.60	0.034
71	4.61	0.00	0.00	4.47	0.13	0.16	3.39	0.028
21	4.61	0.00	0.00	3.80	0.81	0.86	3.36	0.175
63	4.61	0.00	0.00	4.44	0.15	0.18	3.20	0.034
47	4.61	0.00	0.00	3.03	1.57	0.61	2.89	0.340
10	4.61	0.00	0.00	4.18	0.41	0.10	2.25	0.089
30	4.61	0.00	0.00	4.54	0.07	0.08	2.15	0.014
45	4.61	0.00	0.00	4.52	0.07	0.17	2.02	0.015
52	4.61	0.00	0.00	3.49	1.11	0.42	1.78	0.242
40	4.61	0.00	0.00	4.59	0.01	0.06	1.54	0.003
29	4.61	0.00	0.00	4.41	0.19	0.05	1.21	0.042
70	4.61	0.00	0.00	4.16	0.44	0.39	1.06	0.096
69	4.61	0.00	0.00	4.42	0.16	0.06	0.39	0.035
58	4.61	0.00	0.00	4.59	0.00	0.01	0.33	0.001
12	4.61	0.00	0.00	4.59	0.00	0.00	0.02	0.000
26	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
42	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
43	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
28	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
33	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
22	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
34	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
76	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
20	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
6	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
50	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
56	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
75	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

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EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)
--------------------------------------------------------------

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Starting Date ............ NOV-14-2018 00:00:00
Ending Date .............. NOV-16-2018 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 01:00:00


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......       462.272         1.500
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........       454.190         1.474
Surface Runoff ...........         2.119         0.007
```

Wasilla Creek Watershed

```
Final Storage ............        6.048         0.020
Continuity Error (%) .....       -0.019


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......        0.000         0.000
Wet Weather Inflow .......        2.120         0.691
Groundwater Inflow .......        0.000         0.000
RDII Inflow ..............        0.000         0.000
External Inflow ..........        0.000         0.000
External Outflow .........        2.120         0.691
Flooding Loss ............        0.000         0.000
Evaporation Loss .........        0.000         0.000
Exfiltration Loss ........        0.000         0.000
Initial Stored Volume ....        0.000         0.000
Final Stored Volume ......        0.000         0.000
Continuity Error (%) .....        0.000


***************************
Subcatchment Runoff Summary
***************************
```

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
4	1.50	0.00	0.00	1.46	0.00	0.00	0.00	0.000
6	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
8	1.50	0.00	0.00	1.40	0.06	0.14	1.83	0.040
10	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
12	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
13	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
20	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
21	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
22	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
26	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

28	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
29	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
30	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
33	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
34	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
35	1.50	0.00	0.00	1.30	0.15	0.04	0.90	0.103
40	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
41	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
42	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
43	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
45	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
46	1.50	0.00	0.00	1.30	0.16	0.32	1.41	0.107
47	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
50	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
51	1.50	0.00	0.00	1.48	0.01	0.00	0.10	0.006
52	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
53	1.50	0.00	0.00	1.29	0.21	0.18	4.11	0.137
56	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
58	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
59	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
60	1.50	0.00	0.00	1.47	0.00	0.00	0.01	0.000
61	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
63	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
64	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
68	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
69	1.50	0.00	0.00	1.46	0.00	0.00	0.00	0.000
70	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
71	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
72	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
74	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
75	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
76	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
77	1.50	0.00	0.00	1.47	0.00	0.00	0.00	0.000

Analysis begun on: Wed Dec 12 15:20:14 2018
Analysis ended on: Wed Dec 12 15:20:14 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	1.50	0.00	0.00	1.29	0.21	0.18	4.11	0.137
