JUNEAU STORMWATER HYDROGRAPHY REPORT

ACWA GRANT # 14-06

JUNEAU WATERSHED PARTNERSHIP

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JUNEAU WATERSHED PARTNERSHIP

Our mission is to promote watershed integrity in the City and Borough of Juneau through education, research and communication while encouraging sustainable use and development.

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INTRODUCTION

Juneau is located on the Southeast panhandle of Alaska, nestled between the ocean and mountainous terrain. Due to the city's geographic location, there is limited developable land leading to dense development in Juneau's urban areas.

Juneau is home to approximately 31,000 people, the majority of which live in the population centers of the Mendenhall Valley and the Lemon Creek Valley. These geographic areas are the focus of this report as they, like many urban areas, have waterways have been impacted by development. Juneau currently has five impaired waterbodies: Jordan, Duck, Pederson Hill, Vanderbilt, and Lemon Creeks. Impaired watersheds are those that do not meet the state's water quality standards for one or more parameters and the waterbody cannot support its designated use(s). Juneau's impaired watersheds comprise a large portion of the urbanized area in the Mendenhall and Lemon Creek Valleys.

Sediment and high turbidity attributed to urban and road run-off and habitat modifications are the identified causes of the impairment of these waterbodies with the exception of Pederson Hill Creek, which is impaired due to high fecal coliform from failing septic systems. Even though stormwater is not explicitly listed as a source of impairment for Pederson Hill Creek, it has been shown to be linked to the creek's impairment. This is not surprising given the dense development in these watersheds and the 54 inches of precipitation Juneau receives annually. Since stormwater is the common factor contributing to the impairment of these watersheds, the way stormwater is transported and treated throughout these watersheds is extremely important.

Stormwater maps would improve understanding of the connections between the waterbodies and stormwater system, and will support stormwater management and treatment, and restoration projects, within these impaired watersheds. While the CBJ has relatively current (as of 2008), near-complete maps of stormwater outfall locations on Juneau's impaired watersheds, this data is lacking in stormwater flow paths over land and through the stormwater system, and could contain outdated information. Knowledge of the flow paths would assist in delineating the areas contributing to the stormwater entering each waterbody.

In 2010 and 2011, the Juneau Watershed Partnership (JWP) in conjunction with the U.S. Fish and Wildlife Service (USFWS), worked to map the run-off contributing areas and stormwater structures for the lower portion of Jordan Creek, below Egan Drive. This is the only urban hydrography map in Juneau; however, it is incomplete. The upper watershed and portions of the lower watershed were not included.

The JWP in cooperation with the City and Borough of Juneau (CBJ) and the Alaska Department of Transportation and Public Facilities (DOT&PF), proposed to conduct stormwater mapping on Juneau's impaired watersheds to address the need for a completed Geographic Information System (GIS) urban hydrography data layer showing stormwater flow and structures for these watersheds. The JWP's proposal received a one-year Alaska Clean Water Actions (ACWA) grant from the Alaska Department of Environmental Conservation (DEC) to begin this mapping effort.

Since funding was received for one year, the JWP decided to focus this year's stormwater mapping efforts on three of the five impaired waterbodies: Lemon, Vanderbilt, and Pederson Hill Creeks. Using the CBJ's outfall data from 2008, and the same process used for mapping stormwater flow paths and contributing areas on lower Jordan Creek, this report begins to address the data gaps for stormwater mapping on Juneau's impaired waterbodies.

METHODS

The JWP used Garmin Rino 120 handheld Global Positioning System (GPS) units to collect the latitude and longitude coordinates of all publically accessible stormwater structures (storm drain inlets, culverts, stream outfalls) in the Lemon Creek, Vanderbilt Creek and Pederson Hill Creek watersheds. The Garmin Rino 120 has an accuracy of within 15 meters (49 feet) and uses a Wide Area Augmentation System (WAAS) enabled, differential ready, 12 parallel channel GPS receiver.

Field observations were used to determine above-ground flow paths and flow through the storm sewer system. Visual observations include the direction of pipes (observed from looking into storm drain inlets), topography and, when possible, flow direction during precipitation events. Flow direction was hand-drawn on maps of the area and GPS waypoints were described in notebooks.

Areas and structures that were not accessible from the public right of way were not mapped in the field. For these areas, and other locations where the JWP had difficulties in interpreting flow direction in the storm sewer system from observations, as-builts or other existing information were used to infer or confirm flow direction.

To generate the final maps, the GPS data was imported into ArcMap 10.2.2 and projected in the WGS 1984 coordinate system. Each of the mapped watersheds is delineated into a series of sub-drainages, which are described in more detail in this report. The size of these subdrainages were estimated using the measuring tool in ArcMap 10.2.2. For the purposes of this mapping effort, a sub-drainage is defined as an area in which all the stormwater run-off is collected and transported to a single discharge point on the waterbody.

STORMWATER AS A SOURCE OF POLLUTANTS

Stormwater is the run-off generated from precipitation (rain, snowmelt). As the stormwater flows across the landscape, particularly in urban areas, it can pick up and transport a variety of pollutants including sediment, hydrocarbons (petroleum, oil), other chemicals, and garbage/debris. Stormwater pollutants are typically associated with road surfaces and industrial and commercial development. However, even vegetated areas, such as parks and yards, can contribute to pollutants in stormwater including pesticides and fertilizers. In undisturbed natural areas, sediment can enter stormwater from erosional features.

Out of all the pollutants transported by stormwater, sediment is usually the most abundant. However, most people, if asked to name a pollutant, would not typically give sediment as an example. Sediment is problematic when it affects the water's clarity, and/or deposits and accumulates on the streambed. Suspended and deposited sediment and high turbidity could affect the capacity of a creek to support its designated uses including drinking water, aquaculture, recreation and supporting aquatic life and wildlife. High turbidity can reduce the amount of light penetrating through the water, which can affect photosynthesis, water temperature, and the amount of dissolved oxygen within the water column. This could then impact the health and food supply of juvenile fish. Suspended sediments in large concentrations could also clog and damage the gills of adult and juvenile fish.

If suspended particles are able to settle, spawning habitat can become unsuitable and salmon redds (nests) can be damaged. Alevin (sac-fry) emergence can be prevented from fine sediment accumulation. Salmon alevins generally experience difficulties when the percentage of fine sediments exceeds 20% of the substrate volume. Sediment can also adversely impact macroinvertebrates in the stream. The particles can also transport pesticides, toxic metals and excess nutrients throughout the watershed. Furthermore, suspended particles may provide a place for harmful bacteria and microorganisms to settle and grow, such as fecal coliform bacteria. This will not only make the stream unsuitable for aquatic life and wildlife, but for human use as well.

In developed areas, impervious surfaces and artificial drainage structures alter natural stormwater movement and water flow. Impervious surfaces do not allow stormwater to percolate into the ground, nor are they rough enough to slow the water. This allows more stormwater to accumulate and move quickly across these surfaces. To prevent damage to paved infrastructure from quickly flowing water, most urbanized areas will collect and convey stormwater using a storm sewer system, which eventually discharges the stormwater into local waterbodies. These systems are typically owned and operated by a state or local public entity (e.g. a city/borough).

