Restoration, Enhancement, and Mitigation Opportunities within Juneau Watersheds
Vol. I Literature Review

JUNEAU
WATERSHED PARTNERSHIP

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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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Contents

INTRODUCTION

Juneau, Alaska is located on the Southeast panhandle of Alaska, approximately 700 miles southeast of Anchorage and 950 miles north of Seattle. The community of Juneau is nestled between the Gastineau Channel and mountainous terrain. In Juneau, mining and urban development have had the greatest impacts to watershed health. Originally the territory of the Auk Tlingit Tribe, American settlement of Juneau began in 1880 after the discovery of placer gold deposits in the Gold Creek and Silverbow Basins. Active mining and settlements also occurred in the Lemon Creek Valley and in Douglas in the 1880s, and Douglas particularly thrived around the Treadwell Mine. Juneau's gold rush lasted until the 1940s, after which the town switched to other industries such as fishing, canneries, transportation and trading services and timber. Urban development accelerated throughout Juneau in the 1950s and 1960s. Gravel mining operations, including in-stream gravel mining, supported this growth.

With urban development came the loss of wetlands and riparian habitat, channel disturbance, degradation of water quality, and alteration of surface and ground water hydrology. Since the 1970s, considerable effort and funding have been directed toward improving aquatic and riparian habitats in Juneau. However, few projects were consistently monitored to evaluate whether projects were successful. In 2010, the JWP partnered with the U.S. Fish and Wildlife Service to inventory and assess past habitat restoration and enhancement projects implemented within the City and Borough of Juneau (CBJ) road system. We found that several restoration and enhancement project failures in Juneau are due to inadequate pre-project planning, including project selection, choice of methods, and lack of project monitoring. Many project failures appear to be the result of poor project choice and demonstrate a lack of understanding of hydrologic or biologic processes in design.

In 2012, the JWP received grant funding through the Coastal Impact Assistance Program (CIAP) to identify restoration, enhancement and mitigation opportunities in Juneau's road-accessible watersheds. The purpose of this project is to create a comprehensive catalogue of projects that will protect or improve local water quality, fish populations, fish passage, and aquatic and riparian habitats in road-accessible sites within Juneau watersheds that have the highest potential for restoration opportunities. By compiling this catalog of projects, we hope to avoid project failures by providing an appropriate selection of projects and suggested methods.

There were four components to this project:

- a literature review;
- field assessments of priority streams;

- a comprehensive list and interactive map of identified restoration, enhancement, and mitigation measures; and
- conceptual designs for priority projects

Each component is addressed in separate volumes of this document. This volume presents the Literature Review. Volume II provides the compilation of the field assessments. Volume III provides the comprehensive list of identified restoration, enhancement, and mitigation measures, and the conceptual designs for the priority projects.

Though all of Juneau's road-accessible watersheds are potentially vulnerable to impacts from future development, many of these watersheds are currently considered to be in relatively pristine condition, and particularly those located the furthest from populated areas. The watersheds within the CBJ Urban Service Area Boundary (USAB) are urbanized and susceptible to continuing development. These watersheds have the highest potential for restoration, enhancement and mitigation opportunities and would benefit most from such measures. For this reason, the JWP focused efforts on the watersheds within the USAB.

As a result of this project, the JWP was able to identify over 200 projects across 35 road-accessible watersheds, and create four conceptual designs for projects plus two standard best management practices (BMPs).

This is not intended to be a static document. The watershed priorities and recommendations outlined in this document are intended to change over time as projects are implemented, conditions in the watersheds change, and new information arises.

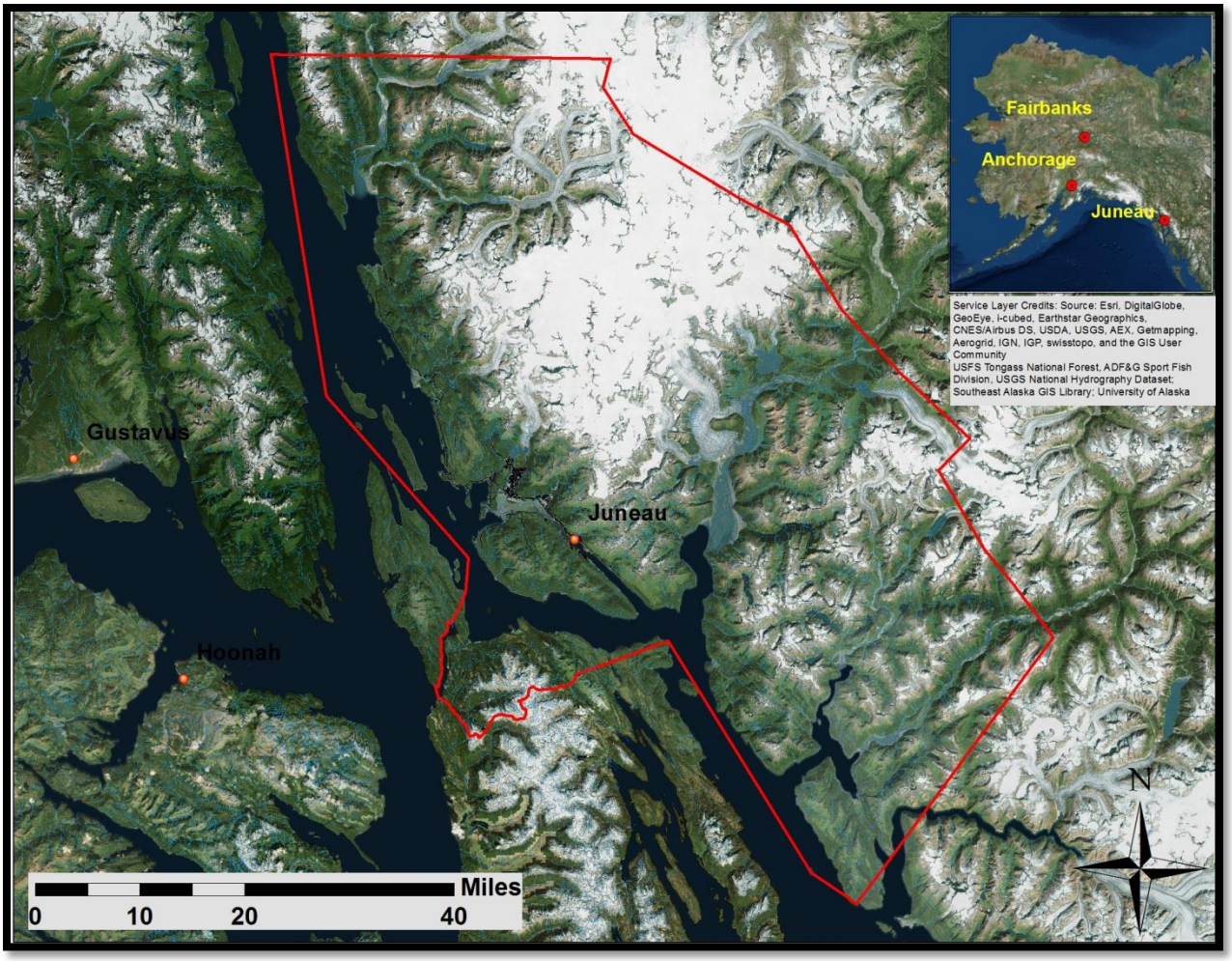

Figure 1. The City and Borough of Juneau boundary. The CBJ Borough Boundary layer provided courtesy of CBJ.

BACKGROUND

Juneau, Alaska is located on the Southeast panhandle of Alaska, approximately 700 miles southeast of Anchorage and 950 miles north of Seattle (Figure 1). The City and Borough of Juneau (CBJ) encompasses 3,248 square miles, about 90 percent of which consists of water or rugged mountains and glacial icefields located within the boundaries of the Tongass National Forest (Figure 2). In addition, the CBJ includes a number of islands. Given this, much of the CBJ is not accessible by Juneau's road system. The non-road accessible areas are considered "remote." The major road system includes Glacier Highway/Egan Drive, which extends 40 miles north from Downtown Juneau to the Mendenhall Valley and then out to Echo Cove; Thane Road, which extends 6 miles, which extends 13 miles north from the Douglas Bridge; and the Douglas Highway, which extends approximately 2 miles south from the Douglas Bridge (Figure 3).

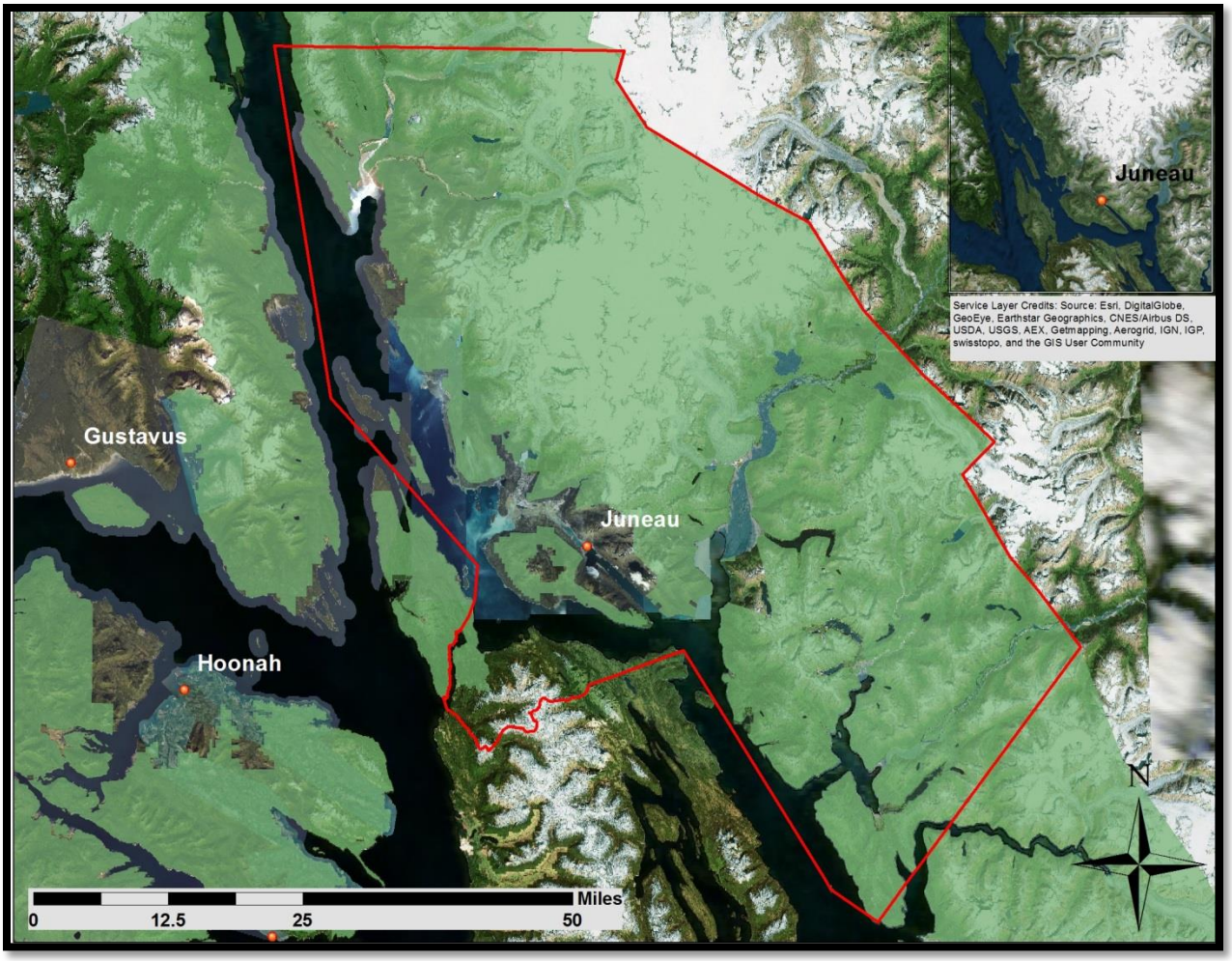

Figure 2. The extent the Tongass National Forest within the City and Borough of Juneau (CBJ). The CBJ Borough Boundary layer provided courtesy of CBJ.

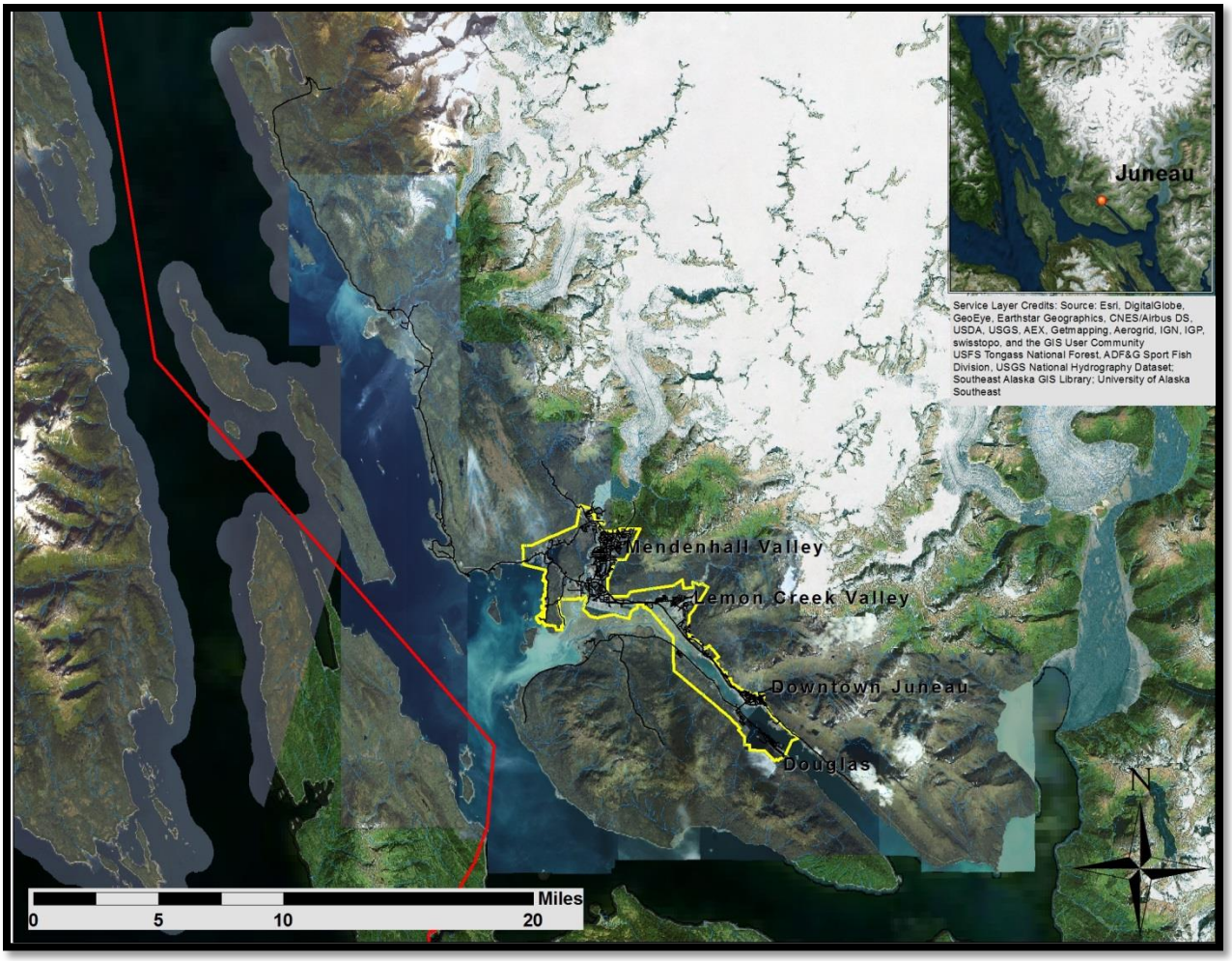

Figure 3. The extent of the Juneau road system in relation to the Urban Service Area Boundary (yellow) and the populated areas of Mendenhall Valley, Lemon Creek Valley, Downtown Juneau and Douglas. The CBJ Borough Boundary layer and Urban Service Area layer provided courtesy of CBJ.

Due to the landscape, the CBJ is characterized by numerous short, steep streams with relatively small watersheds. There are a few larger watersheds in valleys that have been carved by glaciers. In all, the CBJ encompasses approximately 85 12-digit Hydrologic Unit Codes (HUCs). HUCs are unique numerical identifiers assigned according to a hierarchal classification system used by the U.S. Geological Survey (USGS) to divide the country in hydrologic units, with the 12-digit HUC being the smallest unit. Each 12-digit HUC is considered a sub-watershed though the HUC boundaries may not correspond with the classic watershed boundaries used to discuss Juneau's watersheds because of their small size. Only 11 of CBJ's 12 digit HUCs are accessible by the Juneau road system (Figure 4). Table 1 provides a list of each road-accessible 12-digit HUC and the corresponding waterbodies that are discussed in this document.

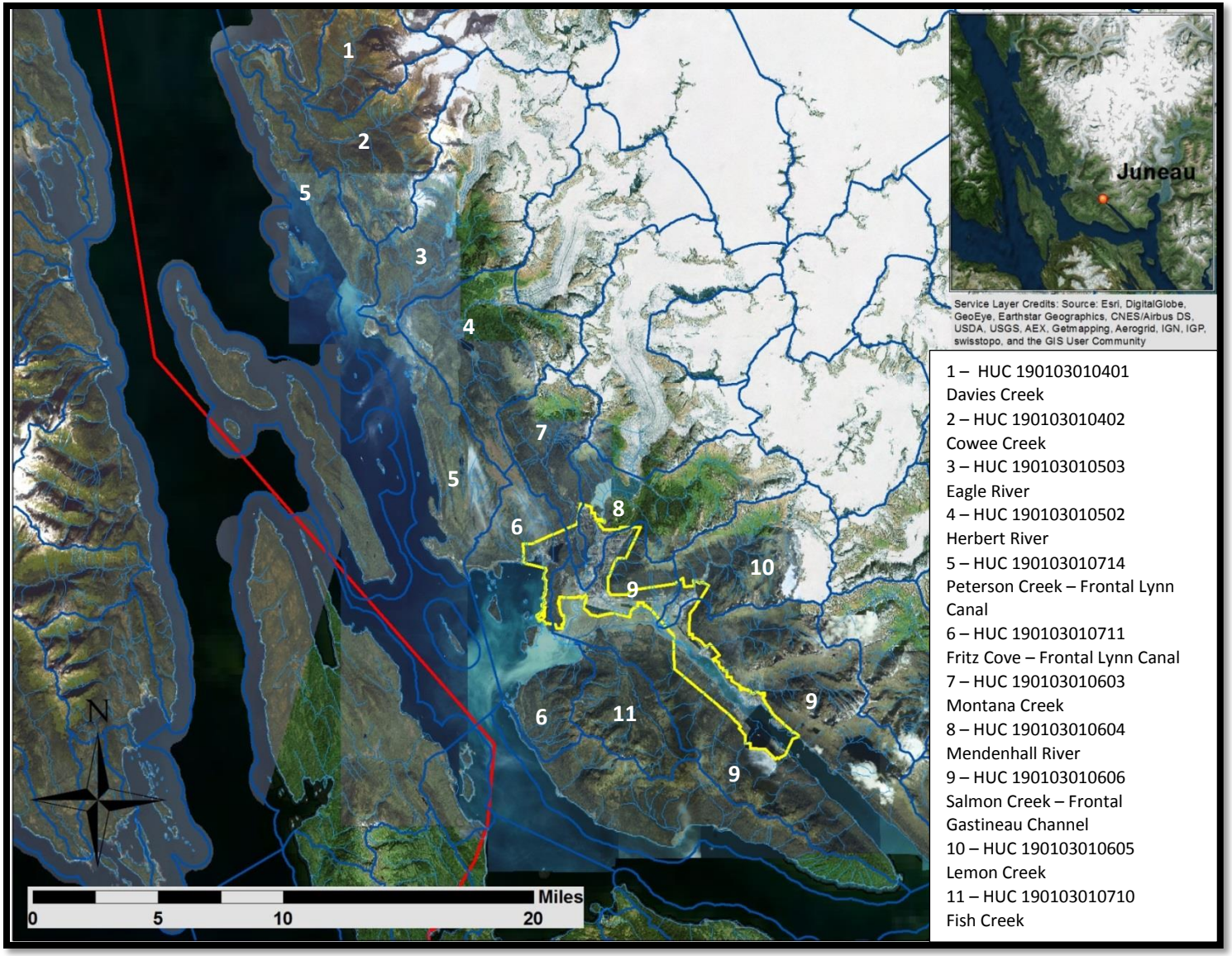

Figure 4. The 12 Digit Hydrologic Unit Codes accessible by the Juneau Road System in relation to the Urban Service Boundary.

Table 1. The road-accessible Juneau watersheds by 12-digit HUC shown on Figure 4. The watersheds within the Urban Service Area Boundary are noted with an asterisk (*).

# on Index Map	HUC-12	HUC Name	Included Waterbodies
1	HUC 190103010401	Davies Creek	Davies Creek
2	HUC 190103010402	Cowee Creek	Cowee Creek South Fork Creek (Cowee Creek Tributary) Canyon Creek (Cowee Creek Tributary)
3	HUC 190103010503	Eagle River	Eagle River Boulder Creek (Eagle River Tributary)
4	HUC 190103010502	Herbert River	Herbert River Windfall Creek (Herbert River Tributary) Strawberry Creek (Herbert River Tributary)
5	HUC 190103010714	Peterson Creek – Frontal Lynn Canal	Bridget Cove Creek Bessie Creek Peterson Creek Shrine Creek North Tee Creek
6	HUC 190103010711	Fritz Cove – Frontal Lynn Canal	Auke Nu Creek* Waydelich Creek* Bay Creek* Lake Creek* (Auke Lake Tributary) Lake Two Creek* (Auke Lake Tributary) UAJ Creek*(Auke Lake Tributary) Auke Lake* Auke Creek*(Auke Lake Outlet) Peterson (Outer Point) Creek Elevenmile Creek Cove Creek
7	HUC 190103010603	Montana Creek	Montana Creek*(Mendenhall River Tributary) McGinnis Creek (Montana Creek Tributary)
8	HUC 190103010604	Mendenhall River	Mendenhall River*

# on Index Map	HUC-12	HUC Name	Included Waterbodies
9	HUC 190103010606	Salmon Creek – Frontal Gastineau Channel	Duck Creek* (Mendenhall River Tributary) Jordan Creek* West Creek* East Creek* Switzer Creek* Salmon Creek* Gold Creek* Snowslide Creek* Cross Bay Creek Sheep Creek Paris Creek Lawson Creek* Kowee Creek* Grant Creek* Eagle Creek* Falls Creek* Neilson Creek* Hendrickson Creek Johnson Creek Ninemile Creek
10	HUC 190103010605	Lemon Creek	Lemon Creek*
11	HUC 190103010710	Fish Creek	Fish Creek

Detailed assessments to identify restoration, enhancement and mitigation opportunities on all of these watersheds are not feasible or practicable, or even necessary. The development and infrastructure of the community follows the developable land along the coastline, but is primarily concentrated in the relatively flat areas in the Mendenhall Valley, Lemon Creek Valley, and Downtown Juneau (Figure 3). The road accessible watersheds outside of Juneau's populated areas are generally considered to be in relatively pristine condition. These watersheds primarily encompass Tongass National Forest lands, with some private lands along the road corridors. Most of these watersheds are only impacted by a single road crossing with limited, mostly rural residential development on the privately owned lands adjacent to road corridors. It is anticipated that there is little current need for restoration, enhancement or mitigation on these watersheds.

For this reason, the JWP focused efforts on the watersheds within the City and Borough of Juneau (CBJ) Urban Service Area Boundary (USAB) (Figure 3). The USAB is formally designated in the city's Comprehensive Plan, and provides a logical boundary for excluding the relatively pristine watersheds that are unlikely to need restoration, enhancement or mitigation. The USAB is a 23.9 square mile area that encompasses the urban and suburban areas where most of Juneau's development has occurred and where community growth is planned to occur in the future. The USAB is officially defined as the area where water, sewer, access roads and other community services are provided or will be provided in the near future to encourage development. The intent of the USAB is to concentrate community development within this area to maintain the existing community character.

PURPOSE AND METHODS

Literature Review

The intent of this literature review is to:

- Determine the current conditions of road accessible watersheds;
- Identify any past recommendations for restoration, enhancement and mitigation measures;
- Prioritize field review of watersheds based on current status and past recommendations; and
- Prioritize watersheds in terms of restoration needs

Since the scope of the project is limited to the road-accessible watersheds, Juneau's remote watersheds are precluded from this effort. A list of the remote watersheds is included in Appendix A. Road accessible watersheds are listed in Table 1. Road accessible watersheds

within the USAB have the highest potential for restoration, enhancement and mitigation opportunities. Therefore, the JWP focused the literature review on these watersheds.

While road accessible watersheds outside the USAB will not be the focus of this project, a brief literature review is provided for these watersheds as a group to offer support for the JWP's use of the USAB as a boundary for excluding these watersheds from a more detailed assessment. A detailed literature review is provided for each of the road accessible watersheds within the USAB in order to prioritize these watersheds in based on the need for restoration, enhancement and mitigation.

The lowest priority was given to relatively pristine watersheds that require little to no restoration, enhancement or mitigation at this time. That is not to say that these relatively pristine watersheds are not valued; a low priority ranking simply means that these watersheds have been minimally impacted by human activities. The highest priority was given to watersheds that require extensive restoration, enhancement or mitigation to offset negative impacts in order to improve current conditions on the waterbody.

In addition, for each road accessible watersheds within the USAB, the need for a field assessment to further identify addition restoration, enhancement and mitigation measures is determined based on the information available in the literature review. For watersheds

A summary of the findings for each road-accessible watershed within the USAB is provided.

Literature Review Sources and Assumptions

Several documents and data sets were integral to this literature review, and provided the basis for assumptions regarding the current conditions of Juneau's watersheds. These are:

- 2013 *Comprehensive Plan of the City and Borough of Juneau*
- 2012 *Integrated Water Quality Monitoring and Assessment Report*
- *Juneau Fish Habitat Assessment (Revised)*
- *SEAKHydro ChannelType Map Server* and the *Channel Type User Guide*

The 2013 update of the *Comprehensive Plan of the City and Borough of Juneau* provides the current policy for managing community growth and development within the CBJ boundaries over its 20 year planning period. The Urban Service Area Boundary (USAB) is formally designated in the 2013 *Comprehensive Plan*, and is defined as "an area within the municipality that represents a legal, orderly expansion of urban development patterns where municipal services, particularly water and sewer service, is provided." The JWP decided to focus efforts within the Urban Service Area Boundary (USAB) due to the CBJ's policy to promote continued urban development within the USAB. For watersheds outside the USAB but on the Juneau road system, the JWP also looked at New Growth Areas designated in the 2013 Comprehensive Plan.