8	1.50	0.00	0.00	1.40	0.06	0.14	1.83	0.040
46	1.50	0.00	0.00	1.30	0.16	0.32	1.41	0.107
35	1.50	0.00	0.00	1.30	0.15	0.04	0.90	0.103
51	1.50	0.00	0.00	1.48	0.01	0.00	0.10	0.006
60	1.50	0.00	0.00	1.47	0.00	0.00	0.01	0.000
22	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
13	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
3	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
21	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
29	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
30	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
20	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
26	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
33	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
10	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
34	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
6	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
42	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
40	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
4	1.50	0.00	0.00	1.46	0.00	0.00	0.00	0.000
41	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
47	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
43	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
52	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
74	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
50	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
45	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
56	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
58	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
59	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
61	1.50	0.00	0.00	1.50	0.00	0.00	0.00	0.000
63	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
71	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
69	1.50	0.00	0.00	1.46	0.00	0.00	0.00	0.000
70	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
28	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
12	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
64	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
75	1.50	0.00	0.00	1.49	0.00	0.00	0.00	0.000
72	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
77	1.50	0.00	0.00	1.47	0.00	0.00	0.00	0.000
68	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000
76	1.50	0.00	0.00	1.48	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... NO
  Water Quality .... NO
Infiltration Method ...... GREEN_AMPT
Starting Date NOV-14-2018 00:00:00
Ending Date NOV-16-2018 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

Wasilla Creek Watershed

*************************** Runoff Quantity Continuity ***************************	Volume acre-feet ---------	Depth inches -------
Total Precipitation	773.439	2.510
Evaporation Loss	0.000	0.000
Infiltration Loss	751.950	2.440
Surface Runoff	15.607	0.051
Final Storage	6.054	0.020
Continuity Error (%)	-0.022	

*************************** Flow Routing Continuity ***************************	Volume acre-feet ---------	Volume 10^6 gal ---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	15.611	5.087
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	15.611	5.087
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

****
Subcatchment Runoff Summary
****

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
4	2.51	0.00	0.00	2.47	0.00	0.04	1.15	0.001
6	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
8	2.51	0.00	0.00	2.34	0.13	0.31	4.50	0.052
10	2.51	0.00	0.00	2.22	0.26	0.06	1.12	0.105
12	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
13	2.51	0.00	0.00	2.46	0.03	0.18	1.98	0.011
20	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
21	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
22	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
26	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
28	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
29	2.51	0.00	0.00	2.37	0.13	0.04	0.60	0.052
30	2.51	0.00	0.00	2.45	0.05	0.06	1.08	0.019
33	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
34	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
35	2.51	0.00	0.00	2.23	0.23	0.06	1.84	0.093
40	2.51	0.00	0.00	2.49	0.01	0.04	0.68	0.003
41	2.51	0.00	0.00	2.44	0.06	0.16	2.35	0.023
42	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
43	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
45	2.51	0.00	0.00	2.44	0.04	0.11	1.03	0.017
46	2.51	0.00	0.00	1.60	0.86	1.75	6.23	0.344
47	2.51	0.00	0.00	2.40	0.09	0.03	0.18	0.034
50	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
51	2.51	0.00	0.00	2.16	0.33	0.19	1.01	0.132
52	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
53	2.51	0.00	0.00	1.74	0.77	0.67	13.90	0.307

Wasilla Creek Watershed

56	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
58	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
59	2.51	0.00	0.00	2.39	0.10	0.13	1.81	0.041
60	2.51	0.00	0.00	2.46	0.03	0.05	2.67	0.012
61	2.51	0.00	0.00	2.51	0.00	0.01	0.45	0.001
63	2.51	0.00	0.00	2.39	0.10	0.12	1.60	0.041
64	2.51	0.00	0.00	2.31	0.19	0.15	3.77	0.075
68	2.51	0.00	0.00	2.43	0.06	0.72	9.44	0.025
69	2.51	0.00	0.00	2.47	0.00	0.00	0.02	0.001
70	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
71	2.51	0.00	0.00	2.41	0.09	0.11	1.69	0.035
72	2.51	0.00	0.00	2.48	0.01	0.01	0.36	0.004
74	2.51	0.00	0.00	2.46	0.05	0.09	2.22	0.018
75	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
76	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
77	2.51	0.00	0.00	2.48	0.00	0.01	0.54	0.001

Analysis begun on: Wed Dec 12 15:21:36 2018