Any publically-owned storm sewer systems that are not part of a combined sanitary sewer and not part of a publically owned treatment works (or sewage treatment plant), is called a municipal separate storm sewer systems, or MS4. Discharges from an MS4 are considered point-source discharges and are regulated under Section 402 of the Clean Water Act. Section 402 requires operators of MS4s to obtain a National Pollutant Discharge Elimination System (NPDES) permit that requires implementation of a stormwater management program to reduce pollutants in stormwater discharges and to prohibit illegal discharges of pollutants into the system.

The MS4 NPDES permit program was implemented in two phases: Phase I required cities and certain counties with population of 100,000 or more to obtain permit coverage; Phase II requires smaller MS4 operators in urbanized areas and those outside of the urbanized area specifically designated by the permitting authority to obtain permit coverage. Urbanized area is based on the decennial Census definition of urbanized area; therefore, the number of regulated small MS4s can change every ten years. In addition, the permitting authority, which is the Department of Environmental Conservation (DEC) in Alaska, could also elect to require an MS4 permit from other operators of publically-owned storm sewer systems.

While the City and Borough of Juneau it not yet a regulated MS4 operator, there is potential for the CBJ to become regulated in the future. Having a map of the storm sewer system is a requirement of the MS4 program, so these maps could benefit the City in the future as well as help to understand stormwater flows for the purposes of protecting impaired watersheds.

LEMON CREEK

Lemon Creek is situated in the center of the Lemon Creek Valley. The mainstem is approximately seven miles long, from the headwaters to the outlet at Gastineau Channel. Lemon Creek's primary headwaters are the terminal lakes of two glaciers, the Thomas and Lemon Glaciers. The Ptarmigan Glacier also forms a major tributary, Ptarmigan Creek. Several non-glacial (clear water) tributaries are included in the Lemon Creek watershed: Canyon Creek, No Name Creek, Sawmill Creek and several unnamed smaller drainages that form on Blackerby Ridge.

The watershed is approximately 25 square miles and includes alpine, forested upland, and wetlands habitats as well as urban areas. The upper Lemon Creek basin is primarily undeveloped, consisting of alpine and forested areas within the Tongass National Forest boundaries. The lower basin began experiencing extensive development in the 1950s, with a period of rapid growth in the 1970s. The urbanized area of the Lemon Creek watershed consists primarily of residential, industrial and commercial areas. Nearly 16 percent of Juneau's current population resides in the Lemon Creek Valley and nearby Switzer Creek and Twin Lakes communities. In addition, Lemon Creek is one of Juneau's industrial centers consisting of large box stores, a power generation plant, a brewery, small business and retail facilities, concrete, gravel mining and stockpiling operations, and the local landfill.

The rapid development of the lower watershed has led to the impairment status of Lemon Creek. It was listed on the state's Section 303 (d) list of impaired water bodies in 1990 due to turbidity, sediment and habitat modification. Urban run-off and gravel mining were identified as the probable pollutant sources. The mapping effort on Lemon Creek focused on the developed residential, industrial and commercial areas in the lower Lemon Creek Valley downstream of the correctional facility.

The only development upstream of the correctional facility is the gravel mining areas in the geographic location known as Hidden Valley. Though a potentially substantial source of sediment in Lemon Creek, this land is privately owned (by Secon, Inc.) and, therefore, was not included in this mapping effort. Likewise, the City's gravel pit adjacent to Home Depot was not included in the mapping effort though, as described later, the gravel pit stormwater discharge that co-mingles with the Home Depot stormwater discharge was included in the mapping effort. Locations of outfalls above the mapped area shown in the map are from CBJ's Stormwater Outfall Inventory conducted in 2008, which are included to provide some information regarding the unmapped areas.

Figure 1. Map of the Lemon Creek valley, including the Switzer, Lemon and Vanderbilt Creek watersheds.

The Lemon Creek watershed is delineated into seven sub-drainages, which are described in more detail in the following sections.

Concrete Way Sub-Drainage

The commercial – industrial sites located on Commercial Boulevard encompass a sub-drainage of approximately 18 acres in the JRM Subdivision. Stormwater in this subdrainage is primarily conveyed through a storm sewer system. The stormwater from this area is directed southwest and discharges into Lemon Creek at an outfall located in between lots JRM LT8B (5760 Concrete Way) and JRM LT 9A (5750 Concrete Way) on riprap embankment (Figure 2). This outfall coincides with the outfall labeled LCOUTF001 in the CBJ outfall data from 2008. According to this data, this outfall was a ditch that discharged to the creek at this location and a pipe outfall, LCOUTF002, was located upstream. During our mapping effort, JWP attempted to locate the LCOUTF002 outfall; however, LCOUTF002 appears to have been decommissioned.

Figure 2. Map of the Concrete Way sub-drainage, showing the mapped stormwater structures (orange dots) and the outfalls identified during CBJ's 2008 inventory (yellow dots). The subdrainage discharge point to Lemon Creek is shown in red.

There are some best management practices occurring in this sub-drainage. Catch basins are used in the storm sewer system, providing some treatment. Some of the industrial sites in this sub-drainage are not paved. The gravel and dirt surfaces, though compacted, do allow some stormwater to infiltrate into the ground rather than sheet flowing into the storm sewer system. In addition, roof drains seem to be routed to discharge directly into the storm sewer system rather than to the surface. This allows roof run-off to enter the system relatively clean. In addition, a vegetated buffer has been kept along the stream and a diversion berm is located along the top edge of the buffer to re-direct sheet flow and provide erosion control.

According to the CBJ staff report submitted to the Planning Commission for the JRM Subdivision preliminary plat application, oil/water separators were incorporated into the storm sewer system for the subdivision (Bishop, 2005). The oil/water separators were to be placed ahead of the stream outfalls. While JWP did not confirm this, it is a safe assumption that the permitting process for the subdivision ensured that this requirement was fulfilled. Whether or not the oil/water separators are being maintained appropriately is another matter, and JWP did not investigate this as part of the stormwater mapping effort.

Space Unlimited, Inc. Business Center Sub-Drainage

The Space Unlimited, Inc. Business Center Sub-drainage is relatively small, only approximately 1.5 acres. It encompasses the business center and a portion of Glacier Highway (Figure 3). Most of the parking lot drains toward a storm drain inlet located in the parking lot. A vegetated roadside ditch captures stormwater runoff from Glacier Highway and the rest of the business center's parking lot. The ditch flow is conveyed under the entrance driveway to the business center via a culvert where it combines with the stormwater from the parking lot storm drain into a series of vegetated ditches and culverts located on the northwest end of the business center. This provides some treatment of the stormwater prior to it discharging into Lemon Creek.

Figure 3. Map of the Space Unlimited and Lemon Creek Bridge sub-drainages, showing the mapped stormwater structures (orange dots). Outfalls to Lemon Creek are shown in red. Flow through the Space Unlimited subdrainage is shown by the arrows. The entire Lemon Creek Bridge subdrainage consists of overland flow to the outfalls on the bridge.

Lemon Creek Bridge Sub-Drainage

The Lemon Creek Bridge Sub-Drainage is quite small, only 0.2 acres. It consists of the Lemon Creek Bridge and an adjoining portion of Glacier Highway. Though a sub-drainage, for the purpose of this report, is defined as an area in which all the stormwater run-off is collected and transported to a single discharge point on the waterbody, this sub-drainage is an exception. Stormwater flows into three drain inlets located on the east side of the bridge that discharge directly to the creek below and another inlet on the corner of Davis Avenue and Glacier Highway that discharges to the vegetated hillside just upstream of the bridge (Figure 3).

