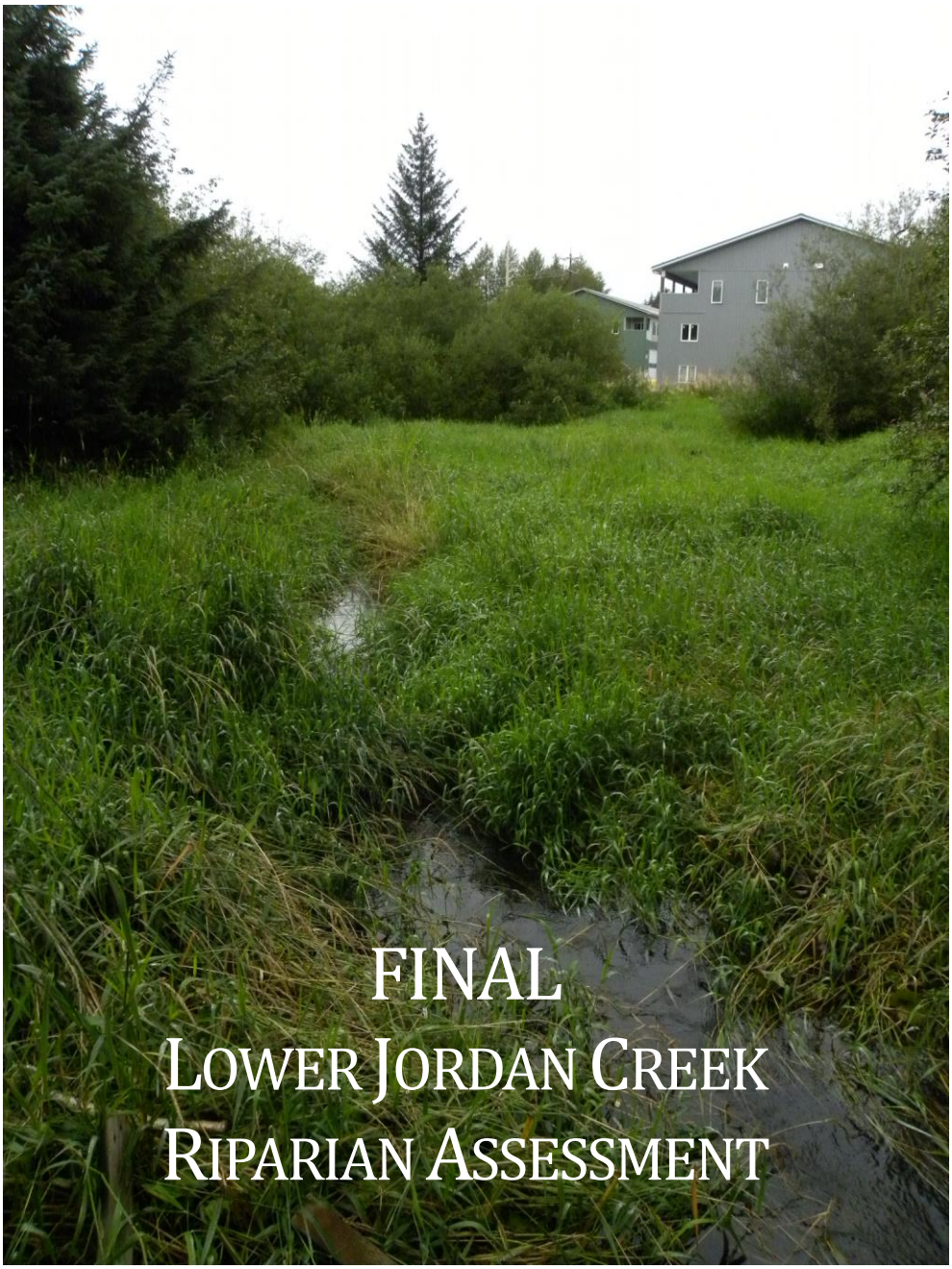

FINAL
LOWER JORDAN CREEK RIPARIAN ASSESSMENT

JUNEAU WATERSHED PARTNERSHIP

SOUTHEAST ALASKA WATERSHED COALITION

CONNECT - INFORM - PARTICIPATE

JUNEAU WATERSHED PARTNERSHIP

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

Organization Name: Juneau Watershed Partnership/Southeast Alaska Watershed Coalition

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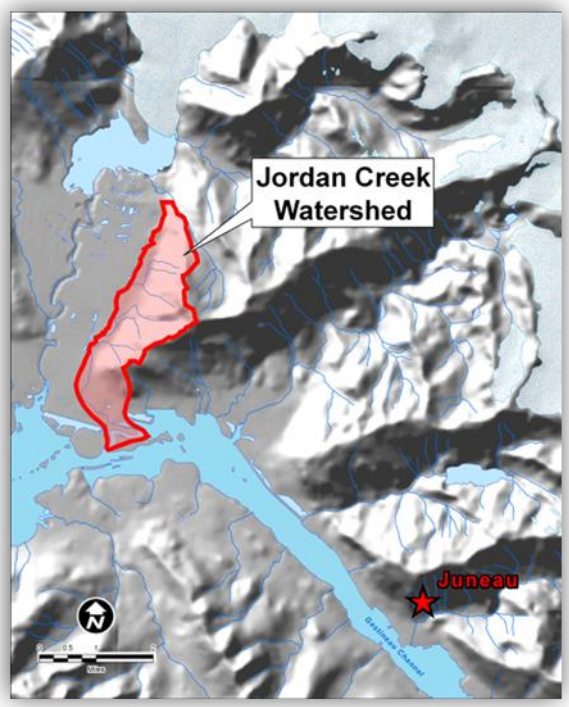
Contents

Introduction

Jordan Creek is an impaired anadromous fish stream located in the Mendenhall Valley of Juneau, Alaska. Jordan Creek was listed as an Impaired Waterbody by the State of Alaska in 1998 due to non-attainment of sediment, dissolved oxygen, and residue (debris) standards. While stormwater runoff from urban areas was identified as being the major source of pollutant delivery to the stream, the loss of riparian habitat can be contributing to poor instream habitat and water quality problems.



The Jordan Creek watershed

In general, the riparian zone is considered as the area alongside a stream or other waterbody that interacts with the waterbody and is distinct from surrounding uplands because of unique soil and vegetation characteristics. It can be described as the interface between the aquatic and terrestrial ecosystems, and are an integral component to a healthy stream ecosystem.

Riparian zones provide a variety of benefits to streams such as:

- Capturing and treating urban stormwater
- Protecting streambanks from erosion
- Providing a source of large woody debris, allowing complexity in stream habitats
- Providing cover and food resources for terrestrial invertebrates, birds, and mammals
- Delivering leaf litter, organic debris, and terrestrial invertebrates to streams, which are sources of food for fish and aquatic invertebrates
- Shading streams to maintain cool water temperatures necessary for salmon and other aquatic organisms
- Providing off-channel aquatic habitat as a flood refugium for rearing and overwintering fish

The upper watershed (upstream of Egan Drive) still largely has its riparian areas intact, with sections protected as part of state and federal public land holdings. However, urban development in the lower watershed (below Egan Drive) encroaches on the stream, resulting in loss or alteration of much of the riparian area. Most of the natural land cover in this area has been replaced with roads, parking lots, and buildings.

Many communities establish regulatory protections to prevent impacts to riparian zones. A stream buffer ordinance is regulatory tool that can provide protection for riparian zones by prohibiting and/or limiting the types of activities that can occur adjacent to the stream. The City and Borough of Juneau (CBJ) has had such an ordinance in place in its Land Use Code since the 1980s. The current ordinance in

49.70.310 is locally called the “streamside setback.” It establishes two protection zones: a 25-foot and a 50-foot setback from the stream. The ordinance states, “there shall be no disturbance . . . within 25 feet of streams” and “development…is prohibited within 50 feet of the banks of streams.” Unfortunately, this ordinance was implemented after much of the lower Jordan Creek watershed was developed and the riparian zone already impacted. Even so, many current

However, the lower watershed will likely see on-going re-development as community needs change, providing opportunities to bring current practices in line with the streamside setback to improve water quality and habitat conditions. The purpose of this *Jordan Creek Riparian Assessment* is to assess current condition of the 25- and 50-foot setback along lower Jordan Creek from below Egan Drive to Yandukin Drive, and identify policies and actions needed to continue improving the health of the Jordan Creek watershed.

Methodology

The lower Jordan Creek riparian assessment took place over the fall and winter of 2016, and was completed by the Juneau Watershed Partnership (JWP) and U.S. Fish and Wildlife (USFWS) staff.

Lower Jordan Creek was divided into reaches, which were further divided into sections ranging from 50 to 125 feet long (Figure 1). The typical section length was 75 feet. JWP and USFWS staff used handheld Global Positioning System (GPS) units to collect latitude and longitude coordinates at the upper and lower end of each section on both the left and right banks for mapping purposes. To generate the final maps, the GPS data were imported into ArcMap 10.2.2 and projected in the WGS 1984 coordinate system.

For each section, the 25 and 50-foot setbacks were measured from the ordinary high-water mark, perpendicular to the stream bank, from both the left and right banks (looking downstream) at the upper and lower ends of the section. The 25 and 50-foot setback areas on the right and left banks were then individually assessed by section. The assessment began at Egan Drive and progressed downstream.

The riparian assessment qualitatively and quantitatively described conditions of vegetated and developed portions of each setback area as described below:

Vegetation conditions: condition of the vegetated riparian area including both natural vegetation and landscaped areas, as measured by the following parameters:

- Percent vegetated: percent of the setback that is covered in vegetation (percent vegetated and percent developed should total 100 percent)
- Percent Invasive: percent of the vegetated area that is covered with invasive plants
- Common overstory vegetation: a list of the common overstory species
- Condition of the overstory vegetation (i.e. woody vegetation over x feet tall): described as either intact (all plants are native and plant abundance, health and/or growth are not impacted by development, invasive species, or human uses of the area), impacted (invasive plants, development, and/or human use of area are impacting the abundance, health, or growth of native vegetation), or not intact (no overstory)
- Canopy cover: percent of the vegetated area covered by the overstory canopy

- Height of the overstory vegetation
- Common understory vegetation: a list of the common understory species
- Condition of the understory vegetation: described as either intact, impacted, or not intact
- Percent bare ground: percent of the vegetated area that is bare soil
- Development conditions: condition of the developed riparian area including unvegetated fill, impervious surfaces, and built structures, as measured by the following parameters:
  - Percent developed: percent of the setback that is developed (percent vegetated and percent developed should total 100 percent)
  - Percent impervious: percent of the developed area that is covered by impervious surfaces
  - Structures: a list of structures within the setback

Additional GPS points were taken for major riparian impacts such as stream crossings and invasive European mountain ash and bird cherry. For each GPS point for the invasive tree species, the number of plants and estimated trunk diameter at breast height (DBH, in inches) were noted.

During the assessment, additional notes regarding conditions, impacts, and opportunities for improving riparian conditions were noted.

All information was noted on field data sheets and then transferred to an Excel spreadsheet. A copy of a blank assessment form is provided in Appendix A.

Figure 1. Map showing each reach, section and streamside setbacks along lower Jordan Creek. The stream flows north to south, with the right bank on the western side. This is for visualization purposes only; breaks between stream Sections were estimated using GPS waypoints and setbacks projected using the buffer tool in ArcGIS.

Riparian conditions were quantified for each stream section and bank by calculating the percent of the 25-foot and 50-foot setback areas covered in invasive plants, natural vegetation, impervious development and pervious development (EQNs 1 – 4).

EQN 1. % Invasive Plant Cover = (% Vegetated Area)(% Invasive)/100

EQN 2. % Natural Vegetation Cover = (%Vegetated Area) – (% Invasive Plant Cover)

EQN 3. % Impervious Surface Cover = (% Developed Area)(% Impervious)/100

EQN 4. % Pervious Development Cover = (% Developed Area) – (% Impervious Surface Cover)

Example: Reach 1, Section 1, Right Bank, 25-foot setback

Measured in field:

% Vegetated Area = 80%; % Invasive = 15%; % Developed Area = 20%; and % Impervious = 40%

EQN 1. % Invasive Plant Cover = (80)(15)/100 = 12%

EQN 2. % Natural Vegetation Cover = (80) – (12) = 68%

EQN 3. % Impervious Surface Cover = (20)(40)/100 = 8%

EQN 4. % Pervious Development Cover = (20) – (8) = 12%

Similar calculations were used to quantify riparian conditions for each reach and the entire length of lower Jordan Creek.

Results

The following presents the results of the riparian assessment by stream reach and individual sections, starting from the upstream end of the survey at Egan Drive to the downstream end at Yandukin Drive. A summary of the data for the entire lower Jordan Creek is also provided. Raw data is provided in Appendix A.

Reach 1 - Egan Dr. to Trout St.

Reach Information

Total Stream Length: ~375 feet

Zoning: Light Commercial

Number of streamside property owners: 2

Overstory Vegetation: Sitka Spruce, red alder, willow species, black cottonwood

Understory Vegetation: reed canary grass, Sitka spruce (saplings), Western hemlock saplings), skunk cabbage, lady fern, goat's beard, false lily of the valley, salmonberry, lawn/grass

Disturbances within 25-feet: Invasive plant species, garbage/debris, foot traffic, landscaping, parking lot, encampment, dumpster

Development within 50-feet: Parking lot, storage shed, picnic area

Number of Stream Crossings: 3

- Egan Dr. culverts
- Multiuse path bridge @ Egan Dr.
- Trout St. bridge

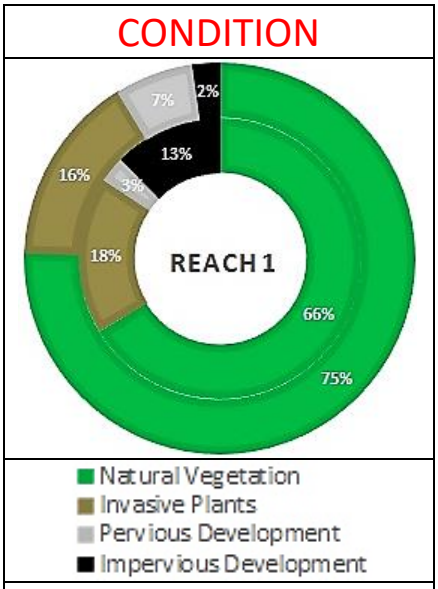


Figure 2. The riparian condition of Reach 1 including the percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

Data for Each Stream Section

Number of Stream Sections in Reach 1 is shown in Table 1 and Figure 3. Sections are numbered in order from the upstream end at Egan Drive to the downstream end at Trout Street.

Table 1. Section numbers and lengths for Reach 1.

Section	Approximate Section Length (ft)
1	50
2	50
3	50
4	100
5	125

Synopsis

Reach 1 is bordered by Jordan Avenue on the right and Motel 8 on the left. Riparian vegetation on the right bank is largely intact, with large spruce trees and other native vegetation. The spruce overstory provides excellent canopy cover. The left bank is impacted by impervious surfaces and invasive plant species in both the 25- and 50-foot setback. Garbage was found throughout the reach, particularly on the right bank.