New Growth Areas are defined as "sites in rural and remote areas quite distant from the Urban Service Area and potentially suitable for urban/suburban development as a self-contained community." According to the 2013 *Comprehensive Plan*, communities within New Growth Areas will be "characterized by compact development of urban densities and a full complement of services and facilities, including water and sewer, recreational, educational, and neighborhood commercial services…Non-residential primary uses such as dock and port facilities or resource-related industrial development may also be appropriate." Designation of New Growth Areas within a watershed indicates it is vulnerable to future development that could affect the relatively pristine character of the watershed.

The Department of Environmental Conservation (DEC) is responsible for determining whether all the State's waters are meeting water quality standards, as mandated by the Clean Water Act (CWA). The 2012 *Integrated Water Quality Monitoring and Assessment Report* (or simply, the 2012 *Integrated Report*) has DEC's most current assessment of the State's waters. This document was used in assessing the water quality status of Juneau's watersheds. In the 2012 Integrated Report, waterbodies are placed in one of five categories (see Table below). According to DEC, most (99.9%) of Alaska's Waters are in Category 1, meeting State Water Quality Standards. However, due to the large number of waterbodies in Alaska (714,000 miles of streams and rivers, 3 million lakes, and 174,600,000 acres of wetlands), Category 1 waterbodies are not specifically listed in the Integrated Report like the waterbodies placed in the other categories. DEC updates this report and waterbody categorization every two years; the 2014 Integrated Report is not yet available online. Therefore, JWP assumes that if a waterbody is not specifically listed as a Category 2, 3, 4, or 5 in the 2012 Integrated Report, it is a Category 1 waterbody that is meeting State water quality standards unless there is other information from the literature review that suggests this is not an appropriate assumption.

Category #	**Water Quality Status**
1	Meets Water Quality Standards
2	Waters attaining some Water Quality Standards but with insufficient or no data to determine whether other Water Quality Standards are met
3	Waters with insufficient or no data to determine whether Water Quality Standards are met
4a	Impaired Waters with Completed TMDLs
4b	Impaired Waters not needing a TMDL
5	Section 303(d) Impaired Waterbodies

The revised *Juneau Fish Habitat Assessment* (Bethers et al, 2012) is a comprehensive habitat assessment for 64 of Juneau's road-accessible waterbodies was produced for the Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. For each waterbody, the *Juneau Fish Habitat Assessment* lists the fish species supported by each waterbody, the habitat type and quality for both anadromous and resident fish, land

ownership, present and future land use impacts, and provides recommendations to improve fish habitat. In addition, the report provides basic information regarding each water body. For streams, this includes length and gradient. For lakes this includes surface area and depths. Although this document was produced a few years ago, conditions regarding fish habitat are assumed to be relatively the same, unless other documentation supports otherwise.

The *SEAKHydro ChannelType Map Server*, hosted by the Southeast Alaska GIS Library at the University of Alaska Southeast, is a dataset that provides channel type and stream class classifications. This data is collaboratively maintained by the U.S. Forest Service (USFS), Tongass National Forest and the Alaska Department of Fish and Game (ADF&G). This data layer works in conjunction with the USFS Region 10 *Channel Type User Guide*. The Channel Type Classification System categorizes a watershed's stream network into basic fluvial process groups and specific channel type units within each process group. Together, these classifications help understand interrelationship between the landscape, erosion and depositional processes, channel morphology, and fish and riparian habitat. The JWP relied on the current data layer and *Channel Type User Guide* to discuss hydrologic processes occurring within Juneau watersheds. While site specific information should always be gathered for designing projects, this is the first step in considering hydrologic processes when making decisions about potential restoration, enhancement and mitigation projects.

LITERATURE REVIEW FOR WATERSHEDS OUTSIDE THE USAB

The road accessible watersheds outside of the USAB are listed in Table 1. The following presents the literature review for these watersheds as a group, since they are considered to be in relatively pristine condition and there is little information on these individual watersheds.

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report. http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Alaska Dept. of Fish and Game. Fish Resource Monitor Interactive Map.

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

Condition

The road-accessible watersheds outside the USAB are generally located on the fringes of Juneau, away from the heavily populated areas. However, there are a few waterbodies outside the USAB that are closer to the heavily populated areas. These are the waterbodies that contribute to the upper watershed of the Mendenhall River, such as the Mendenhall Lake, Nugget Creek and Steep Creek.

Most of these streams support both anadromous and resident fish. Depending on the system, this may include coho, pink and chum salmon, Dolly Varden, cutthroat trout, rainbow trout and steelhead. All of the road-accessible watersheds outside of the USAB are assumed to meet Water Quality Standards, as none of these waterbodies are listed in the 2012 *Integrated Report* as a Category 2, 3, 4a, 4b, or 5.

Most road-accessible waterbodies outside the USAB have upper watersheds primarily within the bounds of the Tongass National Forest, which is managed by U.S. Forest Service. State, City and private lands within these watersheds are primarily located in the lower watershed adjacent to the road system. The exceptions to this ownership pattern are: Cross Bay Creek and Sheep Creek, accessible from Thane Road; Ninemile, Johnson and Hendrickson Creeks accessible from North Douglas Highway; and Shrine Creek accessible from Glacier Highway. These watersheds are located all within the City boundaries.

The road-accessible watersheds outside the USAB have not been extensively developed. Development may include recreational facilities (e.g. trail system, cabins, campsites, other park facilities) and rural residential development. Much of the development has been confined along the road system. Notable rural residential areas are located at Lena Point and Tee Harbor accessible from Glacier Highway, and False Outer Point accessible from North Douglas Highway.

The road crossings on these watersheds appear to be the sole source of detrimental impacts (see Past Recommendations). Of the road-accessible watersheds outside the USAB, there are a few to note as either particularly vulnerable to development. These include Cowee and Davies Creeks, Eagle and Herbert Rivers, and Peterson Creek (Douglas), and Fish Creek. These watersheds will be discussed separately.

Cowee and Davies Creeks

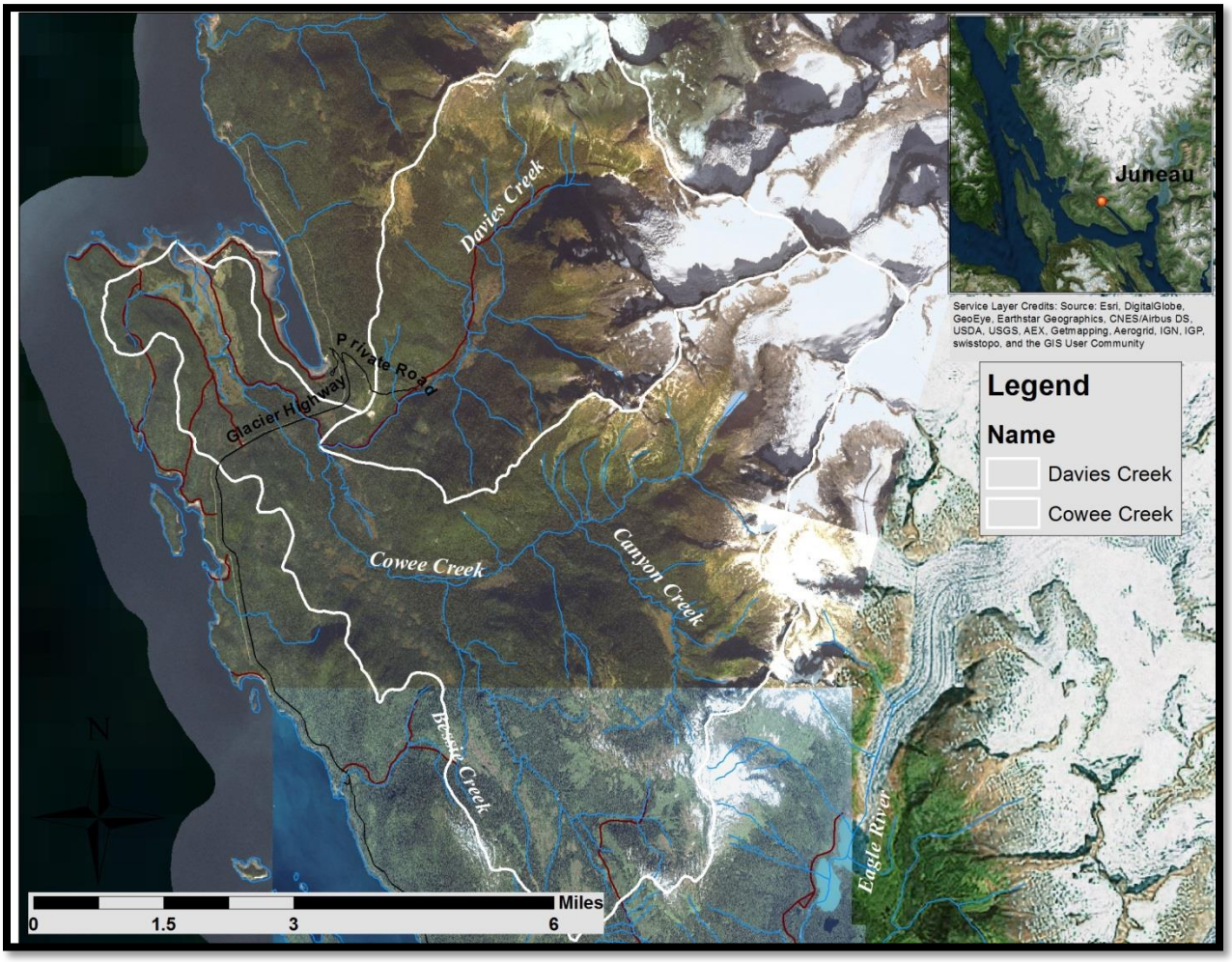

Figure 5. The Cowee Creek and Davies Creek watersheds accessible from Glacier Highway.

Cowee and Davies Creeks are located "out-the-road," crossing Glacier Highway near mile 40 near the road terminus at Echo Cove. Davies Creek is the largest tributary to Cowee Creek, and the watershed drains approximately 46 square miles. These creeks flow from Tongass National Forest Lands through CBJ lands and Point Bridget State Park, where Cowee Creek discharges into the south end of Berner's Bay. The watershed supports coho, pink and chum salmon, Dolly Varden, cutthroat trout, and steelhead. According to Bethers et al (2012), this system might be one of the most productive fish streams on the Juneau Road system. As such, Cowee Creek is a popular sport fishing location as well as waterfowl and big game hunting. The lower watershed along the floodplain is known to have the most large tree old growth of any watershed in Juneau. However, the Cowee-Davies watershed is particularly vulnerable to

development. The City's lands within the lower watershed include parcels designated for resource development, and the Echo Cove area is designated as a New Growth Area in the 2013 CBJ Comprehensive Plan. The New Growth Area is intended to provide a mixture of residential, recreational and water-related uses. In addition, both a native corporation and the U.S. Forest Service have proposed timber harvests in the area in the past.

Eagle and Herbert Rivers

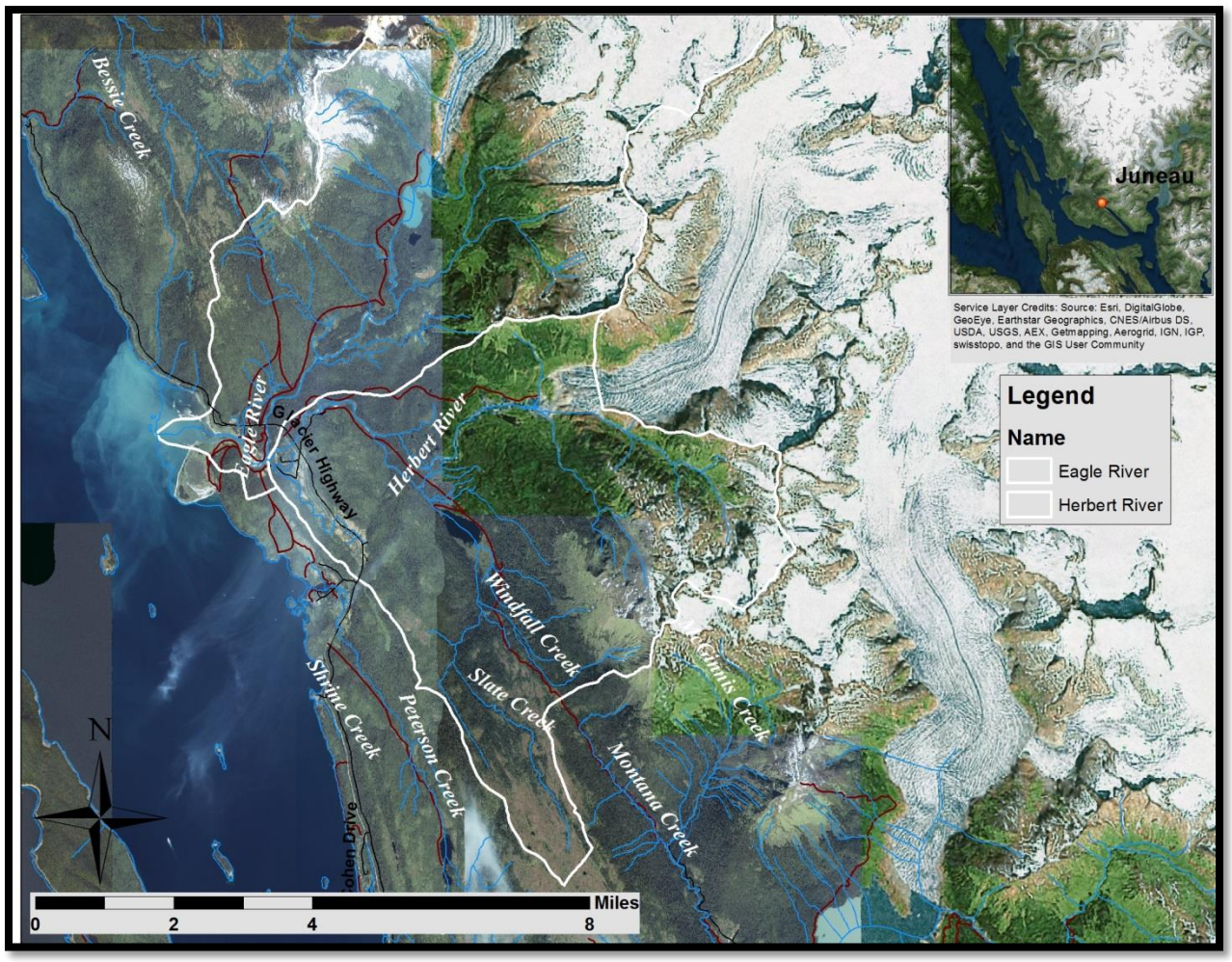

Figure 6. The Eagle River and Herbert River watersheds accessible from Glacier Highway.

Both the Eagle and Herbert Rivers are glacial systems, receiving significant amounts of flow from the Eagle and Herbert Glaciers, respectively. Together, the Eagle – Herbert River system drains an area of 46 square miles. Eagle River has approximately 15 small Clearwater (non-glacial) tributaries, with Boulder Creek being the largest. Herbert River has two major non-glacial tributaries: Strawberry Creek and Windfall Creek/Windfall Lake.

Though they have distinct, large drainages, they are considered together because the two rivers join before entering Lynn Canal. In addition, the Eagle – Herbert River system is jointly identified as one of the "Tongass 77." The Tongass 77 consists of 77 watersheds identified as intact, high value watersheds

on Tongass National Forest lands that are not in a protected land status. Conservation groups are seeking to obtain protection for these important watersheds.

The Eagle – Herbert River system supports coho, pink, chum, and sockeye salmon; cutthroat and steelhead trout; and Dolly Varden. Due to being large glacial systems, the fish habitat has not been assessed on the mainstem of these rivers. However, the Eagle – Herbert River system has clearwater tributaries, beaver pond, and wetland systems that provide both spawning and rearing habitat. Both rivers are accessible via a well-established trail system that is pretty heavily used. There is a very popular sport sockeye fishery in the area.

Both watersheds are largely owned by U.S. Forest Service and managed as part of the Tongass National Forest. There are State, CBJ and private land holdings along Glacier Highway. State lands encompass the Eagle Beach State Recreation Area. The CBJ lands are primarily Amalga Meadows Natural Area Parklands, although there are CBJ lands designated for resource development. In addition, there is a subdivision designated for rural dispersed residential development.

Future mining and gravel extraction are the greatest threats to these two watersheds. Eagle River has been impacted by gravel mining in the past, and is identified as a potential source of gravel for future use. Recent mineral exploration occurring in the Herbert River watershed near the base of the Herbert Glacier area spurred concern about a potential mining operation. Exploration for Gold, Silver, Copper, Zinc, Lead and Tungsten was conducted on unpatented lode claims between 2010 and 2012. Baseline water quality studies were conducted in 2013. While the mining companies are in the very early stages of exploration, they are proposing a gold mine at this location.

Peterson Creek (Douglas)

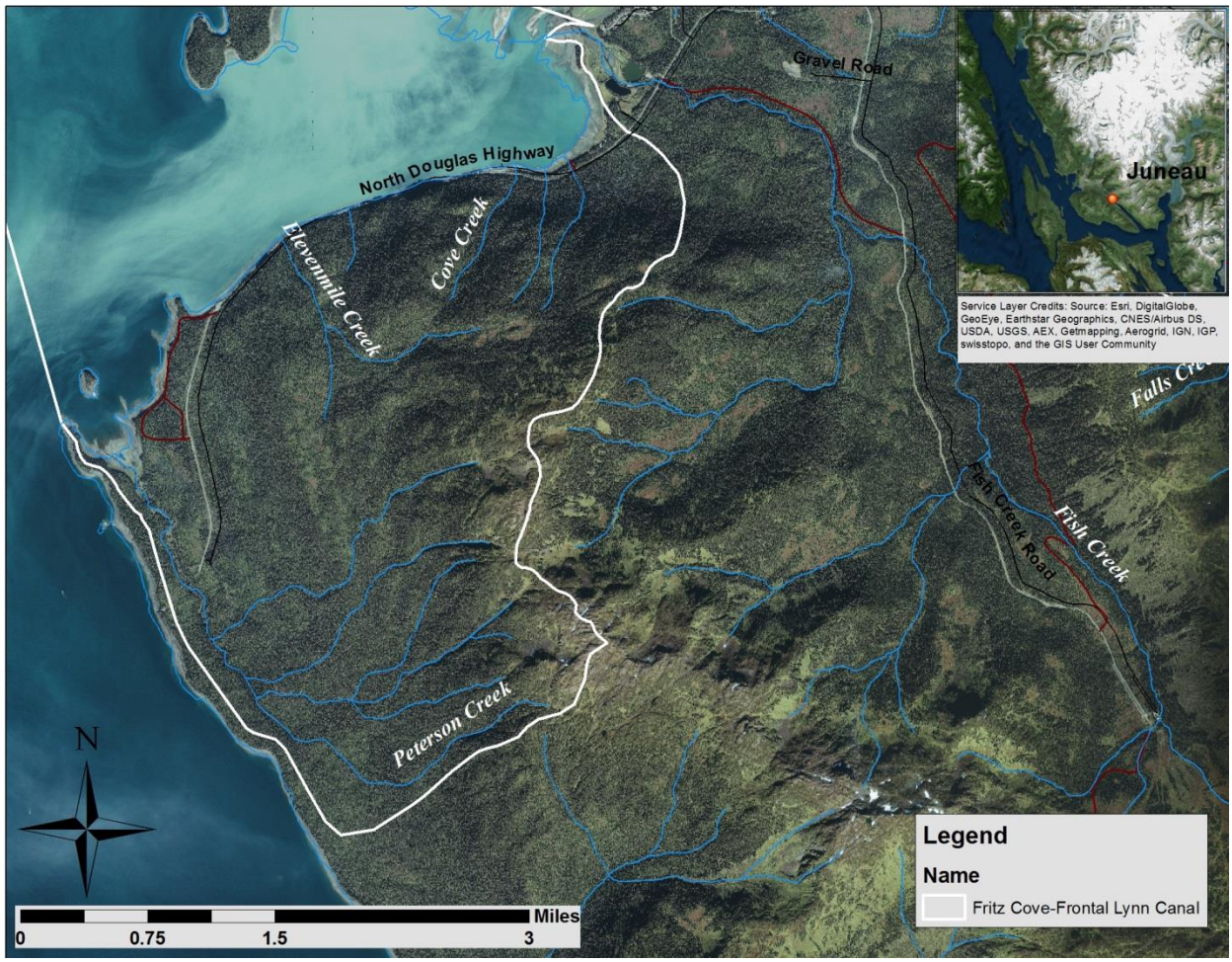

Figure 7. The Peterson Creek watershed on Douglas Island, accessible from North Douglas Highway. The watershed is part of the Hydrological Unit Code (HUC) Fritz Cove – Frontal Lynn Canal; the HUC boundary (shown) does not correspond solely with the Peterson Creek watershed boundary.

Peterson Creek (also known as Outer Point Creek), is located on the northwest end of Douglas Island. It drains an area of approximately 6 square miles. The watershed supports coho, pink and chum salmon, cutthroat trout and Dolly Varden. It is considered one of the most intact, high functioning watersheds on the Juneau road system. The creek is accessible from the terminus of North Douglas Highway by a well-developed trail. Other than this trail system, a power station, and a few private residences, the watershed is mostly undeveloped. The lower ¾ mile is on private property, but the remainder of the watershed is on U.S. Forest Service, CBJ, and Goldbelt Native Corporation lands. This watershed is particularly vulnerable to development. Two New Growth Areas were designated on the west side of Douglas Island in the 2013 CBJ Comprehensive Plan, one of which encompasses the Peterson Creek watershed. According to the CBJ, these New Growth Areas can accommodate over 2,000 new residential units along with port development, commercial, industrial and recreational facilities. These areas are intended for phased development in accordance with the West Douglas Concept Plan.

Fish Creek

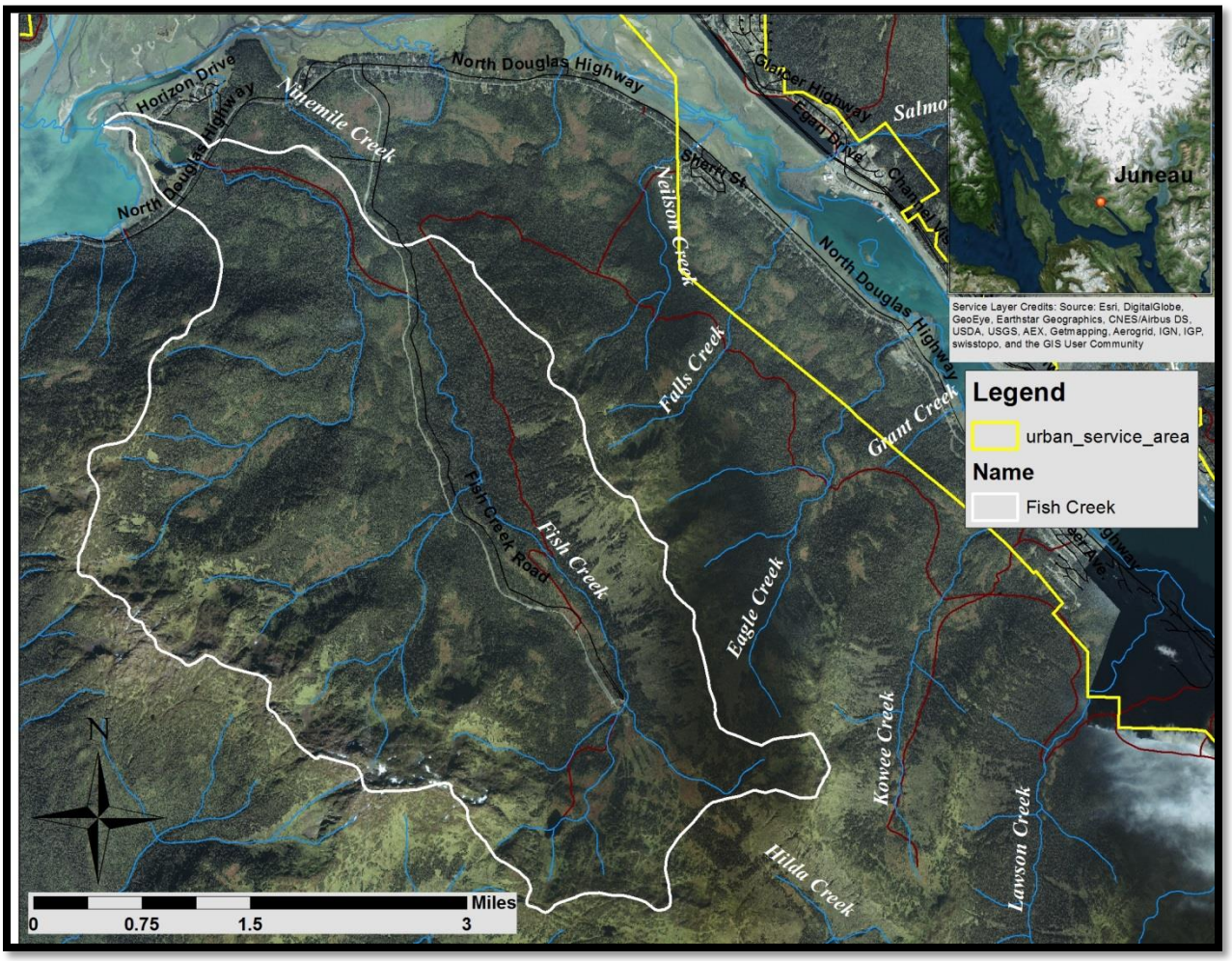

Figure 8. The Fish Creek watershed accessible from North Douglas Highway.

Fish Creek is located on Douglas Island, crossing North Douglas Highway just past mile 8. Fish Creek originates from Cropley Lake and discharges into the south side of Fritz Cove, which is part of the Mendenhall Wetlands. The watershed drains approximately 14 square miles. The upper watershed is located on State and U.S. Forest Service lands. The lower watershed is primarily located on CBJ land. The watershed supports coho, pink and chum salmon, Dolly Varden, cutthroat trout and rainbow trout. According to Bethers et al (2012), Fish Creek is one of the most productive fish streams on the Juneau Road system and is a favorite sport fishing location. The estuary at the mouth of Fish Creek is noted to be a fish and wildlife hotspot, and is popular spot for hunting waterfowl. However, the watershed has been impacted in the past by land use activities. The estuary was first impacted by the construction of dikes and dredge ponds beginning in the early 1960s and expanded through the 1970s. The estuary was also impacted by construction of the North Douglas Highway in the early 1970s, when the intertidal was filled in to provide a staging area for equipment. An additional road was constructed to access the ski area, Eaglecrest, in the mid-1970s and, in the mid-1980s, the ski area began withdrawing water from Cropley Lake to supply its snowmaking machine. Fish Creek continues to be vulnerable to development from recreational facilities and associated road improvements.