Analysis ended on: Wed Dec 12 15:21:36 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	2.51	0.00	0.00	1.74	0.77	0.67	13.90	0.307
68	2.51	0.00	0.00	2.43	0.06	0.72	9.44	0.025
46	2.51	0.00	0.00	1.60	0.86	1.75	6.23	0.344
8	2.51	0.00	0.00	2.34	0.13	0.31	4.50	0.052
64	2.51	0.00	0.00	2.31	0.19	0.15	3.77	0.075
60	2.51	0.00	0.00	2.46	0.03	0.05	2.67	0.012
41	2.51	0.00	0.00	2.44	0.06	0.16	2.35	0.023
74	2.51	0.00	0.00	2.46	0.05	0.09	2.22	0.018
13	2.51	0.00	0.00	2.46	0.03	0.18	1.98	0.011
35	2.51	0.00	0.00	2.23	0.23	0.06	1.84	0.093
59	2.51	0.00	0.00	2.39	0.10	0.13	1.81	0.041
71	2.51	0.00	0.00	2.41	0.09	0.11	1.69	0.035
63	2.51	0.00	0.00	2.39	0.10	0.12	1.60	0.041
4	2.51	0.00	0.00	2.47	0.00	0.04	1.15	0.001
10	2.51	0.00	0.00	2.22	0.26	0.06	1.12	0.105
30	2.51	0.00	0.00	2.45	0.05	0.06	1.08	0.019

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
45	2.51	0.00	0.00	2.44	0.04	0.11	1.03	0.017
51	2.51	0.00	0.00	2.16	0.33	0.19	1.01	0.132
40	2.51	0.00	0.00	2.49	0.01	0.04	0.68	0.003
29	2.51	0.00	0.00	2.37	0.13	0.04	0.60	0.052
77	2.51	0.00	0.00	2.48	0.00	0.01	0.54	0.001
61	2.51	0.00	0.00	2.51	0.00	0.01	0.45	0.001
72	2.51	0.00	0.00	2.48	0.01	0.01	0.36	0.004
47	2.51	0.00	0.00	2.40	0.09	0.03	0.18	0.034
69	2.51	0.00	0.00	2.47	0.00	0.00	0.02	0.001
52	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
50	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
43	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
56	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
70	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
42	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
34	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
28	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
33	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
58	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
22	2.51	0.00	0.00	2.51	0.00	0.00	0.00	0.000
3	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
21	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
20	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
12	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000
75	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
26	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
6	2.51	0.00	0.00	2.50	0.00	0.00	0.00	0.000
76	2.51	0.00	0.00	2.49	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... NO
  Water Quality .... NO
Infiltration Method ...... GREEN_AMPT
Starting Date NOV-14-2018 00:00:00
Ending Date NOV-16-2018 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

Wasilla Creek Watershed

***************************	Volume	Depth
Runoff Quantity Continuity	acre-feet	inches
***************************	---------	-------
Total Precipitation	1195.602	3.880
Evaporation Loss	0.000	0.000
Infiltration Loss	1144.280	3.713
Surface Runoff	45.564	0.148
Final Storage	6.058	0.020
Continuity Error (%)	-0.025	

***************************	Volume	Volume
Flow Routing Continuity	acre-feet	10^6 gal
***************************	---------	---------
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	45.573	14.851
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	45.573	14.851
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	0.000	

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Subcatchment Runoff Summary

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Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	3.88	0.00	0.00	3.20	0.67	0.75	3.06	0.172
4	3.88	0.00	0.00	3.73	0.11	1.63	13.61	0.029
6	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
8	3.88	0.00	0.00	3.10	0.74	1.75	17.35	0.190
10	3.88	0.00	0.00	3.59	0.26	0.06	1.64	0.068
12	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
13	3.88	0.00	0.00	3.84	0.02	0.13	2.46	0.005
20	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
21	3.88	0.00	0.00	3.44	0.43	0.46	1.88	0.112
22	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
26	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
28	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
29	3.88	0.00	0.00	3.76	0.11	0.03	0.82	0.027
30	3.88	0.00	0.00	3.84	0.03	0.04	1.32	0.008
33	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
34	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
35	3.88	0.00	0.00	2.96	0.89	0.24	5.87	0.228
40	3.88	0.00	0.00	3.87	0.01	0.03	0.88	0.001
41	3.88	0.00	0.00	3.83	0.04	0.12	3.03	0.011
42	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
43	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
45	3.88	0.00	0.00	3.82	0.04	0.09	1.31	0.009
46	3.88	0.00	0.00	1.80	2.04	4.13	15.73	0.526
47	3.88	0.00	0.00	2.73	1.13	0.44	2.06	0.292
50	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
51	3.88	0.00	0.00	2.56	1.30	0.74	3.34	0.336
52	3.88	0.00	0.00	3.16	0.70	0.27	1.13	0.182
53	3.88	0.00	0.00	2.06	1.82	1.58	30.96	0.469

Wasilla Creek Watershed

56	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
58	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
59	3.88	0.00	0.00	3.78	0.09	0.11	2.47	0.022
60	3.88	0.00	0.00	3.51	0.35	0.55	15.00	0.090
61	3.88	0.00	0.00	3.87	0.01	0.02	1.24	0.002
63	3.88	0.00	0.00	3.78	0.08	0.10	2.18	0.022
64	3.88	0.00	0.00	3.71	0.16	0.13	5.36	0.041
68	3.88	0.00	0.00	3.82	0.05	0.55	12.41	0.012
69	3.88	0.00	0.00	3.74	0.10	0.03	0.27	0.026
70	3.88	0.00	0.00	3.66	0.21	0.19	0.55	0.054
71	3.88	0.00	0.00	3.80	0.07	0.08	2.24	0.017
72	3.88	0.00	0.00	3.66	0.20	0.15	3.05	0.052
74	3.88	0.00	0.00	3.83	0.04	0.09	3.45	0.011
75	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
76	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