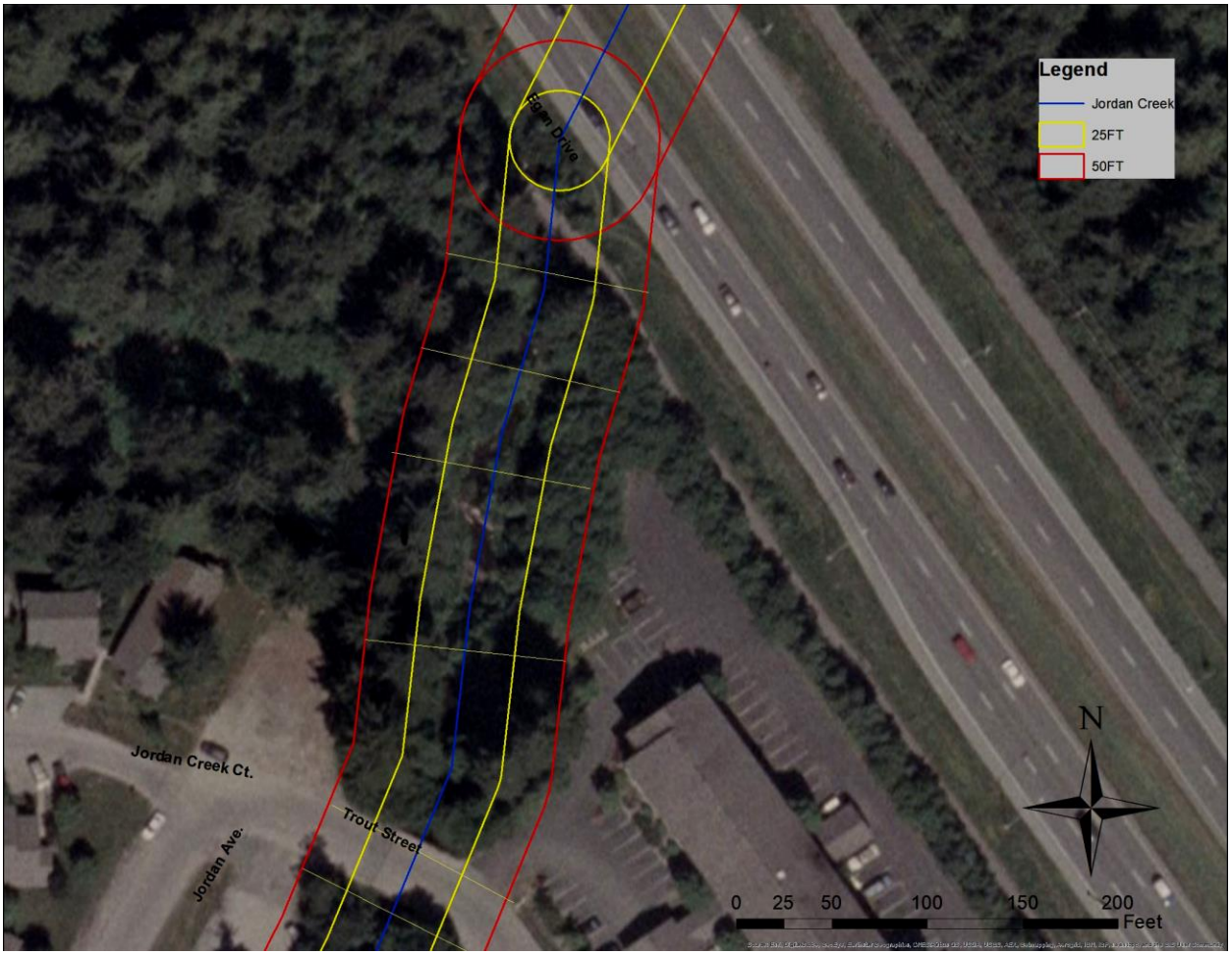
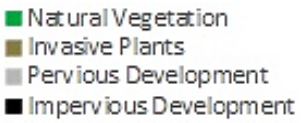
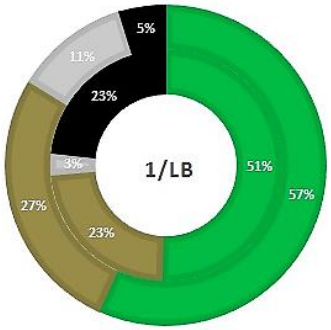
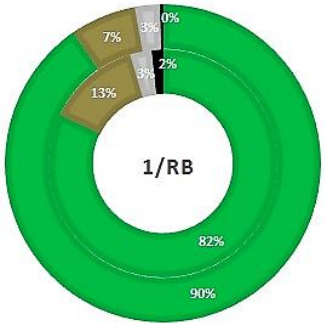


Figure 3. The 25 and 50-foot streamside setbacks along Reach 1 of lower Jordan Creek (yellow and red, respectively). The stream flows north to south, with the right bank on the western side. This is for visualization purposes only; breaks between stream Sections were estimated using GPS waypoints and setbacks projected using the buffer tool in ArcGIS. Note that the aerial photograph is not current, as Jordan Avenue has been extended, and a new storage unit and condominium complex has been built to the north-west of Jordan Creek Court, as shown in Figure 1.

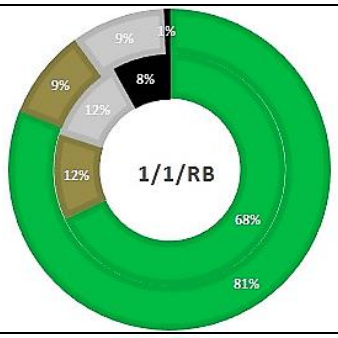
Table 2. The riparian condition of Reach 1 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

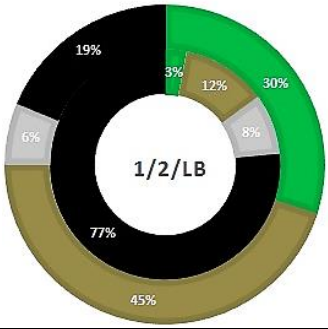


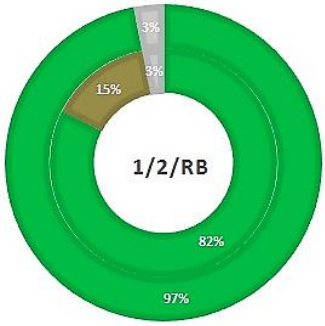


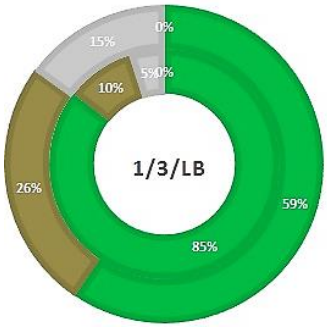


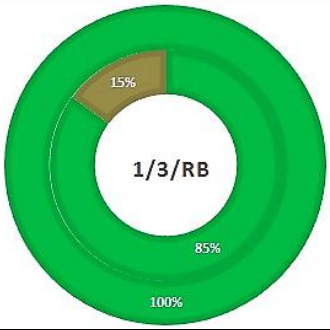
Data was not collected for Reach1/Section 1/Stream Left, since much of the area was outside of the study area and encompassed Egan Drive











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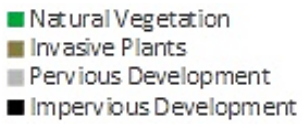
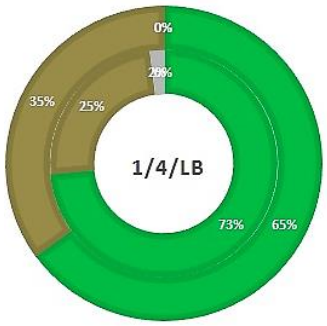
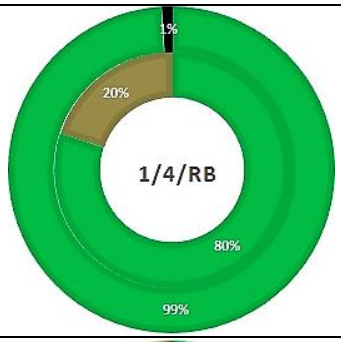
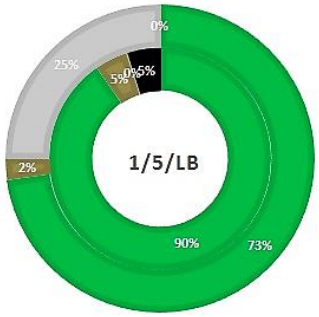
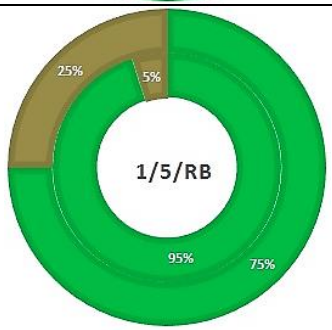










Reach 2 - Trout St. to Jordan Ave.

Reach Information

Total Stream Length: ~570 feet

Zoning: Light Commercial

Number of streamside property owners: 2

Overstory Vegetation: Sitka Spruce, red alder, willow species, black cottonwood, European mountain ash

Understory Vegetation: reed canary grass, European mountain ash (saplings), skunk cabbage, elderberry, lady fern, false lily of the valley, salmonberry, goat's beard, horsetail, moss, lawn/grass

Disturbances within 25-feet: Invasive plant species, debris, foot traffic, landscaping, parking lot, snow storage

Development within 50-feet: Parking lot

Number of Stream Crossings: 4

- Trout St. bridge
- Two pedestrian bridges behind the Jordan Creek Center
- Jordan Ave. bridge

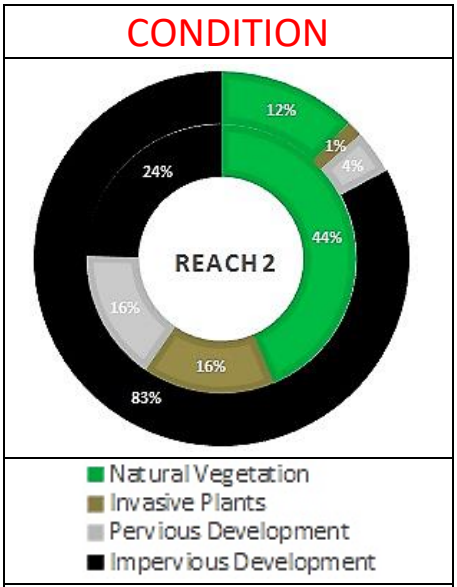


Figure 4. The riparian condition of Reach 2 including the percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

Data for Each Stream Section

Number of stream sections in Reach 2 is shown in Table 3 and Figure 5. Sections are numbered in order from the upstream end at Trout Street to the downstream end at Jordan Avenue.

Table 3. Section numbers and lengths for Reach 2.

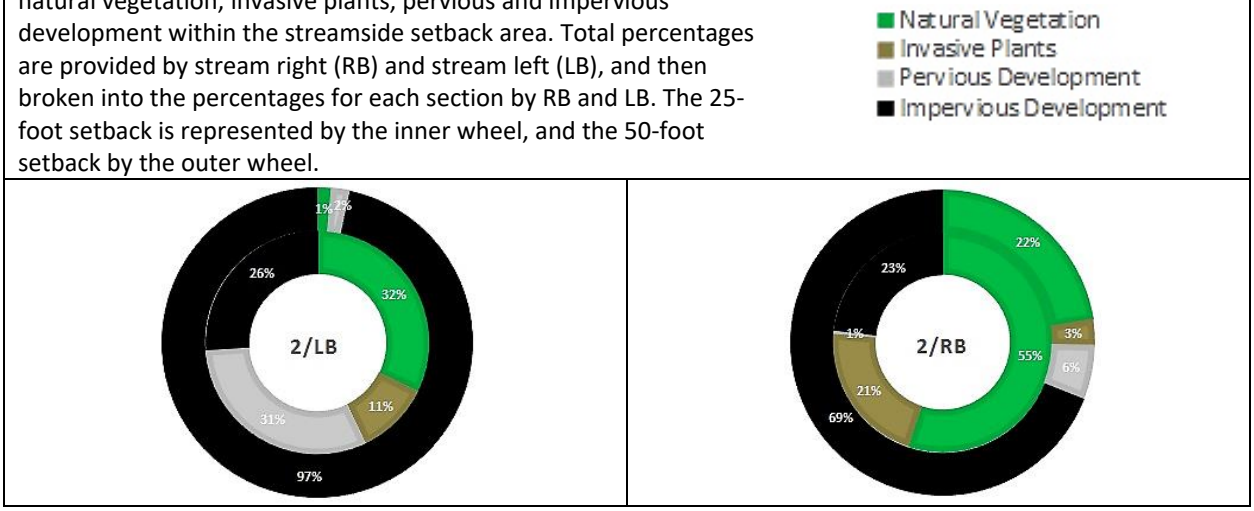
Section	Approximate Section Length (ft)
1	75
2	75
3	75
4	75
5	75
6	75
7	120

Synopsis

Reach 2 is bordered by the Jordan Creek Center on the left and Jordan Avenue on the right. Reach 2 has the greatest percent of the riparian zone developed with impervious surfaces in both the 25- and 50-foot setbacks. The 50-foot setback on the left bank consists almost entirely of paved parking.

Figure 5. The 25 and 50-foot streamside setbacks along Reach 2 of lower Jordan Creek (yellow and red, respectively). The stream flows from northeast to southwest in this reach, with the right bank on the western side. This is for visualization purposes only; breaks between stream Sections were estimated using GPS waypoints and setbacks projected using the buffer tool in ArcGIS.

Table 4. The riparian condition of Reach 2 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.



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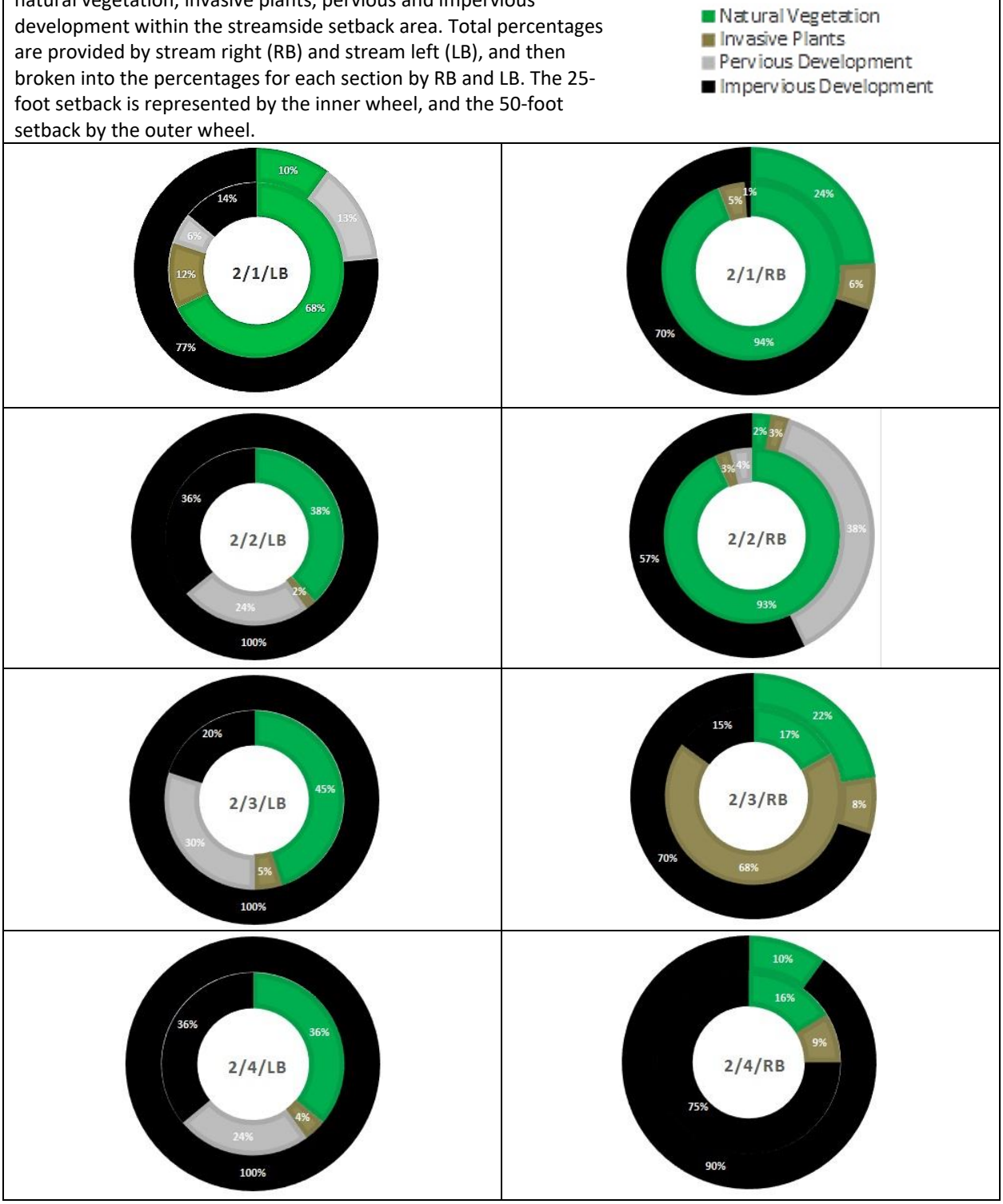

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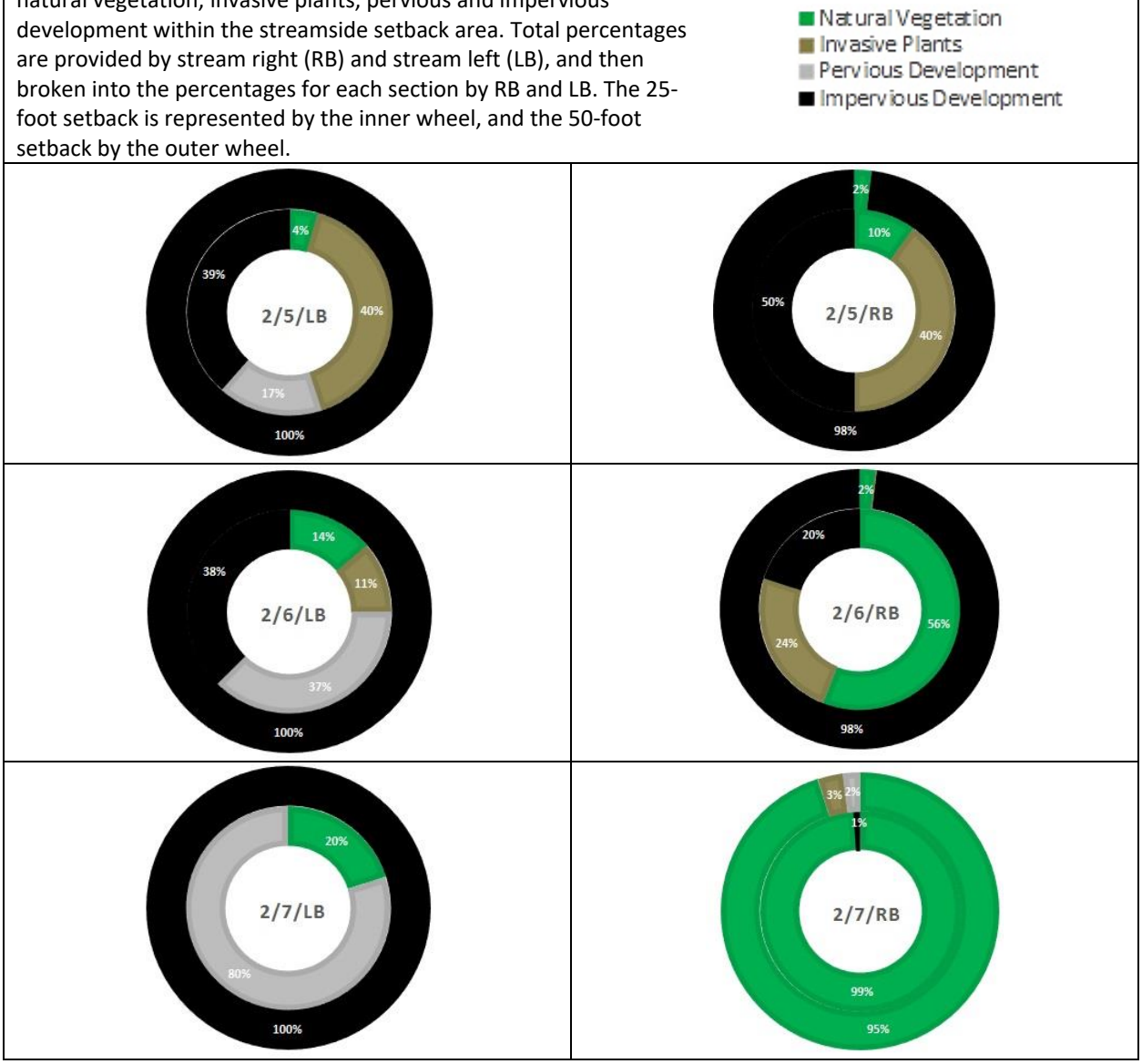


Reach 3 - Jordan Ave. to Glacier Hwy.