Due to the placement of these inlets, the area draining into each of them is relatively small and it is difficult to delineate them. However, each of these inlets are receiving run-off sheet flowing from the road and bridge surface. Therefore, it made sense to put them into the same sub-drainage. Though the size of this subdrainage is relatively small, this area does receive high traffic, including heavy equipment from neighboring industrial areas. Since there is no buffer between the creek and the discharges, it is likely that this subdrainage contributes extremely low quality stormwater to Lemon Creek.

Pinewood Park Residential Sub-Drainage

The Pinewood Park Residential Sub-draining is so named as it encompasses the residential subdivisions of Pinewood Park 2 and Pinewood Park 3, which is boarded by Davis Avenue to the south, Central Avenue to the north and Churchill Way to the east. This sub-drainage is approximately 85 acres.

This residential area is designated for mid to high density residential use, and is currently zoned as D-5 and D-10 (five and ten units per acre, respectively). The stormwater conveyance system in this sub-drainage generally consists of vegetated ditches with cross-culverts that capture and transport run-off from yards and the smaller neighborhood roads. The vegetated ditch network works like a swale, allowing stormwater to slow and sediment to settle in the ditch rather than discharging directly into the storm sewer system. These ditches appear to work quite well, as stormwater was observed moving very slowly through the roadside ditch system. It appears that the water moves slowly southeast, where the ditch network connects to the storm sewer system at each street's intersection with Davis Avenue (Figure 4).

Figure 4. Map of the Pinewood Park Residential sub-drainage, showing the mapped stormwater structures (orange dots). Outfalls to Lemon Creek are shown in red. The outfalls identified during CBJ's 2008 inventory (yellow dots). The general flow through this subdrainage is shown by the arrows.

Davis Avenue, which is a main neighborhood access road from Glacier Highway, includes a storm sewer/curb and gutter system, which quickly conveys stormwater from the roadway. Another feature along Davis Avenue is a shallow, vegetated swale located between the sidewalk and residences on the north side of the street. The swale intercepts run-off from the yards and sidewalk. Drain inlets are located along the bottom of the swale to convey stormwater from the swale into the storm sewer system located along Davis Avenue. This whole system discharges into Lemon Creek at an outfall located across from Montgomery Street upstream from the Lemon Creek bridge on Glacier Highway. This outfall discharges to riprap velocity dissipater (or rock apron) before entering the creek, preventing erosion at the site of the discharge. This outfall coincides with LCOUTF003 in the CBJ outfall data (Figure 5).

Figure 5. Close up of Pinewood Park Residential sub-drainage along Davis Avenue showing the outfalls to Lemon Creek in red and the outfalls identified during CBJ's 2008 inventory (yellow dots).

In addition to the curb and gutter, a shallow vegetated swale is located between the road and the multi-use path that parallels Lemon Creek. This trailside swale captures some run-off from Davis Avenue, though most of the road drains to the storm sewer system. This swale also captures some of the run-off from the multi-use path. The swale appears to hold the water until it either infiltrates or evaporates. As-built surveys, obtained from the City and Borough of Juneau, indicate that two storm drain inlets are located in this swale. One of these drains is shown in the plans to convey the captured stormwater to an outfall located across from the Davis Avenue – Pine Street intersection, which corresponds with the CBJ outfall LCOUTF004 (Figure 5). The other drain inlet is shown to connect with the storm sewer system that discharges from the outlet across from Montgomery Street, or LCOUTF003.

JWP was unable to locate these drain inlets, but was able to locate both outfalls. The outfall located across from the Davis Avenue – Pine Street intersection, or LCOUTF004 in the CBJ data, after two days of rain. No water was discharging from the outfall. Very little water was observed in the swale at this time. This suggests the inlet is either buried or overgrown with vegetation to the point that the water present cannot enter the drain, or perhaps the inlet is no longer there. The CBJ outfall data outfall indicates that LCOUTF004 was discharging water when observed by CBJ staff in 2008, so it was at least operational then. Since the storm sewer system drains to the outlet across from Montgomery Street (or LCOUTF003), water was observed discharging from this outfall, but this is not an indication whether stormwater is entering an inlet in the trailside swale. It is recommended to revisit this area in the fall or early winter, after the vegetation has died down, to see if the inlets can be located to get a better picture of how the stormwater is being conveyed in this area.

There are also two outfalls on the eastern end of Davis Avenue, coinciding with LCOUTF005 and LCOUTF009, but no stormwater was observed discharging from these outfalls (Figure 5). It is unclear if the residential areas to the north of these outfalls contribute stormwater to the storm sewer system that discharges across from Montgomery Street or if this area discharges at these outfall locations. Construction was occurring during field work, and improvements were being made to the storm sewer system in the area. This may have affected the observations. It is recommended to revisit this area to get a better picture of how the stormwater is being conveyed.

Aisek Street Sub-drainage

The Aisek Street Sub-drainage encompasses approximately 96 acres of commercial and industrial development. The contributing area includes Anka Street, Commercial Boulevard, as well as adjoining lots. The stormwater in this sub-drainage is conveyed through a storm sewer system, which discharges to Lemon Creek from an outfall on the streambank to the northwest of Aisek Street, at the edge of the Skookum Sales and Recycling lot. This outfall coincides with the outfall LCOUTF013 in the CBJ outfall data from 2008 (Figure 6).

A large portion of the Home Depot parking lot included in this subdrainage.

Figure 6. Map of the Aisek sub-drainage, showing the mapped stormwater structures (orange dots). The outfall LCOUTF013 identified during CBJ's 2008 inventory (yellow dot) is the discharge point for this subdrainage. The general flow through the storm sewer system is indicated by the arrows.

There are two storm drain inlets located on the south lot of Home Depot adjacent to the Commercial Boulevard cul-de-sac that collect stormwater from a small area of the parking lot. These drains connect to the storm sewer system at Commercial Boulevard. Debris and pallets were observed around these inlets and it is likely that smaller pieces could be entering the storm sewer system at these locations.

Stormwater from the main Home Depot parking lot flows toward five storm drains located along the west end of the lot. These drains convey stormwater south where it discharges into a vegetated swale located along the border between the Home Depot and Costco lots. This vegetated swale also treats stormwater run-off coming from a narrow strip on east-side of the Costco lot. The stormwater from this swale is conveyed into the storm sewer system at Commercial Boulevard (Figure 6).

The storm drain inlet at the southwest corner of the Costco parking lot receives stormwater from that section of the parking lot. This inlet also connects to the storm sewer system at Commercial Boulevard. The Commercial Boulevard storm sewer system collects stormwater from the roadway and from the adjoining properties. The stormwater is conveyed west towards Anka Street (Figure 6).