77	3.88	0.00	0.00	3.76	0.10	0.39	5.72	0.024

Analysis begun on: Wed Dec 12 15:22:23 2018
Analysis ended on: Wed Dec 12 15:22:23 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	3.88	0.00	0.00	2.06	1.82	1.58	30.96	0.469
8	3.88	0.00	0.00	3.10	0.74	1.75	17.35	0.190
46	3.88	0.00	0.00	1.80	2.04	4.13	15.73	0.526
60	3.88	0.00	0.00	3.51	0.35	0.55	15.00	0.090
4	3.88	0.00	0.00	3.73	0.11	1.63	13.61	0.029
68	3.88	0.00	0.00	3.82	0.05	0.55	12.41	0.012
35	3.88	0.00	0.00	2.96	0.89	0.24	5.87	0.228
77	3.88	0.00	0.00	3.76	0.10	0.39	5.72	0.024
64	3.88	0.00	0.00	3.71	0.16	0.13	5.36	0.041
74	3.88	0.00	0.00	3.83	0.04	0.09	3.45	0.011
51	3.88	0.00	0.00	2.56	1.30	0.74	3.34	0.336
3	3.88	0.00	0.00	3.20	0.67	0.75	3.06	0.172
72	3.88	0.00	0.00	3.66	0.20	0.15	3.05	0.052
41	3.88	0.00	0.00	3.83	0.04	0.12	3.03	0.011
59	3.88	0.00	0.00	3.78	0.09	0.11	2.47	0.022
13	3.88	0.00	0.00	3.84	0.02	0.13	2.46	0.005

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
71	3.88	0.00	0.00	3.80	0.07	0.08	2.24	0.017
63	3.88	0.00	0.00	3.78	0.08	0.10	2.18	0.022
47	3.88	0.00	0.00	2.73	1.13	0.44	2.06	0.292
21	3.88	0.00	0.00	3.44	0.43	0.46	1.88	0.112
10	3.88	0.00	0.00	3.59	0.26	0.06	1.64	0.068
30	3.88	0.00	0.00	3.84	0.03	0.04	1.32	0.008
45	3.88	0.00	0.00	3.82	0.04	0.09	1.31	0.009
61	3.88	0.00	0.00	3.87	0.01	0.02	1.24	0.002
52	3.88	0.00	0.00	3.16	0.70	0.27	1.13	0.182
40	3.88	0.00	0.00	3.87	0.01	0.03	0.88	0.001
29	3.88	0.00	0.00	3.76	0.11	0.03	0.82	0.027
70	3.88	0.00	0.00	3.66	0.21	0.19	0.55	0.054
69	3.88	0.00	0.00	3.74	0.10	0.03	0.27	0.026
33	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
42	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
43	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
26	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
28	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
56	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
22	3.88	0.00	0.00	3.88	0.00	0.00	0.00	0.000
34	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
58	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
20	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
76	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000
6	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
50	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
75	3.88	0.00	0.00	3.87	0.00	0.00	0.00	0.000
12	3.88	0.00	0.00	3.86	0.00	0.00	0.00	0.000

Wasilla Creek Watershed

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.009)

Wasilla Creek Watershed
model of outfall and dispersed catchments
Existing

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****
Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... YES
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... NO
  Water Quality .... NO
Infiltration Method ...... GREEN_AMPT
Starting Date NOV-14-2018 00:00:00
Ending Date NOV-16-2018 06:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Wet Time Step 00:05:00
Dry Time Step 01:00:00

Wasilla Creek Watershed

```
**************************      Volume       Depth
Runoff Quantity Continuity    acre-feet      inches
**************************    ---------     -------
Total Precipitation ......     1420.545       4.610
Evaporation Loss .........        0.000       0.000
Infiltration Loss ........     1331.736       4.322
Surface Runoff ...........       83.124       0.270
Final Storage ............        6.059       0.020
Continuity Error (%) .....       -0.026


**************************      Volume      Volume
Flow Routing Continuity       acre-feet    10^6 gal
**************************    ---------   ---------
Dry Weather Inflow .......        0.000       0.000
Wet Weather Inflow .......       83.139      27.092
Groundwater Inflow .......        0.000       0.000
RDII Inflow ..............        0.000       0.000
External Inflow ..........        0.000       0.000
External Outflow .........       83.139      27.092
Flooding Loss ............        0.000       0.000
Evaporation Loss .........        0.000       0.000
Exfiltration Loss ........        0.000       0.000
Initial Stored Volume ....        0.000       0.000
Final Stored Volume ......        0.000       0.000
Continuity Error (%) .....        0.000


***************************
Subcatchment Runoff Summary
***************************
```

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
3	4.61	0.00	0.00	3.34	1.26	1.41	5.95	0.274
4	4.61	0.00	0.00	4.29	0.29	4.07	25.63	0.062
6	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
8	4.61	0.00	0.00	3.37	1.19	2.84	26.51	0.259
10	4.61	0.00	0.00	4.06	0.52	0.12	2.76	0.114
12	4.61	0.00	0.00	4.59	0.00	0.01	0.24	0.000
13	4.61	0.00	0.00	4.53	0.06	0.40	4.97	0.014
20	4.61	0.00	0.00	4.59	0.00	0.00	0.08	0.000
21	4.61	0.00	0.00	3.62	0.99	1.04	4.20	0.214
22	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
26	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
28	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
29	4.61	0.00	0.00	4.33	0.26	0.07	1.50	0.057
30	4.61	0.00	0.00	4.51	0.10	0.12	2.70	0.021
33	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
34	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
35	4.61	0.00	0.00	3.25	1.32	0.35	8.61	0.287
40	4.61	0.00	0.00	4.58	0.02	0.10	1.91	0.004
41	4.61	0.00	0.00	4.48	0.12	0.34	5.89	0.026
42	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
43	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
45	4.61	0.00	0.00	4.48	0.10	0.25	2.59	0.022
46	4.61	0.00	0.00	1.86	2.71	5.48	21.91	0.588
47	4.61	0.00	0.00	2.82	1.77	0.69	3.56	0.384