Reach Information

Total Stream Length: ~835 feet

Zoning: Light Commercial and Residential D-5

Number of streamside property owners: 8

Overstory Vegetation: Sitka Spruce, red alder, willow species, black cottonwood, European mountain ash, pine, crab apple

Understory Vegetation: red alder (saplings), European mountain ash (saplings), Western hemlock (saplings), red osier dogwood, salmonberry, blueberry, goat's beard, elderberry, orange hawkweed, bishop's weed, false lily of the valley, lady fern, marsh marigold, moss, various grasses/lawn

Disturbances within 25-feet: Invasive plant species, garbage/debris, foot traffic, landscaping, fences, parking lots, buildings, snow storage, revetments, stormwater pipe

Development within 50-feet: Parking lots, buildings

Number of Stream Crossings: 4

- Jordan Ave. bridge
- Two driveway bridges
- Glacier Hwy. culverts

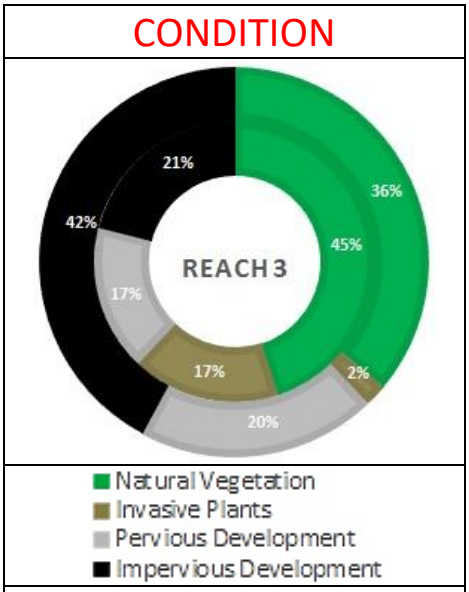


Figure 6. Riparian condition of Reach 3 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

Data for Each Stream Section

Number of stream sections in Reach 3 is shown in Table 5 and Figure 7. Sections are numbered in order from the upstream end at Jordan Avenue to the downstream end at Glacier Highway.

Table 5. Section numbers and lengths for Reach 3.

Section	Approximate Section Length (ft)
1	75
2	75
3	75
4	75
5	75
6	75
7	75
8	75
9	75
10	75
11	62L/85R

Synopsis

A residential area borders Reach 3 on the right and several commercial properties border it on the left. This reach meanders around the Jordan Square Building. The difference in land use has preserved native vegetation on the right bank, with some sections entirely free of invasive plant species. However, reed canarygrass dominates in the downstream sections immediately adjacent to Glacier Highway. Both banks are impacted by impervious and pervious surfaces associated with development. This reach is known to cause flooding on adjacent properties. A streambank stabilization project was completed on the upstream end of the reach on the left bank.

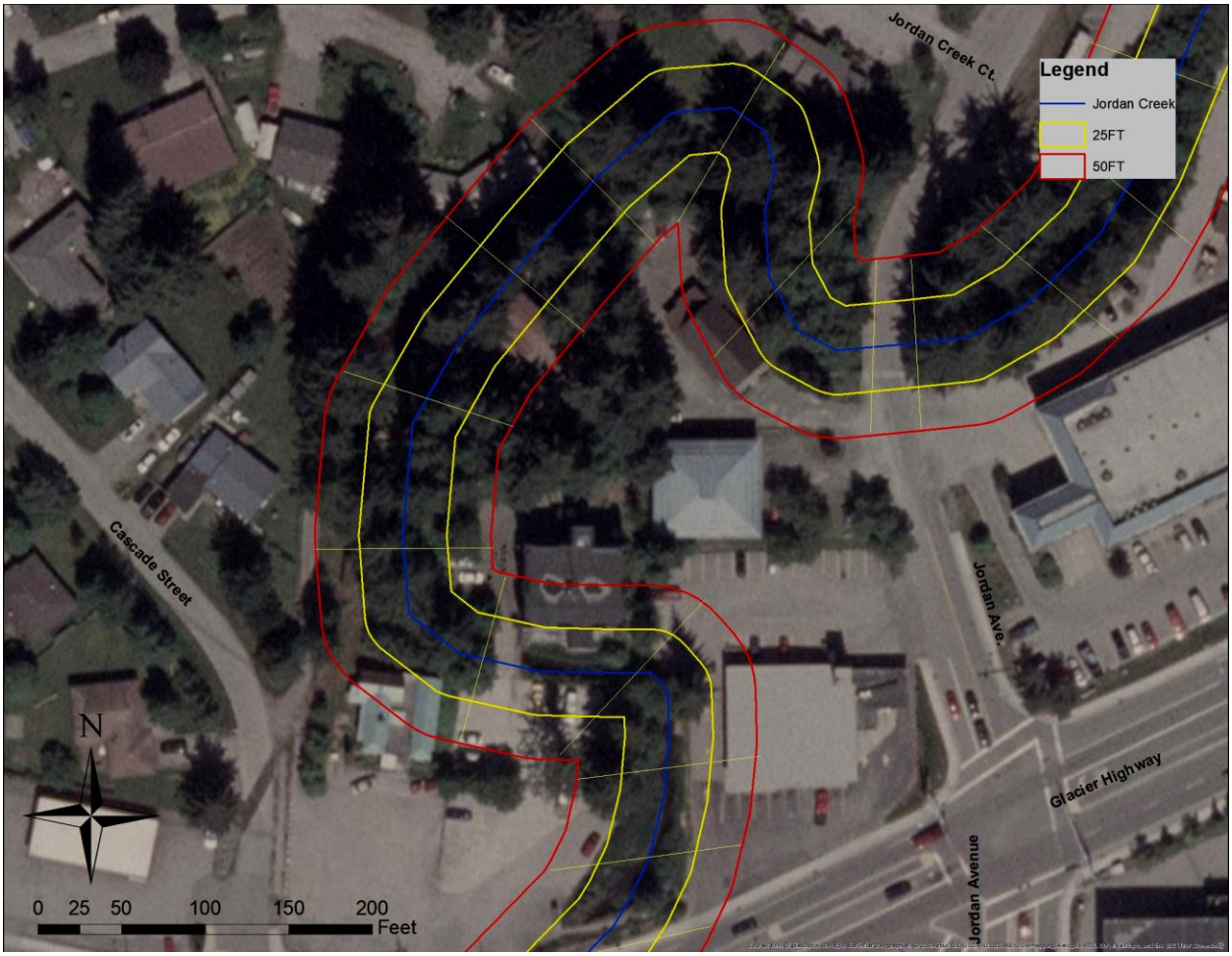
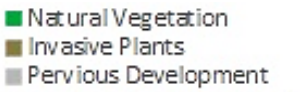
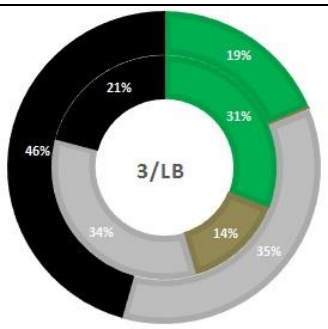
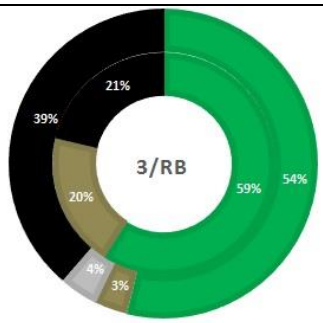


Figure 7. The 25 and 50-foot streamside setbacks along Reach 3 of lower Jordan Creek (yellow and red, respectively). The stream flows roughly north to south, meandering around the Jordan Square Building. The right bank is located on the western side. This is for visualization purposes only; breaks between stream Sections were estimated using GPS waypoints and setbacks projected using the buffer tool in ArcGIS.

Table 6. The riparian condition for each stream section of Reach 3 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.







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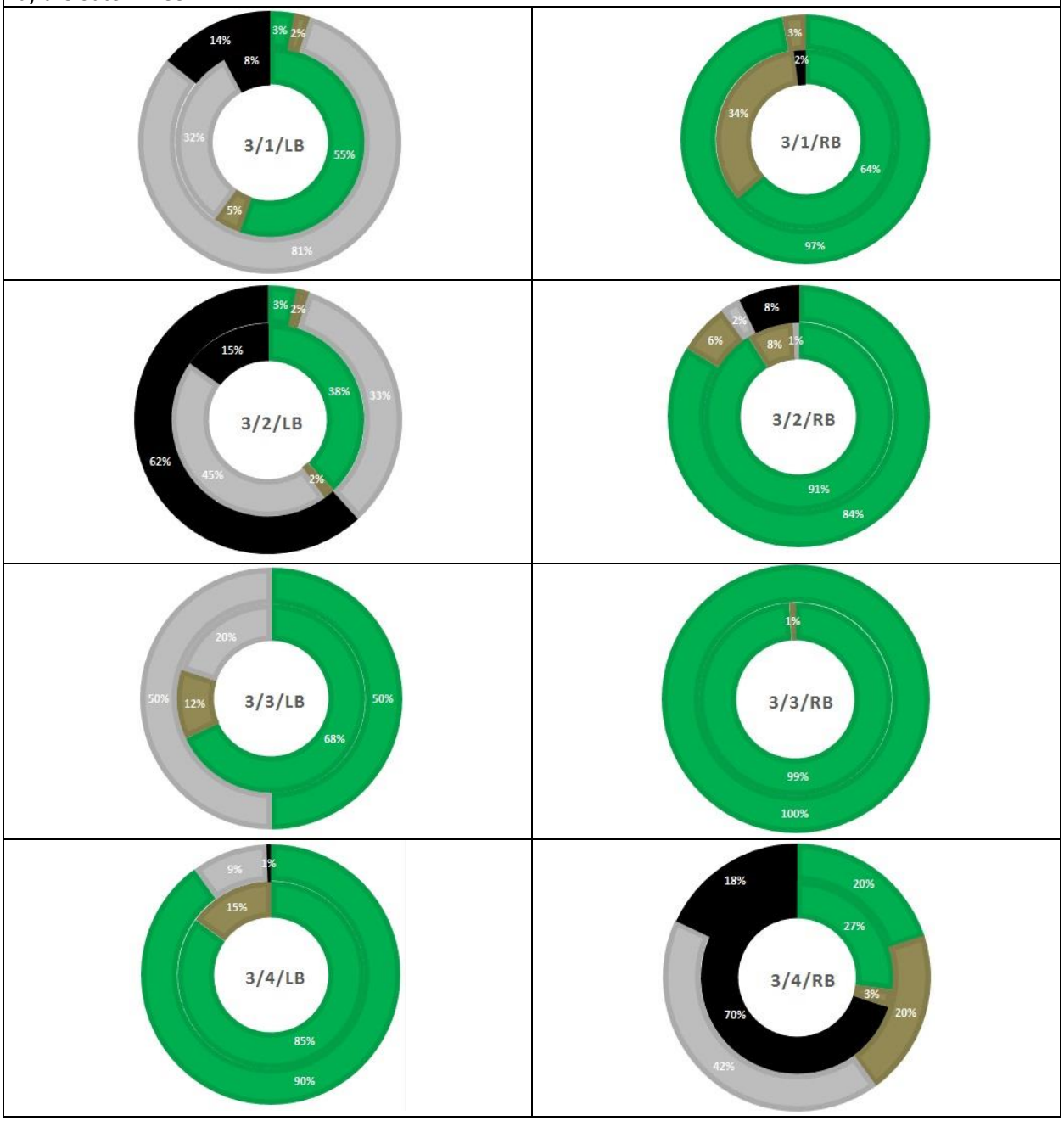


Table 6. The riparian condition for each stream section of Reach 3 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

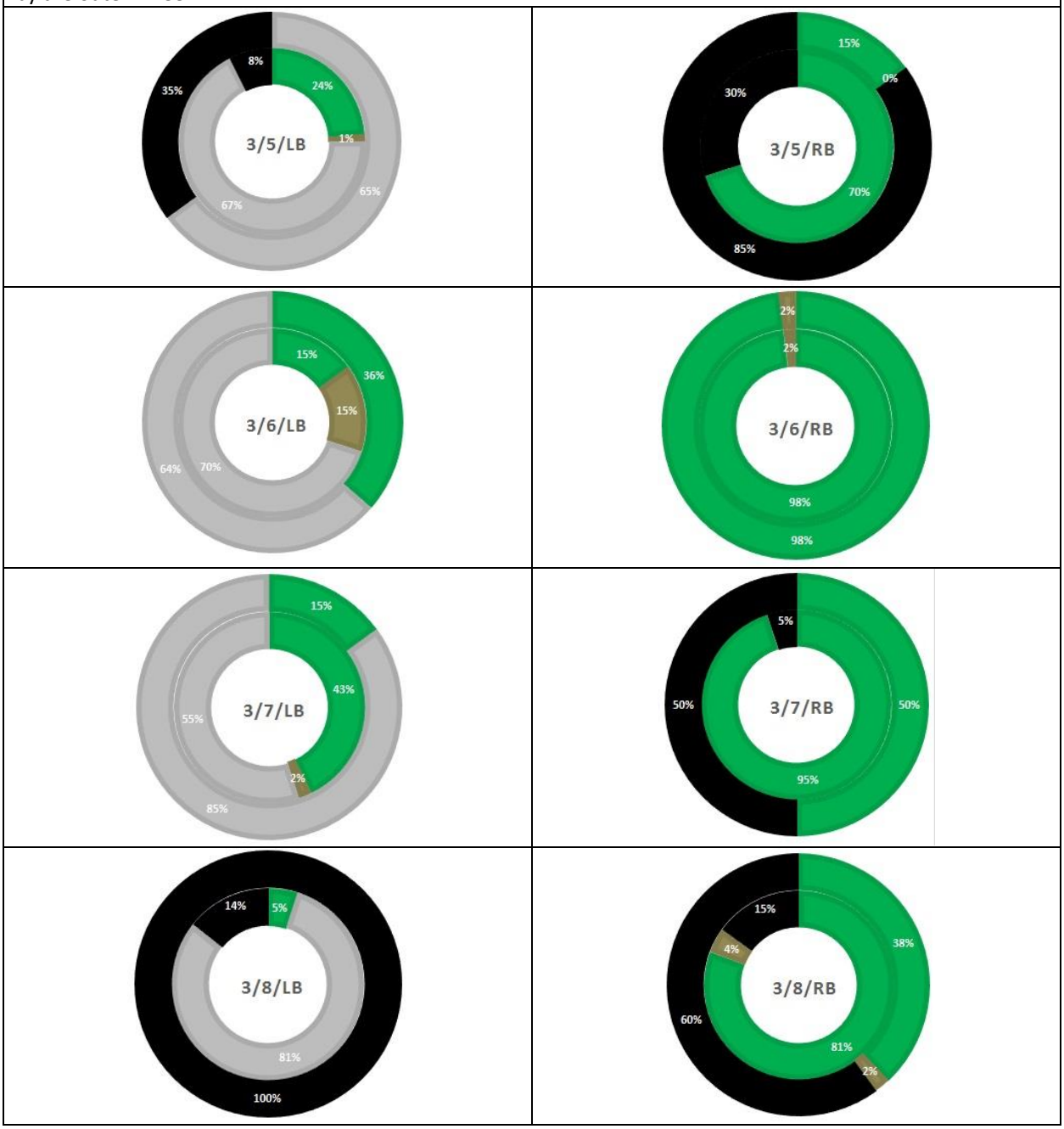
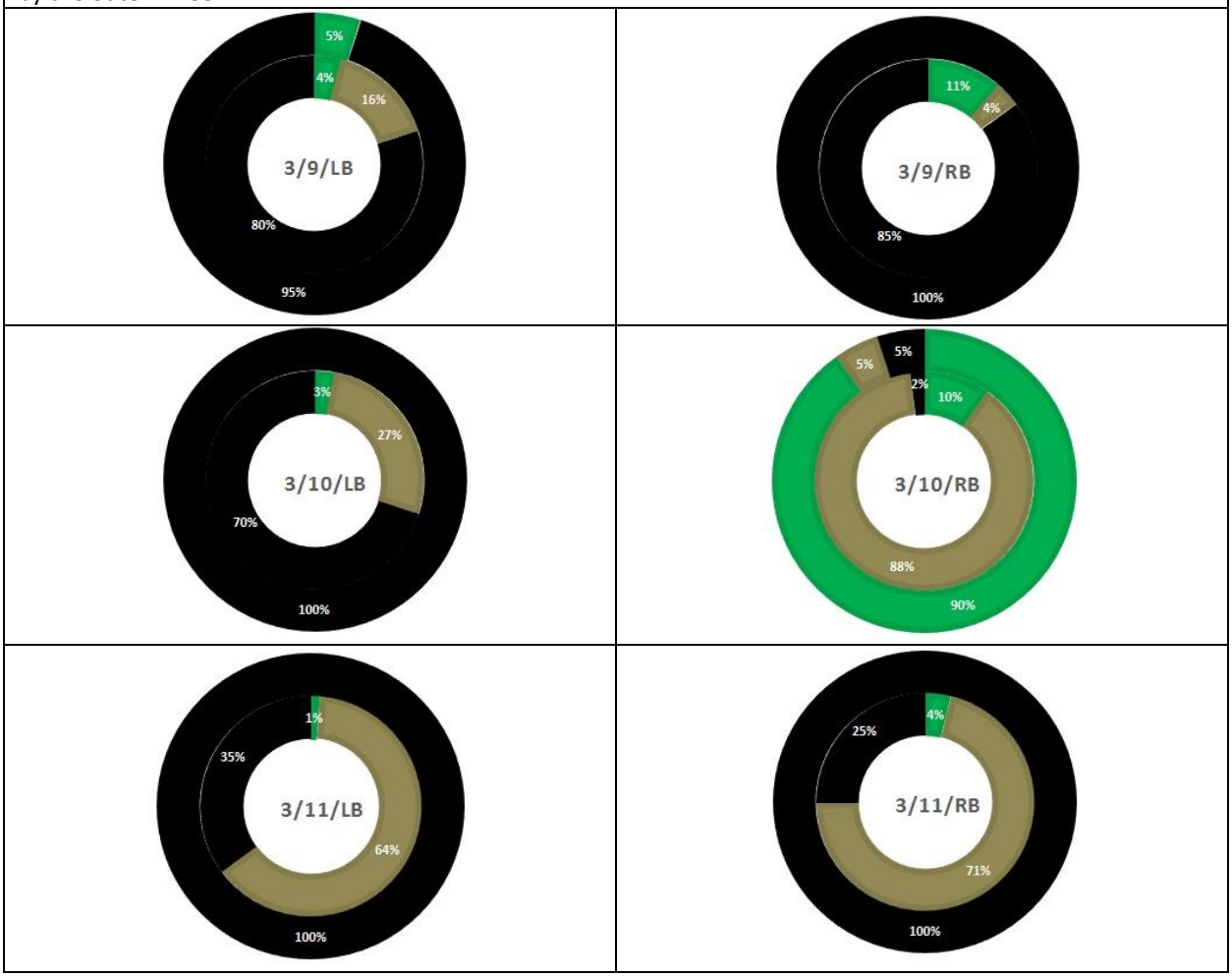