Past Recommendations

The watersheds outside the USAB have not been as intensively studied as those within the USAB. Even in the limited literature reviewed, there have been recommendations regarding the watersheds outside the USAB. However, many of these are general recommendations for protecting these pristine watersheds or recommendations for further studies, particularly to better understand the fisheries values of these watersheds.

Protection Measures/Watershed Studies	Waterbodies
Designate as a top priority fish stream and given maximum protection	○ Eagle and Herbert Rivers ○ Peterson (aka Outer Point) Creek ○ Peterson Creek (Glacier Highway) ○ Fish Creek
Critically review land use permits	○ Peterson (aka Outer Point) Creek ○ Peterson Creek (Glacier Highway) ○ Fish Creek ○ Hendrickson Creek ○ Johnson Creek ○ Picnic Creek ○ Strawberry Creek
Maintain water quality	○ Elevenmile Creek ○ Fish Creek ○ Herbert River ○ Johnson Creek ○ Nugget Creek ○ Sheep Creek
Do not permit logging in the watershed	○ Cowee – Davies Creeks
Do not permit instream gravel mining or gravel mining in the floodplain	○ Eagle River ○ Herbert River
Do not permit placer mining activities	○ Herbert River
Assess fisheries and recreational values	○ Cowee – Davies Creeks ○ Eagle River ○ Herbert River
Conduct salmon escapement survey	○ Hendrickson Creek ○ Johnson Creek ○ Picnic Creek
Identify valuable channels and ensure streamside buffers	○ Strawberry Creek

The literature also included more site-specific recommendations for restoration, enhancement and mitigation measures. However, many of these recommendations were focused on improving fish passage by either replacing or assessing culverts. Some site-specific studies were also recommended.

These site-specific recommendations include the following:

- Replace the following RED culverts:
    - Cowee Creek Tributary culvert at Glacier Highway
    - Bessie Creek culvert at Glacier Highway
    - Two Peterson Creek culverts at Glacier Highway
    - Picnic Greek culvert at Glacier Highway
    - Johnson Creek culvert at North Douglas Highway
    - Two Hendrickson Creek culverts at North Douglas Highway
    - Hendrickson Creek double culvert on a private drive
    - Snowslide Creek culvert at Thane Road

- Assess the following GRAY culverts and replace as needed to improve fish passage:
    - Eagle River tributary culvert at Glacier Highway
    - Strawberry Creek side channel culvert at Glacier Highway
    - Picnic Creek culvert at Lena Point Road
    - Picnic Creek culvert at Picnic Beach Road

- Investigate upwelling areas in front of the Eagle Glacier moraine to determine their potential for use in fish habitat enhancement
- Investigate offshore topography at the mouth of Elevenmile Creek to determine its potential for use as a saltwater release site for hatchery-reared salmon smolts
- Investigate effects of water withdrawals from Cropley Lake on Fish Creek
- Investigate feasibility of enhancing intertidal spawning habitat on Neilson Creek through channel stabilization and placement of spawning substrate
- Monitor conditions at the mouth of Picnic Creek to determine whether gravel berms are not inhibiting fish passage in the spring outmigration and fall immigration periods
- Investigate the feasibility of using Picnic Creek as an imprint site for hatchery-reared salmon smolts
- Develop fish viewing areas on Steep Creek that are supported by stabilized banks

Conclusion

For the road-accessible watersheds outside the USAB, it is generally recommended to maintain and protect water quality and fisheries values. The JWP encourages use of the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future development.

This process will be particularly important in watersheds where new growth is being encouraged. Where possible, the JWP recommends working with the Alaska Department of Transportation and Public Facilities (DOT&PF) to replace RED culverts as part of road rehabilitation/reconstruction projects on all fish streams. Given the relatively pristine condition of these watersheds, the JWP does not recommend

conducting a field assessment on any of the watersheds outside the USAB at this time to identify additional site-specific restoration opportunities.

Due to the pristine nature of these watersheds, the JWP recommends that these watersheds be considered a low-priority in terms of implementing restoration, enhancement and mitigation measures -- with one exception: Fish Creek. Fish Creek has some opportunities to greatly improve the estuarine area at the mouth of the creek that was subject to gravel mining in the past. This work should be considered a high priority for this watershed. The Southeast Alaska Watershed Coalition (SAWC) hopes to restore the estuarine wetlands of Fish Creek as part of their in-lieu fee program, when their program has received approval from the U.S. Army Corps of Engineers.

LITERATURE REVIEW FOR WATERSHEDS WITHIN THE USAB

The following sections present the literature review for each watershed in the USAB. Each watershed section includes:

- A list of reviewed literature;
- A description of the current condition of the watershed as discussed in existing literature;
- A description of the hydrological processes;
- A list of past recommendations for restoration, enhancement and mitigation included in existing literature; and
- Conclusions for the watershed based on the existing literature

The conclusion for each watershed will discuss whether JWP recommends conducting field assessments to confirm past recommendations and/or to identify current opportunities for restoration, enhancement and mitigation, as well as the watershed's priority in terms of restoration needs.

Mendenhall River

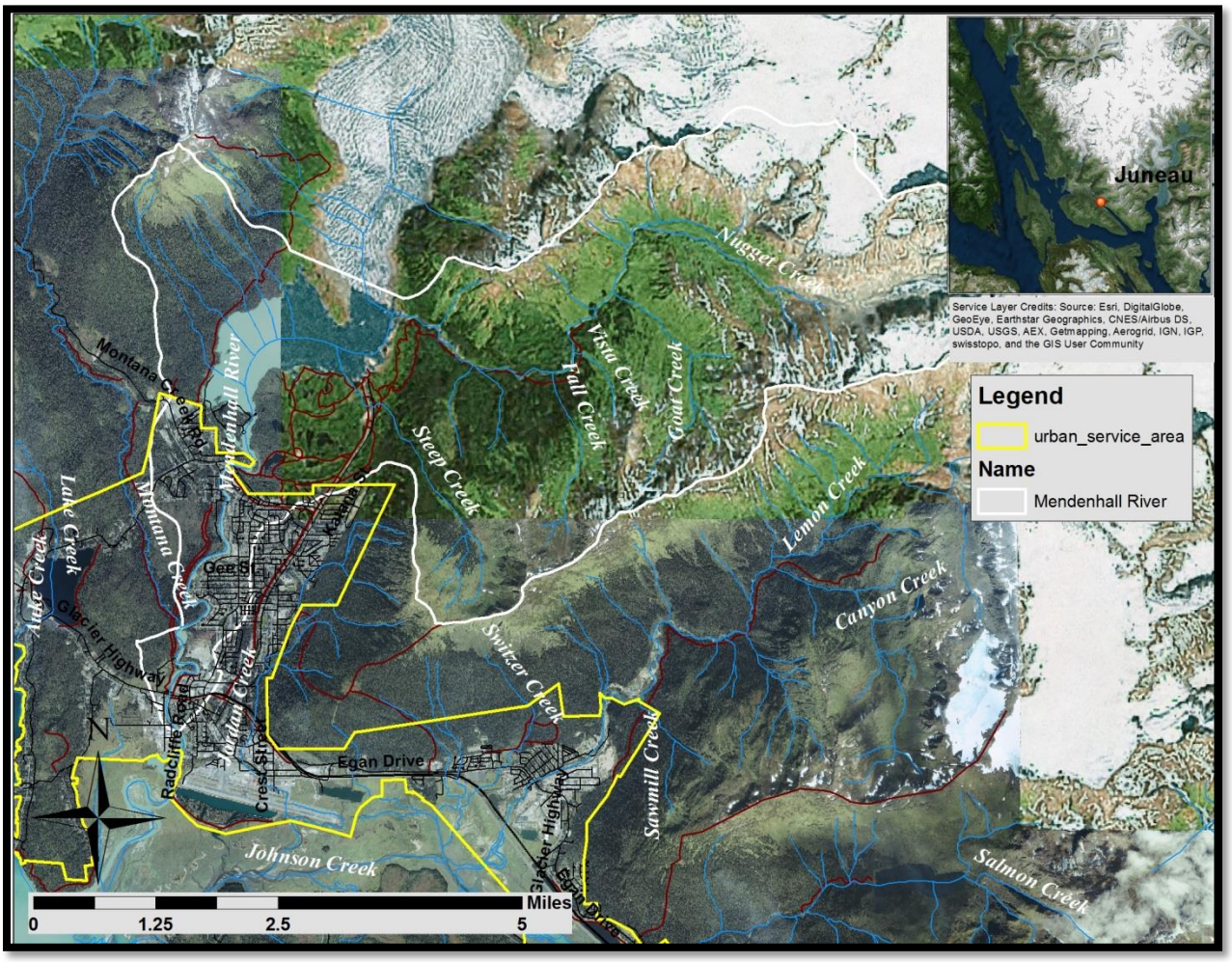

Figure 9. The Mendenhall River watershed located in the heart of the Mendenhall Valley. The boundary shown is for the Hydrologic Unit Code (HUC). The Mendenhall River watershed also includes Montana Creek, which is not included in this HUC boundary, but is discussed separately in this document.

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

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Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

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Condition

The Mendenhall River is located in the Mendenhall Valley (Figure 9). It is approximately five miles long. It originates from the Mendenhall Lake, which is a meltwater lake at the base of the Mendenhall Glacier, and discharges into Fritz Cove. The Mendenhall River is part of an extensive, 100 square mile watershed that includes glacial ice, Mendenhall Lake and its tributaries, McGinnis Creek, Montana Creek, and Duck Creek.

The Mendenhall Lake and its major tributaries Nugget Creek and Steep Creek are not discussed in this report, as these waterbodies are considered to be in relatively pristine condition and are located on U.S. Forest Service land managed as part of the Tongass National Forest. Montana and Duck Creeks are tributaries to the Mendenhall River. McGinnis Creek is the largest tributary to Montana Creek. Montana and Duck Creeks are discussed separately in this report. McGinnis Creek is included in the Montana Creek discussion.

The Mendenhall River is an anadromous stream that supports coho, pink, chum and sockeye salmon, cutthroat and steelhead/rainbow trout, and Dolly Varden. Eulachon may be found in the lower reaches of the river in spring. However, fish habitat has never been assessed due to the river's size and glacial characteristics. Even so, it is considered important for fish species, as it provides the primary migration route to spawning habitat in the upper watershed.

The upper watershed is mostly undeveloped, while the lower watershed includes residential, commercial, and industrial developments. Most of the urban development has occurred on the east bank of the river. The west bank is relatively undisturbed and is located within designated city parklands. The Mendenhall River has also been historically impacted by gravel mining.

The stream banks of the Mendenhall River are considered to be moderately susceptible to erosion due to being composed of unconsolidated alluvium which can be undermined by high velocity flows. Erosion can be accelerated if channels are constricted (e.g. by bridge abutments) or riparian vegetation is removed. The effects of this can be seen along the Mendenhall River.

Efforts have occurred to prevent erosion of property along the river in several locations. The river banks have been traditionally stabilized with riprap protection. However, resource agencies have encouraged moving away from this traditional method in order to utilize more modern bank protection techniques that are affordable, functional and do not adversely affect fish habitat.

While there have been several studies regarding the hydrology and geomorphology of the Mendenhall River due to its active nature, there is little water quality data. The DEC 2012 Integrated Report lists the Mendenhall River as a Category 2 waterbody, which means there is insufficient or no data for DEC to

determine whether water quality standards are attained. From the little information available, the Mendenhall River seems to meet water quality standards for dissolved oxygen and temperature. Turbidity was found to be high, but this is expected for a glacial system. Stormwater runoff from adjacent development, the old Red-Samm gravel pit and the Mendenhall Valley Wastewater Treatment Plant are potential sources of pollutants that could affect water quality.

Hydrologic Processes

The entire length of the Mendenhall River is classified in the Glacial Outwash process group, with a Glacial Outwash Estuarine (GES) Channel Type up to the airport and Large Meandering Glacial Outwash (GOL) Channel Type for the remaining length of the river. Rivers in this process groups are, as suggested by the name, associated with glaciers. A GOL channel functions for sediment transport, and tend to carry high sediment loads. Typically these channels have moderate energy due to flow containment and low stream gradient. Stream banks of GOL channels are moderately sensitive to erosion. High velocity flows can undermine stream banks and bridge abutments may accelerate bank erosion where they constrict the channel. This can be seen along the Mendenhall River. Riparian vegetation is important for bank stability. GOL channels may have flood plain side channels and sloughs that provide important fish rearing habitat. A GES channel functions as a deposition channel. Tidal influences may affect flow and river stage far upstream from saltwater. Stream banks in GES channels are highly sensitive and lateral channel migration is active in these channels. This process is most visible in the Mendenhall River at the oxbow near the airport. Riparian areas along GES channels are typically tidal marshes, like those of the Mendenhall Wetlands.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures for the Mendenhall River. These are:

- Provide for bank stabilization upstream of West Mendenhall Valley Greenbelt/Brotherhood Park
- Replace culverts on Mendenhall River tributary on Mendenhall Riverside Trail impeding fish passage
- Acquire parcels to establish natural streamside corridors rather than stabilizing continually with riprap

There are also management and enhancement recommendations for the GES and GOL channels applicable for the Mendenhall River. These are:

- Management and protection measures should focus on:
    - Controlling erosion
    - Controlling in-stream operations
    - Protecting stream banks and riparian vegetation
    - Maintaining and protecting flood plain functions and values
    - Maintaining and protecting wetland functions and values
    - Maintaining sources of large woody debris
- Design and construction of infrastructure should consider:

- Channel stability when locating and designing stream crossings
- Enhancement opportunities include:
  - Introducing and managing beaver populations to increase habitat associated with side channels and sloughs.

Conclusion

The JWP does not recommend conducting a field assessment on the Mendenhall River at this time, as this watershed is considered to be in relatively pristine condition. The Mendenhall River has only been heavily impacted on its eastern bank, and the primary concern in the literature is bank stability and enhancing existing revetments. The JWP recommends conducting interviews with agency personnel to determine where existing revetments could be enhanced to improve riparian habitat. The JWP recommends Mendenhall River as a medium-priority watershed at this time.

Montana Creek

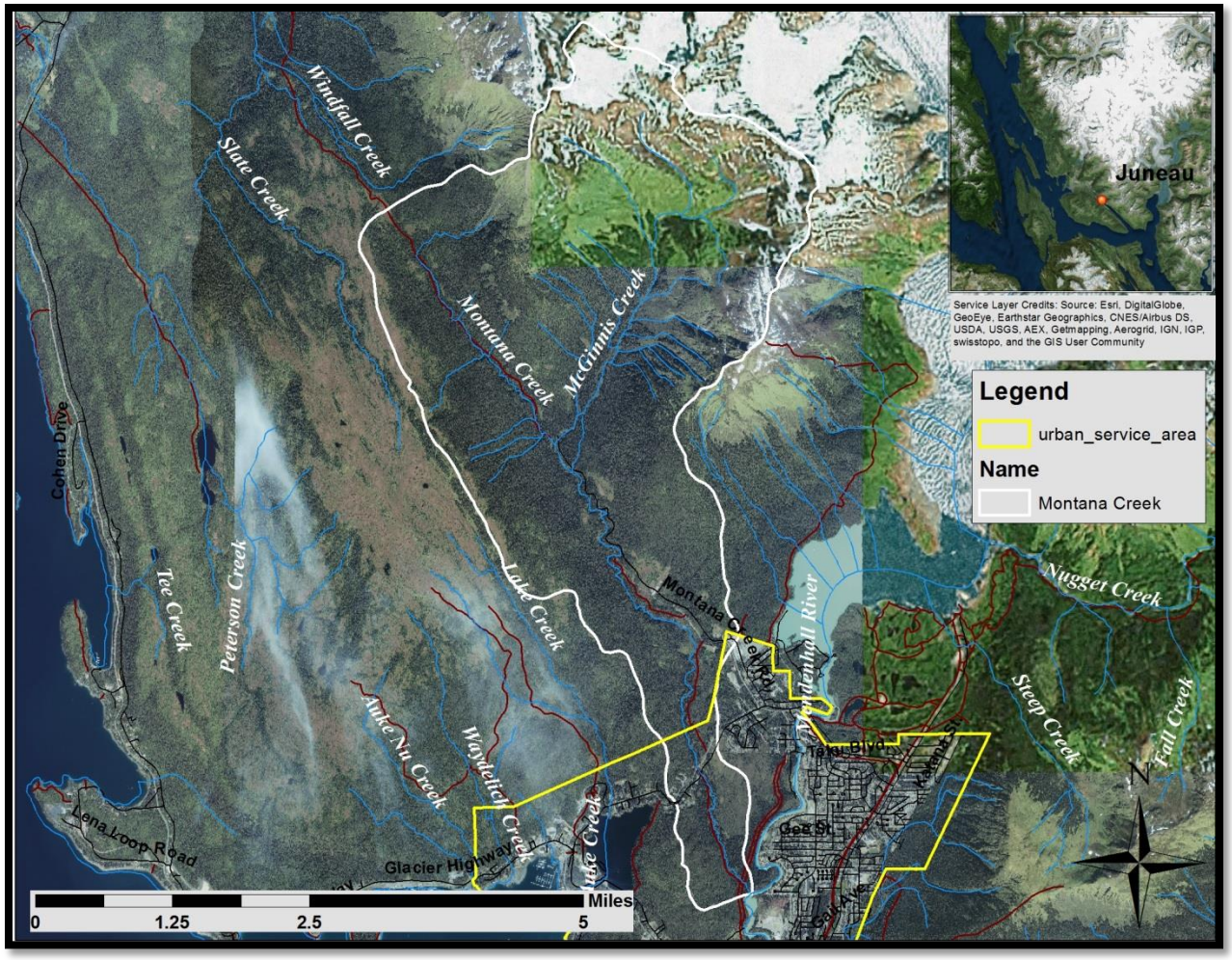

Figure 10. The Montana Creek watershed. Montana Creek is a major tributary to the Mendenhall River.

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report. http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

JWP. 2014. Montana Creek Stewardship Plan.

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Condition

Montana Creek watershed is located in the Mendenhall Valley (Figure 10). The Montana Creek watershed is approximately 9,722 acres that primarily consists of undeveloped alpine, forest, and wetland habitats as well as pockets of urban areas. The main tributary to Montana Creek, McGinnis Creek, originates from the meltwater of McGinnis and Stroller White Mountains, which border the Juneau Ice field. Montana Creek's headwaters come from a smaller, unnamed mountain to the west. Montana Creek discharges into the Mendenhall River, approximately one mile upstream from where Glacier Highway crosses the river.

Only a portion of the Montana Creek watershed is located within the Urban Service Area Boundary (USAB) (Figure 10). Land within the USAB is designated for low and medium density residential development, parklands, and resource development. The CBJ also designated the upper Montana Creek watershed as a potential drinking water source. The State of Alaska owns a significant corridor along the upper mainstem. State lands are managed for recreation, fish and wildlife habitat, and fishing and hunting. The U.S. Forest Service owns much of the upper watershed, though there are a few privately owned parcels are located in the upper watershed as well. The U.S. Forest Service land within the Montana Creek watershed is designated for semi-remote recreation.

The upper watershed is mostly undeveloped, with the exception of recreation trails (Figure 10). The lower watershed winds through residential and commercial developments. The urban pockets occur along Mendenhall Loop Road and Montana Creek Road in the mid to lower portion of the watershed (Figures 10). Urban development largely consists of residential areas, though commercial development and recreation facilities also exist. There are several acres of conservation land managed by Southeast Alaska Land Trust.

The Montana Creek watershed supports both anadromous and resident fish including chum salmon, coho salmon, chinook salmon, pink salmon, cutthroat trout, steelhead trout, and Dolly Varden. Excellent

spawning and rearing habitat for both anadromous and resident fish is present throughout the watershed.

The Montana Creek watershed is known for its numerous recreational opportunities such as fishing, hunting, hiking, skiing, snowshoeing, horseback riding, recreational gold panning and mining. Due to its proximity to the population center of Mendenhall Valley and its plentiful wild stock of salmon and trout, Montana Creek is especially popular for freshwater sport fishing. The Alaska Department of Fish and Game Area Sport Fishing reports for Juneau identify Montana Creek as a good fishing spot for coho salmon, Dolly Varden and cutthroat trout, and the best time for freshwater sport fishing is July through September.

The 2012 Integrated Report lists Montana Creek as a Category 2 waterbody, which means the DEC feels there is insufficient or no data to determine whether water quality standards are attained. However, the watershed is generally considered pristine by the community and local advocates (e.g. Trout Unlimited) striving to maintain its pristine character. Development, motorized use (ATVs), suction dredge mining and invasive plant species are considered to be potential threats to the health of the Montana Creek watershed.

Hydrologic Processes

Montana Creek within the USAB is classified as being in the Floodplain Channel process group, with a Medium Flood Plain Channel Type (FPM). This process group is defined by high stream flows that are typically not contained within the active channel and, therefore, having some degree of floodplain development. These channels are dominated by well-defined pools, riffles and gravel bars. Input of large woody debris is a major factor influencing pool development. Both bank erosion and bank building processes occur in floodplain channels, and stream banks are susceptible to erosion. Retention of sediment is high, as sediment is stored in pools, point bars and within the floodplain. Sediment transport occurs during high flows.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures on Montana Creek. These are:

- Conduct feasibility study for excavating a streamside smolt release facility (hatchery)
- Replace the four side by side culverts on a side channel of Mt. Creek to improve fish passage
- Research the impacts of suction dredge mining, including cumulative impacts
- Identify non-fish streams that could be productive for suction dredge mining
- Map undocumented anadromous and resident fish habitat
- Assess and restore ATV damaged areas

There are also generic management and enhancement recommendations for a FPM channel that are applicable for Montana Creek. These are:

- Management and protection measures should focus on:
    - Controlling erosion

    - Protecting stream banks
    - Controlling in-stream operations
- Design and construction of infrastructure should consider:
    - Bridges should be used for stream crossings
- Enhancement opportunities include:
    - Placing large woody debris
    - Constructing side channels for spawning, where shallow groundwater sources are present
    - Stocking fry when downstream barriers are not posing a fish passage barrier

Conclusion

JWP recently completed the *Montana Creek Stewardship Plan* (2014). Due to the recent planning efforts and the relatively pristine condition of this watershed, the JWP does not recommend conducting a field assessment on Montana Creek at this time, as it is unlikely to uncover additional restoration, enhancement, or mitigation measures. Given the watershed's current condition and the potential for residential development, the JWP encourages using the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future development. Since some opportunities exist to address current impacts from existing development and the community values the watershed for recreation and fish and wildlife habitat, the JWP recommends Montana Creek as a medium-priority watershed at this time.

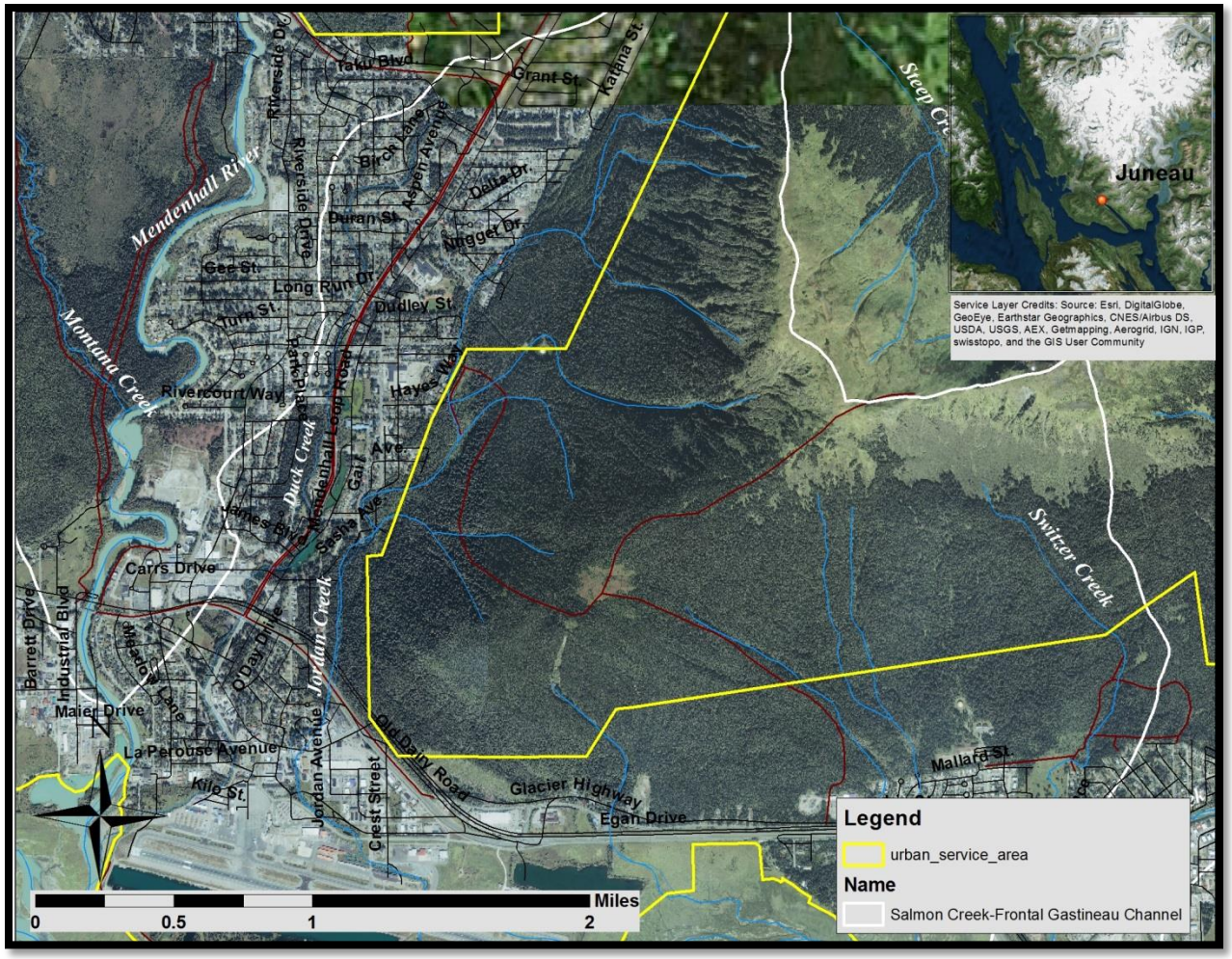

Figure 11. The Duck Creek and Jordan Creek watersheds located in the Mendenhall Valley. These watersheds are a part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. Note that the HUC boundary does not correspond with the watershed boundaries for these individual streams.