50	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
51	4.61	0.00	0.00	2.69	1.91	1.08	4.99	0.413
52	4.61	0.00	0.00	3.29	1.30	0.50	2.19	0.283
53	4.61	0.00	0.00	2.16	2.46	2.13	40.41	0.533

Wasilla Creek Watershed

56	4.61	0.00	0.00	4.58	0.01	0.00	0.15	0.002
58	4.61	0.00	0.00	4.57	0.02	0.06	1.16	0.003
59	4.61	0.00	0.00	4.37	0.22	0.29	4.51	0.048
60	4.61	0.00	0.00	3.94	0.64	1.01	24.49	0.139
61	4.61	0.00	0.00	4.54	0.07	0.22	7.31	0.016
63	4.61	0.00	0.00	4.37	0.22	0.25	4.00	0.047
64	4.61	0.00	0.00	4.24	0.36	0.28	9.62	0.078
68	4.61	0.00	0.00	4.46	0.13	1.57	23.65	0.029
69	4.61	0.00	0.00	4.32	0.26	0.09	0.53	0.055
70	4.61	0.00	0.00	4.02	0.59	0.51	1.37	0.127
71	4.61	0.00	0.00	4.41	0.18	0.23	4.22	0.039
72	4.61	0.00	0.00	4.15	0.43	0.32	5.27	0.094
74	4.61	0.00	0.00	4.48	0.13	0.26	6.96	0.028
75	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
76	4.61	0.00	0.00	4.59	0.00	0.00	0.07	0.001
77	4.61	0.00	0.00	4.34	0.24	0.98	10.50	0.052

Analysis begun on: Wed Dec 12 15:23:07 2018
Analysis ended on: Wed Dec 12 15:23:07 2018
Total elapsed time: < 1 sec

Wasilla Creek Watershed

Subcatchment Runoff Summary

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
53	4.61	0.00	0.00	2.16	2.46	2.13	40.41	0.533
8	4.61	0.00	0.00	3.37	1.19	2.84	26.51	0.259
4	4.61	0.00	0.00	4.29	0.29	4.07	25.63	0.062
60	4.61	0.00	0.00	3.94	0.64	1.01	24.49	0.139
68	4.61	0.00	0.00	4.46	0.13	1.57	23.65	0.029
46	4.61	0.00	0.00	1.86	2.71	5.48	21.91	0.588
77	4.61	0.00	0.00	4.34	0.24	0.98	10.50	0.052
64	4.61	0.00	0.00	4.24	0.36	0.28	9.62	0.078
35	4.61	0.00	0.00	3.25	1.32	0.35	8.61	0.287
61	4.61	0.00	0.00	4.54	0.07	0.22	7.31	0.016
74	4.61	0.00	0.00	4.48	0.13	0.26	6.96	0.028
3	4.61	0.00	0.00	3.34	1.26	1.41	5.95	0.274
41	4.61	0.00	0.00	4.48	0.12	0.34	5.89	0.026
72	4.61	0.00	0.00	4.15	0.43	0.32	5.27	0.094
51	4.61	0.00	0.00	2.69	1.91	1.08	4.99	0.413
13	4.61	0.00	0.00	4.53	0.06	0.40	4.97	0.014

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
59	4.61	0.00	0.00	4.37	0.22	0.29	4.51	0.048
71	4.61	0.00	0.00	4.41	0.18	0.23	4.22	0.039
21	4.61	0.00	0.00	3.62	0.99	1.04	4.20	0.214
63	4.61	0.00	0.00	4.37	0.22	0.25	4.00	0.047
47	4.61	0.00	0.00	2.82	1.77	0.69	3.56	0.384
10	4.61	0.00	0.00	4.06	0.52	0.12	2.76	0.114
30	4.61	0.00	0.00	4.51	0.10	0.12	2.70	0.021
45	4.61	0.00	0.00	4.48	0.10	0.25	2.59	0.022
52	4.61	0.00	0.00	3.29	1.30	0.50	2.19	0.283
40	4.61	0.00	0.00	4.58	0.02	0.10	1.91	0.004
29	4.61	0.00	0.00	4.33	0.26	0.07	1.50	0.057
70	4.61	0.00	0.00	4.02	0.59	0.51	1.37	0.127
58	4.61	0.00	0.00	4.57	0.02	0.06	1.16	0.003
69	4.61	0.00	0.00	4.32	0.26	0.09	0.53	0.055
12	4.61	0.00	0.00	4.59	0.00	0.01	0.24	0.000
56	4.61	0.00	0.00	4.58	0.01	0.00	0.15	0.002
20	4.61	0.00	0.00	4.59	0.00	0.00	0.08	0.000

Wasilla Creek Watershed

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
76	4.61	0.00	0.00	4.59	0.00	0.00	0.07	0.001
26	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
42	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
22	4.61	0.00	0.00	4.61	0.00	0.00	0.00	0.000
28	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
33	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
75	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
6	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
50	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
43	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000
34	4.61	0.00	0.00	4.60	0.00	0.00	0.00	0.000

APPENDIX E: PRECIPITATION AND SOILS DATA

NOAA Atlas 14, Volume 7, Version 2 PALMER 5 NW
Station ID: 50-6875
Location name: Palmer, Alaska, USA*
Latitude: 61.65°, Longitude: -149.2°
Elevation:
Elevation (station metadata): 630 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Douglas Kane, Sarah Dietz, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Svetlana Stuefer, Amy Tidwell, Carl Trypaluk, Dale Unruh, Michael Yekta, Erica Betts, Geoffrey Bonnin, Sarah Heim, Lillian Hiner, Elizabeth Lilly, Jayashree Narayanan, Fenglin Yan, Tan Zhao

NOAA, National Weather Service, Silver Spring, Maryland
and
University of Alaska Fairbanks, Water and Environmental Research Center

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.104** (0.078-0.141)	**0.135** (0.101-0.185)	**0.180** (0.132-0.251)	**0.217** (0.157-0.307)	**0.268** (0.190-0.387)	**0.307** (0.214-0.450)	**0.347** (0.238-0.516)	**0.386** (0.261-0.582)	**0.440** (0.293-0.676)	**0.479** (0.314-0.746)
10-min	**0.139** (0.105-0.189)	**0.181** (0.135-0.248)	**0.242** (0.177-0.338)	**0.291** (0.210-0.412)	**0.360** (0.255-0.519)	**0.413** (0.288-0.605)	**0.465** (0.320-0.691)	**0.519** (0.352-0.782)	**0.590** (0.392-0.906)	**0.644** (0.422-1.00)
15-min	**0.163** (0.123-0.221)	**0.212** (0.158-0.291)	**0.283** (0.207-0.395)	**0.341** (0.246-0.483)	**0.421** (0.298-0.608)	**0.483** (0.337-0.707)	**0.545** (0.375-0.810)	**0.607** (0.411-0.915)	**0.691** (0.459-1.06)	**0.754** (0.494-1.17)
30-min	**0.216** (0.163-0.293)	**0.282** (0.210-0.387)	**0.375** (0.274-0.523)	**0.453** (0.327-0.641)	**0.558** (0.395-0.805)	**0.641** (0.447-0.939)	**0.723** (0.497-1.07)	**0.806** (0.546-1.22)	**0.917** (0.610-1.41)	**1.00** (0.656-1.56)
60-min	**0.296** (0.223-0.401)	**0.386** (0.287-0.529)	**0.514** (0.376-0.717)	**0.620** (0.447-0.877)	**0.765** (0.541-1.10)	**0.878** (0.612-1.29)	**0.990** (0.680-1.47)	**1.10** (0.748-1.66)	**1.26** (0.835-1.93)	**1.37** (0.898-2.13)
2-hr	**0.368** (0.277-0.499)	**0.481** (0.358-0.659)	**0.662** (0.484-0.924)	**0.812** (0.586-1.15)	**1.02** (0.720-1.47)	**1.17** (0.819-1.72)	**1.33** (0.914-1.98)	**1.54** (1.04-2.32)	**1.82** (1.21-2.79)	**2.03** (1.33-3.16)