Table 6. The riparian condition for each stream section of Reach 3 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.



Reach 4 - Glacier Hwy. to the Jordan Creek Greenbelt

Reach Information

Total Stream Length: ~825 feet

Zoning: General Commercial, Industrial

Number of streamside property owners: 9

Overstory Vegetation: Sitka Spruce, red alder, willow species, black cottonwood, European mountain ash, European bird cherry

Understory Vegetation: reed canarygrass, cow parsnip, willow (saplings), European bird cherry (saplings), European mountain ash (saplings), current, salmonberry, raspberry, skunk cabbage, creeping buttercup, various grasses/lawn

Disturbances within 25-feet: Invasive plant species, debris, foot traffic, landscaping, fences, parking lots, buildings, snow storage, roads, utility maintenance

Development within 50-feet: Parking lots, buildings, gravel fill, concrete barriers, fences

Number of Stream Crossings: 1

- Glacier Hwy. culverts

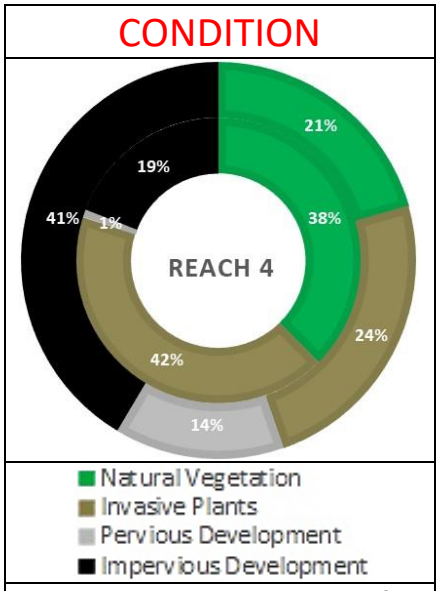


Figure 8. The riparian condition of Reach 4 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

Data for Each Stream Section

Number of stream sections in Reach 4 is shown in Table 7 and Figure 9. Sections are numbered in order from the upstream end at Glacier Highway to the downstream end near the corner of Teal Street.

Table 7. Section numbers and lengths for Reach 4.

Section	Approximate Section Length (ft)
1	75
2	75
3	75
4	75
5	75
6	75
7	75
8	75
9	75
10	75

Synopsis

Reach 4 is bordered by office buildings and parking lots on both sides, resulting in the upstream half of this reach being severely impacted. The left bank, in particular, has a high percentage of impermeable surfaces including sections where both setbacks are almost entirely paved. There are notable problems with bank erosion throughout this reach. Invasive plant species begin to dominate the vegetated areas. Several improvements have occurred along the right bank including riparian plantings, streambank stabilization, protective fencing, and a rain garden.

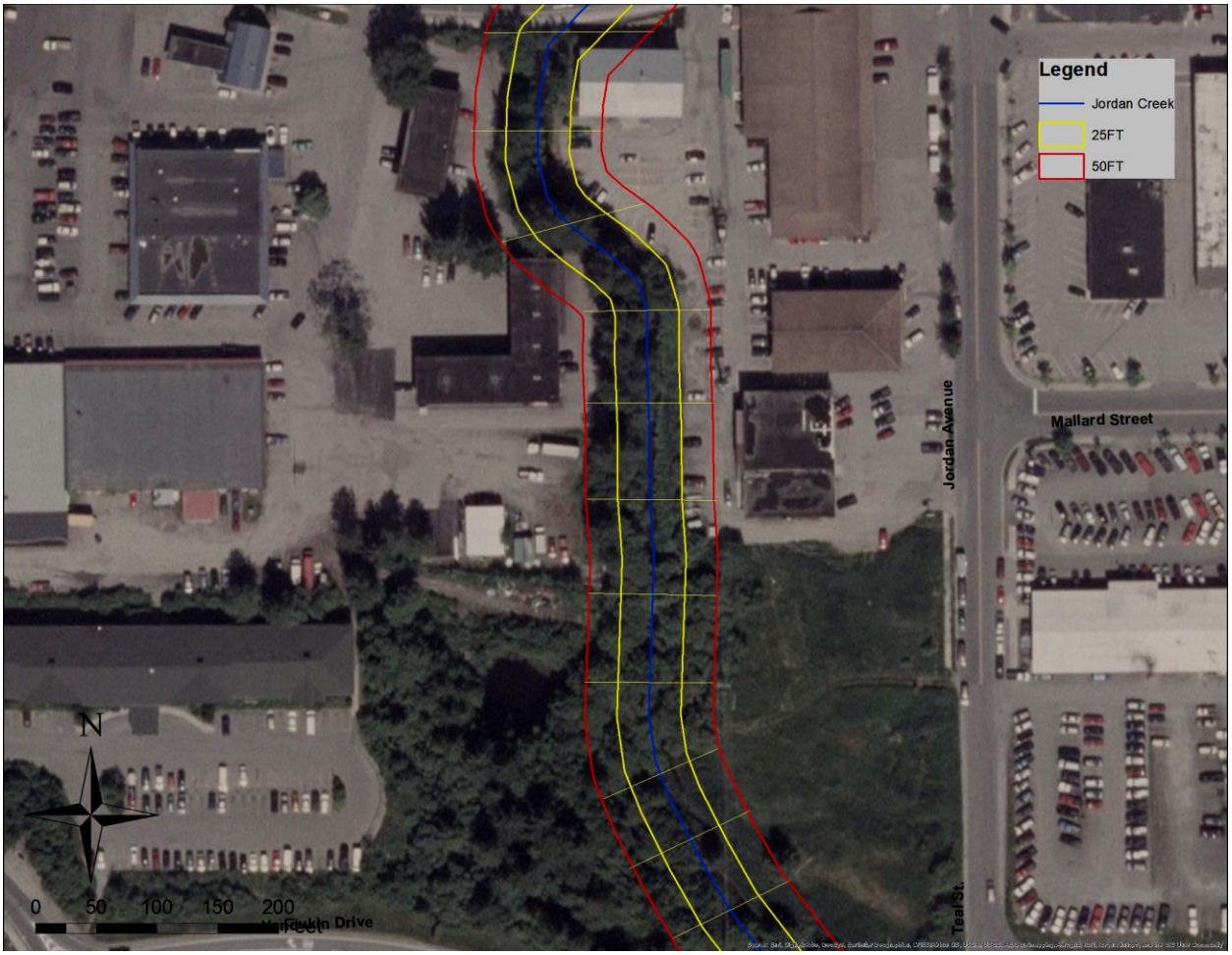


Figure 9. The 25 and 50-foot streamside setbacks along Reach 4 of lower Jordan Creek (yellow and red, respectively). The stream flows north to south, with the right bank on the western side. This is for visualization purposes only; breaks between stream Sections were estimated using GPS waypoints and setbacks projected using the buffer tool in ArcGIS. Note that the aerial photograph is not current, as Jordan Avenue has been extended, and a new storage unit and condominium complex has been built to the north-west of Jordan Creek Court

Table 8. The riparian condition of Reach 4 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

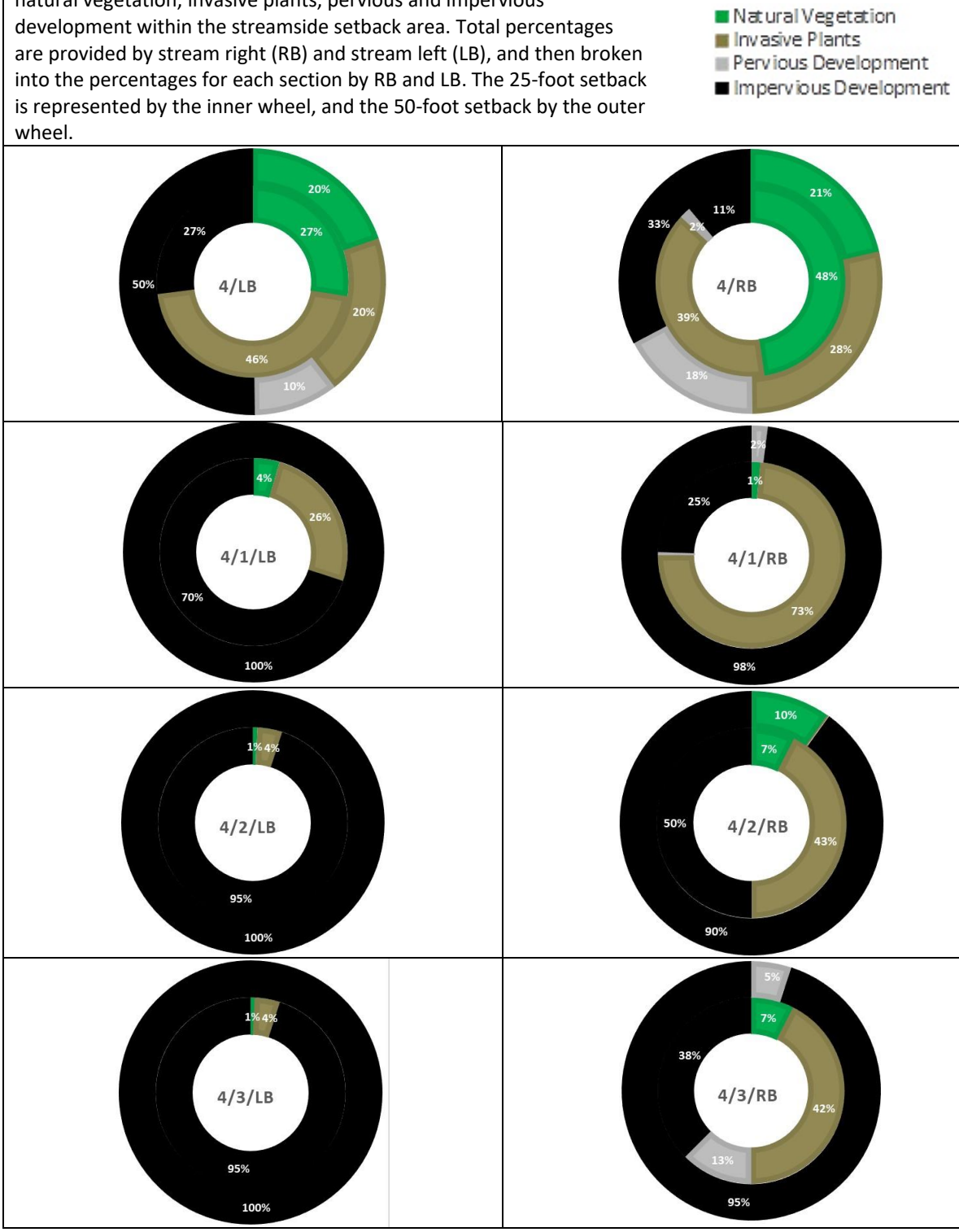
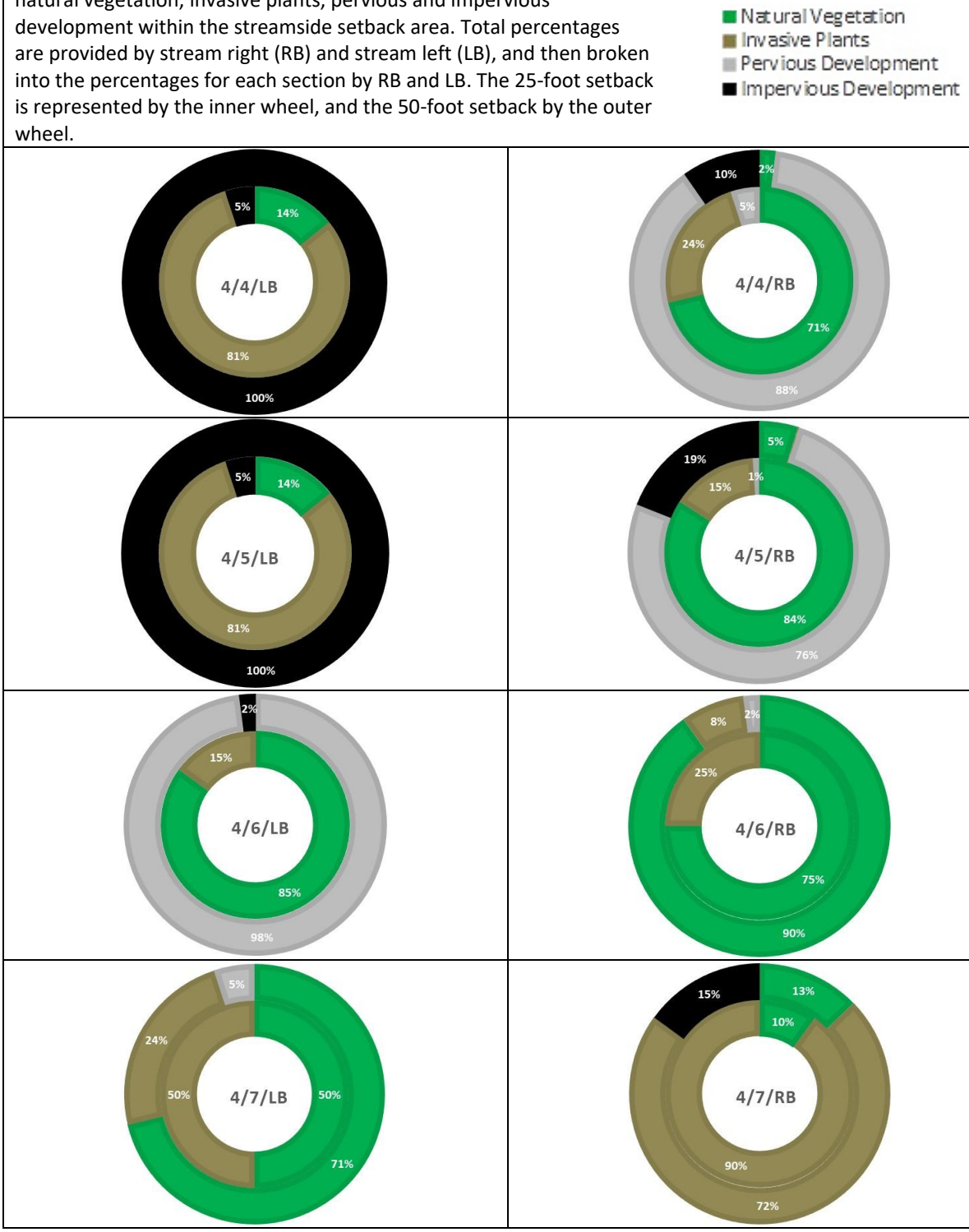


Table 8. The riparian condition of Reach 4 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.