Costco – Home Depot Sub-Drainage

The Costco – Home Depot sub-drainage in the Lemon Creek watershed encompasses approximately 9 acres of commercial and industrial development, with Costco and Home Depot being the most notable developments in the sub-drainage. The northern half of the Costco lot and a small portion along the northern edge of the Home Depot lot is included in this subdrainage. Stormwater from this sub-drainage discharges to Lemon Creek from an outfall located on riprap embankment across from the Anka Street – Ralph's Way Intersection, which corresponds to the outfall LCOUT007 from the 2008 CBJ Inventory (Figure 7).

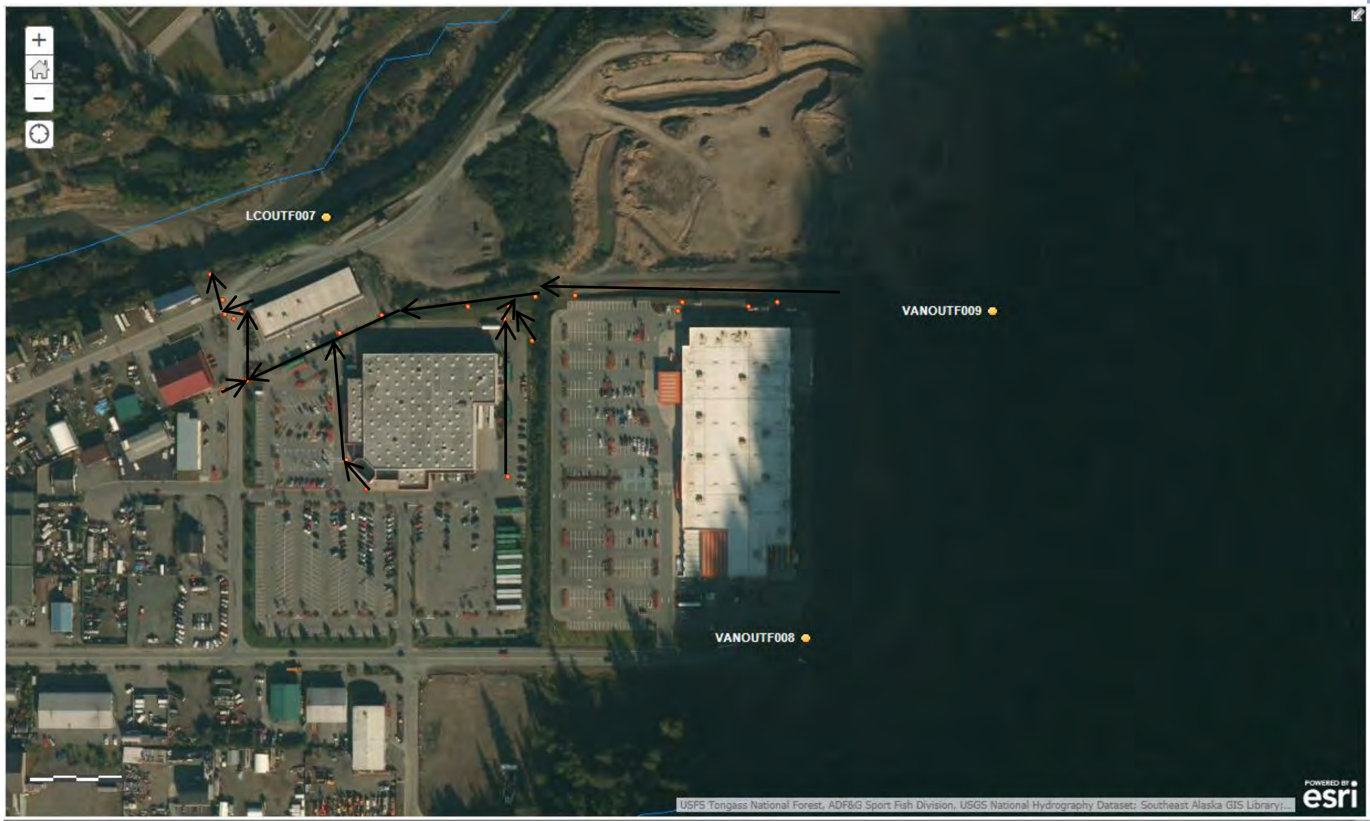

Figure 7. Map of the Costco-Home Depot sub-drainage, showing the mapped stormwater structures (orange dots). The outfalls identified during CBJ's 2008 inventory (yellow dots). The general flow through the subdrainage is shown by the arrows.

A large swale constructed of vegetated, large rock is located on the north end of the lot between the Home Depot and CBJ gravel pit; this is primary stormwater conveyance in the subdrainage from the Home Depot lot. Two inlets in the northeast end of the Home Depot parking lot also convey stormwater into the swale and the CBJ gravel pit has at least one outfall into the swale. This swale is designed to handle a substantial amount of stormwater. The outlet to the swale has a grate to keep debris from leaving. This is beneficial as garbage and debris was observed in the swale, adjacent to parked cars in the Home Depot parking lot. This swale discharges to the vegetated ditch located on the north end of the Costco.

This ditch also receives stormwater from several storm sewer inlets in the Costco parking lot. One of these is the stormdrain inlet located near the service/delivery area is spray-painted with the slogan “Do Not Dump, Drains to Stream.” The stormwater in this ditch re-enters the storm sewer system at the corner of the O’Reilly Auto Parts parking lot.

The stormdrain located at the northwest corner of the Costco parking lot is interestingly placed just outside the parking lot curbs, which have an opening to direct stormwater into this drain. However, the stormwater is routed over small gravel that could be transported into the stormwater. Because of its location outside of the parking area, there is some potential to provide a grassy area around the inlet to help treat the stormwater. Stormwater from the Play It Again Sports parking lot enters a ditch and is conveyed across Ralph’s Way to connect with the storm sewer system at this Costco inlet. The stormwater is then routed north along Ralph’s Way where the stormwater discharges to Lemon Creek (Figure 7).

VANDERBILT CREEK

The Vanderbilt Creek is located on the eastern side of the Lemon Creek Valley. The creek’s mainstem is approximately one mile long. The headwaters of Vanderbilt Creek flow from Blackerby Ridge through steep, forested uplands before entering a nearly level course passing through urban areas, wetlands and braided channels. Vanderbilt Creek enters Gastineau Channel at the intersection of Egan Drive and Vanderbilt Hill Road.

Vanderbilt Creek is listed by the Department of Environmental Conservation (DEC) as impaired due to high turbidity and sediment attributable to urban run-off and habitat modification, and has been listed as impaired since 1990. Vanderbilt Creek’s impairment is the result of its history of stream channel and flow patterns alterations.

Since the 1950s, Vanderbilt Creek and its tributaries have been redirected, relocated or filled in to allow for development. For example, Vanderbilt Creek’s main channel once flowed through the area where Capitol Landfill (formerly known as Channel Landfill) and Western Auto are now located (Adamus et al. 1987). Vanderbilt Creek also once connected with the marsh adjacent to the Pioneers Home, but was redirected to its current channel during the construction of Egan Highway in 1973 (Armstrong et al. 2004).

However some of modifications were made with the intent to protect the creek. When the headwaters of Vanderbilt Creek were being impacted by runoff from the Kaiser/CBJ gravel pits, runoff was diverted through a ditch along Jenkins Street, allowing it to by-pass the most productive section of the stream (Adamus et al 1987). Later, when the area changed to commercial and industrial use, the runoff was re-routed into Lemon Creek (ADEC 1995). A section downstream of Glacier Highway was re-established in the 1970s after being impacted by commercial development (Adamus et al1987).