3-hr	**0.439** (0.330-0.595)	**0.574** (0.427-0.787)	**0.809** (0.592-1.13)	**1.00** (0.723-1.42)	**1.27** (0.896-1.83)	**1.47** (1.02-2.15)	**1.67** (1.15-2.48)	**1.97** (1.34-2.97)	**2.37** (1.58-3.65)	**2.68** (1.76-4.17)
6-hr	**0.616** (0.464-0.835)	**0.805** (0.599-1.10)	**1.16** (0.847-1.62)	**1.45** (1.05-2.05)	**1.85** (1.31-2.68)	**2.16** (1.51-3.17)	**2.48** (1.70-3.68)	**3.00** (2.03-4.52)	**3.69** (2.45-5.67)	**4.21** (2.76-6.56)
12-hr	**0.848** (0.638-1.15)	**1.11** (0.826-1.52)	**1.56** (1.14-2.18)	**1.94** (1.40-2.75)	**2.50** (1.77-3.61)	**2.97** (2.07-4.34)	**3.46** (2.38-5.15)	**4.21** (2.85-6.35)	**5.21** (3.46-8.00)	**5.96** (3.91-9.28)
24-hr	**1.15** (1.04-1.28)	**1.50** (1.34-1.70)	**2.04** (1.79-2.36)	**2.51** (2.16-2.95)	**3.24** (2.73-3.90)	**3.88** (3.21-4.75)	**4.61** (3.74-5.73)	**5.58** (4.45-7.06)	**6.87** (5.36-8.89)	**7.84** (6.02-10.3)
2-day	**1.46** (1.32-1.63)	**1.88** (1.68-2.13)	**2.51** (2.20-2.90)	**3.05** (2.63-3.59)	**3.88** (3.26-4.66)	**4.59** (3.79-5.61)	**5.37** (4.36-6.69)	**6.38** (5.09-8.08)	**7.72** (6.02-9.99)	**8.72** (6.70-11.5)
3-day	**1.67** (1.51-1.86)	**2.13** (1.90-2.40)	**2.81** (2.46-3.25)	**3.39** (2.92-3.99)	**4.26** (3.58-5.12)	**5.00** (4.13-6.11)	**5.81** (4.72-7.23)	**6.83** (5.45-8.64)	**8.17** (6.38-10.6)	**9.19** (7.06-12.1)
4-day	**1.84** (1.66-2.05)	**2.33** (2.09-2.64)	**3.06** (2.68-3.54)	**3.67** (3.16-4.31)	**4.57** (3.84-5.49)	**5.33** (4.40-6.52)	**6.15** (4.99-7.65)	**7.16** (5.72-9.07)	**8.50** (6.64-11.0)	**9.52** (7.31-12.5)
7-day	**2.30** (2.08-2.57)	**2.90** (2.59-3.28)	**3.75** (3.29-4.33)	**4.45** (3.83-5.22)	**5.43** (4.57-6.53)	**6.24** (5.15-7.63)	**7.09** (5.76-8.82)	**8.07** (6.45-10.2)	**9.38** (7.32-12.1)	**10.4** (7.96-13.6)
10-day	**2.66** (2.41-2.97)	**3.34** (2.99-3.78)	**4.29** (3.76-4.96)	**5.05** (4.34-5.93)	**6.10** (5.12-7.33)	**6.93** (5.73-8.48)	**7.80** (6.33-9.70)	**8.76** (6.99-11.1)	**10.0** (7.83-13.0)	**11.0** (8.45-14.5)
20-day	**3.75** (3.39-4.18)	**4.66** (4.16-5.26)	**5.87** (5.14-6.78)	**6.80** (5.85-7.99)	**8.04** (6.76-9.66)	**8.98** (7.42-11.0)	**9.93** (8.06-12.4)	**10.9** (8.68-13.8)	**12.1** (9.47-15.7)	**13.1** (10.0-17.2)
30-day	**4.75** (4.30-5.30)	**5.87** (5.25-6.64)	**7.33** (6.42-8.47)	**8.42** (7.24-9.89)	**9.83** (8.27-11.8)	**10.9** (8.99-13.3)	**11.9** (9.66-14.8)	**12.8** (10.2-16.3)	**14.1** (11.0-18.2)	**15.0** (11.5-19.8)
45-day	**6.00** (5.44-6.70)	**7.37** (6.59-8.33)	**9.12** (7.98-10.5)	**10.4** (8.95-12.2)	**12.0** (10.1-14.4)	**13.2** (10.9-16.1)	**14.3** (11.6-17.8)	**15.3** (12.2-19.4)	**16.6** (13.0-21.5)	**17.6** (13.5-23.2)
60-day	**6.80** (6.16-7.58)	**8.29** (7.41-9.37)	**10.2** (8.91-11.7)	**11.5** (9.93-13.6)	**13.3** (11.2-16.0)	**14.6** (12.0-17.8)	**15.8** (12.8-19.6)	**16.9** (13.5-21.4)	**18.4** (14.4-23.8)	**19.5** (15.0-25.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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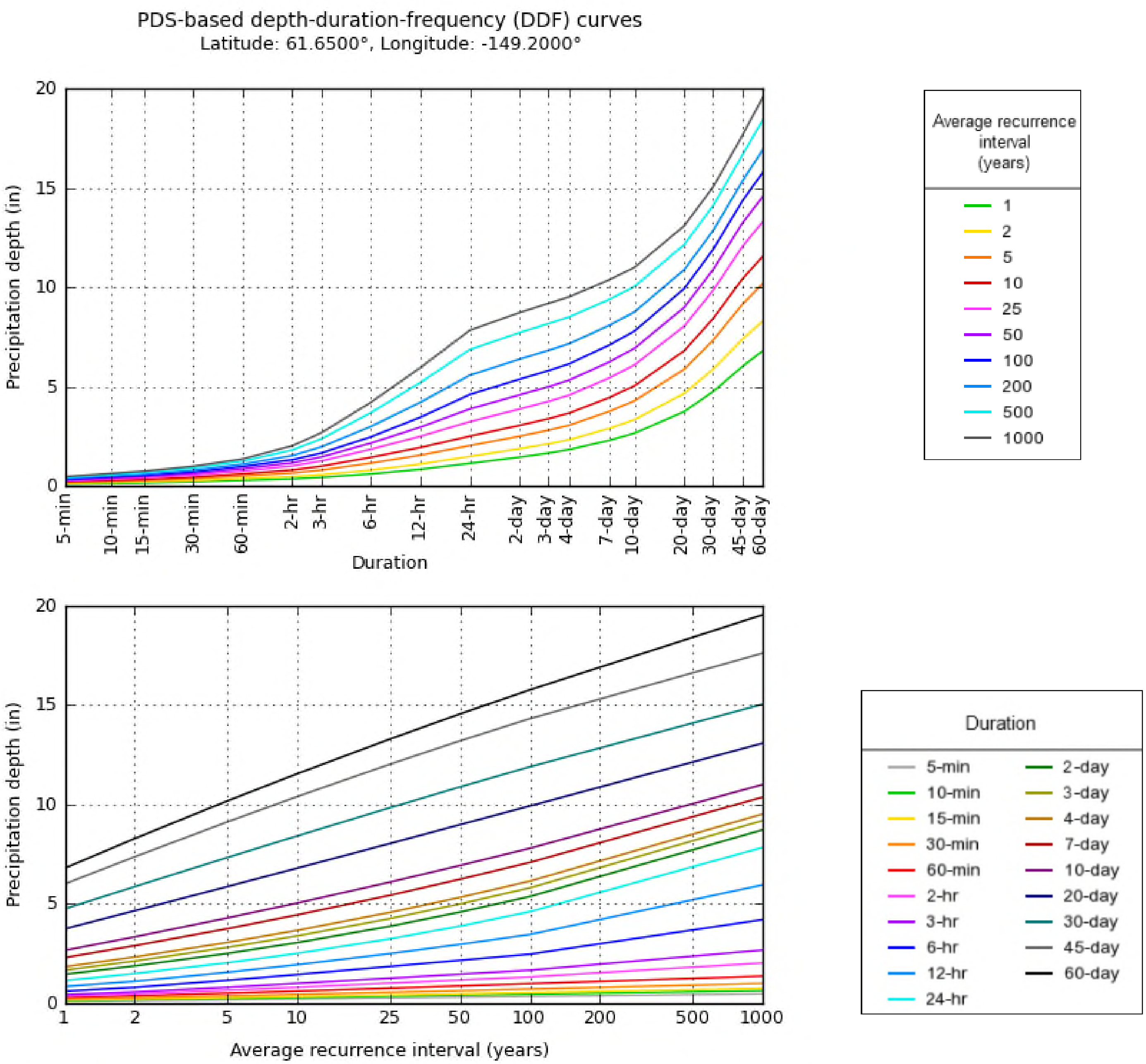
PF graphical



NOAA Atlas 14, Volume 7, Version 2 Created (GMT): Mon Oct 8 19:17:44 2018

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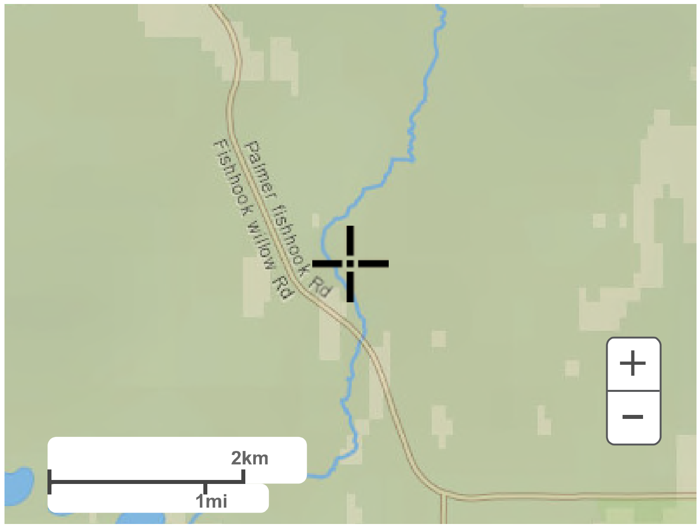
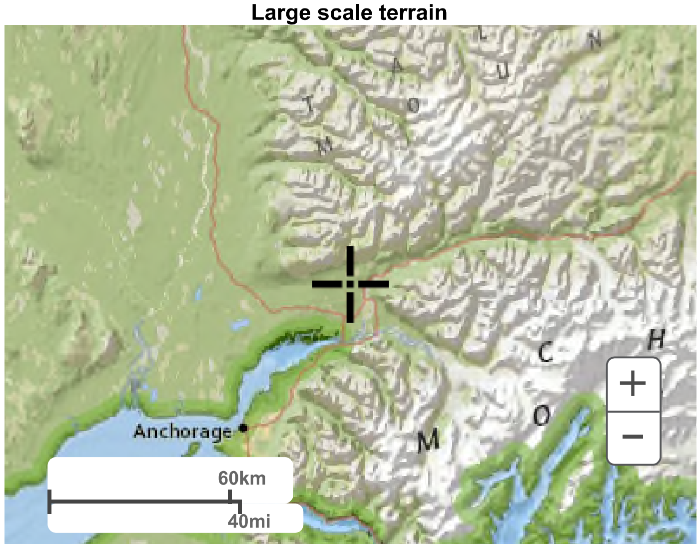
Maps & aerials

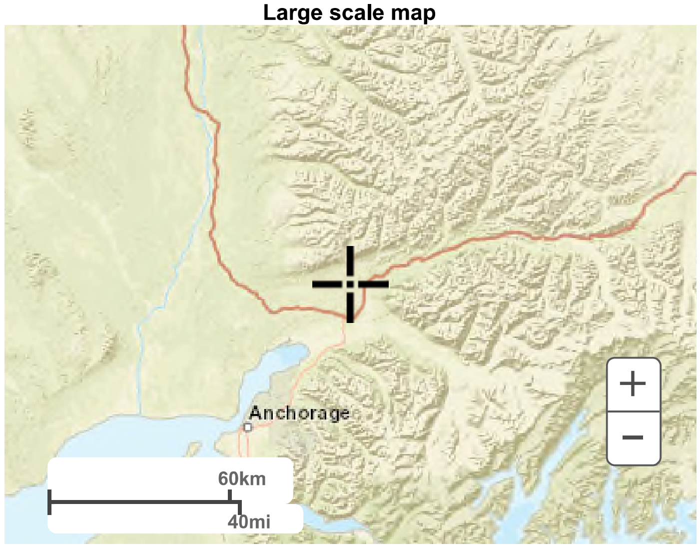
Small scale terrain



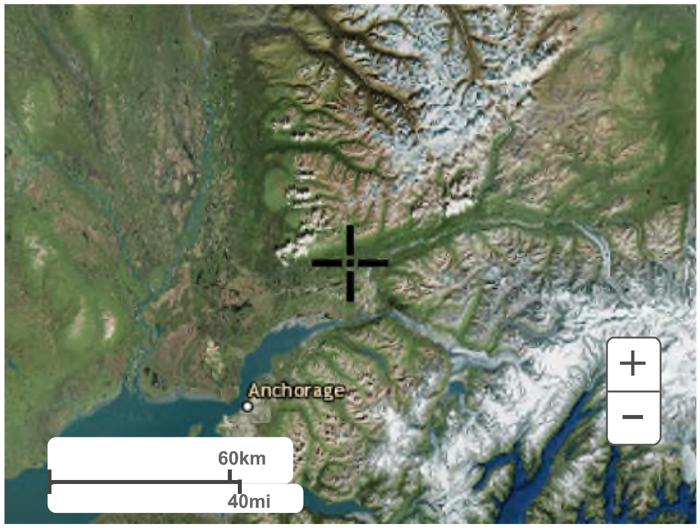
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Record of Climatological Observations

These data are quality controlled and may not be identical to the original observations.

Generated on 11/21/2018

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 230 ft. Lat: 61.5961° N Lon: -149.0916° W

Station: **PALMER MUNICIPAL AIRPORT, AK US USW00025331**

Observation Time Temperature: Unknown Observation Time Precipitation: 2400

Year	Month	Day	Temperature (F) 24 Hrs. Ending at Observation Time Max.	Min.	At Observation	Precipitation 24 Hour Amounts Ending at Observation Time Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	At Obs. Time Snow, Ice Pellets, Hail, Ice on Ground (in)	Evaporation 24 Hour Wind Movement (mi)	Amount of Evap. (in)	Soil Temperature (F) 4 in. Depth Ground Cover (see *)	Max.	Min.	8 in. Depth Ground Cover (see *)	Max.	Min.
2018	08	01	65	56		0.18												
2018	08	02	60	54		0.18												
2018	08	03	73	53		T												
2018	08	04	70	53		0.00												
2018	08	05	64	57		0.06												
2018	08	06	61	55		0.35												
2018	08	07	61	53		0.86												
2018	08	08	59	51		0.11												
2018	08	09	64	49		0.09												
2018	08	10	67	44		0.00												
2018	08	11	65	52		0.14												
2018	08	12	68	52		0.13												
2018	08	13	62	52		0.73												
2018	08	14	56	49		0.18												
2018	08	15	57	48		0.23												
2018	08	16	60	48		0.12												
2018	08	17	62	48		0.02												
2018	08	18	59	43		0.00												
2018	08	19	61	48		0.08												
2018	08	20	62	49		0.12												
2018	08	21	56	51		0.63												
2018	08	22	64	50		0.09												
2018	08	23	55	47		0.20												
2018	08	24	59	48		0.06												
2018	08	25	60	43		0.00												
2018	08	26	58	50		0.38												
2018	08	27	60	48		T												
2018	08	28	64	46		0.00												
2018	08	29	64	42		T												
2018	08	30	58	48		0.61												
2018	08	31	57	44		0.00												
		Summary	62	49		5.55		0.0										

Empty, or blank, cells indicate that a data observation was not reported.