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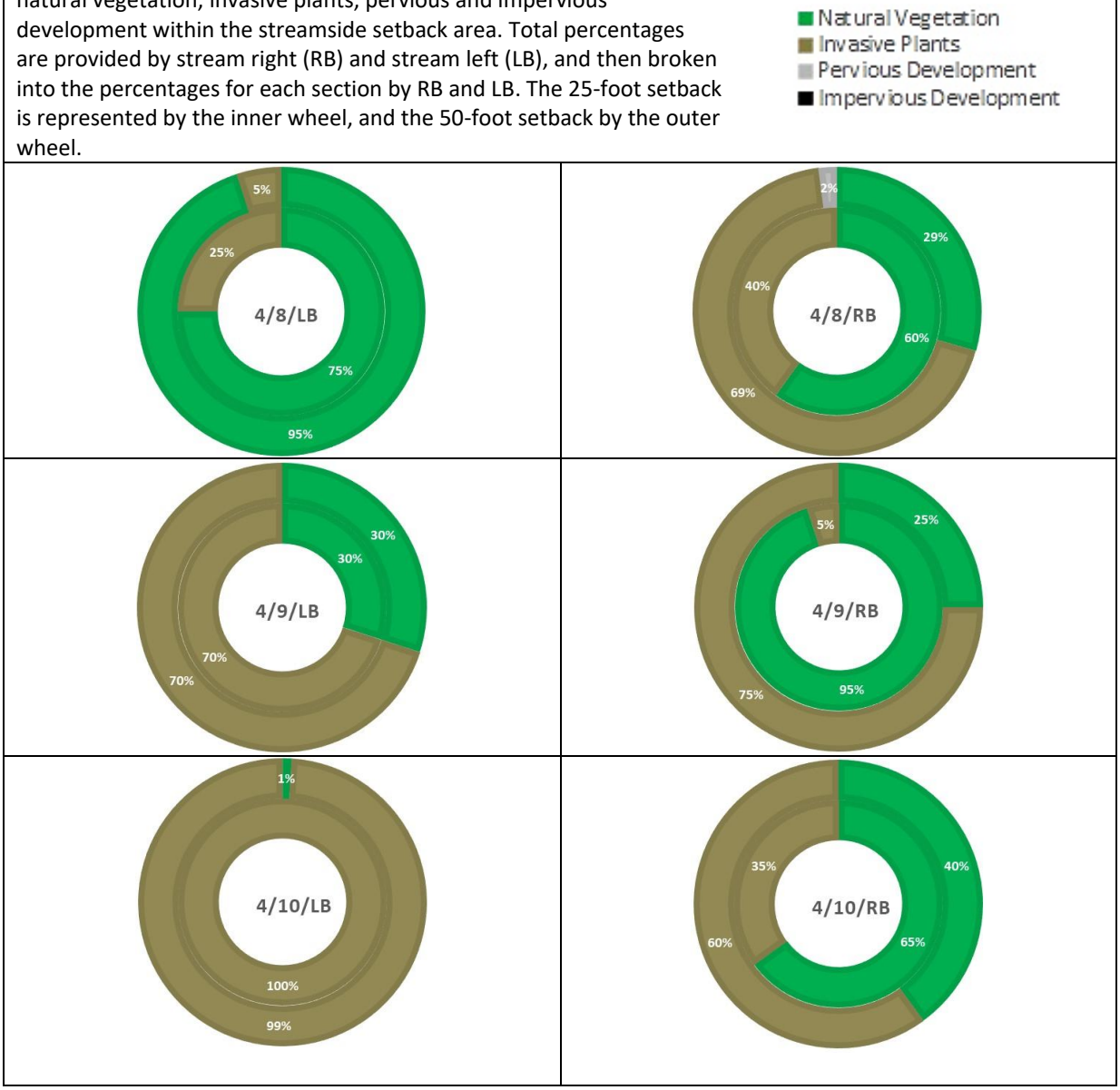


Reach 5 - Jordan Creek Greenbelt to Yandukin Dr.

Total Stream Length: ~1,500 feet

Zoning: General Commercial, Industrial

Number of streamside property owners: 1

Overstory Vegetation: Sitka Spruce, red alder, willow species, European mountain ash, European bird cherry, elderberry

Understory Vegetation: reed canarygrass, European bird cherry (saplings), European mountain ash (saplings), Sitka spruce (saplings), cow parsnip, black lily, skunk cabbage, marsh marigold, horsetail, angelica, forget-me-not, elderberry, salmonberry, high brush cranberry, nagoonberry, raspberry, trailing current, black current, false lily of the valley, rosy twisted stalk, touch-me-not, spiny wood fern, lady fern, moss, creeping buttercup, large leaf avens, dandelion, various grasses/lawn

Disturbances within 25-feet: Invasive plant species, debris, foot traffic, landscaping, snow storage, encampments

Development within 50-feet: Road

Number of Stream Crossings: 4

- Three pedestrian bridges (Greenbelt)
- Yandukin Dr. culverts

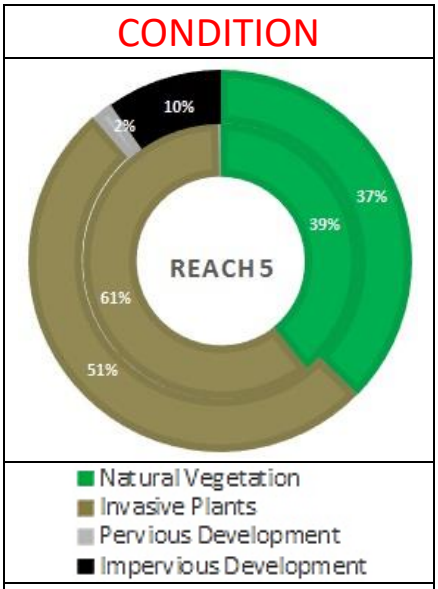


Figure 10. The riparian condition of Reach 5 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

Data for Each Stream Section

Number of stream sections in Reach 5 is shown in Table 9 and Figure 11. Sections are numbered in order from the upstream end near the corner of Teal Street to the downstream end at the Yandukin Drive crossing of the stream.

Table 9. Section numbers and lengths for Reach 5.

Section	Approximate Section Length (ft)
1	75
2	75
3	75
4	75
5	75
6	75
7	75
8	75
9	75
10	75
11	75
12	75
13	75
14	75
15	75
16	75
17	75
18	75
19	75
20	75

Synopsis

Reach 5 is within the Jordan Creek Greenbelt. While this reach has the greatest percentage of vegetated area, it includes a high proportion of invasive plant species, primarily reed canarygrass. Other than invasive plants, poor snow management and garbage/debris associated with illegal encampments are the main concern.

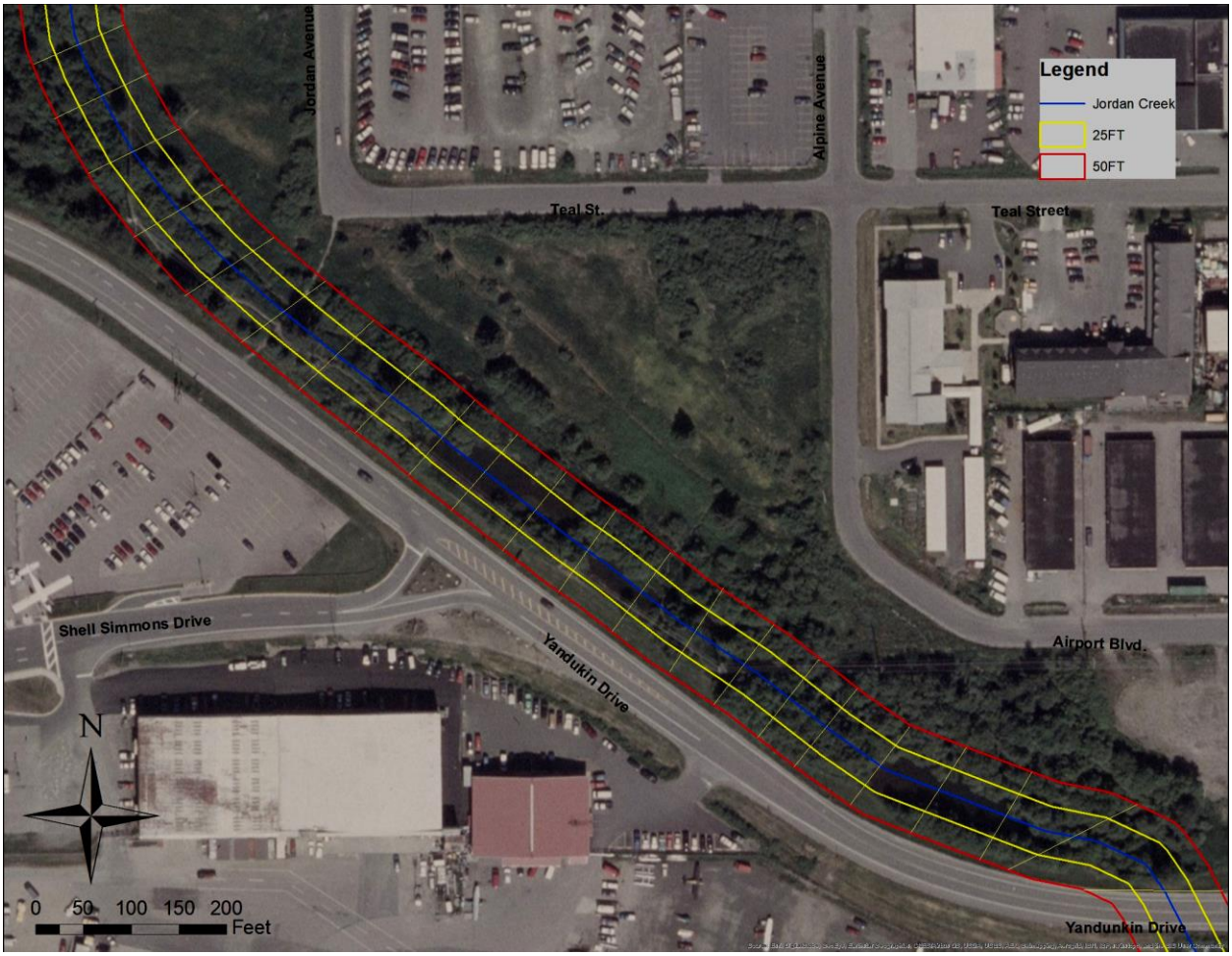
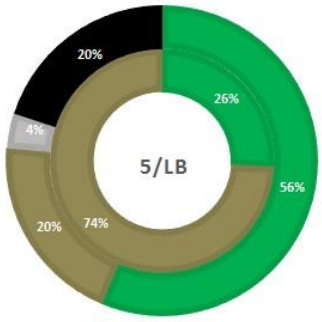


Figure 11. The 25 and 50-foot streamside setbacks along Reach 5 of lower Jordan Creek (yellow and red, respectively). The stream flows northwest to southeast, with the right bank adjacent to Yandukin Drive. This is for visualization purposes only; breaks between stream sections were estimated using GPS waypoints and setbacks projected using the buffer tool in ArcGIS.

Table 10. The riparian condition of Reach 5 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.



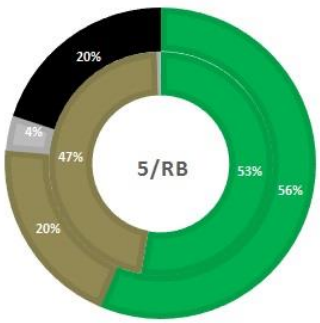
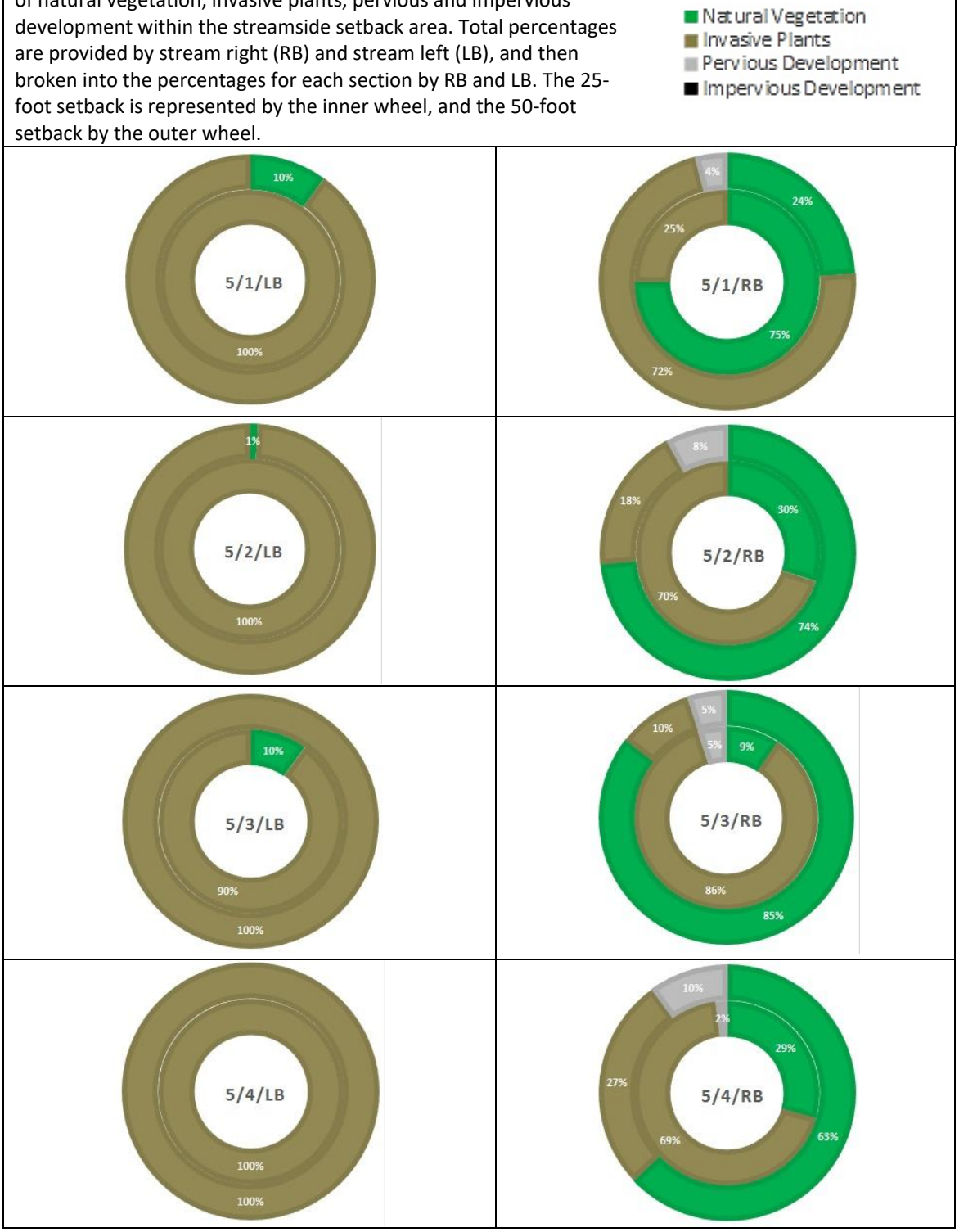


Table 10. The riparian condition of Reach 5 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.



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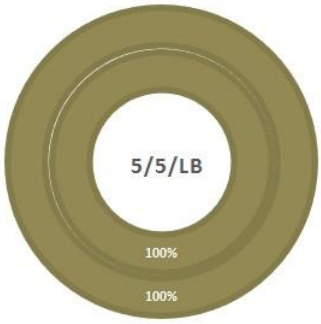
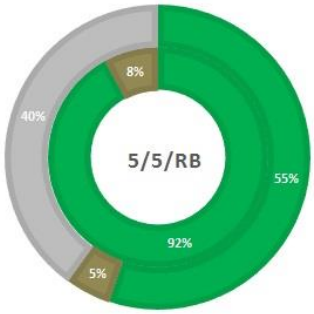
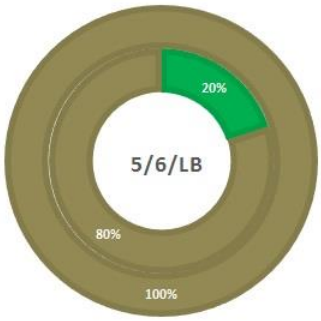
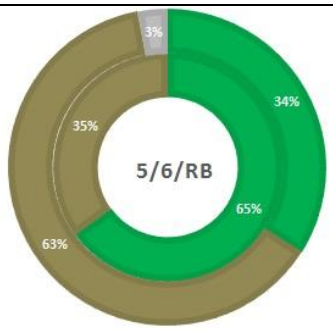
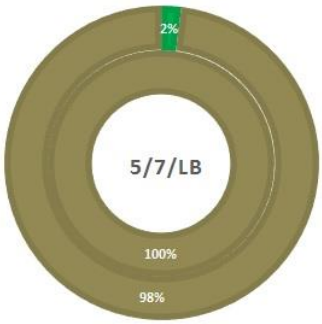


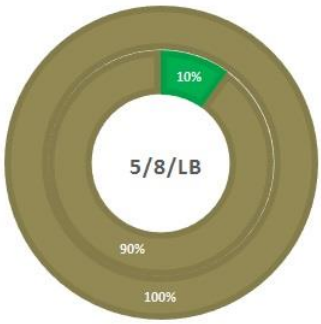








Data was not collected for Reach5/Section 7/Stream Right, since the stream meander made it challenging to visualize the setback and the section may have been overlapping with other assessed areas.