Duck Creek

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Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

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Hood, E.; Hoferkamp, L; and Hudson, J. 2005. Duck and Jordan Creek Protection and Recovery. http://dec.alaska.gov/water/wnpspc/protection_restoration/juneau/pdfs/DuckJordan_FinalReport2005.pdf

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Rinella, D. and Bogan, D. Testing Alaska'a Macroinvertebrate and diatom-based stream condition indices in selected urban streams. Environmental and Natural Resources Institute and Alaska Natural Heritage Program, University of Alaska Anchorage. Prepared for the Alaska Department of Environmental Conservation, Anchorage, Alaska. http://dec.alaska.gov/water/wnpspc/protection_restoration/juneau/pdfs/2010_Duckcreekbioassessment_report.pdf

Condition

Duck Creek is located in the Mendenhall Valley and is a tributary to the Mendenhall River (Figure 11). The creek is approximately 3.5 miles long and discharges into the Mendenhall River directly upstream of

the Juneau International Airport. It drains a watershed of approximately 1.7 square miles. The entire watershed is within the USAB (Figure 11). It is primarily a spring-fed system, but also relies on precipitation and some snow melt for water flow. Duck Creek is an anadromous stream that supports pink, chum, and coho salmon, Dolly Varden and cutthroat trout.

Duck Creek has one of the most intensely developed watersheds in Juneau. Duck Creek is listed as an impaired waterbody since 1994 due to non-attainment of State water quality standards for debris, low dissolved oxygen, metals, fecal coliform bacteria and turbidity. Development and urban stormwater run-off are the source of impairment.

Duck Creek also suffers from low flow and sections of the creek go dry. Isostatic rebound has been identified as a likely contributor to declining stream flows and may be a factor in observed changes to habitat access and quality; as the land uplifts, Duck Creek is disconnected from groundwater which provides the primary source of flow for the stream.

A local advocacy group, the Duck Creek Advisory Group (DCAG), formed in 1993 to "coordinate, plan initiate and carry out activities to restore water quality and anadromous fish habitat in Duck Creek and its freshwater and estuarine wetlands" (Koski and Lorenz, 1999). Five years later, the Mendenhall Watershed Partnership (MWP) evolved out of the DCAG to promote the health of the Mendenhall Watersheds. The early focus of the MWP continued to be Duck Creek, but this group also began focusing efforts on Jordan Creek. These groups were successful in leveraging resources to identify and address water quality and habitat concerns on these waterbodies.

Due to these efforts, numerous recovery efforts have been completed on Duck Creek based on recommendations included in various reports and plans since 1998. These recovery efforts include water quality monitoring, culvert maintenance and replacement, stream bank revegetation, sediment removal and channel reconfiguration, wetland restoration and stream clean up events. These efforts focused primarily on ensuring the system is able to support fish habitat. There have been mixed results from these efforts.

In spite of the focus on Duck Creek, water quality parameters and assessment of macroinvertebrate assemblages continue to show impairment. Though challenges with urban development continue to stress the watershed, natural processes are also found to be affecting the creek's ability to recover.

Recently, the focus has shifted off of Duck Creek, especially in terms of restoring fish habitat. However, Duck Creek is still considered to provide other watershed values such as stormwater treatment, flood control, open space/greenbelt, wildlife habitat, aesthetics, and recreation. The community still sees the importance of ensuring Duck Creek is able to support these functions and values.

Hydrologic Processes

Duck Creek has not been assessed and mapped by Stream Process Group and Channel Types.

Past Recommendations

Numerous recommendations are included in the literature pertaining to Duck Creek. However, many of these are general, watershed-wide recommendations such as:

- Implement illegal dumping/illicit connection detection and elimination programs
- Augment flow in the stream channel
- Restore riparian vegetation in open areas
- Improve storm drain system to alleviate flooding
- Retrofit stormwater infrastructure with treatment systems such as settling ponds, oil traps, or oil skimmers
- Place snow fences at road crossings and other locations where snow is commonly plowed into the stream
- Remediate high concentrations of dissolved iron by either capping areas with organic fill or using a precipitating or binding material or aerating groundwater mechanically to trap iron below surface
- Improve culvert sizing and placement to restore habitat, channel morphology and flow
- Create wetlands in borrow pits to function as stormwater treatment systems
- Line sections of the stream that go dry with impervious material
- Acquire/establish green belt areas along the stream
- Place woody debris for instream habitat
- Remove fine sediment
- Revegetate the riparian corridor
- Develop and implement a long term water quality and aquatic insect monitoring program

The more site-specific recommendations for restoration, enhancement and mitigation measures (that haven't been completed yet) include:

- Create a wetland at Allison Pond
- Replace Nancy St. culvert, which is a ADF&G documented fish passage barrier
- Evaluate the Cinema Dr. culvert, which is documented by ADF&G as a potential fish passage barrier

Conclusion

Given the impaired status of the Duck Creek watershed, the numerous past recommendations, and the number of restoration efforts already conducted, JWP recommends a field assessment of Duck Creek to determine more site-specific restoration, enhancement, and mitigation recommendations. Such recommendations should focus on improving stormwater treatment, flood control, open space/greenbelt enhancement, wildlife habitat, aesthetics, and recreation. However, given that focus has shifted off of the Duck Creek watershed in terms of agency and community priorities, JWP recommends that this be a medium-priority watershed at this time.

Jordan Creek

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

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Host, R., and E. Neal. 2004. Baseline Characteristics of Jordan Creek, Juneau, Alaska. http://pubs.usgs.gov/of/2004/1220/ofr2004_1220.pdf

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Savell, Samia. 2006. Jordan Creek Watershed Recovery and Management Plan. http://www.juneauwatersheds.org/publications/Jordan%20Creek%20plan.pdf

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Condition

The Jordan Creek is located on the east side of the Mendenhall Valley (Figure 11). The mainstem is approximately 3.5 miles long and drains a watershed of about three square miles, only a portion of which is outside of the USAB (Figure 11). The headwaters originate on the western edge of Thunder Mountain on Tongass National Forest lands at an elevation of 2,800 feet. Jordan Creek discharges into the Mendenhall Wetlands. Jordan Creek is an anadromous stream supporting populations of coho, chum and pink salmon, Dolly Varden and cutthroat trout.

The upper watershed (above Egan Drive) is mostly undeveloped on the eastern side, due to the lack of easily developable land along Thunder Mountain. However, residential developments lie on the western side of the upper watershed. The most intensely developed area is below Egan Drive, where residential and commercial developments encroach on the stream. A greenbelt was established by the CBJ along a section of the lower watershed, adjacent to the few remaining undeveloped parcels. Of the parcels that were undeveloped at the time the greenbelt was established, only one remains undeveloped at this time. However, apartment-style housing is planned to be constructed on this parcel in the near future.

Jordan Creek is listed as an impaired water body by the State of Alaska for non-attainment of sediment, dissolved oxygen, and residue (debris) standards. It has been listed since 1998. A Total Maximum Daily Load (TMDL) was developed to address the sediment and dissolved oxygen impairments. Urban development and stormwater runoff are the primary sources of impairment. Other major sediment sources include off-road vehicle trails and snow storage areas.

Like Duck Creek, Jordan Creek also suffers from low flows and some sections of the creek go dry. Glacial recession and isostatic rebound have been identified as a likely contributor to declining stream flows. Glacial melt waters no longer contribute to the flow and, as the land uplifts, Jordan Creek is disconnected from groundwater which provides a source of flow for the stream.

Even though Jordan Creek is an impaired waterbody, water quality parameters and monitoring of macroinvertebrates show that water quality in Jordan Creek is generally better than Duck Creek, and conditions in the upper watershed are generally better than in the lower watershed. There have been some recovery efforts implemented on Jordan Creek, but not to the same extent as Duck Creek.

Hydrologic Processes

Jordan Creek is classified as being in the Floodplain Channel process group to Tongass Boulevard, and then the stream is classified as a mix of Palustrine and Floodplain process group channels along the valley bottom at the base of Thunder Mountain.

Reaches of Jordan Creek within the Floodplain Channel process group are of the Small Floodplain Channel Type (FPS), though some are classified within the Foreland Outwash Shrub Phase (FPSh). These channels function as sediment deposition channels, where sediment transport only occurs at peak flows. Otherwise, sediment is stored in the channel, point bars and in the adjacent floodplain. Stream banks in FPS channels are affected by both constructive and erosive forces, and can contribute to the sediment load in these channels. Due to low stream power, these channels are sensitive to sediment inputs. This plays a factor in Jordan Creek's impairment. The FPSh channels are influenced by groundwater influx.

The Palustrine Process Group is associated with low relief landforms and wetlands. The lower Palustrine Process Group channels are classified as Small Palustrine Channel Type (PAS) and those upstream are Beaver Dam/Pond Channel Types (PAB). Palustrine channel types function as deposition channels. A low gradient stream channel contributes to low stream power. In the PAB channels, sediment retention is particularly high and can buffer downstream sediment transport. The PAB channels can also buffer flows from extreme run-off events. In all Palustrine channels, streamflow and chemistry are influenced by

peat bogs or wetlands, resulting in brown coloration and high tannic acids. Palustrine channels have less sensitive stream banks, though heavy uses (e.g. heavy foot traffic) can cause stream bank degradation. This can be seen in areas of Jordan Creek where ATV use has impacted riparian areas and stream banks.

Past Recommendations

Numerous recommendations are included in the literature pertaining to Jordan Creek. However, many of these are general, watershed-wide recommendations such as:

- Discourage motorized use in upper Jordan Creek by eliminating/blocking access points, posting signs and conducting outreach
- Rehabilitate disturbed streambanks, riparian areas, floodplains and uplands
- Reestablish riparian corridors where possible
- Establish snow storage areas that include measures to prevent offsite transport of sediment
- Establish a regular monitoring program
- Promote the use of bear-proof containers or centrally located trash receptacles in high density housing areas, store parking lots
- Assess and map point and non-point sources of pollution
- Assess active contaminated sites and groundwater flow into Jordan Creek
- Assess and prioritize replacement of inadequate or unnecessary stream crossings
- Clear debris from existing structures on a regular basis
- Clean and maintain catch basins and oil/water separators regularly to prevent transport of sediment and other pollutants to Jordan Creek.
- Meltwater from snow storage areas, which may contains debris, sediment and other pollutants, was observed flowing directly into Jordan Creek, into stormwater networks that discharged to Jordan Creek, or into swales and ditches that were functioning as swales. Avoid storing snow where meltwater will flow into the stream or a catch basin. Store snow where meltwater flows to a swale, retention basin, or infiltration basin.
- To reduce the amount of fine sediment transported to Jordan Creek by springtime runoff, streets should be cleaned at the earliest opportunity in late winter/early spring
- Modify ditches to function as swales to promote stormwater infitration into the ground
- Ditch maintenance activities that remove vegetation and accumulated sediment expose soils to erosion resulting in sediment transport to streams. Avoid removing vegetation from ditches and swales. If ditches must be cleaned, remove the vegetated mat and replace it after excess sediment has been removed, or use check dams to reduce erosion
- Construct check dams in ditches to promote sedimentation by slowing water velocity.
- Identify opportunites for diverting runoff away from catch basins and into existing or constructed swales and infiltration basins

The more site-specific recommendations for restoration, enhancement and mitigation measures (that haven't been completed yet) include:

- Promote the use of bear-proof containers near McDonald's and Breeze In

- Effluent from the McDonalds' trash compactor sump has been observed mixing with stormwater and flowing into the Trout Street ditch. Prevent trash compactor effluent from mixing with stormwater.
- A hydrodynamic separator should be installed at the downstream end of the Trout St. ditch to capture petroleum hydrocarbons, sediment, and debris.
- Install check dams in the Trout Stream ditch to promote sediment deposition by reducing runoff velocity.
- Construct a retention or infiltration basin between North Jordan Ave. and the existing outfall to remove sediment and other pollutants from runoff.
- The hydrodynamic separator in this system does not capture suspended sediment. Inspect the hydrodynamic separator two times per year and within 48 hours of a major storm event.
- Construct a vegetated filter strip on a portion of the Airport Mall/CCTHITA gravel parking area to encourage stormwater infiltration and trap sediment and other pollutants before they reach the stream.
- Pave the remaining portion of the Airport Mall/CCTHITA gravel parking area to eliminate sediment sources.
- Restore the strip of trees and other native vegetation on the north side of the Extended Stay Hotel to reduce stormwater runoff rates and improve water quality.
- Eliminate stormwater runoff to Jordan Creek from a portion of West Yandukin Drive by constructing a vegetated filter strip along the toe of an existing grass-covered embankment, between the road and the airport parking lot
- The size of the retention basin on South Jordan Ave. is not sufficient to capture sediment from the volume of runoff in this stormwater system. To enhance sediment capture, reduce runoff rates, and improve the quality of water entering Jordan Creek from this outfall, divert the ditch into a constructed wetland in CBJ parkland on the south side of Teal Street.
- Install a hydrodynamic separator between the last two catch basins of Yandukin Dr. (located in a grass covered area at the east edge of the parking lot) to prevent transport of fine sediment, debris, and petroleum hydrocarbons to Jordan Creek.
- Re-direct stormwater from ditches on the north end of Alpine Ave. and the east end of Teal Street to the grass-covered swale along the south end of Alpine Ave., which has very little runoff flow into the swale and could treat this additional stormwater.
- Construct an infiltration basin to reduce or eliminate runoff into the stormwater system and capture pollutants prior to stormwater entering the catch basin located at the northeast corner of the Nugget Mall parking.
- Lower elevation of the swale located on the east side of the Nugget Mall parking lot to increase stormwater holding and infiltration capacity of the grassy swale. If necessary, replace existing soil with more permeable material to enhance infiltration.
- Encourage property owners along Crest Street and east Airport Blvd to pave gravel surfaces or convey runoff away from catch basins into swales or infiltration basins to reduce high turbidity runoff.

- Reconstruct a shallow swale along Crest Street between Teal Street and Airport Blvd. since vehicle use of the swale has destroyed vegetation, disturbed soils, and created ponds of turbid water which flows into this stormwater system. The new vegetated swale could have steep banks to discourage access by vehicles between Teal Street and Airport Blvd.
- Reroute the ditch located on the east side of the creek channel immediately upstream of Yandukin Drive to a 1,400-foot long grassy swale on the south side of Yandukin Drive east of Crest Street. If necessary, elevate the inlet of an existing catch basin in the center of the swale to increase swale capacity.
- Protect the wetlands on Airport Blvd. from development through purchase or a conservation easement.
- Snow pushed from adjacent properties into the wetland complex at Airport Blvd. damages vegetation and introduces sediment and other pollutants. Educate property owners on the impacts of snow storage practices on wetland habitat and water quality.

There are also management and enhancement recommendations for FPS, PAS and PAB channels that are applicable to Jordan Creek.

- Management and protection measures should consider:
    - controlling erosion sources (FPS and PAS channels)
    - controlling in-stream operations (FPS and PAS channels)
    - protecting wetland functions and values (PAS and PAB channels)
    - protecting stream banks (FPS channels)
- Design and construction of infrastructure should consider:
    - culverts may present fish passage barriers (FPS and PAS channels)
- Enhancement opportunities include:
    - Introducing and managing beaver populations to increase habitat (all Jordan Creek channel types)
    - stocking fry in PAB channels where carry capacity is not reached

Conclusion

Given the impaired status of the Jordan Creek watershed and the numerous past recommendations from the literature, the JWP recommends conducting a field assessment of Jordan Creek to determine appropriate site-specific restoration, enhancement, and mitigation recommendations. Such recommendations should focus on improving fish habitat, stormwater treatment, flooding, and reducing garbage and debris. Due to the impaired status and the agency interest in the watershed, the JWP recommends Jordan Creek as a high-priority watershed at this time.

Pederson Hill Creek

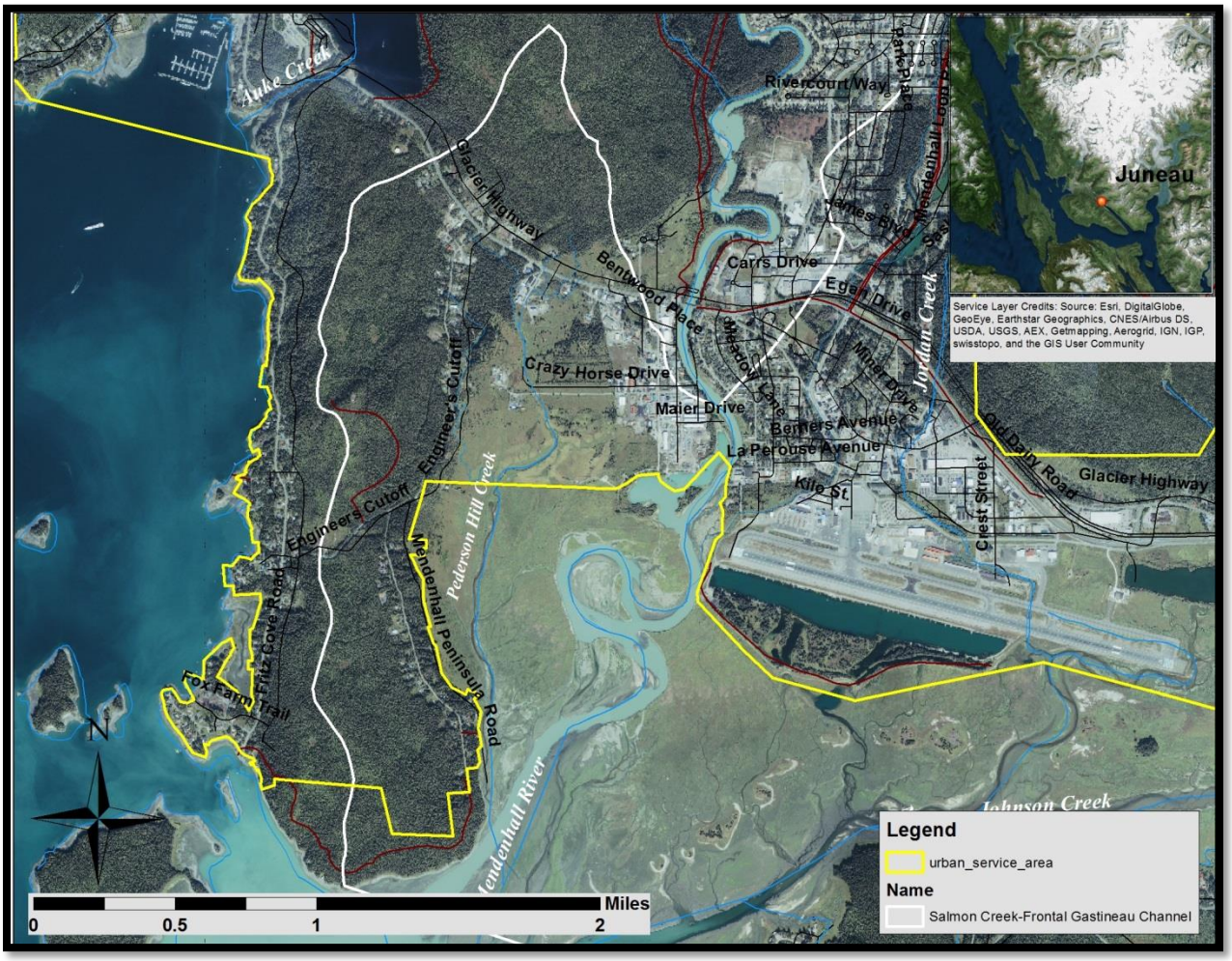

Figure 12. The Pederson Hill Creek watershed located on the Mendenhall Peninsula. Pederson Hill Creek is part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. The HUC boundary does not correspond with the watershed boundary.

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Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

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Condition

Pederson Hill Creek (also known as Casa Del Sol Creek) is located on the Mendenhall Peninsula (Figure 12). 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 watershed is approximately 1,000 acres and only the upper half of the watershed is located within the USAB (Figure 12).

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, future residential development is planned to occur in the upper watershed. Existing development has already altered the stream channel and flow patterns of Pederson Hill Creek and its tributaries via culverts and the filling of wetland areas for development. 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 identified as an impaired waterbody in 1990 due to elevated levels of fecal coliform bacteria. Failing septic tanks were identified as the probable pollutant source. 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 have been observed in the reach between Sherwood Lane 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.

Hydrologic Processes

Pederson Hill Creek primarily has channels categorized in the Estuarine and Palustrine Process Groups. Estuarine and palustrine channels are depositional channels with low stream energy. Estuarine channels, however, are subject to tidal influence. The Palustrine Process Group is associated with low relief landforms and wetlands, which influence streamflow and chemistry that result in brown coloration and high tannic acids.

The specific channel types within Pederson Hill Creek are: Large Estuarine Channel Type (ESL) and Small Palustrine Channel Type (PAS). Both ESL and PAS channels are sensitive to sediment inputs and cumulative effects from upstream disturbance tend to be a management concern. Stream banks of ESL estuarine channels are sensitive to erosion and bank erosion can be a significant source of sediment. Palustrine channels are less sensitive due to organic root mats, though high impact uses (e.g. heavy foot traffic) can cause bank degradation.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Replace the Tributary culvert at Glacier Highway to improve fish passage
- Replace the culvert at Engineers Cut Off to improve fish passage
- Restore wetlands at sewage sludge disposal area, including potentially filling the ditches and dike removal
- Remove or control orange hawkweed and reed canary grass, particularly in lower watershed near Industrial Blvd.
- Provide pools in lower creek to enhance rearing habitat and refuges during low flows
- Provide spawning substrate in lower stream sections adjacent to culverts

There are also management and enhancement recommendations for ESL and PAS channels that are applicable to Pederson Hill Creek.

- Management and protection measures should consider:
    - Controlling erosion (ESL and PAS channels)
    - Protecting wetland functions and values (ESL and PAS channels)
    - Protecting riparian habitat (ESL channels)
    - Protecting stream banks (ESL channels)
    - Controlling road drainage and maintenance (ESL channels)
    - Controlling in-stream operations (PAS channels)

- Design and construction of infrastructure should consider:
    - Culverts may present fish passage barriers (PAS channels)
- Enhancement opportunities include:
    - Placing large woody debris using design and anchoring methods that consider tidal movement (ESL channels)
    - Introducing and managing beaver populations to increase habitat (PAS channels)

Conclusion

The JWP is finalizing the *Assessment and Conservation Plan for the Pederson Hill Watershed*. Due to the recent planning efforts, the JWP does not recommend conducting a field assessment on Pederson Hill Creek at this time, as it is unlikely to uncover additional restoration, enhancement, or mitigation measures. Since Pederson Hill Creek is an impaired waterbody with new residential development planned in the foreseeable future, the JWP encourages use of the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future residential development. The JWP recommends Pederson Hill Creek as a high-priority watershed.

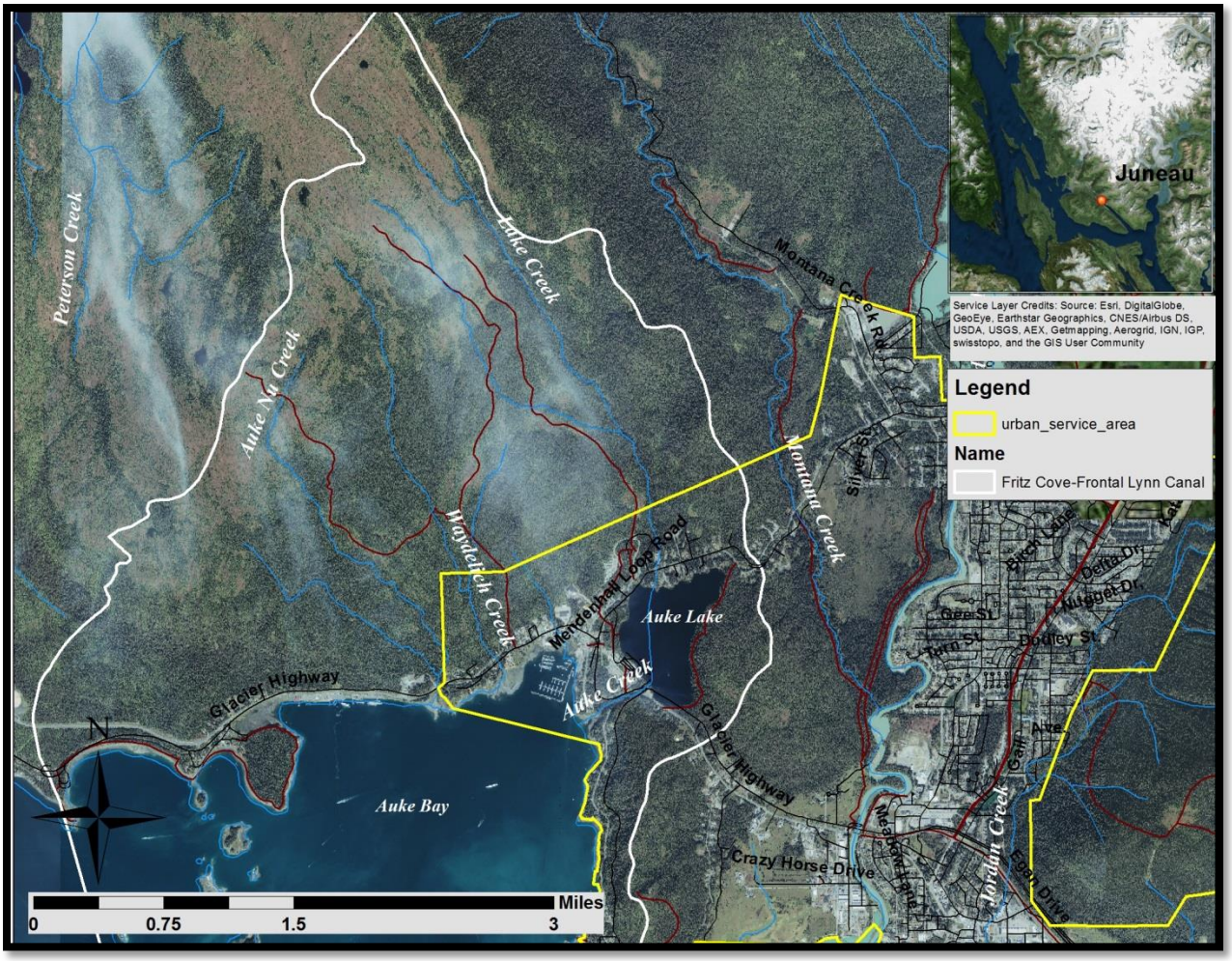

Figure 13. The Auke Nu Creek, Waydelich Creek, Auke Creek, Auke Lake, and Lake Two Creek watersheds located near Auke Bay. These watersheds are part of the Hydrologic Unit Code (HUC) Fritz Cove – Frontal Lynn Canal. Note that the HUC boundary does not correspond with the watershed boundaries for these individual streams.

Auke Nu Creek

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Conditions

Auke Nu Creek is located in Auke Bay, and can be accessed by Glacier Highway at approximately MP 13.2 (Figure 13). It drains a watershed of approximately one square mile and discharges into Auke Nu Cove, at the north end of Auke Bay. This watershed is at the edge of the USAB, with only a small portion within the USAB limits (Figure 13).