These alterations, particularly in the lower watershed, have connected the stream channel directly to stormwater conveyance ditches with little to no treatment of the stormwater before it enters Vanderbilt Creek. The creek essentially becomes part of the stormwater treatment system.

The mapping effort in the Vanderbilt Creek watershed focused primarily on the heavily developed commercial/industrial areas attributing to Vanderbilt Creek's impairment. The low density residential areas to the east of Glacier Highway are not likely attributing sediment laden storwater, as stormwater from this area is probably treated by the wetlands and other vegetation prior to entering the creek as it sheet flows into the wetland areas. The Vanderbilt Creek watershed is delineated into four sub-drainages, which are described in more detail in the following sections.

Shaune Drive Sub-drainage

The Shaune Drive sub-drainage consists of run-off from the vegetated hillside/Lemon Creek Trail as well as an undeveloped commercial/industrial lot. Stormwater in this subdrainage is conveyed through a combination of storm sewer system and a network of drainage ditches. Stormwater from this sub-drainage discharges from an outfall at the Charles Way – Shaune Drive cul-de-sac to wetlands that drain into the upper reaches of Vanderbilt Creek. The area of this subdrainage is difficult to measure because the drainage area consists largely of undeveloped areas.

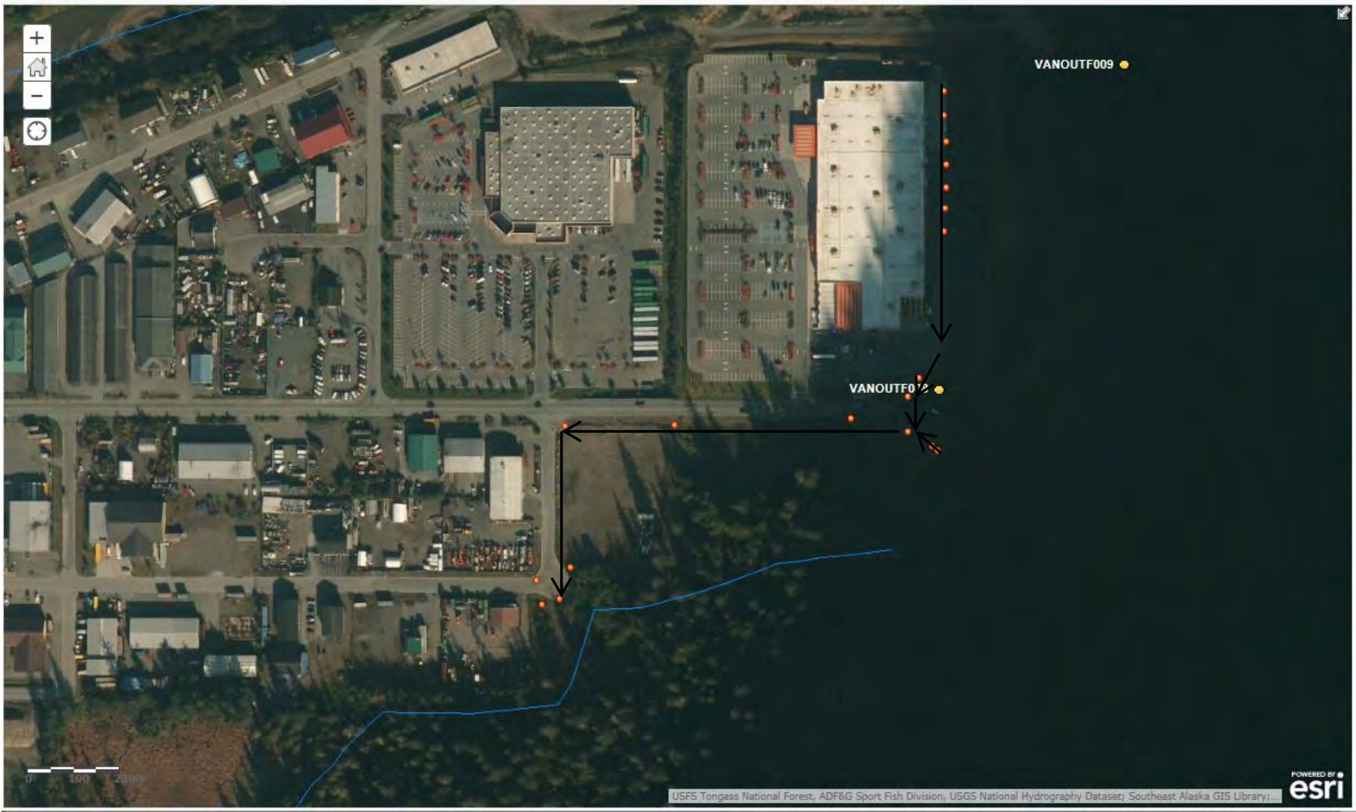

Figure 8. Map of Shaune Drive sub-drainage, showing the mapped stormwater structures (orange dots). The outfalls identified during CBJ's 2008 inventory are indicated by yellow dots.

The drainage from the hillside/trail bench behind Home Depot is routed around the impermeable surfaces of Commercial Boulevard through separate drainage ditches and structures from those that convey stormwater from the roadways and parking lot (Figure 8). The backside of the Home Depot lot drains into a swale that parallel's the paved edge of the lot. The swale is constructed of large rock and is vegetated. Seven roof drains, which connect to underground piping, also discharge to this swale via culvert outlets. The swale outlet is located adjacent to the Commercial Boulevard cul-de-sac. Here stormwater is conveyed into the storm sewer system along Commercial Boulevard, Charles Way and Shaune Drive (Figure 8). The intention was to supply additional water to the creek, which has been historically cut off from its headwaters, but to route the stormwater in a manner that it discharges into Vanderbilt Creek in a "clean" state. Since this water is draining from a vegetated area rather than impermeable surfaces, the quality of this water is going to be higher than that from the paved surfaces.

Glacier Highway – Tonsgard Court Sub-Drainage

The Glacier Highway – Tonsgard Court sub-drainage contains 5 acres of commercial/industrial development. The stormwater in this sub-drainage is transported through a combination of storm sewer system and roadside ditches along Glacier Highway, Tonsgard Court and private property (Figure 9).

Figure 9. Map of Glacier Highway – Tonsgard Court sub-drainage, showing the mapped stormwater structures (orange dots). The observed flow through the storm sewer system in this subdrainage is indicated by the black arrows. The green arrow shows the hypothesized flow through the swale that borders the landfill, which is based on the landfill's plan sets.

A storm drain inlet located in a grassy swale on the north side of Glacier Highway, as well as a nearby storm drain inlet in the roadway, transport stormwater under Glacier Highway to the storm sewer system under Tonsgard Court. The storm drain inlet in the swale on Glacier Highway does not seem to provide much treatment of the water prior to it entering the storm sewer system. The stormwater flowing into this drain is coming from a building lot that seems to be serving commercial/industrial uses, as a storage area for equipment.