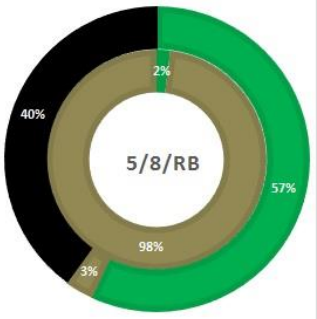
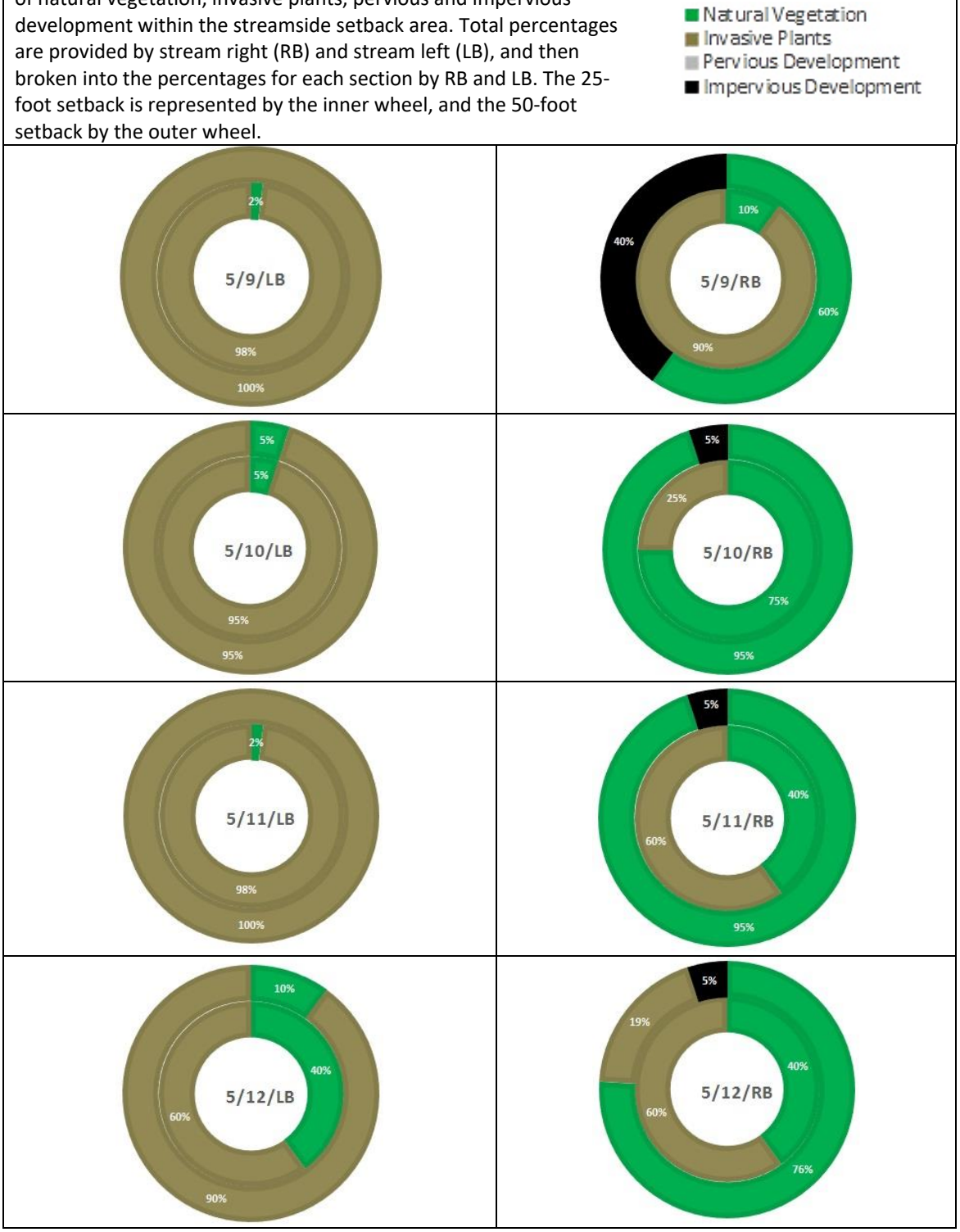


Table 10. The riparian condition of Reach 5 including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Total percentages are provided by stream right (RB) and stream left (LB), and then broken into the percentages for each section by RB and LB. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.



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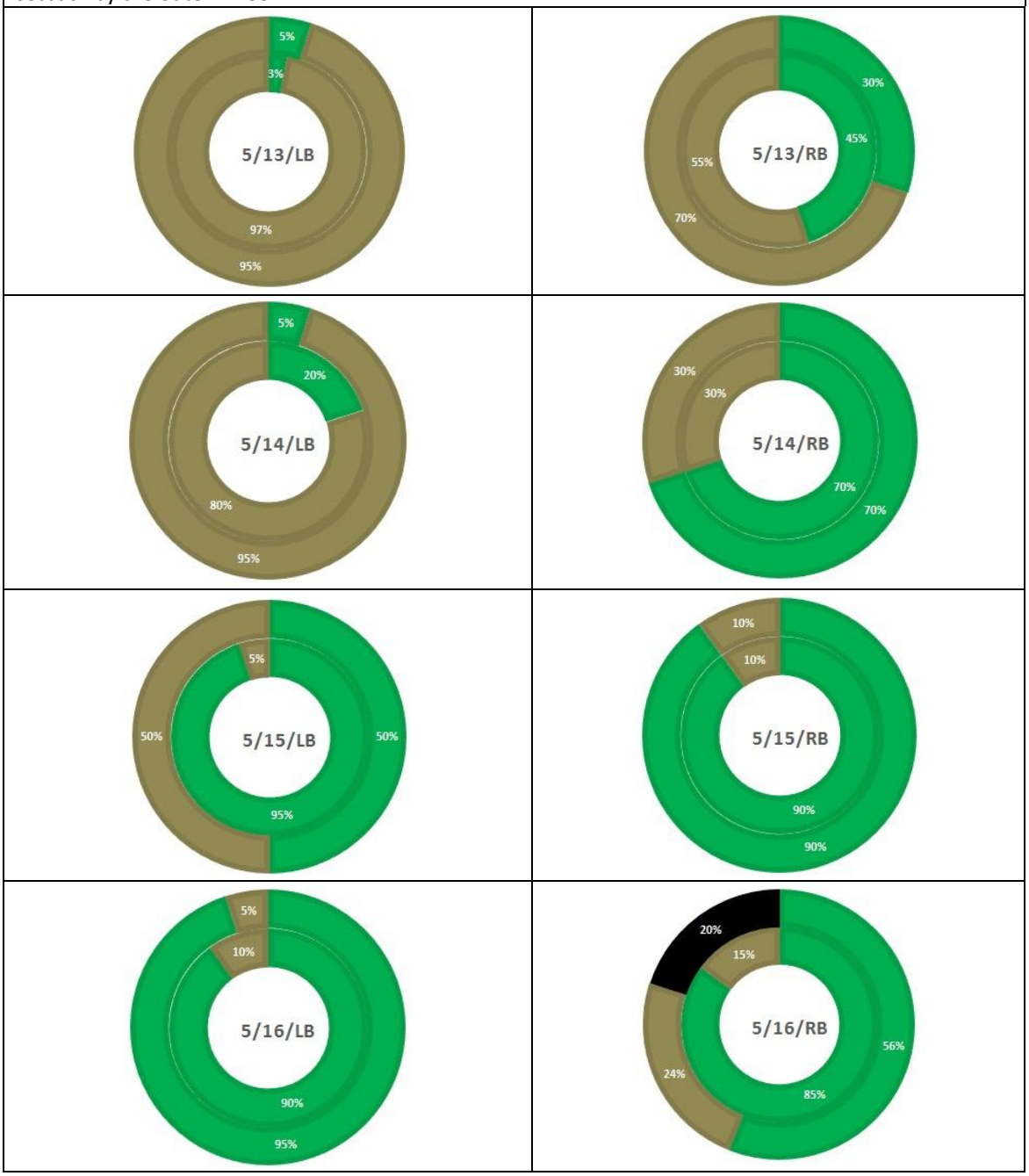

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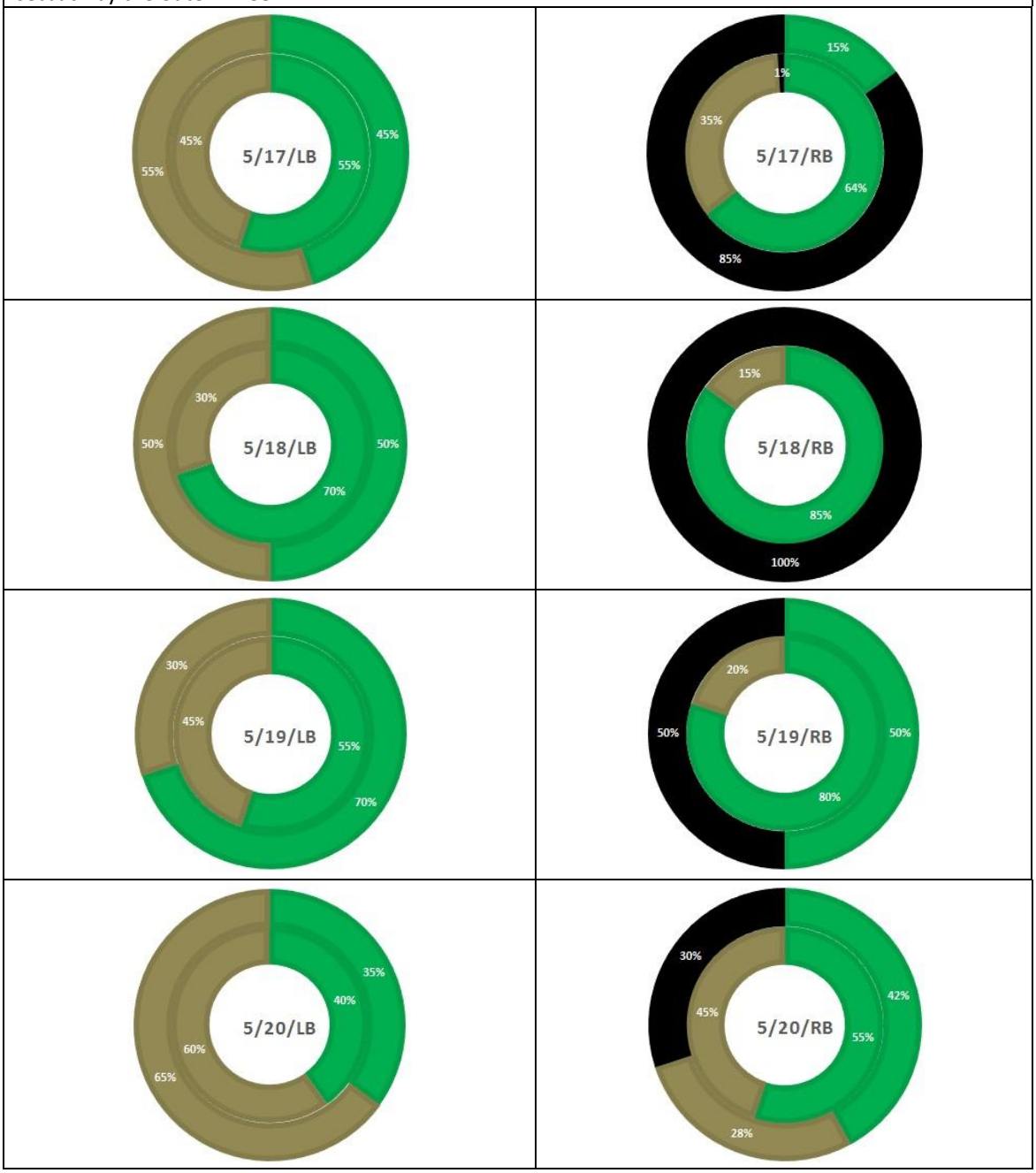


Lower Jordan Creek Summary

Total Stream Length: ~4,105 feet

Zoning: Residential D-5, Light Commercial, General Commercial, Industrial

Number of streamside property owners: 21

Overstory Vegetation: Sitka Spruce, red alder, willow species, black cottonwood, European mountain ash, European bird cherry

Understory Vegetation: reed canarygrass, cow parsnip, black lily, skunk cabbage, marsh marigold, horsetail, angelica, forget-me-not, elderberry, salmonberry, high brush cranberry, nagoonberry, raspberry, trailing current, black current, false lily of the valley, rosy twisted stalk, touch-me-not, spiny wood fern, lady fern, moss, creeping buttercup, large leaf avens, orange hawkweed, bishop's weed, dandelion, various grasses/lawn, Sitka spruce (sapling), Western hemlock (sapling), European mountain ash (sapling), European bird cherry (sapling)

Disturbances within 25-feet: Invasive plant species, debris/litter, foot traffic, encampments, landscaping, utility maintenance, snow storage, parking lots, fences, small structures (e.g. shed, picnic tables), buildings, roads

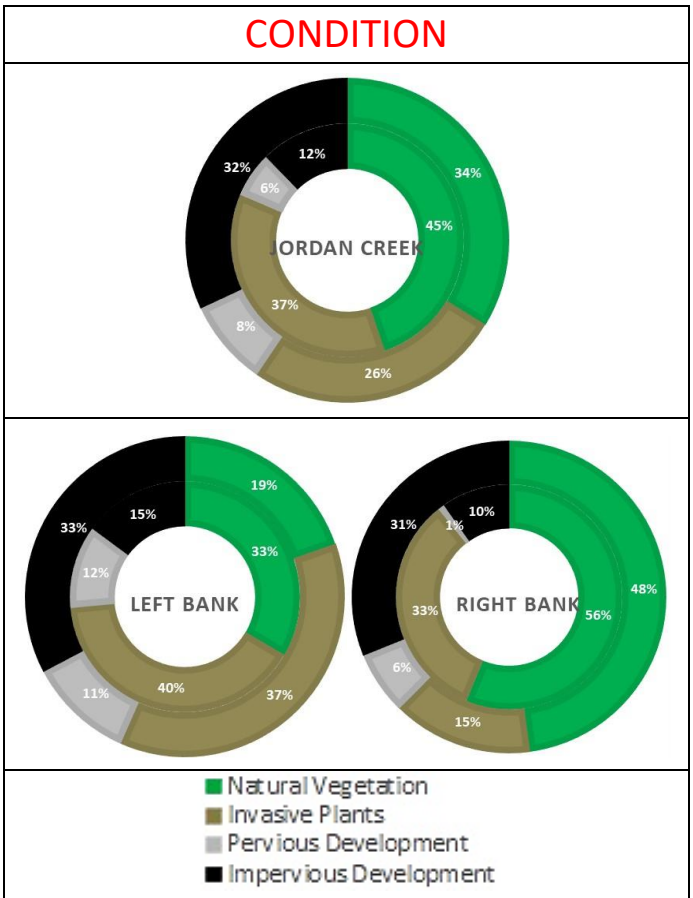


Figure 12. The riparian condition for lower Jordan Creek including percent cover of natural vegetation, invasive plants, pervious and impervious development within the streamside setback area. Percentages for stream right and stream left. The 25-foot setback is represented by the inner wheel, and the 50-foot setback by the outer wheel.

Development within 50-feet: parking lots, roads, buildings

Number of Stream Crossings: 13

- Egan Dr. culverts
- Multiuse path bridge @ Egan Dr.
- Trout St. bridge
- Two pedestrian bridges behind the Jordan Creek Center
- Jordan Ave. bridge
- Two driveway bridges
- Glacier Hwy. culverts
- Three pedestrian bridges (Greenbelt)
- Yandukin Dr. culverts

Discussion

Although the streamside setback ordinance was enacted after much of the area adjacent to the lower Jordan Creek was developed, this riparian assessment can still inform management decisions and bring current practices in line with the intent of the ordinance. The lower Jordan Creek riparian zone within the 25- and 50-foot streamside setback is in poor condition. Combined, 71 percent of the setback area remains undeveloped. However, only about half of the undeveloped setback area consists of native riparian vegetation.

The 25-foot setback is a "no disturbance zone." The term "disturbance" is not defined in the CBJ Land Use Code. For the purposes of this study, it is assumed the 25-foot setback is intended to remain in a natural vegetated state, where vegetation and the soil is not allowed to be removed or disturbed in any way. In an ideal state, the entire 25-foot setback should be 100 percent vegetated and not show signs of disturbance. About 81 percent of the 25-foot "no disturbance" setback is undeveloped, vegetated area. As expected, the 25-foot setback along Reach 5, which corresponds with the Jordan Creek Greenbelt, has the highest percent vegetated area. The 25-foot setback had the least vegetated area along Reaches 2 and 3 on the stream left (Table 11). The right bank generally had greater vegetated areas on these reaches due to the right bank being adjacent to residential and lighter commercial development.