*Ground Cover: 1=Grass; 2=Fallow; 3=Bare Ground; 4=Brome grass; 5=Sod; 6=Straw mulch; 7=Grass muck; 8=Bare muck; 0=Unknown

"s" This data value failed one of NCDC's quality control tests.

"T" values in the Precipitation or Snow category above indicate a "trace" value was recorded.

"A" values in the Precipitation Flag or the Snow Flag column indicate a multiday total, accumulated since last measurement, is being used.

Data value inconsistency may be present due to rounding calculations during the conversion process from SI metric units to standard imperial units.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Record of Climatological Observations

These data are quality controlled and may not be identical to the original observations.

Generated on 11/21/2018

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 230 ft. Lat: 61.5961° N Lon: -149.0916° W

Station: **PALMER MUNICIPAL AIRPORT, AK US USW00025331**

Observation Time Temperature: Unknown Observation Time Precipitation: 2400

Year	Month	Day	Temperature (F) 24 Hrs. Ending at Observation Time Max.	Temperature (F) 24 Hrs. Ending at Observation Time Min.	Temperature (F) At Observation	Precipitation 24 Hour Amounts Ending at Observation Time Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	At Obs. Time Snow, Ice Pellets, Hail, Ice on Ground (in)	Evaporation 24 Hour Wind Movement (mi)	Amount of Evap. (in)	Soil Temperature (F) 4 in. Depth Ground Cover (see *)	4 in. Max.	4 in. Min.	8 in. Depth Ground Cover (see *)	8 in. Max.	8 in. Min.
2018	09	01	62	43		0.00												
2018	09	02	64	41		0.00												
2018	09	03	66	40		0.00												
2018	09	04	64	41		0.00												
2018	09	05	65	39		T												
2018	09	06	62	46		0.01												
2018	09	07	64	41		0.00												
2018	09	08	67	44		0.00												
2018	09	09	65	37		T												
2018	09	10	65	37		0.00												
2018	09	11	65	40		0.00												
2018	09	12	67	44		0.00												
2018	09	13	64	43		0.00												
2018	09	14	67	41		0.00												
2018	09	15	63	47		0.00												
2018	09	16	57	44		T												
2018	09	17	62	48		0.00												
2018	09	18	62	47		T												
2018	09	19	59	48		0.00												
2018	09	20	59	44		0.05												
2018	09	21	55	46		0.04												
2018	09	22	57	47		0.20												
2018	09	23	57	41		0.01												
2018	09	24	58	48		0.13												
2018	09	25	58	40		0.01												
2018	09	26	54	37		0.00												
2018	09	27	52	41		T												
2018	09	28	56	45		0.02												
2018	09	29	61	36		T												
2018	09	30	57	34		0.00												
		Summary	61	42		0.47		0.0										

Empty, or blank, cells indicate that a data observation was not reported.

*Ground Cover: 1=Grass; 2=Fallow; 3=Bare Ground; 4=Brome grass; 5=Sod; 6=Straw mulch; 7=Grass muck; 8=Bare muck; 0=Unknown

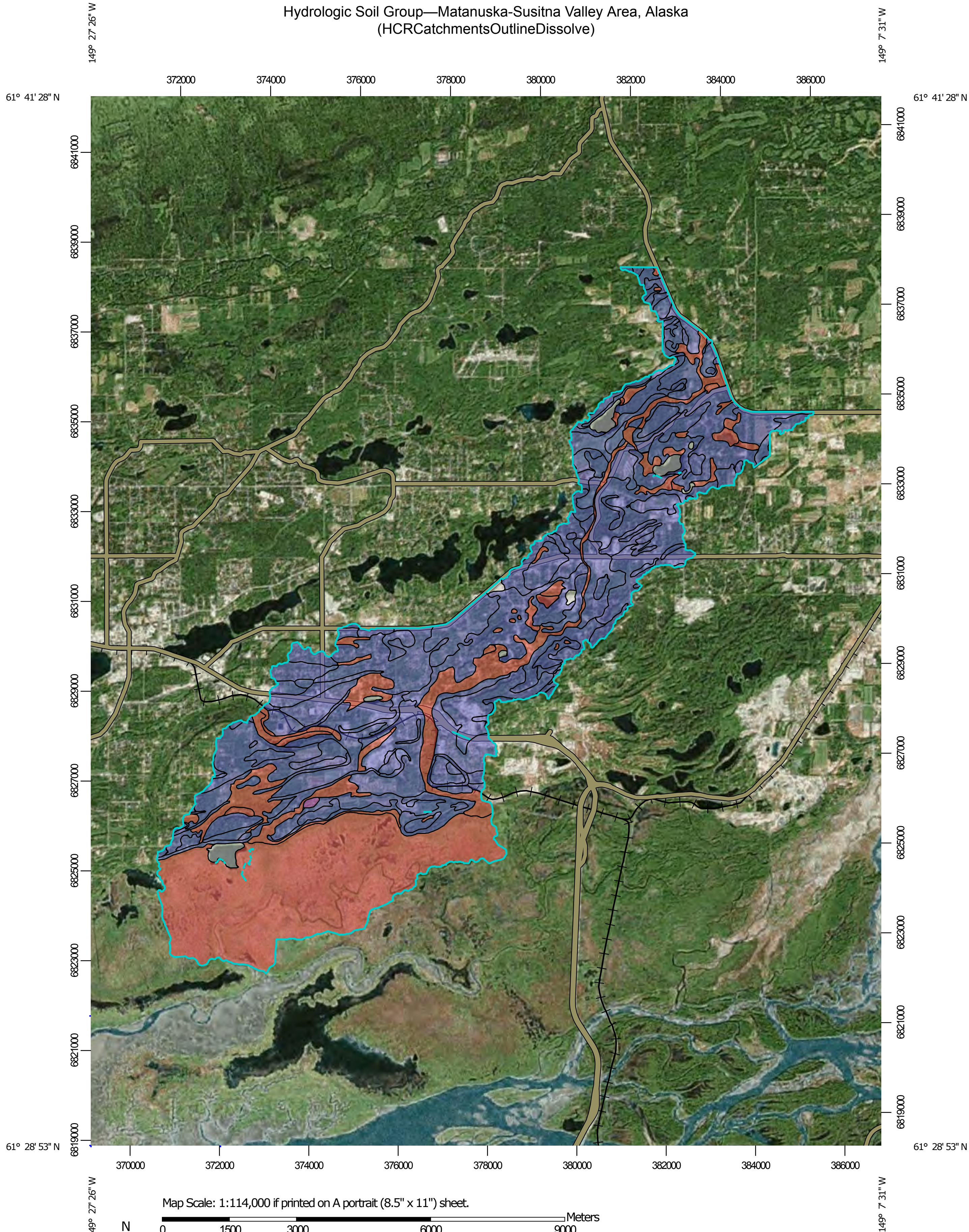
"s" This data value failed one of NCDC's quality control tests.

"T" values in the Precipitation or Snow category above indicate a "trace" value was recorded.