Storm drain inlets located along Tonsgard Court in the roadway collect run-off from the road and adjoining lots. There is a storm drain inlet in a swale near the Glacier Highway – Tonsgard Court intersection collecting storm water from the gas station into the storm sewer system. The grassy area is not very large and does not provide for much treatment of stormwater prior to it entering the storm sewer system. Another inlet is located in a swale on the opposite side of the gas station. This inlet collects stormwater from the gas station and the adjacent commercial/ industrial lot. Again, this swale does not appear to provide much treatment. The fact that some of the commercial/industrial sites in this sub-drainage are not paved may allow for some infiltration of stormwater, reducing the amount of pollutants being transported. Stormwater in the Tonsgard Court storm sewer system flows toward Capitol Landfill and discharges into a system of vegetated ditches, which may provide additional treatment of the stormwater from this commercial/industrial area.

Unfortunately, stormwater flows through sections of this vegetated ditch system could not be mapped in the field as it occurs on private property that is inaccessible. According to as-builts provided by the City and Borough of Juneau, the Tonsgard Court stormwater discharges into a swale that continues along the property line between the Alaska Electric Light and Power (AEL&P) property and Capitol Landfill, which are fenced off. Therefore, some assumptions about how the stormwater flows through this swale by using the as-built, a plan set from the landfill's operations manual and aerial photography (Figure 9). It seems that this subdrainage eventually discharges to the dredge ponds located in the lower Vanderbilt Creek watershed, or possibly makes its way into the west ditch along Glacier Highway, which is connected to the mainstem of Vanderbilt Creek. The actual stormwater flow through this area should be confirmed at a later date, by seeking the cooperation of the land-owners.

West Ditch Sub-Drainage

The west ditch sub-drainage consists of approximately 60 acres of commercial/industrial development that eventually flows into the west ditch along Glacier Highway and discharges into Vanderbilt Creek. The west ditch receives water from Shaune Drive, Jenkins Drive, Glacier Highway as well as the areas immediately adjacent to the ditch.

Stormwater from Shaune Drive is routed down Borrow Street and then into the ditch along Jenkins Drive. The stormwater is then routed through a ditch to the east of the Wells Fargo. This is may be a pinch point for the amount of stormwater being transported through this sub-drainage. The stormwater is then routed under Glacier Highway to the west ditch.

The west ditch along Glacier Highway begins at the intersection with Anka Street and parallels the road to Grant Plaza/Western Auto. The ditch is steeply sloped and relatively deep, and ranges from sparsely vegetated to well vegetated in areas. The ditch is designed to convey high flows of stormwater during storm events, but is not armored enough to prevent erosion of the ditch. Therefore, the ditch itself contributes sediment to the stormwater.

The ditch flow from this area eventually discharges directly into Vanderbilt Creek where a culvert routes Vanderbilt Creek under Glacier Highway and into the west ditch. From this point, the creek essentially becomes a part of the stormwater treatment system. Grant's Plaza contains six storm drain inlets that convey stormwater from the parking lot into the stream channel, just downstream of where it is connected to the west ditch. The stormwater in the entire ditch-line was extremely turbid during the June 14, 2014 rain event. Sheen was observed in stormwater sheet flowing in Grant's Plaza.

It should be noted that the Alaska Department of Transportation and Public Facilities (DOT&PF) is planning to reconstruct Glacier Highway through this sub-drainage within the next year or so, which could alter the stormwater system from what is described here.

Figure 10. Map of the West Ditch and East Ditch sub-drainages, showing the mapped stormwater structures (orange dots) and the outfalls identified during CBJ's 2008 inventory (yellow dots). The general flow through the subdrainage is shown by the arrows.

East Ditch Sub-Drainage

The east ditch sub-drainage consists of commercial, industrial, and residential development that eventually flows into the east ditch along Glacier Highway and discharges into Vanderbilt Creek. The east ditch receives water directly from Glacier Highway as well as the areas immediately adjacent to the ditch.

The east ditch along Glacier Highway begins at the intersection with Anka Street and parallels the road on the east side to Grant Plaza/Western Auto. Like the west ditch, the east ditch is steeply sloped and relatively deep, and ranges from sparsely vegetated to well vegetated in areas. This ditch is also designed to convey high flows of stormwater during storm events, but is also experiencing erosion that is contributing sediment to the stormwater. The ditch flow from the east ditch eventually discharges directly into Vanderbilt Creek just upstream of where a culvert routes Vanderbilt Creek under Glacier Highway and into the west ditch.

It should be noted that the Alaska Department of Transportation and Public Facilities (DOT&PF) is planning to reconstruct Glacier Highway through this sub-drainage within the next year or so, which could alter the stormwater system from what is described here.

Figure 11. Map of the East Ditch sub-drainages, showing the mapped stormwater structures (orange dots) and the outfalls identified during CBJ’s 2008 inventory (yellow dots). The general flow through the subdrainage is shown by the arrows.

PEDERSON HILL CREEK

Pederson Hill Creek (also known in part as Casa Del Sol Creek) is located in the geographic area known as the Mendenhall Peninsula. Pederson Hill Creek is approximately two miles long, approximately half of which is tidally influenced estuarine channels. The creek originates on the north side of Glacier Highway from springs at the base of a bedrock outcrop and runs through forested wetlands, and a hemlock forested floodplain until its confluence estuarine channels and finally, with the Mendenhall River in the Mendenhall Wetlands State Game Refuge.

The Mendenhall Peninsula, together with the West Mendenhall Valley and Auke Bay, is home to approximately 11.5 percent of Juneau's population. Land use designations in the watershed include mid- to low density residential, commercial and industrial uses. Though much of the watershed is not currently developed, the channel and flow patterns of Pederson Hill Creek and its tributaries have been altered via culverts and the filling of wetland areas for the development that has occurred. Though the alterations and development in Pederson Hill Creek may seem minor compared to what has occurred in other local streams, it has had a significant impact on the creek.

Pederson Hill Creek was first included on the state's 303(d) list of impaired waterbodies in 1990 due to impairment from elevated levels of fecal coliform bacteria. Failing septic tanks were identified as the probable pollutant source (ADEC, 2008). However, this is no longer a concern in the watershed as the sewer utility is upgraded. Even though stormwater is not explicitly indicated as a source of the impairment, it is noted in the TMDL that roadside ditches and stormwater run-off from agricultural areas (horse stables/farms) are likely contributing fecal coliform bacteria.

Though Pederson Hill Creek is impaired due to fecal coliforms, it is not the only water quality concern resulting from stormwater. Alterations to Pederson Hill Creek's channel and natural flow patterns, particularly along Engineer's Cut-off, Glacier Highway and Sherwood Lane, connected the stream channel directly to stormwater conveyance ditches with little to no means to treat the stormwater before it enters Pederson Hill Creek. This essentially makes the creek part of the stormwater treatment system and alters the hydrology of the creek. As a result, sediment and iron flocculate could increasingly become water quality concerns as well.

Large sediment deposits were observed by USFWS and JWP in July 2011 in the Pederson Hill Creek reach between Sherwood Drive and Glacier Highway. The sediment present in Pederson Hill Creek is likely attributed to stormwater run-off, as the reaches upstream from this section are intricately connected to the roadside ditches used to convey stormwater from the road and developed areas. The flow in this reach is not enough to transport the additional sediment the creek is receiving from these sources.

In addition, iron flocculate is often present in roadside ditches and in the creek downstream from these sources. This is likely the result of the ditch being cut deep enough that iron-rich groundwater is seeping into the surface water flow.