Table 11. The average percent area vegetated for each stream reach in the 25-foot "no disturbance" zone. The average for the entire reach was calculated from the percent area vegetated for each section of the reach. The average percent area vegetated for the stream right and left (RB and LB, respectively) are also provided for comparison.

Reach	# Sections	Percent Area Vegetated		Reach Average
		RB	LB	
1	5	95.40	73.60	84.5
2	7	76.29	42.86	59.57
3	11	78.64	45.45	62.05
4	10	86.90	73.00	79.95
5	20	98.50	100.00	99.25
Overall Stream Average		**88.96**	**73.55**	**81.25**

Even though the 25-foot setback appears to be intact in terms of being vegetated, the setback was often disturbed in some way. Common disturbances included foot traffic, debris/litter, landscaping practices including maintenance for utility easements and road right-of-ways, and encroachment from development. In addition, if the intent of the 25-foot setback is to protect a natural vegetated state, the presence of invasive plant species within the setback area could arguably be considered as a disturbance or, at the very least, an indication that disturbance is occurring.

Invasive species are non-native (introduced) species that can aggressively spread, outcompete native species, and disrupt ecosystem functions. Invasive plant species comprise 37 and 26 percent of the 25- and 50-foot setbacks along lower Jordan Creek, respectively, which is about half of the entire undeveloped, vegetated portion of the setback area. The Jordan Creek riparian zone should be continuously monitored for invasive plant species to protect non-impacted areas and rehabilitate affected areas.

Figure 13. Reed canarygrass blocking one of the Jordan Creek Glacier Highway culverts during a high flow event. The culvert being blocked is in the center foreground of the photo, to the left of the culvert passing water.

Non-native plant species in Alaska have been given an invasiveness rank calculated based on a species' ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to native ecosystems and 100 representing a plant that poses a major threat to native ecosystems.

Reed canarygrass (*Phalaris arundinacea*) is the most prevalent and highly invasive plant in the watershed. It has an invasiveness rank of 83. It forms dense monocultures that displace native plant communities and constrict stream channels by promoting deposition of sediment (Klein 2011c). Such impacts can be seen throughout the lower Jordan Creek area. For example, the inlet to one of the Glacier Highway culverts is nearly blocked by reed canarygrass (Figure 13) and channel constriction is evident in the CBJ-owned greenbelt south of Jordan Avenue. Due to its prevalence, reed canarygrass was not mapped or counted in detail though its presence was noted in the field assessment.

European mountain ash (*Sorbus acuparia*) and European bird cherry (*Prunus padus*) are also prevalent in the lower Jordan Creek riparian zone (Figure 14 and 15). These tree species have invasiveness ranks of 59 and 74, respectively. While the ecological effects of these species on the Jordan Creek riparian zone are largely unknown, these trees are likely competing with native vegetation for space and nutrients. Both species have fruits that are desirable to birds, which likely help their ability to spread. European mountain ash can hybridize with ash species native to Alaska. European bird cherry contains a chemical that is toxic to animals such as moose and deer. It can create tall shrub layers that reduce light, moisture and available nutrients for other plant species, and can replace willow stands (Klein 2011a and b).

European mountain ash and European bird cherry were mapped and counted, as the occurrence of these species are of interest. European mountain ash was found throughout the lower Jordan Creek riparian area, while (Figures 16). The likely reason for the prevalence of European mountain ash is that it is a common landscaping tree and numerous trees have been planted near the west side of Reaches 1 and 2. The USFWS has been treating European mountain ash in lower Jordan Creek by girdling the trees, and this control technique appeared to be working on some of the treated trees. European bird cherry was primarily limited to Reaches 4 and 5, between Glacier Highway and Yandukin Drive (Figures 17). There are several large European bird cherry trees located in Reaches 4 and 5 that likely represent the parent stock of the trees in this area.

Figure 14. European mountain ash in lower Jordan Creek.

Figure 15. European bird cherry in lower Jordan Creek.

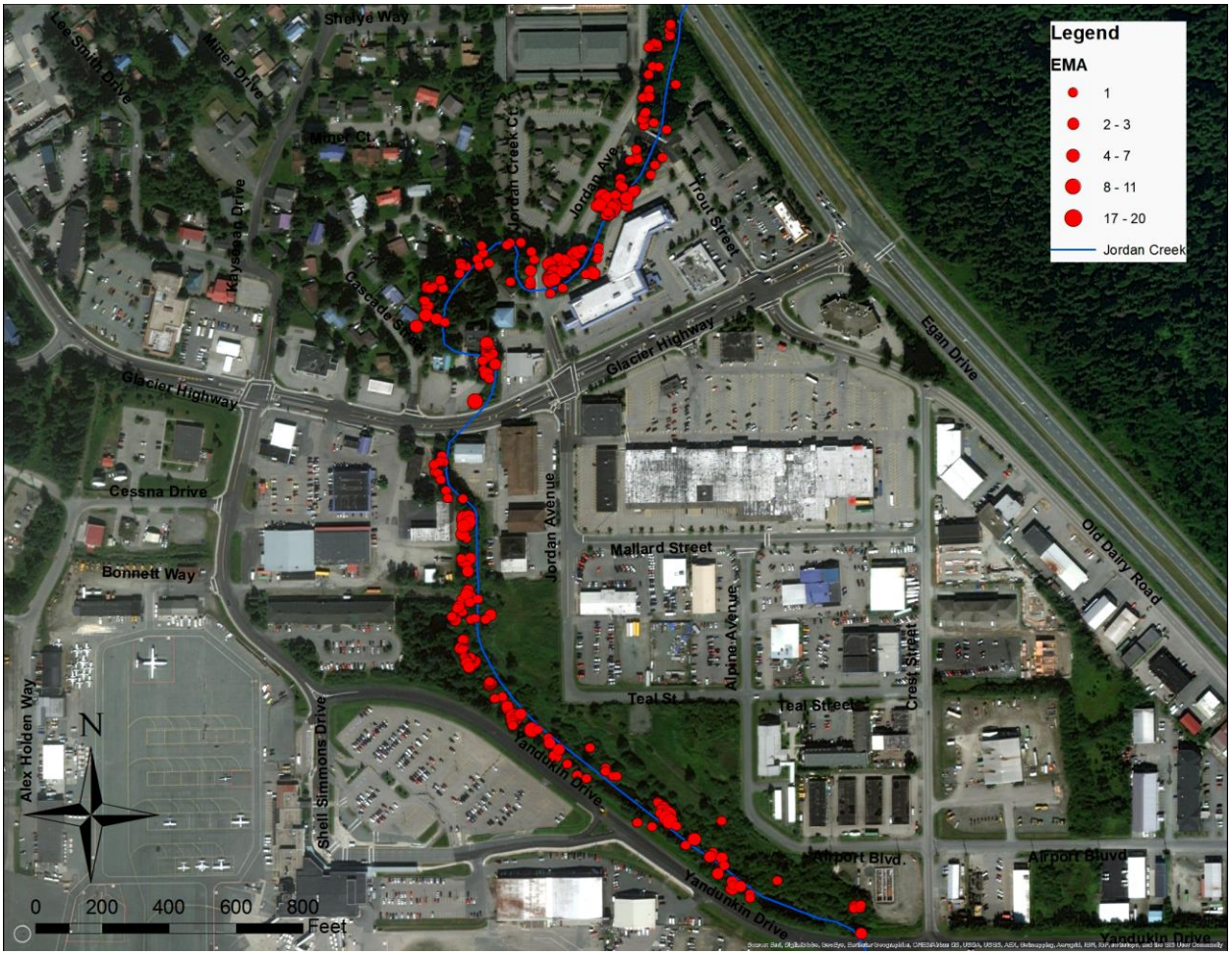


Figure 16. Location of European mountain ash in the lower Jordan Creek riparian area. Size of symbol represents the number of plants at that location.

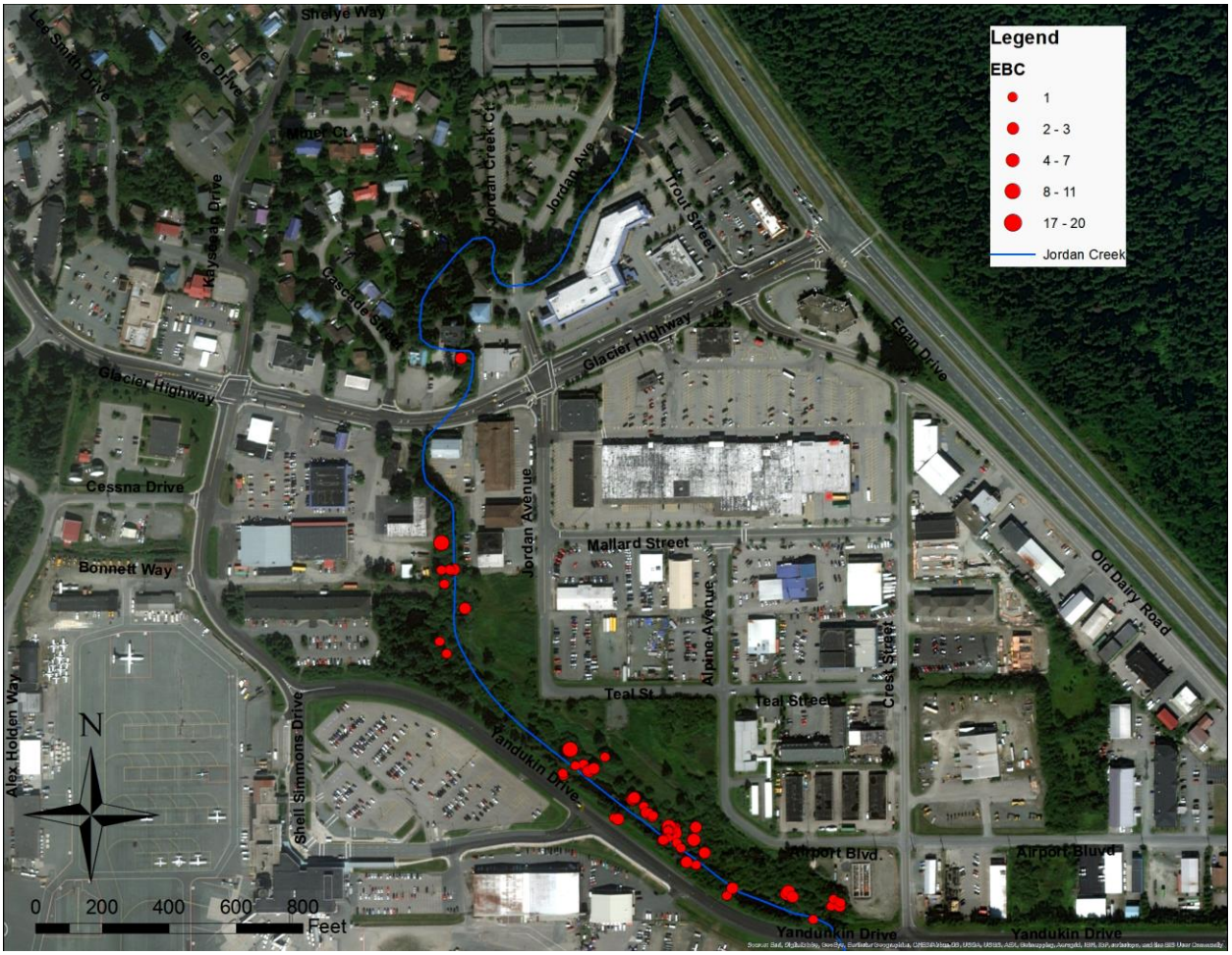


Figure 17. Location of European birch cherry in the lower Jordan Creek riparian area. Size of symbol represents the number of plants at that location.

The prevalence of invasive species along lower Jordan Creek is likely disrupting riparian and stream functions. For this reason, stream reaches where the 25- and 50-foot zones are entirely or largely vegetated but heavily dominated by invasive plants, were considered impacted in this assessment. This determination assumes that the intent of the streamside setback is to protect functioning native riparian areas.

The 50-foot setback is a "no development zone" along the stream. The term “development” is defined in the CBJ Land Use Code and includes activities such as excavation, placement of fill, removal of substantial vegetation, or siting of structures are prohibited. In an ideal state, the entire 50-foot setback would have no development. However, 40 percent of the 50-foot “no development” setback consists of developed areas. Development and structures within the 50-foot setback includes roads, parking lots, commercial buildings, homes, storage sheds, and fences.

The developed areas are highest along Reaches 2, 3, and 4 (Table 12). In some locations on Reaches 2, 3, and 4, the entire 50-foot setback has been paved. These same reaches also have locations where much of the 25-foot setback has also been paved. The left bank (facing downstream) is more impacted by

impervious surfaces than the right bank due to encroaching parking lots from commercial properties. Therefore, there may be more opportunities to work with landowners on the left bank to promote green infrastructure or other measures to reduce the impact of impervious surfaces, particularly when these landowners submit development permits to improve their parking lots.

Table 12. The average percent area developed for each stream reach in the 50-foot "no development" zone. The average for the entire reach was calculated from the percent area developed for each section of the reach. The average percent area vegetated for right and left banks (RB and LB, respectively) are also provided for comparison.

Reach	# of Sections	Percent Area Developed		Reach Average
		RB	LB	
1	5	2.80	16.25	8.78
2	7	74.71	98.57	86.64
3	11	42.73	81.82	62.27
4	10	49.70	60.50	55.10
5	20	23.68	0.00	11.54
Overall Stream Average		**37.58**	**43.46**	**40.52**

Impervious surfaces are surfaces that do not allow water to infiltrate into the underlying ground. Types of impervious surfaces include rooftops, streets, sidewalks and parking lots. There is a positive relationship between the amount of impervious surface within a watershed and stream degradation. This is because impervious surfaces result in impacts such as increased pollutant loads from stormwater, altered hydrology (e.g. increased run-off rates), decreased bank stability, increased water temperatures, reduced habitat and reduced biodiversity. Some of these impacts are apparent in the streamside setbacks of lower Jordan Creek where impervious surfaces encroach on the stream (Figure 18).

Figure 18. An example of encroaching development on lower Jordan Creek.

The U.S. Environmental Protection Agency (EPA) lists percent impervious cover at both the watershed and riparian corridor scale as an indicator of urbanization impacts on water resources. According to the literature compiled by the U.S. EPA, impervious surfaces in a riparian corridor have greater impacts that those impervious surfaces located further from the waterbody, due to their ability to directly impact the waterbody. Degradation of waterbody health occurs at thresholds ranging from 4 to 12 percent impervious area. Impervious surfaces comprise 12 and 32 percent of the 25- and 50-foot setbacks on lower Jordan Creek, respectively. Therefore, reduction of

impervious surfaces or the resultant impacts should be a management goal for the riparian areas within the setback. In addition, no further increases of impervious surfaces should be allowed in the 25-foot setback.

Overstory vegetation, usually trees or large shrubs, is important for shade. One indicator of the ability of overstory vegetation in providing shade is percent canopy cover. According to the Natural Resource Conservation Service (NRCS) visual assessment methods, canopy cover greater than 75 percent is considered beneficial for cold water streams, and less than 20 percent is considered detrimental to the stream. The 25-foot setback along Reaches 1 and 2 provide the best canopy cover (Table 13). These reaches have an overstory consisting primarily of Sitka Spruce, red alder, willow species, and black cottonwood. European mountain ash also occurs in the overstory of these reaches and likely contributes to the available canopy cover.

Table 13. The average percent canopy cover for each stream reach in the 25-foot and 50-foot zones. The average for the entire reach was calculated from the percent area canopy cover for each section of the reach. The average percent canopy cover for the stream right and left (RB and LB, respectively) are also provided for comparison.

		Percent Canopy Cover					
Reach	**# Sections**	**25-foot**		**50-foot**		**Reach Average**	
		RB	**LB**	**RB**	**LB**	**25-foot**	**50-foot**
1	5	80.00	72.50	83.00	71.25	76.67	77.78
2	7	75.71	84.29	25.71	0.00	80.00	12.86
3	11	55.45	57.73	31.82	31.36	56.59	31.59
4	10	91.50	22.50	59.50	21.11	57.00	41.32
5	20	56.25	61.90	31.05	38.95	59.08	35.10
Overall Stream Average		**67.42**	**57.27**	**40.96**	**31.35**	**62.46**	**36.20**

There are several stream sections where there is little to no overstory present, as demonstrated by lower average canopy covers (Table 13). Much of the 25-foot setback provides an average of greater than 50 percent canopy cover on both banks, except for Reach 4. In contrast, much of the 50-foot setback provides less than 50 percent canopy cover. Lower canopy covers typically occurred along sections of the stream where landscaping practices associated with developed properties or a road right-of-way limit overstory growth, or where impermeable surfaces reduce the ability to have any vegetation, including an overstory.

Along Reach 4, the average left bank canopy cover is approaching the 20 percent threshold, where lack of cover becomes detrimental to the stream, within both the 25- and 50-foot setbacks. The percent of canopy cover within the 50-foot setback on Reaches 2 and 5 are also relatively low, and completely lacking on the left bank of Reach 2. These areas present opportunities for improving riparian and in-stream conditions by providing for overstory vegetation. Since trees take time to grow, this should be a long-term management goal.