Auke Nu Creek is an anadromous waterbody that supports Dolly Varden, pink and chum salmon. Auke Nu Cove has sensitive eelgrass beds that are important as food, attachment substrate and shelter for a variety of organisms. The anadromous habitat is limited in this system due to the gradient, flow velocity, stream bed substrate and natural fish passage barriers. The rearing habitat potential is fair, and primarily exists in pools below small falls and bedrock steps. There is a barrier falls on the mainstem about a quarter-mile upstream from Glacier Highway. The tributary is accessible to anadromous fish for only 200 yards of its length. The presence of bedrock and large boulders limits the stream's spawning habitat potential. Much of the spawning habitat is located in the intertidal area below Glacier Highway.

There is limited information available regarding the conditions of Auke Nu Creek. A seafood processing plant was constructed in the lower watershed near Auke Nu Cove in 2005. Concerns were expressed regarding the potential impacts of the plant on the sensitive eelgrass beds located in the cove. There is also an abandoned, flooded mine shaft near the confluence of the mainstem and tributary.

Much of the upper watershed is on public land and remains mostly undeveloped, except for a U.S. Forest Service trail and cabin. There is some residential development adjacent to Glacier Highway. Auke Nu Creek was impacted in the past by the construction of Glacier Highway, but it is thought that the

stream has mostly recovered. However, the Alaska Department of Fish and Game has categorized the Glacier Highway culvert as a "gray culvert," which means that it may impact fish passage.

The 2012 Integrated Report lists Auke Nu Creek as a Category 3 waterbody, which means there is insufficient or no data for DEC to determine whether water quality standards are attained. Auke Nu Creek was nominated by the DEC for Alaska Clean Water Action due to concerns regarding water quality. Pollutants of concerns include nutrients, oils and grease, siltation and sedimentation, turbidity, and debris, foam and scum. Suspected sources of water quality concerns include development, urban runoff, highway maintenance practices, wastewater systems, petroleum spills/leaks, fish waste and draining/filling of wetlands. Due to the minimal development in the watershed, Auke Nu Creek is unlikely to have water quality impacts to the extent of being an impaired stream. However, the water quality of the estuarine environment of Auke Nu Cove may be a concern.

Hydrologic Processes

Auke Nu Creek mainstem adjacent to residential development is classified within the Moderate Gradient Contained. The tributary is classified within the High Gradient Contained Process Groups. These process groups are associated with hillslope landforms and function as sediment transport channels. The mainstem is classified as a Small Moderate Gradient Contained Channel Type (MCS). MCS channels have moderate stream energy due to the moderate gradient and contained flows. Stream banks and side slopes of MCS channels contribute very little sediment to system. Typically there is significant bedrock control of the stream banks and stream bed. There is typically minimal anadromous fish habitat in MCM channels and these channels may not even be accessible to anadromous fish due to downstream barriers. These channel types have few management concerns.

The Auke Nu Creek tributary is categorized as a High Gradient Contained Deeply Incised Channel Type – Wetland Phase (HCDw). These channels are usually situated on hillslopes with undulating terrain dominated by wetlands such as muskegs. The channel sideslopes of HCD channels are highly unstable and have high sediment input potential. Stream flow in these channels responds quickly to rainfall events. There may be short term storage of sediment where large woody debris can trap sediment. These channels have negligible amounts of anadromous habitat and are generally not accessible to anadromous fish due to high flows, high gradients, seasonally low water and downstream barriers.

Past Recommendations

There are no site specific recommendations in the literature for restoration, enhancement, or mitigation measures within the Auke Nu Creek watershed. The DEC Alaska Clean Water Action suggests that water quality monitoring is needed.

There are also management and enhancement recommendations for MCS and HCD channels that are applicable to Auke Nu Creek.

- Design and construction of infrastructure should consider:
    - High bed and debris loads from HCD channels can pose a risk to downstream crossing structures

- Stream bank and sideslope disturbance associated with road cuts alongside HCD channels may result in mass wasting and significant sediment inputs

Conclusion

The JWP does not recommend conducting an extensive field assessment for Auke Nu Creek at this time, as the upper watershed has not been heavily impacted and is considered to be in relatively pristine condition. However, JWP does recommend evaluating the Glacier Highway culvert to determine whether it is a barrier to fish passage and conducting an abbreviated assessment of the lower watershed to identify other site-specific restoration, enhancement and mitigation measures in the lower watershed. Since Auke Nu Creek does not appear to require extensive restoration, enhancement or mitigation measures, the JWP recommends this creek as a low-priority watershed at this time.

Waydelich Creek

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Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

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Conditions

Waydelich Creek (Wadleigh Creek is also used in literature) is located in Auke Bay (Figure 13). The creek's mainstem is approximately two miles long and discharges into the west side of Auke Bay. It drains a watershed of approximately one square mile. Waydelich Creek is an anadromous waterbody that supports Dolly Varden, pink and chum salmon.

Much of the watershed is on public land and remains undeveloped. Only the lower portion of watershed is located within the USAB (Figure 13). It has been impacted in the past by the construction of Glacier Highway and a water system for a condominium complex, which is no longer in operation. The culvert passing the creek under Glacier Highway presents a fish passage barrier as does the dam for the water system. The developers of the water system were required to enhance the spawning area downstream of the dam as mitigation, but heavy stream flows have scoured this section of the stream.

Upstream of Glacier Highway, Waydelich Creek provides rearing habitat for resident Dolly Varden. There are numerous small falls above Glacier Highway that are potential natural barriers to upstream migration. The intertidal area provides spawning for pink and chum salmon.

The 2012 Integrated Report does not list Waydelich Creek in any other Category; therefore, it is assumed to be a Category 1 waterbody meeting State Water Quality Standards. This assumption seems fair, given the limited development in the watershed that would lead to water quality impairment. However, there is limited water quality data to support this.

Hydrologic Processes

Waydelich Creek has a short reach below Glacier Highway classified in the Estuarine Process Group. Just below Glacier Highway to the confluence of the mainstem and tributary, the creek is classified within the Moderate Gradient Contained Process Group.

The Waydelich Creek estuarine channel is categorized as a Small Estuarine Channel Type – Cobble Substrate Phase (ESSc). The ESSc channel functions as a deposition channel. However, this channel type phase occur on where there is a rapid transition from higher energy streams. This allows sediment to be readily flushed during flood or storm events. Stream banks of ESSc channels are moderately sensitive to erosion, but bank erosion is more influenced by tidal movement and beach erosion processes than stream flow. Though these channels tend to have limited fish habitat due to erosion processes and stream flows, they provide migration corridors to upstream habitat.

Medium Moderate Gradient Contained Channel Type (MCM) is primarily sediment transport channels. Stream flow is typically contained in within the channel or adjacent landforms, often with bedrock control of the channel banks and stream bed. Stream bank erosion is variable due to bedrock control. Stream energy is high due to the moderate gradient and containment of high flows. Shallow organic soils and weathered bedrock on channel side slopes are susceptible to mass wasting. Culverts are generally not appropriate on these channels due to high flows and debris transport; however, suitable bridge crossing sites can be difficult to identify.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Replace the Glacier Highway Culvert
- Remove the dam
- Restore conditions in the previously enhanced spawning area

There are also management and enhancement recommendations for ESSc and MCM channels that are applicable to Waydelich Creek.

- Management and protection measures should consider:
    - stream channel protection (ESSc channels)
    - controlling construction in riparian areas (ESSc channels)

    - controlling in-stream operations (ESSc channels)
- Design and construction of infrastructure should consider:
    - culverts should not impede fish passage (ESSc channels)
    - culverts are generally not appropriate crossing structures due to flow volume and debris transport potential (MCM channels)
    - Unstable channel sideslopes should be considered in the location, design and construction of roads within or adjacent to riparian areas (MCM channels)
- Enhancement opportunities include:
    - Placing large woody debris or large boulders to create pool habitat (MCM channels)
    - Modify barriers where sufficient upstream habitat is sufficient (MCM channels)

Conclusion

The JWP does not recommend conducting an extensive field assessment for Waydelich Creek at this time, as the upper watershed has not been heavily impacted and is in relatively pristine condition. However, JWP recommends an abbreviated field assessment of the lower watershed to confirm whether recommendations identified in the past continue to remain valid and to identify any other site-specific restoration, enhancement and mitigation measures. The JWP recommends Waydelich Creek as a low-priority watershed at this time.

Auke Creek

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Conditions

Auke Creek is located in Auke Bay (Figure 13). Auke Creek is a 0.3 mile anadromous stream that begins at Auke Lake and discharges into Auke Bay. It is part of a 2,500 acre watershed that includes Auke Lake and its six inlet streams. Auke Lake and the inlet streams of Lake Creek, Lake Two Creek, and UAJ Creek are discussed separately in this report. Auke Creek supports coho, pink, chum, and sockeye salmon, cutthroat and rainbow trout, and Dolly Varden.

Auke Creek is located entirely within the USAB (Figure 13). The creek has been impacted by the construction of Glacier Highway and Fritz Cove Road, as well as adjacent residential development. However, development and other land use activities occurring upstream in the watershed (e.g. Auke Lake and Lake Creek) could also impact Auke Creek. The Glacier Highway crosses over Auke Creek just below the lake outlet.

In terms of fish populations, Auke Creek is a small but very productive stream. Auke Creek provides good rearing and spawning habitat, as there are many pools with overhead vegetation providing good cover. The upper section of the stream was enhanced with channel stabilization and placement of high quality spawning gravel. In 1963, Auke Creek was modified when the National Marine Fisheries Service (NMFS) installed a water pipe from Auke Lake to the lab and added a spawning channel in the upper portion of the creek. Floods have washed large amounts of the cobble downstream and the upper portion is reverting to bed rock.

The Alaska Department of Fish and Game (ADF&G) for Alaska Clean Water Action due to concerns regarding impacts to fish habitat. Concerns include loss of rearing and spawning habitat, fish passage, and loss of vegetation, low flow, and low dissolved oxygen. The Auke Creek weir and three side-by-side box culverts were potential fish passage barriers. These culverts are currently rated “gray” by ADF&G. There is a fish ladder to assist fish in migrating upstream.

The 2012 Integrated Report lists Auke Creek as a Category 3 waterbody, concluding there is not enough data on Auke Creek’s water quality to determine whether it can support its designated uses. Auke Creek was nominated for Alaska Clean Water Action due to concerns about water quality. Pollutants of concerns include nutrients, oils and grease, and filling and draining. Since Auke Creek drains Auke Lake, polyaromatic hydrocarbons (PAH) may be a concern (see information for Auke Lake, beginning on page 50). Suspected sources of water quality concerns include development, urban runoff, wastewater systems, petroleum spills/leaks, and removal of riparian vegetation.

Samples collected from Auke Lake and Auke Creek to assess the water supply for use in research facilities at Auke Bay Laboratories indicated that selenium, arsenic, copper, lead, mercury, and silver exceeded some parameters may exceed EPA drinking water standards. However, little other water quality information is available.

Hydrologic Processes

Auke Creek includes channel segments in the Estuarine and Moderate Gradient Contained Process Groups. The Auke Creek estuarine channel is categorized as a Small Estuarine Channel Type – Cobble Substrate Phase (ESSc), which extends from the mouth of the creek to just beyond the extent of

vegetation. The ESSc channel functions as a deposition channel. However, this channel type phase occur on where there is a rapid transition from higher energy streams. This allows sediment to be readily flushed during flood or storm events. Stream banks of ESSc channels are moderately sensitive to erosion, but bank erosion is more influenced by tidal movement and beach erosion processes than stream flow. Though these channels tend to have limited fish habitat due to erosion processes and stream flows, they provide migration corridors to upstream habitat.

Medium Moderate Gradient Contained Channel Type (MCM) is primarily sediment transport channels. Stream flow is typically contained in within the channel or adjacent landforms, often with bedrock control of the channel banks and stream bed. Stream bank erosion is variable due to bedrock control. Stream energy is high due to the moderate gradient and containment of high flows. Shallow organic soils and weathered bedrock on channel side slopes are susceptible to mass wasting. Culverts are generally not appropriate on these channels due to high flows and debris transport; however, suitable bridge crossing sites can be difficult to identify.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Rehabilitate streambank located along Glacier Hwy.
- Re-establish spawning habitat where the potential exists
- Establish greenbelt on east shoreline to discourage development where drainage will be difficult to control

There are also management and enhancement recommendations for ESSc and MCM channels that are applicable to Auke Creek.

- Management and protection measures should consider:
    - stream channel protection (ESSc channels)
    - controlling construction in riparian areas (ESSc channels)
    - controlling in-stream operations (ESSc channels)
- Design and construction of infrastructure should consider:
    - culverts should not impede fish passage (ESSc channels)
    - culverts are generally not appropriate crossing structures due to flow volume and debris transport potential (MCM channels)
    - Unstable channel sideslopes should be considered in the location, design and construction of roads within or adjacent to riparian areas (MCM channels)
- Enhancement opportunities include:
    - Placing large woody debris or large boulders to create pool habitat (MCM channels)
    - Modify barriers where sufficient upstream habitat is sufficient (MCM channels)

Conclusion

The JWP recommends conducting a field assessment of Auke Creek to determine appropriate site-specific restoration, enhancement, and mitigation recommendations. Such recommendations should focus on improving conditions fish habitat and stormwater treatment. Due to the high use and

surrounding development, the Auke Creek/Auke Lake system would benefit from restoration, enhancement and mitigation measures. One such benefit would be to prevent the system from becoming impaired. Therefore, the JWP recommends Auke Creek as a medium-priority watershed at this time.

Auke Lake

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

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http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

JWP. 2009. Auke Lake Watershed Assessment.

Condition

Auke Lake is located in the Auke Bay area (Figure 13). It is approximately one mile long and three-fourths of a mile wide, with a surface area of 175 acres. It has a 2,500 acre watershed that includes six tributaries and one outlet stream (Auke Creek). The largest tributaries are Lake Creek and Lake Two Creek. Three of the smaller inlet streams have unofficial names: UAJ Creek, MB Creek and Hanna Creek. Lake Creek, Lake Two Creek, UAJ Creek and Auke Creek are addressed separately in this report.

Auke Lake is an anadromous water that supports coho, pink, chum and sockeye salmon, cutthroat and rainbow trout, and Dolly Varden. Additionally, the lake contains stickleback and cottids. With the exception of chum salmon, weir counts indicate Auke Lake salmon and trout populations are declining. Research indicates this may be attributed to regional factors such as climate change and water temperature fluctuations. Other factors that might contribute to the decline of salmon in Auke Lake is the condition of the flume and weir on Auke Creek , and lack of good salmon spawning conditions in Lake and UAJ creeks.

Auke Lake is located within the USAB, though much of the Auke Lake watershed is undeveloped (Figure 13). Residential development has occurred along Back Loop Road and Glacier Highway along the north, west, and southern edge of the lake. The University of Alaska campus and a research laboratory are also located in the watershed. A trail parallels the eastern side of the lake. Approximately 50 percent of the Auke Lake shoreline is developed. Auke Lake is one of the few road-accessible freshwater lakes in Juneau and, therefore, it is heavily used for recreational activities such as swimming, motorized and non-motorized boating, hiking, and biking.

The 2012 Integrated Report lists the Auke Lake as a Category 3 waterbody, which means there is insufficient or no data for DEC to determine whether water quality standards are attained. There has been concern about the effect of motorized watercraft use on Auke Lake's water quality. This concern has prompted water quality studies to assess polycyclic aromatic hydrocarbon (PAH) concentrations in

relation to recreational use of the lake. The National Marine Fisheries Service (NMFS) conducted periodic water quality sampling in Auke Lake from 1999 to 2003 for PAH discharges, in tandem with daily recreational boating observations. That study showed an increase in PAH concentrations in surface waters of Auke Lake coincided with the increase of two-stroke engine watercraft on the lake.

Past Recommendations

Numerous recommendations are included in the literature pertaining to Auke Lake. However, many of these are general, watershed-wide recommendations such as:

- Identify and map anadromous and resident fish habitat areas in the Auke Lake watershed
- Identify anadromous and resident fish habitat enhancement opportunities in the Auke Lake watershed
- Re-establish spawning habitat where the potential exists
- Conduct an invasive and noxious weed survey and create long term management plan for invasive weeds in the watershed
- Develop and implement a long term water quality monitoring plan to sample basic water quality parameters in Auke Lake
- Assess and map stormwater outfalls in the watershed
- Repair or improve existing stormwater treatment systems
- Rehabilitate disturbed streambanks, riparian areas, floodplains, and uplands where feasible to increase erosion resistance
- Educate boaters about clean boating practices, including safe and proper fuel storage and maintenance
- Educate the public about proper garbage and litter disposal at Auke Lake
- Educate the public about the impacts of dog waste on the watershed
- Conduct outreach and education to area landowners on streamside and lakeside stewardship practices in order to minimize shoreline impacts
- Work with Southeast Alaska Land Trust to identify easement or acquisition opportunities in critical habitat or passive recreation areas
- Establish greenbelt on east shoreline to discourage development where drainage will be difficult to control

The more site-specific recommendations for restoration, enhancement and mitigation measures include:

- Improve parking lot on Glacier Highway to reduce sediment transport
- Rehabilitate bank located along Glacier Hwy.
- Provide disposable dog waste bags at Auke Lake

Conclusion

Since Auke Lake is a high use area and it is suspected that current use has already resulted in impacts, the JWP recommends conducting a field assessment of Auke Lake to determine appropriate site-specific restoration, enhancement, and mitigation recommendations. Such recommendations should focus on

improving conditions near recreational facilities, enhancing fish habitat, and stormwater treatment. Due to the high use and surrounding development, the Auke Creek/Auke Lake system would benefit from restoration, enhancement and mitigation measures. One such benefit would be to prevent the system from becoming impaired. Therefore, JWP recommends Auke Lake as a medium-priority watershed at this time.

Lake Creek

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report. http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

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Cottingham, J. 2005. Alaska Clean Water Action (ACWA) Nomination Form: ACWA Identification Number AK-10301-012-00 – Lake Creek. Prepared for the Alaska Department of Conservation. http://dec.alaska.gov/water/acwa/huc/data3/19010301/lakecrk_nom.pdf

JWP. 2009. Auke Lake Watershed Assessment.

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Sowa, J. 2004. Alaska Clean Water Action (ACWA) Nomination Form: Lake Creek. Prepared for the Alaska Department of Fish and Game. http://dec.alaska.gov/water/acwa/huc/data3/19010301/lakecrk_adfg_nom.pdf

Condition

Lake Creek is located near Auke Bay (Figure 13). It is the largest of the six inlet streams that enter Auke Lake, making it the primary tributary to Auke Lake. The creek's main channel is approximately four miles in length. Lake Creek drains approximately 3.5 square miles of undeveloped forestland. Its headwaters rise nearly 1700 feet in elevation in a substantial forested/shrub wetland complex locally known as 'Spaulding Meadows.' The creek is an anadromous waterbody supporting coho, pink and sockeye salmon, Dolly Varden, cutthroat and rainbow trout.

Most of the land draining into Lake Creek is largely undeveloped and within the Tongass National Forest Boundaries. The lower part of the watershed is located within the USAB limits (Figure 13). The lower section of the watershed has some residential development off of Loop Road, which crosses the stream approximately 600 feet upstream from its outlet at Auke Lake. The lower Lake Creek watershed is vulnerable to future residential development.

Lake Creek provides the primary spawning habitat in the Auke Lake watershed, with most of the spawning habitat occurring in the lower 2,000 feet of the stream. However, the overall rearing habitat potential of the creek is low due to moderate gradients, small pools and sparse cover. A barrier falls is located approximately 1.25 miles upstream from the mouth.

The lower section of Lake Creek has been channelized to prevent flooding. This confined the stream to a single channel to prevent flooding on adjacent property. It has been anecdotally observed that the channel is aggrading in the lower reaches, and low flows go subsurface. Since this is occurring where the spawning habitat is located, this may affect spawning success.

The Alaska Department of Fish and Game (ADF&G) for Alaska Clean Water Action due to concerns regarding impacts to fish habitat. Concerns include loss of rearing and spawning habitat, fish passage, and loss of vegetation, low flow, low dissolved oxygen, sedimentation, and streambank erosion. Low flows seem to have resulted from the creek's being disconnected from the water table. A delta where the creek discharges to the lake has built up, preventing fish passage at low water levels. The bridge crossing on Glacier Highway and the channelization are also concerns.

The 2012 Integrated Report lists Lake Creek as a Category 3 waterbody, which means there is insufficient or no data for DEC to determine whether water quality standards are attained. Lake Creek was nominated by the DEC for Alaska Clean Water Action due to concerns regarding water quality. Pollutants of concerns include nutrients, oils and grease, and filling and draining. Suspected sources of water quality concerns include development, urban runoff, highway maintenance practices, wastewater systems, petroleum spills/leaks, and draining/filling of wetlands.

Hydrologic Processes

The entire length of Lake Creek within the USAB is classified within Moderate Gradient Contained Process Group, as a Medium Moderate Gradient Contained Channel Type (MCM). A MCM channel is primarily a sediment transport channel. Stream flow is typically contained in within the channel or adjacent landforms, often with bedrock control of the channel banks and stream bed. Stream bank erosion is variable due to bedrock control. Stream energy is high due to the moderate gradient and containment of high flows. Shallow organic soils and weathered bedrock on channel side slopes are susceptible to mass wasting.

Past Recommendations

There are no recommendations in the literature for restoration, enhancement, or mitigation measures.

- Rehabilitate bank on lower reaches, which were channelized

There are also management and enhancement recommendations for MCM channels that are applicable to Lake Creek.

- Management and protection measures should consider:
    - culverts are generally not appropriate crossing structures due to flow volume and debris transport potential

    - Unstable channel sideslopes should be considered in the location, design and construction of roads within or adjacent to riparian areas
- Enhancement opportunities include:
    - Placing large woody debris or large boulders to create pool habitat
    - Modify barriers where sufficient upstream habitat is sufficient

Conclusion

The JWP does not recommend conducting an extensive field assessment on Lake Creek at this time, as the upper watershed has not been heavily impacted and is in relatively pristine condition. However, the JWP recommends an abbreviated assessment on the lower section of the creek to determine if there's potential to address concerns identified in the literature review and identify other site-specific restoration, enhancement and mitigation measures in the lower watershed. Such recommendations should focus on improving fish habitat, fish passage, and water quality near the road and residential development. Due to Lake Creek providing the primary spawning habitat for the Auke Lake system, the JWP recommends Lake Creek as a medium-priority watershed at this time.

Lake Two Creek

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report. http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

JWP. 2009. Auke Lake Watershed Assessment.

Condition

Lake Two Creek (also known as Little Auke Creek) is located near Auke Bay. The mainstem is approximately 1.5 miles long, and it drains a watershed of approximately one square mile. While it is not shown in Figure 13, it is located east of Lake Creek.

Most of the land draining into Lake Two Creek is largely undeveloped and within the Tongass National Forest Boundaries. The lower section of the watershed is located within the USAB. There is some residential development off of Loop Road, which crosses the stream approximately 600 feet upstream from the lake outlet.

Lake Two Creek is an anadromous stream supporting coho, pink, and sockeye salmon, Dolly Varden and cutthroat trout. It provides excellent rearing and spawning habitat throughout. Sockeye salmon spawn

in the lower half of the stream, and the upper reaches are used by spawning coho, Dolly Varden and cutthroat. It is very productive for its size and important for Auke Lake fisheries. However, the culverts under Loop Road provide a barrier at lower water levels. An old water supply dam above the road could also be a barrier at low water flows.

The 2012 Integrated Report lists Lake Creek as a Category 3 waterbody, which means there is insufficient or no data for DEC to determine whether water quality standards are attained. However, Lake Two Creek has documented high fecal coliform accounts in the section flowing through the Windfall Lake subdivision, suggesting the water quality may be impacted by private sewage systems.

Hydrologic Processes

Lake Two Creek's channel has not been described and mapped by the U.S. Forest Service.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Terminate private water use and develop alternative sources
- Place large boulders in the stream at the Loop Rd. culverts to facilitate water flow and prevent gravel bars from forming
- Assess spawning habitat to determine if it can be improved

Conclusion

The JWP does not recommend conducting an extensive field assessment on Lake Two Creek at this time, as the upper watershed has not been heavily impacted and is in relatively pristine condition. However, the JWP recommends an abbreviated assessment on the lower section of the creek to determine if there's potential to address concerns identified in the literature review and identify other site-specific restoration, enhancement and mitigation measures in the lower watershed. During the assessment, recommendations should focus on improving fish habitat and fish passage. Due to its providing excellent spawning and rearing habitat, the JWP recommends Lake Two Creek as a medium-priority watershed at this time.

UAJ Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed
http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

JWP. 2009. Auke Lake Watershed Assessment.

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Condition

Little information exists in the literature about UAJ Creek. It is not shown in Figure 13 but it to the west of Lake Creek. UAJ Creek is listed as an anadromous waterbody, supporting populations of coho, Dolly Varden and cutthroat trout. In 1983, construction of University Drive to UAS housing completely rerouted lower UAJ creek. A culvert under University Drive is documented as a fish passage barrier by the Alaska Dept. of Fish and Game. UAJ Creek is not listed in the 2012 Integrated Report. However, rather than assuming that the creek is meeting Water Quality Standards, it is suspected that the creek's water quality may be impacted from adjacent development. For example, stormwater form the UAS access road discharges into UAJ creek, along with fine sediments may be impacting the creek. Since no water quality data exists for this creek, the extent of any impacts surrounding development may have had is unknown.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Rehabilitate banks on main stem
- Stormwater BMP at UAS Housing to treat run-off into creek
- Replace the University Drive culvert, which is a fish passage barrier.

Conclusion

Due to the lack of information on UAJ Creek, JWP recommends conducting a field assessment of UAJ Creek to determine appropriate site-specific restoration, enhancement, and mitigation recommendations. Such recommendations should focus on improving fish habitat and stormwater treatment. The JWP recommends UAJ Creek as a medium-priority watershed at this time.