Due to a large amount of private property in the Pederson Hill Creek watershed, the mapping effort kept to the public right-of-way along the road corridors. Mapping only included the developed areas in the upper to mid-watershed (see Figure 12), where stormwater is likely to contribute to water quality concerns. The Pederson Hill Creek watershed is delineated into four sub-drainages, which are described in more detail in the following sections.

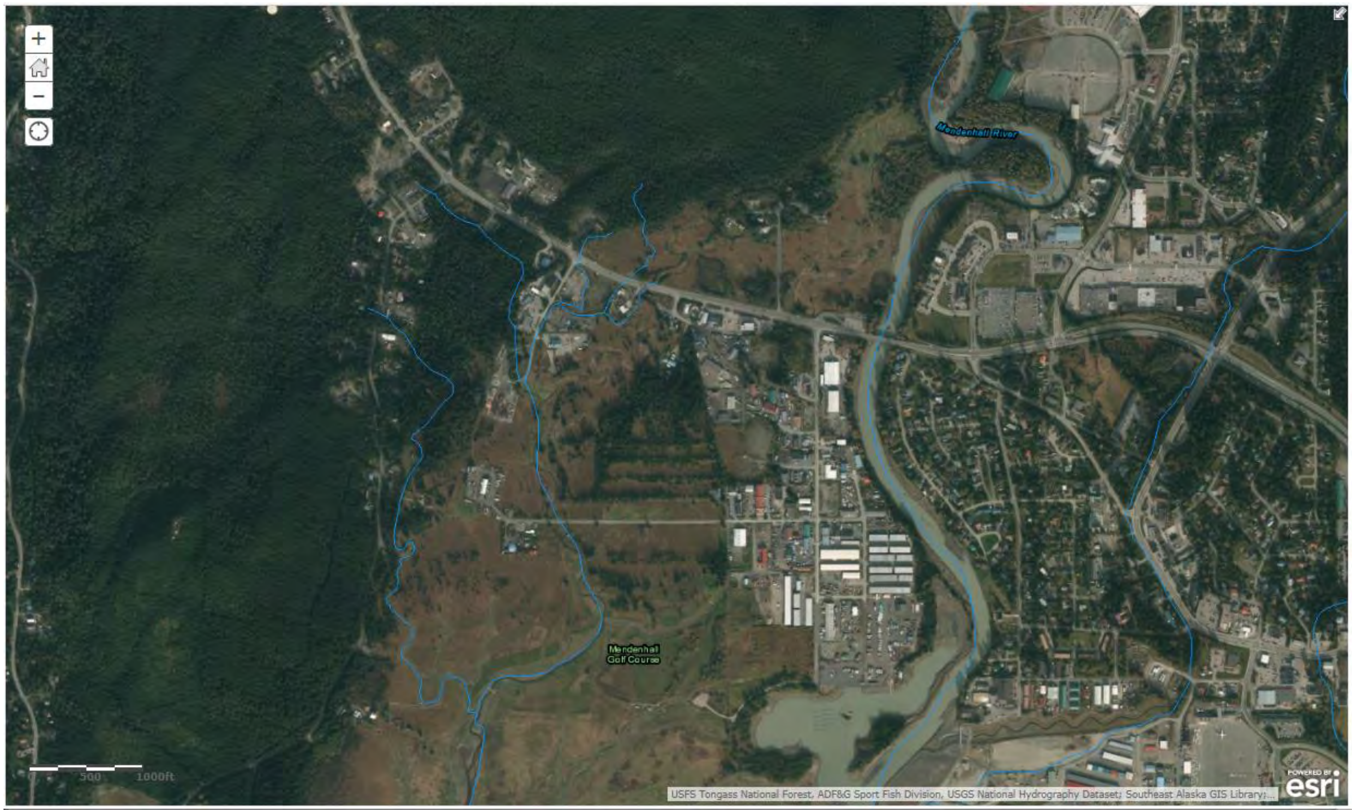

Figure 12. Map of the Pederson Hill Creek watershed.

Lower Engineer's Cut-Off – West Fork Sub-Drainage

The Lower Engineer's Cut-Off – West Fork sub-drainage contains approximately 14 acres of residential development. The land use designation for this sub-drainage is Urban Low Density Residential (ULDR). The stormwater in this sub-drainage is conveyed solely through vegetated roadside drainage ditches with cross-culverts to allow the stormwater to flow under driveways. The flow for this sub-drainage begins in near the bend in the road and heads south in the roadside ditches along Engineer's Cut-Off. The roadside ditches in this sub-drainage discharge into Pederson Hill Creek where the west fork of the creek is directed under Engineer's Cut-off in culverts. In these locations, the ditch flow directly enters the creek.

Figure 13. Map of the lower Engineer's Cut-off subdrainage, showing the mapped stormwater structures (orange dots). The general flow through the subdrainage is shown by the arrows.

The ditches along Engineer's Cut-off are steeply sloped, relatively deep, and vegetated. They are designed to convey substantial amount of stormwater, and they intercept run-off from both the road and adjacent yards. Iron flocculate is present in locations, indicating that groundwater flow is entering the system. It should be noted that the residential area along this length of Engineer's Cutoff still utilizes septic systems.

Upper Engineer's Cut-Off Sub-Drainage

The Upper Engineer's Cut-Off sub-drainage contains approximately 15 acres of residential development. The land use designation for this sub-drainage is a mix of Urban Low Density Residential (ULDR) and Medium Density Residential (MDR). The stormwater in this sub-drainage is conveyed solely through vegetated roadside drainage ditches with cross-culverts to allow the stormwater to flow under driveways.

The stormwater flow for this sub-drainage begins in near the bend in the road and heads northeast in the roadside ditches of Engineer's Cut-Off. It also includes stormwater flow from roadside ditches on the south side of Glacier Highway. The stormwater in the Glacier Highway ditches moves relatively slow and may not necessarily make it to Pederson Hill Creek before infiltrating into the ground. The roadside ditches in this sub-drainage discharge into Pederson Hill Creek where the creek is directed under Engineer's Cut-off in culverts. In these locations, the ditch flow directly enters the creek.

Figure 14. Map of the upper Engineer's Cut-off subdrainage, showing the mapped stormwater structures (orange dots).

Like the ditches along the lower Engineer's Cut-off – West Fork sub-drainage, the roadside ditches in this subdrainage are steeply sloped, relatively deep, and vegetated. They are designed to convey substantial amount of stormwater, as they intercept run-off from both the road and adjacent yards. Iron flocculate is present in locations, indicating that groundwater flow is entering the system. It should be noted that the residential area along this length of Engineer's Cutoff and Glacier Highway still utilize septic systems.

Upper Glacier Highway Sub-Drainage

In the Upper Glacier Highway sub-drainage the stormwater is conveyed through a series of roadside ditches from residential and road run-off. This subdrainage begins at the top of Glacier Highway in the north side ditch and flows southeast in the ditch until it discharges into a tributary of Pederson Hill Creek where the natural creek flow is conveyed under Glacier Highway in a culvert (Figure 15). The north side ditch collects stormwater run-off from the areas north of Glacier Highway as well as the road itself. The stormwater in the Glacier Highway ditches moves relatively slow and may not necessarily make it to Pederson Hill Creek before infiltrating into the ground.