"A" values in the Precipitation Flag or the Snow Flag column indicate a multiday total, accumulated since last measurement, is being used.

Data value inconsistency may be present due to rounding calculations during the conversion process from SI metric units to standard imperial units.

Hydrologic Soil Group—Matanuska-Susitna Valley Area, Alaska
(HCRCatchmentsOutlineDissolve)



Map Scale: 1:114,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 1500 3000 6000 9000

Feet: 0 5000 10000 20000 30000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 6N 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 1:24,000.

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: Matanuska-Susitna Valley Area, Alaska
Survey Area Data: Version 15, Aug 29, 2018

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

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

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
106	Bodenburg silt loam, sloping and moderately steep	B	71.4	0.4%
108	Bodenburg silt loam, undulating	B	166.4	1.0%
116	Cryaquepts, depressional, 0 to 7 percent slopes	D	869.7	5.5%
120	Cryods, low elevation, and Cryochrepts, 30 to 70 percent slopes	B	417.8	2.6%
141	Histosols	D	278.5	1.8%
143	Kalambach silt loam, sloping and moderately steep	B	550.9	3.5%
144	Kalambach silt loam, steep and sloping	B	16.1	0.1%
145	Kalambach silt loam, undulating	B	577.5	3.6%
162	Kidazqeni-Niklason complex, 0 to 2 percent slopes	A	14.6	0.1%
164	Knik silt loam, 0 to 3 percent slopes	B	1,708.3	10.8%
165	Knik silt loam, gently sloping and moderately steep	B	1,444.7	9.1%
166	Knik silt loam, steep and sloping	B	1,740.5	11.0%
167	Knik silt loam, undulating	B	2,011.4	12.7%
179	Pits, gravel		29.1	0.2%
203	Typic Cryaquents, 0 to 2 percent slopes	D	703.6	4.4%
204	Typic Cryaquents, coastal, 0 to 2 percent slopes	D	3,691.1	23.3%
213	Yensus silt loam, sloping and moderately steep	B	1,189.8	7.5%
214	Yensus silt loam, undulating	B	192.3	1.2%
220	Water		196.8	1.2%
Totals for Area of Interest			**15,870.5**	**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 F: COST ESTIMATES

Wasilla Creek Stormwater Analysis date: 5/25/2019
Cost Estimate for Ditch Grading by: HCR

Ditch Grading				
Item	**Units**	**Unit Price**	**Quantity**	**Cost**
Design (15% of Construction Cost)				22.39
ROW Acquisition	Not Included			
Utility Relocation	Not Included			
Construction				
Excavation	CY	$ 42.00	1	$ 62.22
Ditch Linear Grading	STA	$ 1,000.00	0.02	$ 20.00
Topsoil	MSF	$ 600.00	0.016	$ 9.60
Seed	MSF	$ 500.00	0.016	$ 8.00
Construction Subtotal				$ 99.82
Construction Engineering & Admin (CEA, 15%)				$ 14.97
Subtotal Construction and CEA				$ 114.80
Contingency	30%			$ 34.44
			(Construction, contingency) Total:	$ 149.23
			(Design, construction, contingency) Total:	**$ 171.62**
			Rounded (per LF)	**$ 200.00**

Wasilla Creek Stormwater Analysis date: 5/25/2019
Stringfield Road Embankment Erosion by: HCR
Cost Estimate for Rock Lined Ditch

Rock Lined Ditch				
Item	**Units**	**Unit Price**	**Quantity**	**Cost**
Design (15% of Construction Cost)				36.33
ROW Acquisition	Not Included			
Utility Relocation	Not Included			
Construction				
Excavation	CY	$ 42.00	1	$ 42.00
Ditch Lining	CY	$ 120.00	1	$ 120.00
Construction Subtotal				$ 162.00
Construction Engineering & Admin (CEA, 15%)				$ 24.30
Subtotal Construction and CEA				$ 186.30
Contingency	30%			$ 55.89
			(Construction, contingency) Total:	$ 242.19
			(Design, construction, contingency) Total:	**$ 278.52**
			Rounded (per LF)	**$ 300.00**

Wasilla Creek Stormwater Analysis date: 5/25/2019
Palmer-Fishhook Road Wasilla Creek tributary ATV ponding by: HCR
Cost Estimate for Culvert Extension

Extension				
Item	**Units**	**Unit Price**	**Quantity**	**Cost**
Design (15% of Construction Cost)				$ 4,635.25
ROW Acquisition	Not Included			
Utility Relocation	Not Included			
Construction				
Borrow	Ton	$ 45.00	230	$ 10,350.00
2' Culvert	LF	$ 120.00	30	$ 3,600.00
Riprap, Class I	Ton	$ 150.00	40.00	$ 6,000.00
Geotextile	SY	$ 4.00	30.00	$ 120.00
Topsoil	MSF	$ 600.00	1.00	$ 600.00
Seed	MSF	$ 500.00		$ -
Construction Subtotal				$ 20,670.00
Construction Engineering & Admin (CEA, 15%)				$ 3,100.50
Subtotal Construction and CEA				$ 23,770.50
Contingency	30%			$ 7,131.15
(Construction, contingency) Total:				$ 30,901.65
(Design, construction, contingency) Total:				**$ 35,536.90**
Rounded				**$ 36,000.00**

Wasilla Creek Stormwater Analysis date: 5/25/2019
Palmer-Fishhook Road Wasilla Creek tributary ATV ponding by: HCR
Cost Estimate for Armored Channel

Armored Section				
Item	**Units**	**Unit Price**	**Quantity**	**Cost**
Design (15% of Construction Cost)				2471.235
ROW Acquisition	Not Included			
Utility Relocation	Not Included			
Construction				
Riprap	Ton	$ 150.00	70	$ 10,500.00
Geotextile	SY	$ 4.00	130.00	$ 520.00
Construction Subtotal				$ 11,020.00
Construction Engineering & Admin (CEA, 15%)				$ 1,653.00
Subtotal Construction and CEA				$ 12,673.00
Contingency	30%			$ 3,801.90
			(Construction, contingency) Total:	$ 16,474.90
			(Design, construction, contingency) Total:	**$ 18,946.14**
			Rounded	**$ 19,000.00**

Wasilla Creek Stormwater Analysis date: 5/25/2019
Stringfield Road Embankment Erosion by: HCR
Cost Estimate for Embankment Protection

Riprap Banks				
Item	**Units**	**Unit Price**	**Quantity**	**Cost**
Design (15% of Construction Cost)				$ 14,787.05
ROW Acquisition	Not Included			
Utility Relocation	Not Included			
Construction				
Excavation	CY	$ 42.00	240	$ 10,080.00
Riprap, Class I	Ton	$ 150.00	350	$ 52,500.00
Geotextile	SY	$ 4.00	290	$ 1,160.00
Topsoil	MSF	$ 600.00	2	$ 1,200.00
Seed	MSF	$ 500.00	2	$ 1,000.00
Construction Subtotal				$ 65,940.00
Construction Engineering & Admin (CEA, 15%)				$ 9,891.00
Subtotal Construction and CEA				$ 75,831.00
Contingency	30%			$ 22,749.30
(Construction, contingency) Total:				$ 98,580.30
(Design, construction, contingency) Total:				**$ 113,367.35**
Rounded				**$ 114,000.00**