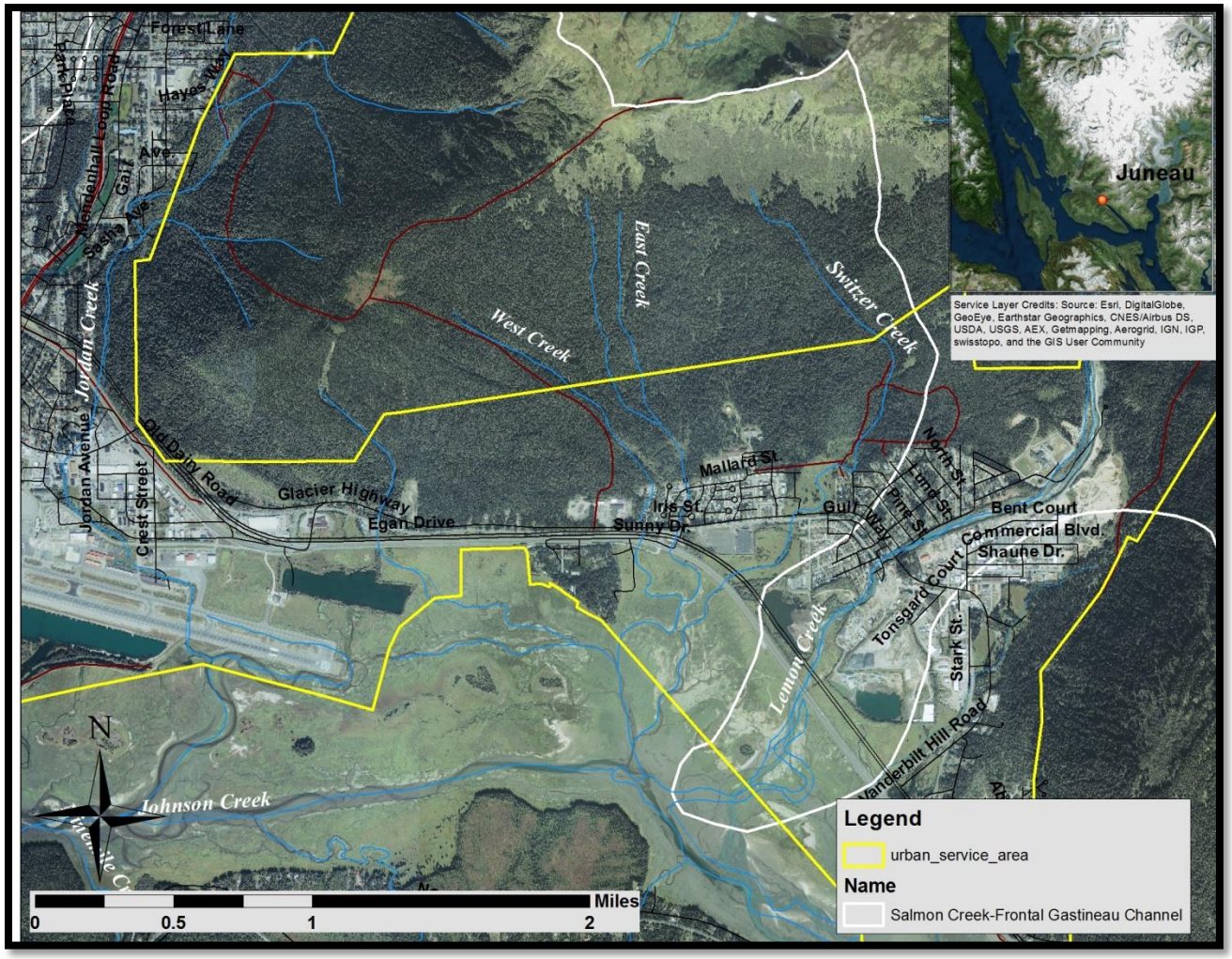

Figure 14. The West Creek, East Creek and Switzer Creek watersheds located near the Lemon Creek Valley. These watersheds are part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. Note that the HUC boundary does not correspond with the individual watershed boundaries for these streams.

West Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed
http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Conditions

West Creek (unofficial name) is located near the Lemon Creek valley (Figure 14). It is a small stream that is one mile long. It drains a watershed of approximately one square mile. It discharges into Gastineau Channel east of Sunny Point.

The headwaters of West Creek originate from the south side of Thunder Mountain, within the Tongass National Forest boundaries. However, the lower part of West Creek is within the USAB limits, and flows through the largest trailer park in Juneau (Figure 14). It has been impacted by two major road crossings Egan Drive and Glacier Highway, but seems to have recovered.

West Creek is listed as an anadromous waterbody, supporting populations of coho and pink salmon, and Dolly Varden. Pink salmon spawn in the intertidal area up to the Glacier Highway crossing. The tidally influenced reaches also provide excellent nursery habitat for marine species. Spawning and rearing coho salmon have been observed immediately upstream of Glacier Highway. However, the stream has low rearing potential for coho and resident fish above Glacier Highway due to fast moving water with few protected areas. A 5-foot high falls approximately three-fourths mile upstream is documented as a potential fish barrier.

A reservoir for the trailer park was located in the stream's headwaters. The gravel build up behind the dam was washed downstream when the dam was removed. The gravel impacted the culverts under Old Glacier Highway and downstream pools. Continued gravel removal has impacted spawning habitat in the lower section of the stream.

There is no information about West Creek's water quality. The 2012 Integrated Report does not list West Creek in any other Category. However, given the intense development around the creek, it is not safe to assume the creek is meeting State Water Quality Standards.

Hydrologic Processes

West Creek has reaches in the Estuarine and Palustrine Process Group below Egan Drive and Alluvial Fan Process Group directly above Egan Drive. Estuarine and palustrine channels are depositional channels

with low stream energy. Estuarine channels, however, are subject to tidal influence. The Palustrine Process Group is associated with low relief landforms and wetlands.

The West Creek Estuarine Process Group channels are classified as Small Estuarine Channel – Gravel Phase (ESSg). These channels are sensitive to sediment inputs and cumulative effects from upstream disturbance tend to be a management concern. Stream banks of estuarine channels are sensitive to erosion and bank erosion can be a significant source of sediment. However, bank erosion is predominantly influenced by tidal movement than stream flow. The West Creek Palustrine Process Group channels are classified as Small Palustrine Channel Type (PAS). In all Palustrine channels, streamflow and chemistry are influenced by peat bogs or wetlands, resulting in brown coloration and high tannic acids. Palustrine channels have less sensitive stream banks, though heavy uses (e.g. heavy foot traffic) can cause stream bank degradation.

Alluvial Fan Process Group channels are transitional channels on alluvial fans that are situated between steep slopes and flat valley bottoms. West Creek above Egan Drive is classified as a Moderate Gradient Alluvial Fan Channel Type (AFM). The channel gradients of an AFM channel can change from steep at the apex of the alluvial fan, through low gradient at the bottom. A range of sediment erosion, transport, and depositional processes occur in these channels. Erosion and transport occurs in the high and moderate gradient reaches while deposition occurs at the lower gradient reaches. Active deposition and channel aggradation result in formation of numerous side channels, though more active alluvial fans may have two or more main flow channels as well. Stream banks of AFM channels are naturally unstable and are sensitive to disturbance.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Replace the Lupine Dr. culvert to improve fish passage
- Determine the feasibility of implementing fish habitat improvements
- Stabilize gravel in the stream rather than continually removing material from the lower stream

There are also management and enhancement recommendations for ESS, PAS and AFM channels that are applicable to West Creek.

- Management and protection measures should consider:
    - controlling in-stream operations (ESS and PAS channels)
    - controlling construction in riparian areas (ESS channels)
    - stream channel protection (ESS channels)
    - controlling erosion (PAS channels)
    - protecting wetland functions and values (PAS channels)
- Design and construction of infrastructure should consider:
    - culverts may present fish passage barriers (PAS channels)

- avoid placing culverts at low gradient channel segments along the base of alluvial fans, as this may restrict upstream migration and culverts may be susceptible to clogging by sediment/woody debris
- incorporating an accelerated maintenance schedule for culverts (AFM channels)
- stabilizing road drainage structures (AFM channels)

- Enhancement opportunities include:
  - Introducing and managing beaver populations to increase habitat (PAS channels)
  - Placing large wood to increase pool/rearing habitat in stable channels while avoiding any methods that might destabilize channels (AFM channels)

Current Recommendations

The JWP does not recommend conducting an extensive field assessment for West Creek at this time. The JWP recommends an abbreviated field assessment of the lower watershed to identify opportunities for restoration, enhancement, or mitigation measures in sections of the creek that flow through developed areas. Such recommendations should focus on improving fish habitat and stormwater treatment. This abbreviated assessment should also confirm whether recommendations identified in the past continue to remain valid. Due to the heavily developed nature of the lower watershed, the JWP recommends West Creek as a medium-priority watershed at this time.

East Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed
http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Conditions

East Creek (unofficial name) is located near the Lemon Creek Valley (Figure 14). It is a small stream that is approximately 1.5 miles long, and drains a watershed of approximately one square mile. East Creek discharges into Gastineau Channel east of Sunny Point. The headwaters of East Creek are within the Tongass National Forest boundaries and are undeveloped. However, the lower part of East Creek is within the USAB limits, and flows through the largest trailer park in Juneau, Switzer Village (Figure 14). It has been impacted by two major road crossings Egan Drive and Glacier Highway, but is considered to have recovered.

East Creek is an anadromous stream supporting coho and pink salmon and Dolly Varden. Pink salmon and coho spawn in the creek. The stream has low rearing potential due to the high gradient channel and low frequency of pools. Rearing coho salmon have been observed in the stream to a point

approximately 100 feet upstream of the trailer park boundary. A small waterfall ¾ mile from the mouth is documented to be a potential barrier at some water levels.

There is no information about East Creek's water quality. The 2012 Integrated Report does not list East Creek in any other Category. However, given the intense development around the creek, it is not safe to assume the creek is meeting State Water Quality Standards.

Hydrologic Processes

East Creek has reaches in the Estuarine and Palustrine Process Group below Egan Drive and Alluvial Fan Process Group directly above Egan Drive. Estuarine and palustrine channels are depositional channels with low stream energy. Estuarine channels, however, are subject to tidal influence. The Palustrine Process Group is associated with low relief landforms and wetlands.

The East Creek Estuarine Process Group channels are classified as Small Estuarine Channel – Gravel Phase (ESSg). These channels are sensitive to sediment inputs and cumulative effects from upstream disturbance tend to be a management concern. Stream banks of estuarine channels are sensitive to erosion and bank erosion can be a significant source of sediment. However, bank erosion is predominantly influenced by tidal movement than stream flow. The East Creek Palustrine Process Group channels are classified as Small Palustrine Channel Type (PAS). In all Palustrine channels, streamflow and chemistry are influenced by peat bogs or wetlands, resulting in brown coloration and high tannic acids. Palustrine channels have less sensitive stream banks, though heavy uses (e.g. heavy foot traffic) can cause stream bank degradation.

Alluvial Fan Process Group channels are transitional channels on alluvial fans that are situated between steep slopes and flat valley bottoms. East Creek above Egan Drive is classified as a Moderate Gradient Alluvial Fan Channel Type (AFM). The channel gradients of an AFM channel can change from steep at the apex of the alluvial fan, through low gradient at the bottom. A range of sediment erosion, transport, and depositional processes occur in these channels. Erosion and transport occurs in the high and moderate gradient reaches while deposition occurs at the lower gradient reaches. Active deposition and channel aggradation result in formation of numerous side channels, though more active alluvial fans may have two or more main flow channels as well. Stream banks of AFM channels are naturally unstable and are sensitive to disturbance.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Replace the Schneider Dr. culvert to improve fish passage
- Determine the feasibility of implementing fish habitat improvements

There are also management and enhancement recommendations for ESS, PAS and AFM channels that are applicable to East Creek.

- Management and protection measures should consider:

    - controlling in-stream operations (ESS and PAS channels)
    - controlling construction in riparian areas (ESS channels)
    - stream channel protection (ESS channels)
    - controlling erosion (PAS channels)
    - protecting wetland functions and values (PAS channels)
- Design and construction of infrastructure should consider:
    - culverts may present fish passage barriers (PAS channels)
    - avoid placing culverts at low gradient channel segments along the base of alluvial fans, as this may restrict upstream migration and culverts may be susceptible to clogging by sediment/woody debris
    - incorporating an accelerated maintenance schedule for culverts (AFM channels)
    - stabilizing road drainage structures (AFM channels)
    - bridge crossing at the apex is the most suitable stream crossing option (AFM channels)
- Enhancement opportunities include:
    - Introducing and managing beaver populations to increase habitat (PAS channels)
    - Placing large wood to increase pool/rearing habitat in stable channels while avoiding any methods that might destabilize channels (AFM channels)

Current Recommendations

The JWP does not recommend conducting an extensive field assessment for East Creek at this time. However, the JWP recommends an abbreviated field assessment of the lower watershed to identify opportunities for restoration, enhancement, or mitigation measures in sections of the creek that flow through developed areas. Such recommendations should focus on improving fish habitat and stormwater treatment. This abbreviated assessment should also confirm whether the Schneider Dr. culvert continues to impede fish passage. Due to the heavily developed nature of the lower watershed, JWP recommends East Creek as a medium-priority watershed at this time.

Switzer Creek

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report. http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Conditions

Switzer Creek is located near the Lemon Creek valley (Figure 14). It is a small, spring-fed stream that is one mile long and discharges into Gastineau Channel east of Sunny Point. Nearly the entire length is tidally influenced. There are four tributaries, two of which enter the mainstem in the meadow upstream of Glacier Highway (Wimpy tributary and East Marriott tributary) and two that enter further upstream in the forested reaches (Robin tributary and West Marriott tributary). The stream provides excellent spawning and rearing habitat, and supports populations of coho, pink, and chum salmon, Dolly Varden and cutthroat trout.

The watershed downstream of Egan Drive is in a mostly natural state. The tidally influenced reach between Egan and Glacier Highway has been channelized, but is located on private property. The mainstem upstream of Glacier Highway is located between two residential developments. Two of the Switzer Creek tributaries flow through or adjacent to developed areas (Wimpy and West Marriott tributaries).

Several well-used recreational trails are also located in the watershed. Litter is problematic on the portions of the trail system immediately adjacent to residential areas. There is also bank erosion in more frequently visited areas.

Large portions of the watershed are owned by the City and Borough (CBJ), which has kept these areas from being developed. However, the CBJ is planning to open land in the Switzer Creek watershed for residential development within the foreseeable future. A major residential subdivision adjacent to the creek is currently in the permitting stages.

Clear cutting in the headwaters during the 1960s may have been a source of fine sediment which has deposited in downstream pools until the area recovered. Although these areas naturally revegetated and are no longer contributing sediment downstream, some downstream pools continue to retain this sediment effecting habitat quality. This was most notable in 'Spring Pond' which was documented to be 8 feet in depth in the 1970s but is now less than half this depth.

The 2012 Integrated Report does not list Switzer Creek in any other Category. Therefore, Switzer Creek is assumed to be a Category 1 waterbody, meeting State Water Quality Standards. However, there is limited water quality data to support this. It is possible that stormwater from adjacent development is -impacting water quality, particularly in the Wimpy and Marriott tributaries. However, the extent of the impact this has on Switzer Creek is unknown.

Hydrologic Processes

Switzer Creek has an estuarine channel below Egan and palustrine above Egan, for most of the stream's length within the USAB. A small segment within the USAB is alluvial fan channel. East Creek has reaches in the Estuarine and Palustrine Process Group below Egan Drive and Alluvial Fan Process Group directly above Egan Drive. Estuarine and palustrine channels are depositional channels with low stream energy. Estuarine channels, however, are subject to tidal influence. The Palustrine Process Group is associated with low relief landforms and wetlands.

The Switzer Creek Estuarine Process Group channels are classified as Small Estuarine Channel – Gravel Phase (ESSg). These channels are sensitive to sediment inputs and cumulative effects from upstream disturbance tend to be a management concern. Stream banks of estuarine channels are sensitive to erosion and bank erosion can be a significant source of sediment. However, bank erosion is predominantly influenced by tidal movement than stream flow. The Switzer Creek Palustrine Process Group channels are classified as Small Palustrine Channel Type (PAS). In all Palustrine channels, streamflow and chemistry are influenced by peat bogs or wetlands, resulting in brown coloration and high tannic acids. Palustrine channels have less sensitive stream banks, though heavy uses (e.g. heavy foot traffic) can cause stream bank degradation.

Alluvial Fan Process Group channels are transitional channels on alluvial fans that are situated between steep slopes and flat valley bottoms. Switzer Creek above Egan Drive is classified as a Moderate Gradient Alluvial Fan Channel Type (AFM). The channel gradients of an AFM channel can change from steep at the apex of the alluvial fan, through low gradient at the bottom. A range of sediment erosion, transport, and depositional processes occur in these channels. Erosion and transport occurs in the high and moderate gradient reaches while deposition occurs at the lower gradient reaches. Active deposition and channel aggradation result in formation of numerous side channels, though more active alluvial fans may have two or more main flow channels as well. Stream banks of AFM channels are naturally unstable and are sensitive to disturbance.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Maintain wide buffers in future developments
- Determine the feasibility for removing fine sediments in pools

There are also management and enhancement recommendations for ESS, PAS and AFM channels that are applicable to West Creek.

- Management and protection measures should consider:
    - controlling in-stream operations (ESS and PAS channels)
    - controlling construction in riparian areas (ESS channels)
    - stream channel protection (ESS channels)
    - controlling erosion (PAS channels)
    - protecting wetland functions and values (PAS channels)
- Design and construction of infrastructure should consider:
    - culverts may present fish passage barriers (PAS channels)
    - avoid placing culverts at low gradient channel segments along the base of alluvial fans, as this may restrict upstream migration and culverts may be susceptible to clogging by sediment/woody debris
    - incorporating an accelerated maintenance schedule for culverts (AFM channels)
    - stabilizing road drainage structures (AFM channels)

- Enhancement opportunities include:
    - Introducing and managing beaver populations to increase habitat (PAS channels)
    - Placing large wood to increase pool/rearing habitat in stable channels while avoiding any methods that might destabilize channels (AFM channels)

Conclusion

JWP does not recommend conducting an extensive field assessment for Switzer Creek at this time. However, JWP recommends an abbreviated field assessment of the lower watershed, particularly on the Wimpy and Marriott tributaries, to identify opportunities for restoration, enhancement, or mitigation measures in sections of the creek that flow through developed areas. Such recommendations should focus on improving fish habitat, stormwater treatment, and conditions near recreational facilities. This abbreviated assessment should also confirm whether recommendations identified in the past continue to remain valid. It is also recommended to use the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future residential development. JWP recommends Switzer Creek as a medium-priority watershed at this time.

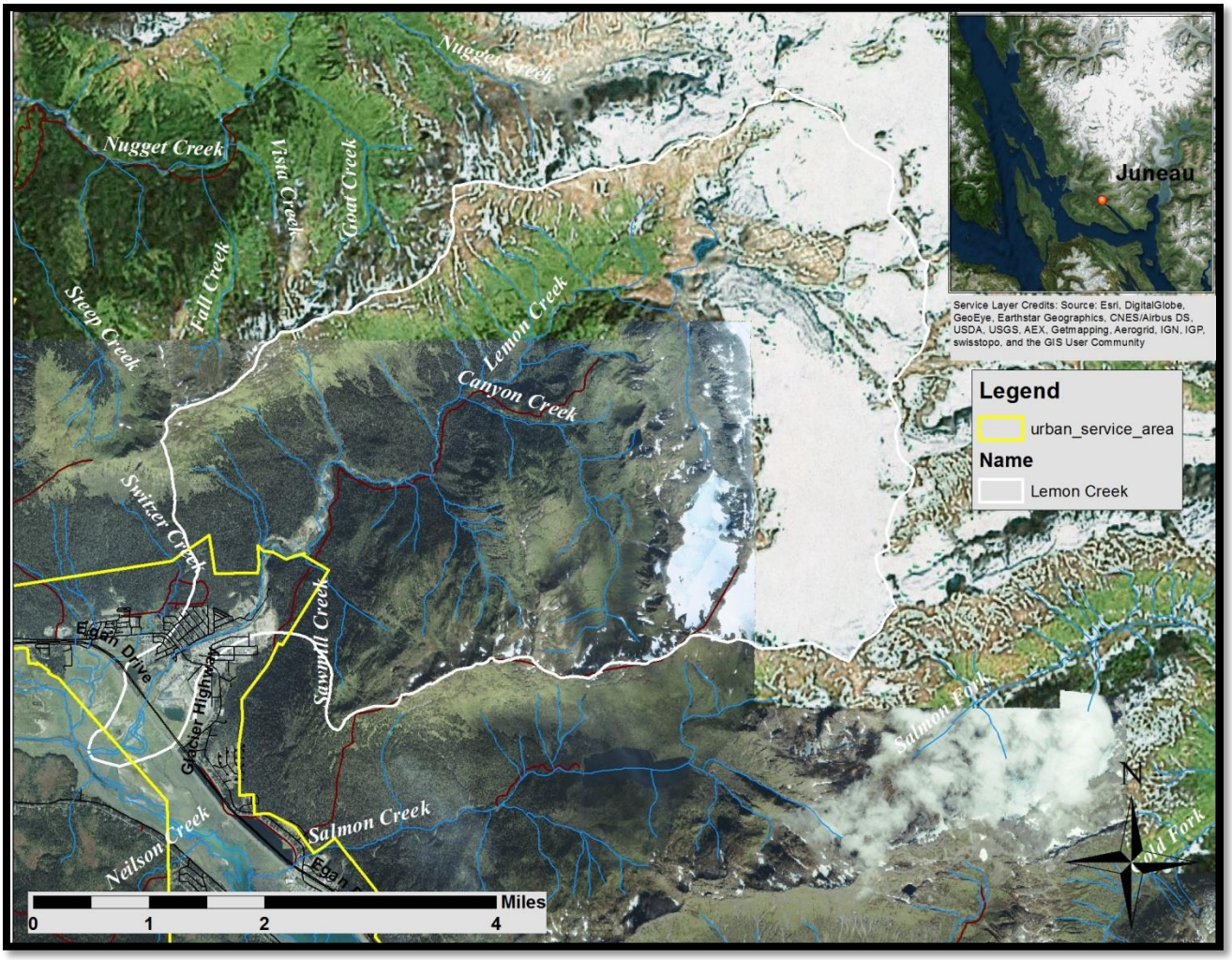

Figure 15. The Lemon Creek watershed located in the Lemon Creek Valley. This watershed is part of the Hydrologic Unit Code (HUC) #190103010605 – Lemon Creek. Note that the HUC corresponds with the individual watershed boundary for this stream.

Lemon Creek

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Conditions

Lemon Creek is situated in the center of the Lemon Creek Valley (Figure 15). 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, within the USAB limits, 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 non-attainment of water quality standards for turbidity, sediment and habitat modification. Urban run-off and gravel mining were identified as the probable pollutant sources.

Hydrologic Processes

Lemon Creek below Glacier Highway is classified within the Estuarine Process Group. Above Glacier Highway, Lemon Creek within the boundaries of the USAB is classified within the Floodplain Process Group. Channels within both Process Groups function as sediment deposition channels.

Lemon Creek below Glacier Highway is defined as a Large Estuarine Channel Type (ESL). ESL channels are sensitive to sediment inputs and cumulative effects from upstream disturbance tend to be a management concern. Stream banks of ESL estuarine channels are sensitive to erosion and bank erosion can be a significant source of sediment.

Above Glacier Highway, Lemon Creek is defined as a Large Floodplain Channel Type (FPL). These channels typically have extensive valley flood plains and river terraces. Smooth meander bends, numerous overflow side channels, extensive gravel bars and large log jams are common. Low gradient and poor flow containment lead to low stream power. Retention of fine sediments is high; therefore, FPL channels are sensitive to sediment inputs and cumulative effects from upstream disturbance. Fine sediments are transported during high/peak flow events.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Provide bear proof garbage receptacles along new bike/pedestrian path on north bank
- Stabilize disturbed hillslopes and historic sidecast areas adjacent to the access road in and below gorge area
- Identify, map, and control historic and recent gravel mining sidecast areas and overburden storage sites
- Require mining operators to store sidecast and overburden at least 25 ft away from the creek
- Improve rearing habitat in lower reaches by adding woody debris, natural vegetation, and side channels
- Stabilize eroding banks in lower reaches
- Incorporate sediment and turbidity controls into future stormwater systems
- Improve haul road surface and embankments
- Create small vegetated berm along the creekside edge of road to direct run-off into catchment basins
- Identify, map and rehabilitate/stabilize locations of actively eroding banks, particularly in Hidden Valley area
- Maintain or re-establish riparian buffers, particularly near critical habitat areas

There are also management and enhancement recommendations for ESL and FPL channels that are applicable to Lemon Creek.

- Management and protection measures should consider:
    - Controlling erosion and sediment sources (ESL and FPL channels)
    - stream bank protection (ESL and FPL channels)
    - protecting wetland functions and values (ESL channels)
    - protecting riparian habitat (ESL channels)
    - controlling road drainage and maintenance (ESL channels)
    - Protecting floodplain (FPL channels)
- Enhancement opportunities include:
    - Placing large woody debris using design and anchoring methods that consider tidal movement (ESL channels)
    - Maintaining sources of large wood or placing large woody debris where large wood is limited (FPL channels)
    - Stocking fry where rearing habitat is underutilized (FPL channels)
    - Constructing spawning channels where adequate groundwater upwelling is present (FPL channels)

Conclusion

The JWP does not recommend conducting a field assessment on Lemon Creek at this time. The JWP recommends conducting interviews with agency personnel to determine where existing revetments could be enhanced to improve riparian habitat. The JWP recommends Lemon Creek as a medium-priority watershed at this time.