Figure 15. Map of the Glacier Highway subdrainage in Pederson Hill Creek watershed, showing the mapped stormwater structures (orange dots). The general flow through the stormwater system is shown by the arrows.

The ditches along Glacier Highway are steeply sloped, relatively deep, and vegetated. They are designed to convey substantial amount of stormwater. Iron flocculate is present in locations, indicating that groundwater flows are entering the system.

Sherwood Lane Subdrainage

Sherwood Lane Sub-drainage is approximately 18 acres of commercial and industrial development. Stormwater is conveyed primarily through roadside ditches and swales, but the commercial parking lot next to the Department of Motor Vehicles (DMV) lot has a small storm sewer system that collects the run-off from the parking lot and discharges it to Pederson Hill Creek. At the site of this outfall, the creek itself discharges from a culvert that passed the creek under Sherwood Lane. At this location, the creek almost immediately re-enters another culvert that conveys it under the DMV parking lot.

Other than the grassy swales and roadside ditches that somewhat act as swales, not many Best Management Practices are utilized in this sub-drainage. Some of the lots are not paved, which may allow for some infiltration of stormwater. It appears that the lots on Sherwood Lane drain toward the road and into the ditch network. However, since many of the lots on the eastern side of Sherwood Lane are privately owned, they were not accessed to determine whether there were additional drainage structures or patterns.

Figure 16. Map of the Glacier Highway subdrainage in Pederson Hill Creek watershed, showing the mapped stormwater structures (orange dots). The outfall to Peterson Hill Creek is shown in red. The general flow through the stormwater system is shown by the arrows.

OTHER AREAS

JWP mapped areas adjacent to Pederson Hill Creek and Lemon Creek to determine if they were contributing stormwater to the watershed. However, after mapping these areas, it was determined that they did not contribute to the watersheds of concern.

Figure 17. Map of the Industrial Boulevard area. Stormwater mapping revealed that this area does not drain to the Pederson Hill Creek watershed; it appears that this area either slowly drains or flows toward the Mendenhall River. The mapped stormwater structures appear as orange dots.

Figure 18. Map of residential area near Switzer and Lemon Creeks. Stormwater mapping revealed that this area does not drain to the Lemon Creek watershed, but to the Switzer Creek watershed. The mapped stormwater structures appear as orange dots.

RECOMMENDATIONS FOR FURTHER STUDIES

After completing this project, the Juneau Watershed Partnership (JWP) makes the following recommendations for further studies:

- Map the impaired watersheds not included in this project
- Map the entire Juneau urban area
- Develop a plan and partnerships to regularly update maps
- Develop and implement a stormwater water quality monitoring plan on impaired watersheds
- Identify sites where permanent stormwater controls (BMPs) could be implemented
- Create watershed boundary maps reflecting the drainage area as altered by stormwater/artificial drainage structures

Each of these recommendations is discussed in more detail below.

Map the impaired watersheds not included in this project

The JWP previously proposed this project as a two-year project to map the stormwater flows and infrastructure for all five impaired watersheds in Juneau. However, we only received funding for one year and were able to map the stormwater flows and infrastructure for three of the five impaired watersheds. The JWP hopes to secure future funding to continue this mapping effort on the remaining un-mapped impaired watersheds. In Juneau's impaired watersheds, information regarding stormwater flows and infrastructure will help in identifying and implementing measures that would help improve the condition of these watersheds and, eventually, remove them from impaired status.

Map the entire Juneau urban area

The JWP also recommends that future stormwater mapping efforts include urban watersheds that are currently meeting State water quality standards, such as Montana Creek, Switzer Creek, and Gold Creek. This is a practical recommendation for several reasons. First of all, watershed boundaries in an urban setting are not always clear, and it is difficult to exclude areas of non-impaired watersheds when mapping adjacent impaired watersheds. Secondly, the JWP believes having a map of the stormwater flows and infrastructure is important information to have readily available for all our urban watersheds, not just for those that are impaired. In those urban watersheds that are currently meeting State water quality standards, stormwater flows should be mapped to assist planning efforts and permitting decisions during future development that could prevent these watersheds from becoming impaired. Finally, if the City and Borough of Juneau (CBJ) were to become regulated under the MS4 program, producing stormwater infrastructure maps of the urban area would be a requirement of the CBJ's MS4 permit, and the CBJ would only have a limited time to produce these maps among other planning tools and programs required of MS4 operators. Already having these maps in place would greatly benefit the City's MS4 permitting process, if and when it ever occurs.

Develop a plan and partnerships to regularly update maps

The JWP recognizes that, once created, there will be a need to regularly update the stormwater maps. For example, updates/clarifications are already needed in areas where the JWP could not confirm the direction of flow or discharge points, such as on private property on Tonsgard Court. In addition, as the JWP noticed this year, many areas in Juneau were under construction. The development and re-development of areas in the future will likely alter the stormwater infrastructure and drainage patterns in previously mapped watersheds. In order to ensure maps are regularly updated, JWP recommends identifying partners (e.g. the CBJ, and the Alaska DOT&PF) and funding sources to develop a collaborative plan and schedule for updating the stormwater maps to reflect current conditions. This recommendation is necessary because if the information becomes too outdated, it will no longer be useful in informing planning and permitting decisions.

Develop and implement a stormwater water quality monitoring plan on impaired watersheds

Since high turbidity due to stormwater discharges is the leading cause of impairment of Juneau's urban watersheds, a water quality monitoring program would help to provide important data that could inform planning and permitting decisions. For example, this data could identify locations of particularly high sediment inputs. Once identified, these locations can be assessed to determine the appropriate stormwater control, or best management practice (BMP), to reduce sediment inputs at each location. In addition, monitoring can be used to assess implemented BMPs to determine whether the control is improving water quality. This could be an important step toward reducing the sediment/turbidity levels on impaired watersheds and, therefore, assist in de-listing these waterbodies from the impaired waterbodies list.

Identify sites where permanent stormwater controls (BMPs) could be implemented

Once these maps are in place, or in conjunction with future mapping and/or monitoring efforts, the JWP recommends using any collected stormwater data to identify sites where permanent stormwater controls could be implemented to improve conditions on waterbodies or throughout the stormwater system. These maps in addition to stormwater water quality monitoring could help locate ideal sites to implement permanent BMPs or green infrastructure. The goal of implementing these measures would be primarily to reduce sediment inputs to improve conditions on impaired streams that they may meet State water quality standards and be removed from the impaired waterbodies list. On streams currently meeting State standards, the goal would be to ensure that water quality continues to meet standards.

Create watershed boundary maps reflecting the drainage area as altered by stormwater/artificial drainage structures

In an urban setting, watershed boundaries are not always clear and do not always correspond with the hydrologic unit code (HUC) watershed boundaries. Artificial drainage structures controlling stormwater flows can alter the boundaries by reducing or increasing the size of the area draining to a waterbody. This directly affects the hydrology of the watershed and can cause problems such as erosion, flooding, dewatering. Having more accurate boundaries will allow for more accurate calculation of total watershed area, total impervious area, etc. and other information that is important in making effective management decisions.

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ATTACHMENT A

As-Built Surveys