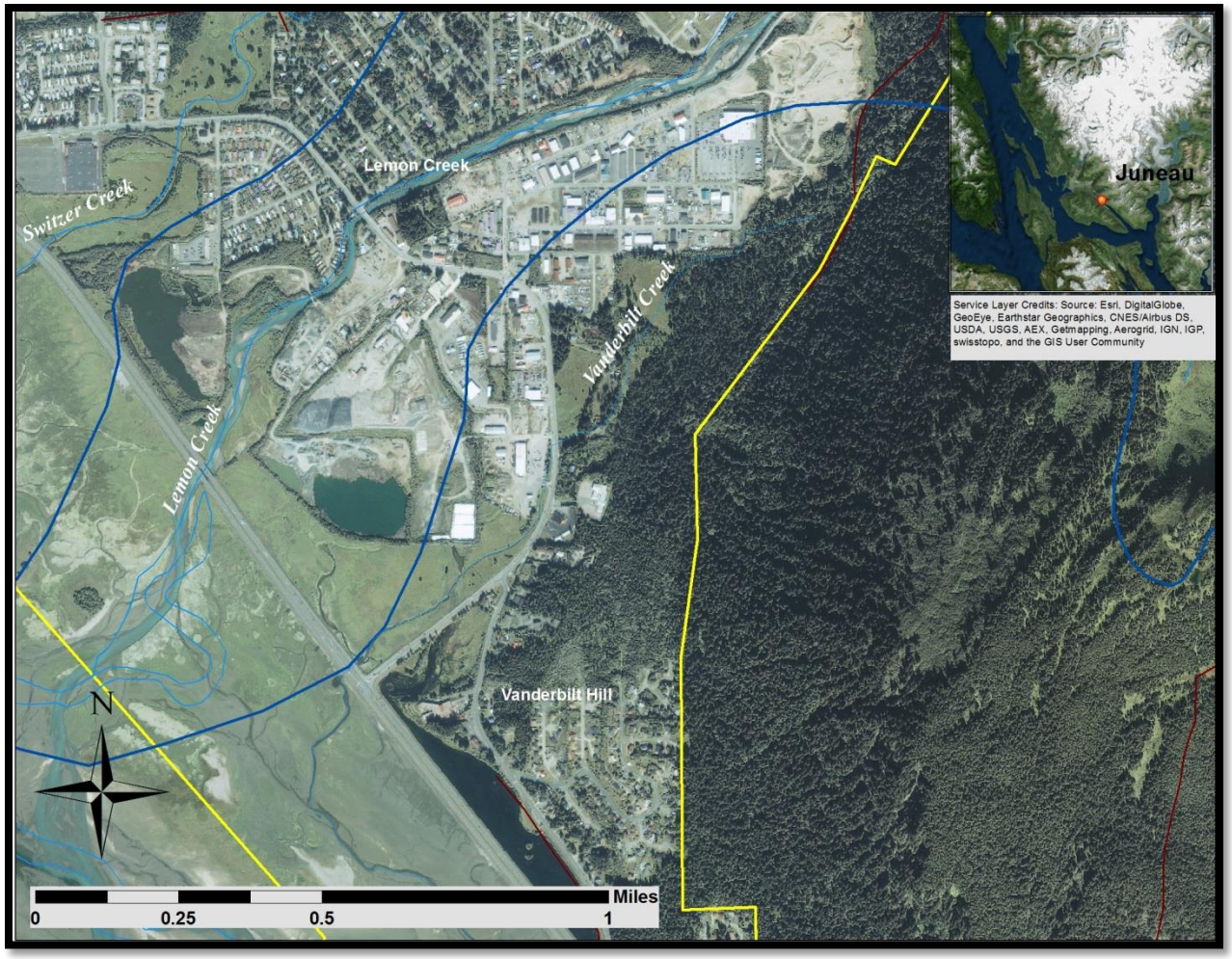

Figure 16. The Vanderbilt Creek watershed located near the Lemon Creek Valley. This watershed is part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. Note that the HUC boundary does not correspond with the individual watershed boundary for this stream.

Vanderbilt Creek

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Condition

Vanderbilt Creek is located on the eastern side of the Lemon Creek Valley (Figure 16). 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. Later, when the area changed to commercial and industrial use, the runoff was re-routed into Lemon Creek. A section downstream of Glacier Highway was re-established in the 1970s after being impacted by commercial development.

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.

Hydrologic Processes

Vanderbilt Creek has not been assessed and mapped by Stream Process Group and Channel Types.

Past Recommendations

The literature review identified several recommendations for restoration, enhancement, or mitigation measures. These are:

- Improve stormwater quality at Short Street grate
- Improve stormwater quality at Glacier Highway drainage pipe
- Provide bear proof garbage receptacles in at Lemon Creek Trail
- Replace culverts on Glacier Hwy. near north entrance of Western Auto/Grant Plaza
- Replace culverts on Lemon Creek Trail that are small and/or perched
- Redesign Lemon Creek Trail where it is a former gravel road; gravel road acts as a dike, affecting hydrology
- Remove creosote bridges and abutments on Glacier Hwy at Western Auto and Jerry's Meats
- Replace culverts on Glacier Hwy. near mouth of creek
- Treat stormwater from industrial area routed along Jenkins, Anka and Glacier Hwy

Conclusion

Given the impaired status of Vanderbilt Creek and the numerous past recommendations, JWP recommends conducting a field assessment of Vanderbilt Creek to determine more site-specific restoration, enhancement, and mitigation recommendations. Such recommendations should focus on improving fish habitat and stormwater treatment. JWP recommends that this be a high-priority watershed at this time.

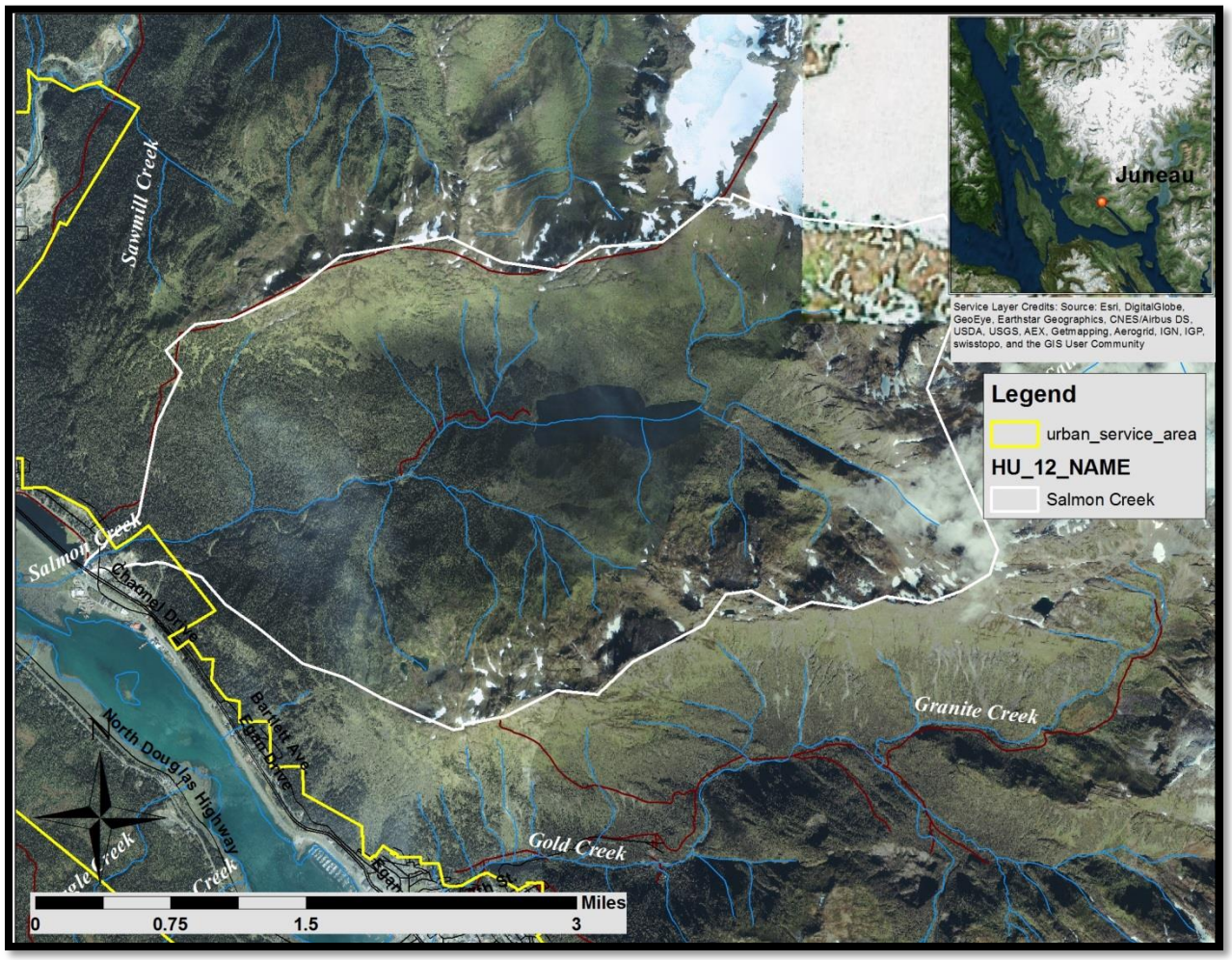

Figure 17. The Salmon Creek watershed located accessible from Glacier Highway. This watershed is part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. Note that the boundary shown corresponds with the individual watershed boundary for this stream.

Salmon Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
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Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Condition

Salmon Creek drains a watershed of nine square miles (Figure 17). Salmon Creek has been modified with a large dam to create the Salmon Creek Reservoir, which provides hydropower and a secondary drinking water source to Juneau. The creek's mainstem is approximately three miles long from its outlet in the Gastineau Channel to the Salmon Creek reservoir.

Salmon Creek is an anadromous waterbody supporting populations of coho, pink and chum salmon, Dolly Varden and brook trout. A falls approximately one-eighth of a mile upstream of the mouth provides a natural barrier to fish passage. Below the barrier, Salmon Creek provides excellent spawning habitat. However, the creek lacks pools and areas of slow water that provide good rearing habitat.

The Salmon Creek Reservoir started providing drinking water in 1984, and is an intermittent source of water due to seasonal high turbidity levels and maintenance of the hydroelectric generator. The Salmon Creek Watershed Control Program was adopted on October 13, 1992 by the CBJ Assembly. This plan and associated ordinances control the activities in the watersheds to ensure that the water sources are not adversely impacted in either water quality or water quantity.

Operation of the hydroelectric plant causes great fluctuations in stream flows, and has cause flows capable of scouring the channel. The Douglas Island Pink and Chum Salmon (DIPAC), Inc. operates a fish hatchery on Gastineau Channel that gets water supply from the Lower Salmon Creek Power House. Historic impacts to Salmon Creek include gravel mining in the lower watershed downstream of Old Glacier Highway during the 1970s and construction of Old Glacier Highway and Egan Drive. However, Salmon Creek is considered to have recovered from these impacts.

The 2012 Integrated Report lists Salmon Creek as a Category 3 waterbody, which means there is limited or no information for DEC to determine whether the creek is meeting State Water Quality Standards. However, it is protected as a drinking water source.

Hydrologic Processes

Salmon Creek from Egan Drive to just above Glacier Highway is classified in the Floodplain Channel process group, with a Medium Flood Plain Channel Type (FPM). This process group is defined by high

stream flows that are typically not contained within the active channel and, therefore, having some degree of floodplain development. These channels are dominated by well-defined pools, riffles and gravel bars. Input of large woody debris is a major factor influencing pool development. FPM channels are generally associated with extensive riparian areas that may include sloughs, side channels, and small spring fed tributaries. Both bank erosion and bank building processes occur in FPM channels, and stream banks are susceptible to erosion. Retention of sediment is high; however, sediment transport occurs during high flows. These channels are sensitive sediment introduction from headwater areas and, due to high sediment retention, can be susceptible to cumulative impacts.

Above the FPL channel, Salmon Creek is a Medium Width Modern Gradient Mixed Control Channel Type (MMM). MMM channels function for sediment transport, and have moderate stream energy due to moderate gradient and somewhat contained flows. These channels are often confined by landform but can develop narrow floodplains. Bedrock knickpoints with cascades may be present. Significant stream bank erosion and lateral channel migration can occur, particularly during high flow events. Disturbance of riparian vegetation can accelerate channel scour and lateral channel migration. Large woody debris has a significant influence on channel morphology and fish habitat in MMM channels. Log jams can stabilize stream bed substrate and can create pool habitats.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Maintain existing fish habitat values
- Coordinate a water use program with the power company to maintain minimum flows

There are also management and enhancement recommendations for a FPM channel that are applicable for Salmon Creek. These are:

- Management and protection measures should focus on:
    - Controlling erosion (FPM channel)
    - Protecting stream banks (FPM channel)
    - Controlling in-stream operations (FPM channel)
    - Maintain sources of large wood sources (MMM channel)
- Design and construction of infrastructure should consider:
    - Bridges should be used for stream crossings (FPM and MMM channels)
    - Culverts will generally not meet fish passage requirements (MMM channel)
    - Bedload and woody debris transport pose a risk to downstream culverts and bridges (MMM channel)
    - Disturbance of stream side vegetation may accelerate channel scour and lateral channel migration (MMM channel)
- Enhancement opportunities include:
    - Placing large woody debris (FPM and MMM channels)
    - Constructing side channels for spawning, where shallow groundwater sources are present (FPM channel)

- Stocking fry when downstream barriers are not posing a fish passage barrier (FPM channel)

Conclusion

Given the highly modified nature of the stream, the relatively otherwise pristine nature of the watershed, and the watershed's protection as a drinking water source, the JWP does not recommend conducting a field assessment for Salmon Creek at this time. Regulating water flow from the dam seems to be the major concern identified in the past. Otherwise, maintaining existing water quality and fish habitat values can be accomplished by using the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future development. The JWP recommends Salmon Creek as a low-priority watershed at this time.

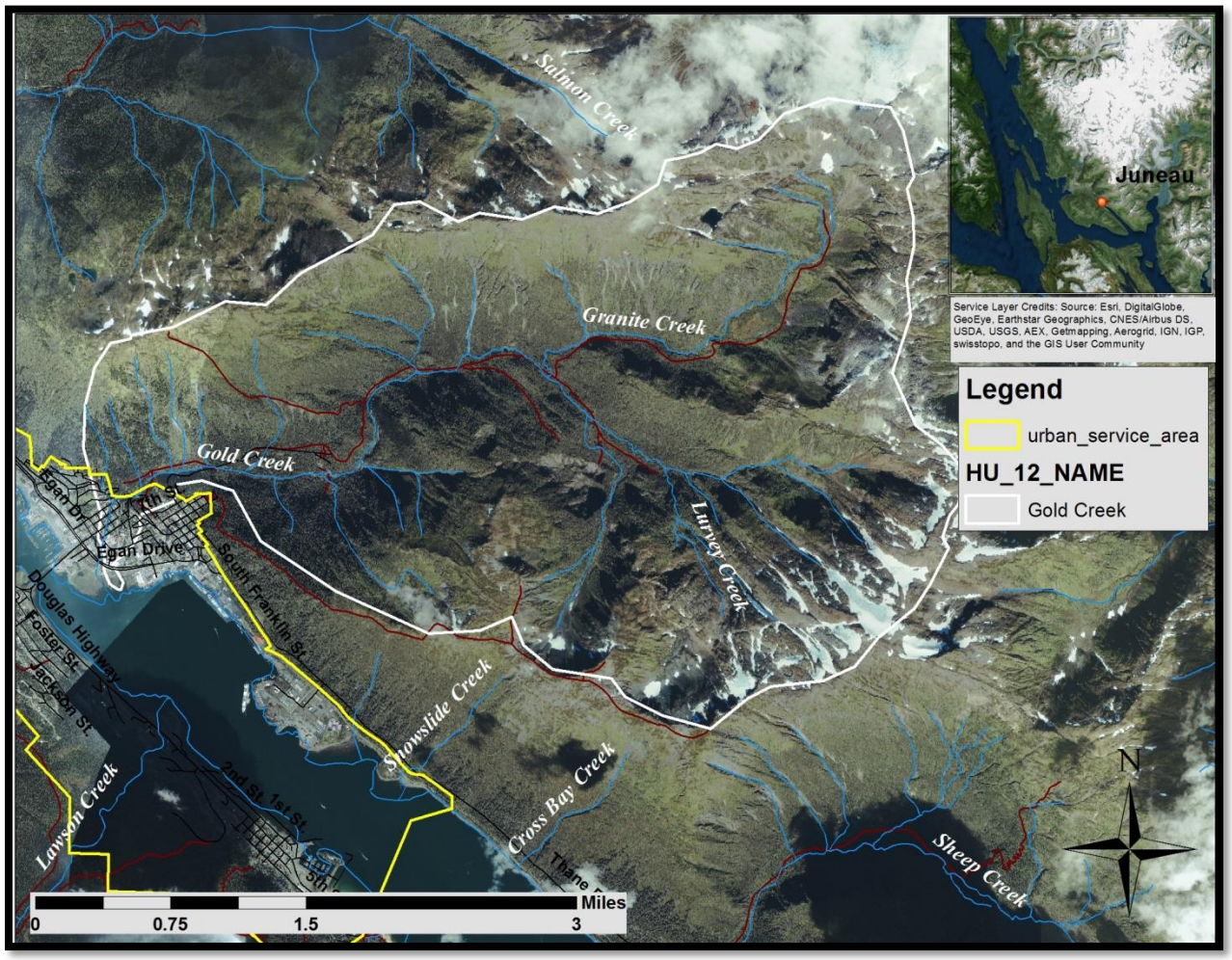

Figure 18. The Gold Creek watershed located near Downtown Juneau. This watershed is part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. Note that the HUC boundary corresponds with the individual watershed boundary for this stream.

Gold Creek

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Condition

Gold Creek is located in Downtown Juneau (Figure 18). Gold Creek is five miles long. The headwaters originate from meltwaters on Mount Juneau, Mount Roberts, and Olds Mountain and Sheep Mountain. Gold Creek discharges into Gastineau Channel.

Gold Creek is an anadromous stream supporting chum and pink salmon. Gold Creek also has resident population of Dolly Varden. Gold Creek was once was an important source of fish to the Auk Tribe and was the site of a fish camp. Historically, Gold Creek was said to support pink, chum, coho salmon and steelhead. However, its fisheries values have been reduced due to various land-use impacts, as discussed below. Ebner Falls is a natural fish passage barrier that is located two miles upstream from the mouth.

Lower Gold Creek has been heavily modified. A concrete flume, installed in the late 1960's to reduce erosion and flooding, confines the lower quarter mile of the creek. This section of the creek runs through residential and mixed-use light commercial areas. The flume displaced spawning and rearing habitat and, due to the high velocity of the water, acts as the first fish passage barrier to the upper reaches of the creek. Small numbers of pink and chum salmon spawn in the intertidal areas below the concrete flume.

Future development and community growth is planned for the lower watershed. The "Willoughby District Land Use Plan" is in draft form at the CBJ and it includes plans to triple the number of residential units in the area, increase commercial use, and to expand civic, cultural and art facilities in the district. The plan also suggests that the CBJ partner with local organizations to remove Gold Creek from the concrete flume from the mouth of the channel up to the Federal Building and try to restore rearing habitat in the lower reach of the creek.

The Last Chance Basin well field within the Gold Creek watershed is one of the CBJ's municipal drinking water supplies. This system was built in 1959, with additional wells drilled and other improvements made in 1976 and 1990. Currently there are five wells operating in the well field that supplies approximately 3.0 to 4.0 million gallons per day to the municipal water system. The entire Gold Creek Watershed is designated as part of the well-head protection area, since the entire area recharges the aquifer and contaminants are reasonably likely to reach the well field from almost anywhere within the recharge area.

Gold Creek has also been used to generate hydropower since the late 1800s. Currently Alaska Electric Light and Power (AELP) operates the active Gold Creek Hydro Plant, which generates a seasonal production of 4.5 GWH of energy annually. Water is diverted for operations by a dam located approximately one mile upstream from the mouth of the creek. The diverted water is conveyed through wooden and concrete flumes to the AELP powerhouse and then out to Gastineau Channel, taking water flow from creek. The AELP diversion dam would also act as a fish passage barrier, if fish could migrate that far upstream.

Upstream of the diversion dam, the stream is in relatively natural condition. However, the upper watershed, particularly the Last Chance and Silverbow Basins, has been impacted by gold mining in the past. Discovery of gold in the Gold Creek watershed in 1880 spurred Juneau's Gold Rush. This past is still evidenced by the historic mining infrastructure and features that exist throughout the watershed. Some of the mining structures continue to divert water from the creek, and it is thought that the relict mine could contribute to contaminants in the water.

Due to the mining history, the Gold Creek watershed is a valuable recreational and historical area for the City and Borough of Juneau. The watershed is home to some of the most popular trails in Juneau, including the Perseverance Trail. Tourists are bused into the area to visit the Mining Museum and to gold pan in the creek.

Although extensive development has fundamentally changed the natural hydrography of the watershed, Gold Creek is thought to have excellent water quality. The 2012 Integrated Report does not list Gold Creek in any other Category. Therefore, Gold Creek is assumed to be a Category 1 waterbody, meeting State Water Quality Standards. Recent data indicates Gold Creek meets State drinking water quality standards. Water discharged from the AJ Mine drainage tunnel had elevated levels of total dissolved solids (TDS), sulfates and other trace metals, but this is found to be diluted below water quality standards after the drainage enters Gold Creek.

Hydrologic Processes

Gold Creek from the mouth of the creek through Cope Park is classified within the Moderate Gradient Mixed Control Process Group, and is entirely defined as a Medium Width Modern Gradient Mixed Control Channel Type (MMM). MMM channels function for sediment transport, and have moderate stream energy due to moderate gradient and somewhat contained flows. These channels are often confined by landform but can develop narrow floodplains. Bedrock knickpoints with cascades may be present. Significant stream bank erosion and lateral channel migration can occur, particularly during high flow events. Disturbance of riparian vegetation can accelerate channel scour and lateral channel migration. Large woody debris has a significant influence on channel morphology and fish habitat in MMM channels. Log jams can stabilize stream bed substrate and can create pool habitats.

Above Cope Park to the crossing of Basin Road, Gold Creek is defined within the Moderate Gradient Contained Process Group, as a Medium Moderate Gradient Contained Channel Type (MCM). A MCM channel is primarily a sediment transport channel. Stream flow is typically contained in within the channel or adjacent landforms, often with bedrock control of the channel banks and stream bed. Stream bank erosion is variable due to bedrock control. Stream energy is high due to the moderate gradient and containment of high flows. Shallow organic soils and weathered bedrock on channel side slopes are susceptible to mass wasting.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Further study mining tunnel drainage to better understand how past and future mining developments might affect water quality and quantity in Gold Creek
- Install a permanent USGS stream gage to obtain information on discharge/flow rates to assist CBJ and AELP
- Restore the tidally influenced, confined reach of Gold Creek to improve rearing and overwintering habitat, and improve aesthetics
- Conduct an invasive and noxious weed survey, and develop a long term management plan from controlling non-native plants in the watershed

There are also management and enhancement recommendations for ESSc and MCM channels that are applicable to Gold Creek.

- Management and protection measures should consider:
    - stream channel protection (ESSc channels)
    - controlling construction in riparian areas (ESSc channels)
    - controlling in-stream operations (ESSc channels)
- Design and construction of infrastructure should consider:
    - culverts are generally not appropriate crossing structures due to flow volume and debris transport potential (MCM channels)
    - Unstable channel sideslopes should be considered in the location, design and construction of roads within or adjacent to riparian areas (MCM channels)

- Enhancement opportunities include:
    - Placing large woody debris or large boulders to create pool habitat (MCM channels)
    - Modify barriers where sufficient upstream habitat is sufficient (MCM channels)

Conclusion

Given the highly modified nature of the lower stream and the otherwise relatively pristine nature of the upper watershed, the JWP does not recommend conducting a field assessment for Gold Creek at this time. Restoring the lower watershed in terms of fish habitat and re-routing diverted water back into the creek would require significant engineering considerations and would likely be costly projects that are not feasible for a small watershed council to implement. Otherwise, Gold Creek is relatively healthy and protected as a municipal drinking water supply. As such, it would be prudent to use the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future development, particularly in the upper watershed. The JWP recommends Gold Creek as a low-priority watershed at this time.

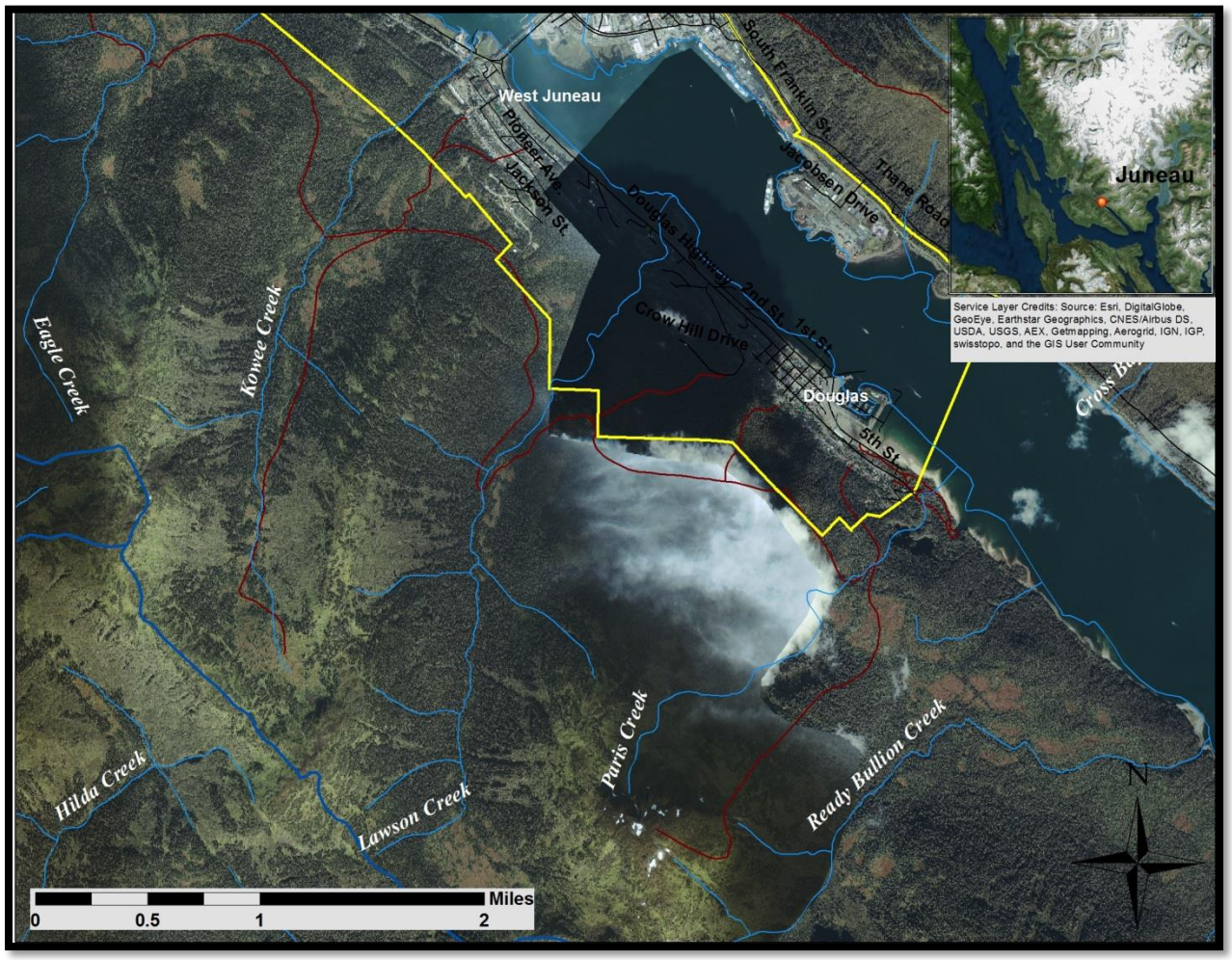

Figure 19. The Lawson Creek and Kowee Creek watersheds located near Douglas and West Juneau. These watersheds are part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. Note that the HUC boundary does not correspond with the individual watershed boundaries for these streams.

Lawson Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed
http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Condition

Lawson Creek is located on Douglas Island (Figure 19). The creek is approximately two miles long and drains a watershed of three square miles. It discharges into Gastineau Channel. There is limited information available regarding the conditions of Lawson Creek.

It is an anadromous stream supporting pink, chum, and coho salmon, Dolly Varden, and cutthroat trout. Fish habitat is limited by a fish passage barrier approximately one-half mile upstream from the mouth. However, due to steep gradients and lack of slow water areas (e.g. pools), Lawson Creek has minimal potential for rearing habitat. Fairly suitable spawning habitat is present from the mouth to about 3/8 mile upstream.

The upper watershed is on U.S. Forest Service and CBJ property, and is mostly undeveloped. Tidelands were filled for the existing residential development. One side of the channel near the mouth of the stream features riprap armament to prevent erosion. The riprap has been vegetated to improve stabilization and riparian functions. Relatively recent residential development upstream from Douglas Highway has contributed to high levels of sediment. There is a concrete dam located approximately one mile upstream of the mouth. This used to provide drinking water to Douglas, but is now used to divert water to Bear Creek. Lawson Creek watershed contains areas where future residential development is planned. A new major housing unit was approved near the creek last year.

The 2012 Integrated Report does not list Lawson Creek in any other Category. Therefore, Lawson Creek is assumed to be a Category 1 waterbody, meeting State Water Quality Standards. However, this assumption may change as the watershed continues to be developed.

Hydrologic Processes

From the mouth of the stream to just above Lawson Creek Road, Lawson Creek is classified within the Estuarine Process Group, and is classified as Small Estuarine Channel – Gravel Phase (ESSg). These channels are sensitive to sediment inputs and cumulative effects from upstream disturbance tend to be a management concern. Stream banks of estuarine channels are sensitive to erosion and bank erosion can be a significant source of sediment. However, bank erosion is predominantly influenced by tidal movement than stream flow.

Upstream from the ESSg channel, Lawson Creek is defined within the Moderate Gradient Contained Process Group, as a Medium Moderate Gradient Contained Channel Type (MCM). A MCM channel is primarily a sediment transport channel. Stream flow is typically contained in within the channel or adjacent landforms, often with bedrock control of the channel banks and stream bed. Stream bank erosion is variable due to bedrock control. Stream energy is high due to the moderate gradient and containment of high flows. Shallow organic soils and weathered bedrock on channel side slopes are susceptible to mass wasting.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Stabilize channel in lower Lawson Creek and introduce suitable spawning gravel to improve spawning habitat
- Include stipulations on future streamside developments to maintain the stream's water quality

There are also management and enhancement recommendations for ESS and MCM channels that are applicable to Lawson Creek.

- Management and protection measures should consider:
    - controlling in-stream operations (ESS channels)
    - controlling construction in riparian areas (ESS channels)
    - stream channel protection (ESS channels)
- Design and construction of infrastructure should consider:
    - culverts are generally not appropriate crossing structures due to flow volume and debris transport potential (MCM channels)
    - Unstable channel sideslopes should be considered in the location, design and construction of roads within or adjacent to riparian areas (MCM channels)
- Enhancement opportunities include:
    - Placing large woody debris or large boulders to create pool habitat (MCM channels)
    - Modify barriers where sufficient upstream habitat is sufficient (MCM channels)

Conclusion

The JWP does not recommend conducting an extensive field assessment for Lawson Creek. However, the JWP recommends an abbreviated field assessment of the lower watershed to identify site-specific opportunities for restoration, enhancement, or mitigation measures in sections of the creek that flow through developed areas. Such recommendations should focus on improving fish habitat and stormwater treatment. JWP recommends Lawson Creek as a medium-priority watershed at this time.

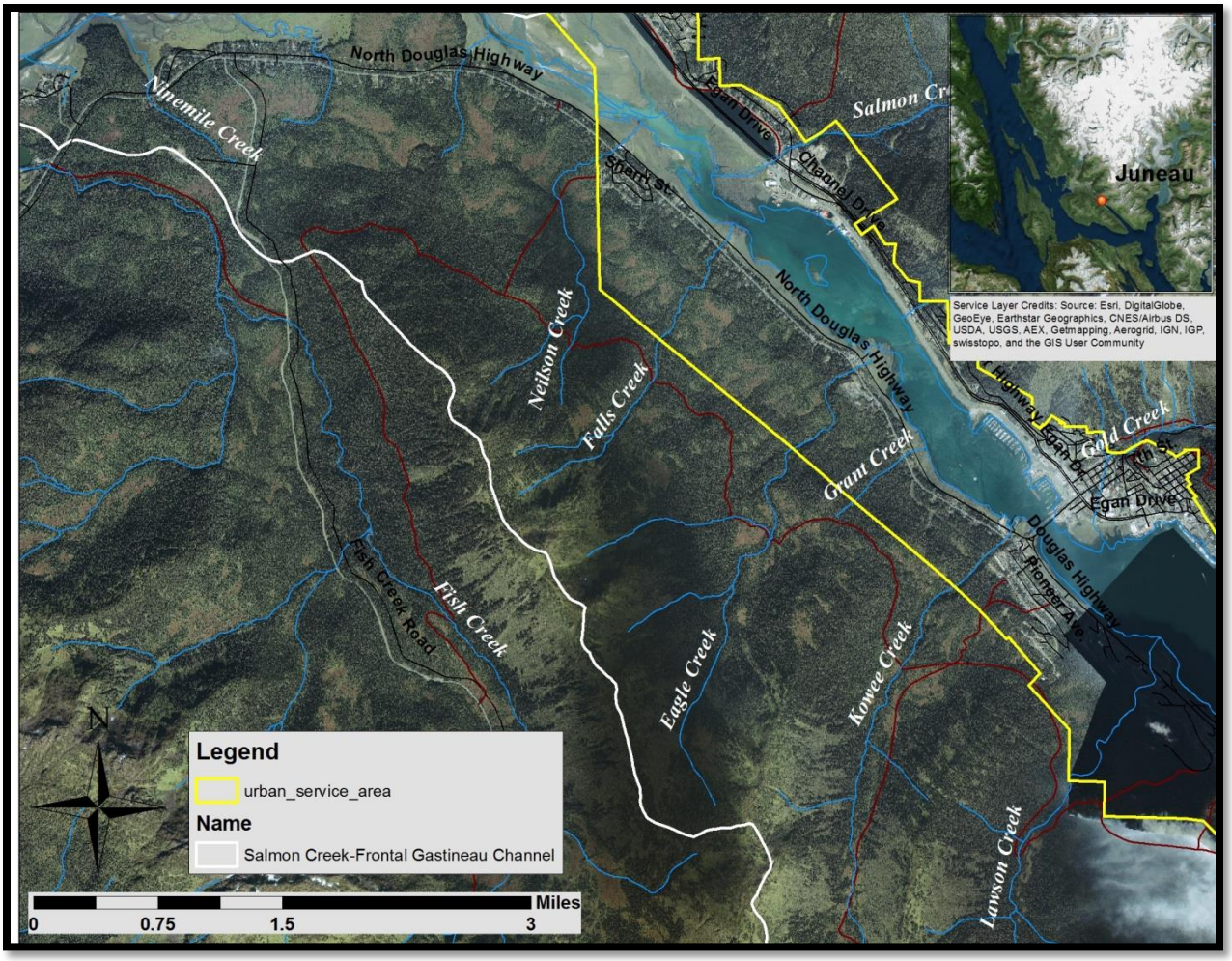

Figure 20. The Kowee Creek, Eagle Creek, Falls Creek and Neilson Creek watersheds accessible from the North Douglas Highway. These watersheds are part of the Hydrologic Unit Code (HUC) Salmon Creek – Frontal Gastineau Channel. Note that the HUC boundary does not correspond with the individual watershed boundaries for these streams.

Kowee Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

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Kowee Creek Anadromous Waters Catalog Nomination Form. Accessed
http://www.adfg.alaska.gov/FDDDOCS/NOM_PDFs/SEA/11-522.PDF

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Conditions

Kowee Creek is located in West Juneau on Douglas Island (Figures 19 and 20). Kowee Creek is two miles long and discharges into Gastineau Channel just west of the Douglas Bridge. It drains a watershed of 2.75 square miles.

The upper watershed is located on U.S. Forest Service land and is undeveloped. Lower Kowee Creek is located within the USAB limits in a primarily residential area (Figure 20). Some industrial development is located adjacent to the mouth of the creek on tidelands. Here, the stream has been confined to a single channel by riprap placed to contain the fill material placed for the industrial development.

The 2012 Integrated Report does not list Kowee Creek in any other Category. Therefore, Kowee Creek is assumed to be a Category 1 waterbody, meeting State Water Quality Standards. However, there is limited water quality data to support this. There may be some impacts from stormwater runoff from the residential area. However, the extent of the impact this has on Kowee Creek is unknown.

Kowee Creek is an anadromous stream that supports pink and chum salmon and Dolly Varden. It primarily provides spawning habitat with limited rearing habitat available. Spawning habitat may have actually been improved by the placement of riprap, but streamside cover is minimal. Fish habitat is ultimately limited by a falls that is a fish passage barrier 200 feet upstream from the mouth, near the original DIPAC hatchery. ADF&G state the falls measure 25 to 30 feet. ADF&G also catalogued a second falls that is estimated to be 50 feet. Above this barrier, the substrate is primarily bedrock and large cobble. For this reason Kowee has limited natural fish production.

However, the hatchery operating on Kowee Creek could enhance annual fish runs if the hatchery began operating in production mode. Currently it is being used for fisheries research by the University of Alaska Southeast.

Hydrologic Processes

Kowee Creek within the USAB is defined within the Moderate Gradient Contained Process Group, as a Medium Moderate Gradient Contained Channel Type (MCM). A MCM channel is primarily a sediment transport channel. Stream flow is typically contained in within the channel or adjacent landforms, often with bedrock control of the channel banks and stream bed. Stream bank erosion is variable due to bedrock control. Stream energy is high due to the moderate gradient and containment of high flows. Shallow organic soils and weathered bedrock on channel side slopes are susceptible to mass wasting.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Determine whether the housing development is impacting anadromous habitat downstream
- Include stipulations on future streamside developments to maintain the stream's water quality

There are also management and enhancement recommendations for ESS and MCM channels that are applicable to Kowee Creek.

- Design and construction of infrastructure should consider:
    - culverts are generally not appropriate crossing structures due to flow volume and debris transport potential (MCM channels)
    - Unstable channel sideslopes should be considered in the location, design and construction of roads within or adjacent to riparian areas (MCM channels)
- Enhancement opportunities include:
    - Placing large woody debris or large boulders to create pool habitat (MCM channels)
    - Modify barriers where sufficient upstream habitat is sufficient (MCM channels)

Conclusion

The JWP does not recommend conducting an extensive field assessment for Kowee Creek at this time. However, the JWP recommends an abbreviated field assessment of the lower watershed to identify site-specific opportunities for restoration, enhancement, or mitigation measures in sections of the creek that flow through developed areas. Such recommendations should focus on improving fish habitat and stormwater treatment. The JWP recommends Kowee Creek as a medium-priority watershed at this time.

Eagle Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed
http://www.seakfhp.org/wp-content/uploads/2013/03/Jnu-Fish-Hab-Assessment-revised-2012.pdf

Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Conditions

Eagle Creek is located on Douglas Island (Figure 20). The stream is approximately three miles long and drains a watershed of three square miles. It discharges into Gastineau Channel at approximately 2.4 mile North Douglas Highway. It is an anadromous stream that supports coho and pink salmon and Dolly Varden.

Eagle Creek is considered to be in a near-natural state. The only development includes North Douglas Highway and fill placed near the mouth of the stream to support residential development. The upper watershed is on U.S. Forest Service land and CBJ owns land in the middle watershed.

Eagle Creek is a high gradient stream. Fish habitat is limited due to a barrier falls located 0.1 mile upstream from the mouth. Above the barrier, there is excellent resident fish rearing habitat but fish populations have not been assessed. It is possible that resident Dolly Varden and cutthroat trout are present. Coho and Dolly Varden spawn and rear upstream of the North Douglas Highway culvert but rearing habitat is limited.

The 2012 Integrated Report does not list Eagle Creek in any other Category. Therefore, Eagle Creek is assumed to be a Category 1 waterbody, meeting State Water Quality Standards. Although there is limited water quality data to support this, this seems to be a fair assumption given the limited extent of development in the watershed.

Hydrologic Processes

Eagle Creek within the USAB has stream reaches within the Estuarine Process Group and High Gradient Contained Process Group. From the mouth of the creek to the crossing of North Douglas Highway, Eagle Creek is defined as a Small Estuarine Channel Type – Cobble Substrate Phase (ESSc). The ESSc channel functions as a deposition channel. However, this channel type phase occur on where there is a rapid transition from higher energy streams. This allows sediment to be readily flushed during flood or storm events. Stream banks of ESSc channels are moderately sensitive to erosion, but bank erosion is more influenced by tidal movement and beach erosion processes than stream flow. Though these channels tend to have limited fish habitat due to erosion processes and stream flows, they provide migration corridors to upstream habitat.

Above North Douglas Highway, the Eagle Creek transitions to a High Gradient Contained Deeply Incised Channel Type – Wetland Phase (HCDw). These channels are usually situated on hillslopes with undulating terrain dominated by wetlands such as muskegs. The channel sideslopes of HCD channels are highly unstable and have high sediment input potential. Stream flow in these channels responds quickly to rainfall events. There may be short term storage of sediment where large woody debris can trap sediment. These channels have negligible amounts of anadromous habitat and are generally not accessible to anadromous fish due to high flows, high gradients, seasonally low water and downstream barriers.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Provide a greenbelt
- Evaluate stream above barrier to assess fish populations
- Include stipulations on future streamside developments to maintain the stream's water quality and habitat values

There are also management and enhancement recommendations for ESSc and HCD channels that are applicable to Eagle Creek.

- Management and protection measures should consider:
    - stream channel protection (ESSc channels)
    - controlling construction in riparian areas (ESSc channels)
    - controlling in-stream operations (ESSc channels)
- Design and construction of infrastructure should consider:
    - High bed and debris loads from HCD channels can pose a risk to downstream crossing structures
    - Stream bank and sideslope disturbance associated with road cuts alongside HCD channels may result in mass wasting and significant sediment inputs

Conclusion

The JWP does not recommend conducting a field assessment for Eagle Creek at this time, as this watershed has not been heavily impacted and is in relatively pristine condition. It is recommended to use the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future development. The JWP recommends Eagle Creek as a low-priority watershed at this time.

Falls Creek

Literature Reviewed

Alaska Department of Environmental Conservation. 2013. Alaska's Final 2012 Integrated Water Quality Monitoring and Assessment Report.
http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf

Bethers, M.; Munk, K. and Seifert, C. 2012. Juneau Fish Habitat Assessment (Revised). Alaska Department of Fish and Game, Divisions of Sport Fish and Commercial Fisheries. Assessed
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Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Conditions

Falls Creek is located on Douglas Island (Figure 20). The stream is approximately two miles long and drains a watershed of approximately one square mile. It discharges into the Gastineau Channel at approximately 3.5 mile North Douglas Highway. The tidelands at the mouth of the creek are part of

Mendenhall Wetlands State Game Refuge. It is an anadromous stream supporting populations of Dolly Varden and cutthroat trout.

Falls Creek is considered to be in a near-natural state. The upper watershed is on U.S. Forest Service land with the middle reaches located on CBJ land. The only development is the North Douglas Highway. The ADF&G has categorized the North Douglas Highway culvert as a "red culvert," which means that it is a barrier to fish passage. However, most of the anadromous spawning and rearing habitat is located downstream of the culvert. Here, there are intermittent spawning gravels, large woody debris and large boulders with alders providing overhanging vegetation.

Upstream of the culvert, rearing habitat is limited due to the steep stream gradient and fast-moving water. Only resident Dolly Varden was found upstream of the culvert. A falls located 200 yards upstream of the culvert may be a fish passage barrier at certain water levels.

The 2012 Integrated Report does not list Falls Creek in any other Category. Therefore, Falls Creek is assumed to be a Category 1 waterbody, meeting State Water Quality Standards. Although there is limited water quality data to support this, this seems to be a fair assumption given the limited extent of development in the watershed.

Hydrologic Processes

Falls Creek within the USAB has stream reaches within the Estuarine Process Group and High Gradient Contained Process Group. From the mouth of the creek to the crossing of North Douglas Highway, Falls Creek is defined as a Small Estuarine Channel Type – Cobble Substrate Phase (ESSc). The ESSc channel functions as a deposition channel. However, this channel type phase occur on where there is a rapid transition from higher energy streams. This allows sediment to be readily flushed during flood or storm events. Stream banks of ESSc channels are moderately sensitive to erosion, but bank erosion is more influenced by tidal movement and beach erosion processes than stream flow. Though these channels tend to have limited fish habitat due to erosion processes and stream flows, they provide migration corridors to upstream habitat.

Above North Douglas Highway, the Falls Creek transitions to a High Gradient Contained Deeply Incised Channel Type – Wetland Phase (HCDw). These channels are usually situated on hillslopes with undulating terrain dominated by wetlands such as muskegs. The channel sideslopes of HCD channels are highly unstable and have high sediment input potential. Stream flow in these channels responds quickly to rainfall events. There may be short term storage of sediment where large woody debris can trap sediment. These channels have negligible amounts of anadromous habitat and are generally not accessible to anadromous fish due to high flows, high gradients, seasonally low water and downstream barriers.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Replace the North Douglas Hwy. culvert to improve fish passage
- Investigate the potential for enhancing intertidal spawning habitat

- Include stipulations on future streamside developments to maintain the stream's water quality

There are also management and enhancement recommendations for ESSc and HCD channels that are applicable to Falls Creek.

- Management and protection measures should consider:
    - stream channel protection (ESSc channels)
    - controlling construction in riparian areas (ESSc channels)
    - controlling in-stream operations (ESSc channels)
- Design and construction of infrastructure should consider:
    - High bed and debris loads from HCD channels can pose a risk to downstream crossing structures
    - Stream bank and sideslope disturbance associated with road cuts alongside HCD channels may result in mass wasting and significant sediment inputs

Conclusion

The JWP does not recommend conducting a field assessment for Falls Creek at this time, as this watershed has not been heavily impacted and is in relatively pristine condition. It is recommended to use the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future development. The JWP recommends Falls Creek as a low-priority watershed at this time.

Neilson Creek

Literature Reviewed

Adamus Resource Assessment, Inc. 1987. Juneau wetlands: functions and values. Prepared for City and Borough of Juneau, Alaska Department of Community Development. http://people.oregonstate.edu/~adamusp/Alaska%20Wetland%20Assessment%20Methods/Juneau_Wetlands/Juneau_Wetlands%201987.pdf

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Paustian, S. (editor), et al. 1992. Channel Type Users Guide for the Tongass National Forest, Southeast Alaska. US Department of Agriculture Forest Service, Alaska Region, R10 Technical Paper 26

Conditions

Neilson Creek is located on Douglas Island (Figure 20). The stream is approximately one mile long and drains a watershed of two square miles. The upper watershed is on U.S. Forest Service land with the

middle reaches located on CBJ land. Only the lower portion is within the USAB limits. The Bonnie Brae subdivision is located on the eastern side of the lower watershed.

Neilson Creek is an anadromous stream supporting coho and pink salmon and Dolly Varden. Spawning habitat is located in the upper intertidal area. Fish rearing habitat is limited due to the steep stream gradient, fast-moving water, lack of pools, and poor bank cover. In addition, a barrier falls is located about 300 yards above the mouth of the stream.

The North Douglas Highway culvert passing Neilson Creek is categorized as a gray culvert by the ADF&G, which means it may impact fish passage. Tidal influence extends up to the North Douglas Highway culvert, but the outfall height might prevent fish from entering at lower tidal levels though evidence suggests that fish could easily enter the culvert at higher tide events. The culvert gradient and constriction ratio may also contribute to fish passage problems.

The 2012 Integrated Report does not list Neilson Creek in any other Category. Therefore, Neilson Creek is assumed to be a Category 1 waterbody, meeting State Water Quality Standards. However, there is limited water quality data to support this. There may be some impacts from stormwater runoff from the residential area. However, the extent of the impact this has on Neilson Creek is unknown.

Hydrologic Processes

Neilson Creek within the USAB has stream reaches within the Estuarine, High Gradient Contained, and Moderate Gradient Contained Process Groups. From the mouth of the creek to the crossing of North Douglas Highway, Neilson Creek is defined as a Small Estuarine Channel Type – Cobble Substrate Phase (ESSc). The ESSc channel functions as a deposition channel. However, this channel type phase occur on where there is a rapid transition from higher energy streams. This allows sediment to be readily flushed during flood or storm events. Stream banks of ESSc channels are moderately sensitive to erosion, but bank erosion is more influenced by tidal movement and beach erosion processes than stream flow. Though these channels tend to have limited fish habitat due to erosion processes and stream flows, they provide migration corridors to upstream habitat.

Above North Douglas Highway, the Neilson Creek consists of a short High Gradient Contained Deeply Incised Channel Type – Wetland Phase (HCDw) reach and then transitions to a Small Moderate Gradient Contained Channel Type (MCS) for the remaining length of the stream within the USAB. Both channel types function for sediment transport. HCDw channels are usually situated on hillslopes with undulating terrain dominated by wetlands such as muskegs. The channel sideslopes of HCD channels are highly unstable and have high sediment input potential. Stream flow in these channels responds quickly to rainfall events. There may be short term storage of sediment where large woody debris can trap sediment. These channels have negligible amounts of anadromous habitat and are generally not accessible to anadromous fish due to high flows, high gradients, seasonally low water and downstream barriers.

MCS channels have moderate stream energy due to the moderate gradient and contained flows. Stream banks and side slopes of MCS channels contribute very little sediment to system. Typically there is significant bedrock control of the stream banks and stream bed. There is typically minimal anadromous

fish habitat in MCS channels and these channels may not even be accessible to anadromous fish due to downstream barriers. These channel types have few management concerns.

Past Recommendations

Recommendations in the literature for restoration, enhancement, or mitigation measures include:

- Include stipulations on future streamside developments to maintain the stream's water quality
- Investigate the potential for enhancing intertidal spawning habitat

There are also management and enhancement recommendations for ESSc, MCS and HCD channels that are applicable to Neilson Creek.

- Management and protection measures should consider:
    - stream channel protection (ESSc channels)
    - controlling construction in riparian areas (ESSc channels)
    - controlling in-stream operations (ESSc channels)
- Design and construction of infrastructure should consider:
    - High bed and debris loads from HCD channels can pose a risk to downstream crossing structures
    - Stream bank and sideslope disturbance associated with road cuts alongside HCD channels may result in mass wasting and significant sediment inputs

Conclusion

The JWP does not recommend conducting a field assessment for Neilson Creek at this time, as this watershed has not been heavily impacted and is in relatively pristine condition. It is recommended to use the planning and project development process to identify opportunities to avoid and minimize impacts, and mitigate for unavoidable adverse impacts associated with any future development. The JWP recommends Neilson Creek as a low-priority watershed at this time.

Appendix A. Remote watersheds of the City and Borough of Juneau not accessible by the Juneau road system.

General Location	Watershed/Waterbodies
North Lynn Canal	Sweeny Creek
	Sherman Creek
Berners Bay	Berners River
	Johnson Creek
	Lace River
	Antler River
	Gilkey River
	Sawmill Creek
Douglas Island	Hilda Creek
	Paris Creek
	Ready Bullion Creek
	Bullion Creek
	Nevada Creek
Thane	Little Sheep Creek
	Dupont Creek
Taku Inlet	Grindstone Creek
	Rhine Creek
	Carlson Creek
	Annex Creek
	Taku River
	Sockeye Creek
	Johnson Creek
	Twin Glacier Creek
	Moose Creek
	Yehring Creek
	Davidson Creek
	Wright Creek
	Fish Creek

General Location	Watershed/Waterbodies
Taku Inlet, cont.	Turner Lake/Turner Creek
	Bart Lake/Dorothy Creek
Port Snettisham	Prospect Creek
	Speel River
	Crescent Lake/Whiting River
	Sweetheart Creek
	Gilbert Creek
	Anmer Creek
Slocum Inlet	Slocum Creek
Taku Harbor	Taku Lake/Taku Creek
Limestone Inlet	Limestone Creek

Appendix B. Road accessible watersheds of the City and Borough of Juneau inside of the Urban Service Area Boundary (USAB), including its condition, whether or not JWP recommends a field assessment to identify restoration opportunities, and the watershed priority. JWP's priorities are in regards to restoration needs. The DEC, DNR and ADF&G priorities are from the 2015 Alaska Clean Water Action priorities compiled by the DEC. Their priorities are based on their agency's concerns: DEC is water quality, DNR is water use, and ADF&G is fish habitat.

Watershed/Waterbodies	**Condition**	**Field Assessment?**	**Watershed Priority***			
			JWP	***DEC***	***DNR***	***ADF&G***
Auke Nu Creek	Pristine	No	Low	Med	Low	Med
Wadleigh Creek	Pristine	Abbreviated	Low	---	---	---
Auke Lake	Vulnerable/Susceptible	No	Med	High	---	Med
Auke Creek	Vulnerable/Susceptible	No	Med	High	Med	Med
Lake Creek	Vulnerable/Susceptible	Abbreviated	Med	Med	Med	High
Lake Two Creek	Vulnerable/Susceptible	Abbreviated	Med	---	---	---
UAJ Creek	Vulnerable/Susceptible	Yes	Med	---	---	---
Mendenhall Lake	Pristine	No	Low	---	---	---
Mendenhall River	Vulnerable/Susceptible	No	Med	High	---	Med
Montana Creek	Vulnerable/Susceptible	No	Med	High	---	Med
Duck Creek	Impaired	Yes	Med	High	High	Med
Jordan Creek	Impaired	Yes	High	High	---	High
Pederson Hill Creek	Impaired	No	High	High	---	---
West Creek	Vulnerable/Susceptible	Yes	Med	---	---	---
East Creek	Vulnerable/Susceptible	Yes	Med	---	---	---
Switzer Creek	Vulnerable/Susceptible	Yes	Med	---	---	---
Lemon Creek	Impaired	No	High	High	---	High
Vanderbilt Creek	Impaired	No	High	High	---	Med
Salmon Creek	Vulnerable/Susceptible	No	Low	High	High	Med
Gold Creek	Vulnerable/Susceptible	No	Low	---	---	---
Snowslide Creek	Pristine	No	Low	---	---	---
Lawson Creek	Vulnerable/Susceptible	Yes	Med	---	---	---
Kowee Creek	Vulnerable/Susceptible	Yes	Med	---	---	---
Grant Creek	Pristine	No	Low	---	---	---
Eagle Creek	Pristine	No	Low	---	---	---
Falls Creek	Pristine	No	Low	---	Low	Low
Neilson Creek	Pristine	No	Low	---	---	---