There are also locations where there is little to no understory vegetation. These locations are typically dominated by thick canopy cover from second-growth Sitka spruce where light is limited or where foot-traffic and other disturbance limits the growth of the understory. Further, there are areas where the understory vegetation is merely grass or lawn. In some locations, this is due to the road right-of-way and sight requirements, which likely limits opportunity to rehabilitate the understory. In other locations, it is due to landscaping practices with yards and commercial parking lots, which might present opportunities for rehabilitation. Lack of understory vegetation, or a diverse understory vegetation, can be potentially problematic, since it limits riparian habitat complexity and reduces soil stabilization.

Since nearly the entire 25-foot setback on lower Jordan Creek is vegetated, revegetating the remaining 19 percent of this setback could potentially be an attainable management goal to restore riparian functions. However, successful revegetation efforts will be challenging due the potential costs with removing paved surfaces and the potential risk of existing invasive plant species spreading to these areas. Any successful restoration effort within the streamside setback will depend upon successful implementation of an invasive plant management program in the lower Jordan Creek watershed.

Reach 5 within the Jordan Creek Greenbelt presents the greatest opportunity to preserve a setback area. This is the longest stretch of stream where the 25- and 50-foot setbacks are nearly entirely undeveloped, vegetated areas and there are already some protections for the Jordan Creek Greenbelt. Though impacted by invasive species such as reed canarygrass, parts of the greenbelt have relatively intact riparian areas. For example, the understory vegetation in the downstream half had a diverse variety of plant species that make it difficult to identify a few dominant plants. In addition, there was evidence of beaver and river otter activities, which suggests that there is suitable habitat for these riparian inhabitants. Here, the challenge will be changing the public perception of the greenbelt as an unsafe place where illicit activities occur, and working with the JIA and CBJ Parks and Recreation on a management approach for the area.

Recommendations

Since much of the riparian area in lower Jordan Creek is privately owned, education and outreach is one of the best tools to encourage management practices to maintain or improve conditions. However, discussing management recommendations with streamside landowners to improve riparian conditions on their property requires sensitivity to landowner concerns. Maintaining natural riparian areas on urban, private land raises property rights concerns such as access and illegal uses, limiting use of the property for other benefits that can increase property values (e.g. viewshed, landscaping, development), and attracting nuisance insects and wildlife. These concerns can often be addressed in ways that also promote healthy riparian areas and stream habitat.

The recommendations herein are merely a way to start the conversation and provide landowners with ideas on how they might improve Jordan Creek's riparian areas while potentially addressing other property concerns.

The JWP is interested in partnering with willing landowners to make improvements on lower Jordan Creek. As a partner, the JWP could:

- Seek funding for design and construction costs
- Obtain necessary permits
- Identify partners and leverage volunteers
- Manage construction
- Conduct PR for project

Recommendation 1. Reduce impermeable surfaces

Both the 25- and 50-foot setbacks on lower Jordan Creek are at or above thresholds where impermeable surfaces are known to degrade water and habitat quality. Impervious surfaces from encroaching commercial parking lots allows stormwater run-off to enter the stream untreated and cause erosion of the streambanks. Impermeable pavement should be removed from the 25-foot setback, where possible, followed by efforts to reestablish native vegetation. This should be considered when landowners re-develop their property to improve parking areas, as appropriate and practical for the circumstances. This may require variances to the required number of parking spaces or other established development standards.

Reestablishing a 25-foot vegetated setback should be a priority in restoring riparian zone ecological functions. Where landowners are unable or unwilling to restore the 25-foot setback, one alternative is encouraging replacing impermeable pavement with green infrastructure that allows water to infiltrate the ground while serving similar purposes to pavement such as turf-reinforced mats or permeable pavers. This would provide some similar benefits to a natural riparian buffer such as reducing run-off rates and pollutant discharges. In addition, this option could reduce problems with standing water. The pros and cons of establishing a natural buffer versus green infrastructure are provided in Table 13. Note that this doesn't present every type of green infrastructure that might be suitable for this purpose, but merely gives examples of some techniques that can be employed.

Table 13. Pros and cons of a natural riparian buffer and green infrastructure for landowners. From Fairbanks Green Infrastructure Group.

Riparian Re-Vegetation	
Pros	**Cons**

• Demonstrable success in Alaska
• Easy to install - - except for pavement removal and excavation, no skilled labor is needed
• Installation typically takes only a few days
• Relatively low-cost
• Minimal maintenance required once vegetation is established
• Reduces property erosion
• Increases infiltration and reduces flooding potential
• Improves habitat for fish and birds
• Aesthetically pleasing
• Can increase property value
	• Loss of paved areas
	• Maintenance considerations during first few growing seasons until plants are established:
	  ○ Watering plants during extended dry periods
	  ○ Replacing unsuccessful plantings as needed
	  ○ Preventing invasive plant species from spreading and taking over new plantings

Permeable Pavers	
Pros	**Cons**

• Easy to install - - except for pavement removal and excavation, no skilled labor is needed
• Installation typically takes only a few days
• Aesthetically pleasing
• Serves same purpose as pavement
• Can increase property value
• Reduces run-off
• Demonstrable success in Alaska
	• Relatively higher-cost
	• Maintenance considerations:
	  ○ Cannot use snow plow over permeable pavers since blocks may catch on plow and damage the pavers and/or the plow.
	  ○ Sweeping is required to remove dirt and sand, at least every spring, to maintain porosity.
	  ○ Will need to replace sections as necessary.

Turf Reinforced Mesh	
Pros	**Cons**

• Easy to install - - except for pavement removal and excavation, no skilled labor is needed
• Installation typically takes only a few days
• Relatively low-cost
• Aesthetically pleasing
• Serves same purpose as pavement
• Can increase property value
• Reduces run-off
	• No demonstrable success in Alaska
	• Cannot use until the grass has grown (~ 4 weeks).
	• May need to buy minimal amount from suppliers.
	• Maintenance considerations:
	  ○ Need to set mower blades to a relatively high setting to avoid cutting the mesh
	  ○ Cannot use snow plow over grass reinforced mesh
	  ○ Will need to replace sections as necessary

While removing pavement may be the most beneficial means in re-establishing a natural buffer on lower Jordan Creek, it can be relatively expensive. To reduce costs, interested landowners could potentially partner with the JWP/SAWC to identify grant funding to rehabilitate riparian areas or to install a green infrastructure project.

Recommendation 2. Fence off riparian areas

Fencing-off riparian areas would discourage activities that could damage riparian vegetation and streambanks such as foot traffic, parking, construction encroachment, and plowing snow into the riparian area or stream. Fencing could also be used to address access concerns. At the very least, fencing could be installed along the 25-foot setback, though protection of more than the 25-foot setback would increase the benefits. Use of fencing and other barriers have been used successfully throughout the Jordan Creek watershed to protect riparian areas (Figure 20). The JWP/SAWC is willing to work with interested landowners to seek grant funding to install protective barriers.

Figure 20. Successful riparian fencing installed on Jordan Creek at the Edward K. Thomas building owned by the Central Council of Tlingit and Haida.

Recommendation 3. Monitor and manage invasive plants

There are several invasive plant species that are affecting riparian areas and instream habitat within the lower Jordan Creek watershed. These include reed canarygrass (*Phalaris arundinacea*), orange hawkweed (*Hieracium aurantiacum*), creeping buttercup (*Ranunculus repens*), European mountain ash (*Sorbus acuparia*), and European bird cherry (*Prunus padus*).

Most often, herbicide use is recommended for treatment of reed canarygrass, as mechanical methods are labor intensive and require long-term investment. Use of herbicide may be controversial if not supported by all stakeholders. However, an integrated approach using multiple control methods is usually the most effective. Other methods include: shading with native plants, covering with shade cloth or sheet mulch, cutting or mowing (this alone will not eradicate an infestation), or tilling. The effectiveness of these methods can be tested by implementing and monitoring test sites in the Jordan Creek watershed.

European mountain ash and bird cherry are also prevalent in the lower watershed. However, control measures for European mountain ash and bird cherry are largely untested. Most trees can be treated by girdling, though there have been mixed results using this method on European mountain ash along lower Jordan Creek. European mountain ash can re-sprout (form secondary replacement trunks) when cut, allowing it to spread more across the canopy, so this is not a recommended practice unless the trunk can be removed.

To be successful, invasive plant control will likely require treatment across several consecutive growing seasons and will require monitoring to determine if measures are successful. Revegetation with native riparian plants should follow successful eradication. Throughout the treatment process, regular

monitoring is required to document the success of treatment measures and to track any spread into new areas. The JWP/SAWC is willing to work with interested landowners to help manage invasive plants on their property.

Information from Alaska Natural Heritage Program on the invasive plants of concern is provided in Appendix B.

Recommendation 4. Educate landowners about harmful landscaping practices

Landscaping makes a property attractive and safe, but some landscaping practices can have adverse effects on the riparian area and stream. Clearing of vegetation causes soil and streambank instability, and contributes to sediment problems in the stream. Limbing trees can reduce shading and contribute to stream warming, and potentially limit large woody debris that contributes to habitat complexity. Gardens and lawns provide a potential vector for invasive and non-native plants, and reduce habitat complexity. Disposing of landscaping debris in the stream can, depending on the material and the amount, clog downstream culverts, impede flow, increase sedimentation, contribute to nutrient loading, and potentially reduce dissolved oxygen as it decomposes. In the riparian area, landscaping debris piles can damage and kill natural vegetation, and can eventually make its way into the stream.

Educating landowners, landscaping professionals and land managers about the potential effects of landscaping practices on Jordan Creek is important to avoid or reduce these impacts. Potential partners in conveying this information to the public may include Juneau Master Gardeners, Southeast Alaska Master Gardeners Association, and the Cooperative Extension Service. In addition, landscaping businesses could carry the JWP's "Living Next to a Salmon Stream" brochure. This can be done as part of a larger effort to promote awareness on Jordan Creek (see Recommendation 8).

Recommendation 5. Educate landowners about harmful snow storage practices

The riparian area is often used for snow storage because they are usually outside of heavy traffic areas. However, plowing snow into the riparian are impacts vegetation through soil disturbance, removal of vegetation or damage from the weight of the snow or by the plow. In addition, plowed snow often contains debris, hydrocarbons, deicing chemicals, and sand or gravel used for traction on roads and driveways. When stored in or directly adjacent to streams, these pollutants enter the system as the snow melts. Stream-side residents and business owners should be encouraged to store snow away from the stream, outside of the riparian area, and to implement best management practices on their properties to reduce transport of pollutants in meltwaters. State and local government crews involved in snow management should also be encouraged to improve snow management practices.

Figure 21. Snow storage at First National Bank causing riparian impacts and sediment deposition in Jordan Creek.

Some practices to improve snow storage management are provided in Appendix C.

Recommendation 6. Thin second-growth to promote understory vegetation

There are several locations in the lower watershed where historical land use resulted in dense stands of second-growth Sitka spruce which is preventing understory vegetation from establishing. Understory vegetation such as shrubs and herbaceous plants provide habitat complexity, improve soil stabilization and can better intercept stormwater run-off. Selectively thinning second growth in these areas would promote the growth of understory vegetation.

Recommendation 7. Remove garbage and debris

Lower Jordan Creek has problems with litter due to the proximity to commercial businesses such as fast food restaurants and convenience stores. In addition, the Jordan Creek Greenbelt near the Juneau International Airport (JIA) has problems with litter from encampments. An annual community-wide clean-up is organized each spring by Litter Free. The JWP participates in the annual clean-up by recruiting volunteers to clean alongside Juneau's streams. As part of the 2016 annual clean-up effort, the JWP initiated a garbage hotspot map on their website to help direct volunteers to the worst sites along Juneau's streams, including Jordan Creek.

However, in addition to the annual spring clean-up, businesses in the lower Jordan Creek watershed should be encouraged to organize junk-hauling days to make efficient and cost-effective trips to the landfill. This would not only have benefits in reducing costs, particularly for disposing large, heavy items but also in making these areas more attractive and safe for employees and customers and the general public. The JIA reports that it often cleans up the Jordan Creek greenbelt at its own expense (Wahto, personal communication).

Figure 22. Examples of some of the debris and litter in the lower Jordan Creek riparian area.

Recommendation 8. Promote community stewardship of Jordan Creek and its riparian areas through educational efforts

Outreach to landowners and the public is an on-going effort to improve stewardship of lower Jordan Creek. The JWP connects with landowners and the public primarily through social media and our website. In addition, the JWP occasionally hosts public meetings and attends public events to make connections with the public.

The JWP recently updated our "Living Next to a Salmon Stream" brochure, which can be used as an outreach tool when discussing the benefits of riparian areas and general recommendations with landowners. The brochure touches on topics such as harmful landscaping and snow removal practices that are of concern along lower Jordan Creek. The JWP can also generate property-specific recommendations based on the riparian assessment to use in one-on-one discussions with landowners. The JWP connected with some landowners during the riparian assessment, several of which expressed interest in working with the JWP in the future. As interested landowners begin working with JWP, their efforts can be recognized in local news media. The JWP has promoted projects using the Juneau Empire and radio spots on KTOO.

There are also several opportunities to promote stewardship of lower Jordan Creek through interpretive signage, which could be placed at strategic locations to educate the public about Jordan Creek. Locations identified during the survey include: the Super 8 Motel, which has a parking lot and picnic area near the creek for guests; the Jordan Creek Center, which has several pedestrian crossings and lots of traffic; and the Jordan Creek Greenbelt, which could have an interpretive trail. In addition, the airport and the hotels near Jordan Creek could also have educational brochures for visitors. Educational signs could also be posted at the Breeze-In and McDonald's to encourage patrons to properly dispose of their garbage to prevent it being transported into the stream. Where needed, outdoor garbage cans should be provided.

Other opportunities for broad outreach campaigns might include public service announcements on public radio or on-screen advertisements at the movie theater, streamside walks with landowners to show them examples of projects already implemented on Jordan Creek and discuss improvements to their properties, providing information to landowners at the annual Homeshow or other community events.

Works Cited

Klein, H. 2011. European bird cherry. Alaska Natural Heritage Program, Alaska Center for Conservation Science. http://accs.uaa.alaska.edu/files/invasive-species/Prunus_padus_BIO_PRPA5.pdf

- -. 2011b. European mountain ash. Alaska Natural Heritage Program, Alaska Center for Conservation Science. http://accs.uaa.alaska.edu/files/invasive-species/Sorbus_aucuparia_BIO_SOAU.pdf

- -. 2011b. Reed canarygrass. Alaska Natural Heritage Program, Alaska Center for Conservation Science. http://accs.uaa.alaska.edu/files/invasive-species/Phalaris_arundinacea_BIO_PHAR3.pdf

U.S. Environmental Protection Agency. Riparian Percent Impervious Cover. Recovery Potential Screening: Tools for Comparing Impaired Waters Restorability. https://www.epa.gov/sites/production/files/2015-11/documents/rp2corrimperv1109.pdf

Appendix A. Blank Riparian Assessment Datasheets and Raw Data

Reach # ____ Section # ____ Date: _____ Weather: _____

LB Section Length: _____ Waypoints: Top _____, Bottom _____

RB Section Length: _____ Waypoints: Top _____, Bottom _____

Survey Crew: _____

Riparian Condition Datasheet

Bank	Vegetation Conditions		Development Conditions	Additional Notes (opportunities, impacts, etc)
25LB	**% Veg** _____ **% Invasive** _____		**% Devt** _____ **% Impervious** _____	
	Overstory Dom: Condition: Canopy Cover: _____% Veg. Height: <1.5m, 1.5 – 3m, 3+m	**Understory** Dom: Condition: Bare Ground: _____%	**Structures**	
50LB	**% Veg** _____ **% Invasive** _____		**% Devt** _____ **% Impervious** _____	
	Overstory Dom: Condition: Canopy Cover: _____% Veg. Height: <1.5m, 1.5 – 3m, 3+m	**Understory** Dom: Condition: Bare Ground: _____%	**Structures**	
25RB	**% Veg** _____ **% Invasive** _____		**% Devt** _____ **% Impervious** _____	
	Overstory Dom: Condition: Canopy Cover: _____% Veg. Height: <1.5m, 1.5 – 3m, 3+m	**Understory** Dom: Condition: Bare Ground: _____%	**Structures**	
50RB	**% Veg** _____ **% Invasive** _____		**% Devt** _____ **% Impervious** _____	
	Overstory Dom: Condition: Canopy Cover: _____% Veg. Height: <1.5m, 1.5 – 3m, 3+m	**Understory** Dom: Condition: Bare Ground: _____%	**Structures**	

Date: _____ Weather: _____

Survey Crew: _____

Riparian Impacts Datasheet

WP	Error	Reach/Section/ Bank	Impact type	Impacted Area	Notes

Additional Notes:

CODES

Vegetation
SS – Sitka Spruce
WH – Western Hemlock
BC – Black Cottonwood
W – Willow spp.
EMA – European Mountain Ash
BCH – Bird Cherry
GA – Green Ash
NO – No Overstory
NU – No Understory
SC – Skunk Cabbage
RCG – Reed Canary Grass
CB – Creeping buttercup
OH – Orange Hawkweed
DD – Dwarf Dogwood
FLB – 5-leaf Bramble
FLV – False Lilly of the Valley
BB – Blueberry
SB – Salmonberry
F – Ferns
DC – Devils Club
NG – Native Grasses
NS – Native Sedges

Vegetation Conditions
I – Intact
N – Not Intact
IM – Impacted

Impact Types/Structures
FIL – Fill (pervious)
IMP – Impervious surface
INV – Invasive plants
RD – Road
BRDG – Bridge
BLDG – Building
CUL – Culvert
PKG – Parking
TRL – Trail
FEN – Fence
CB – Concrete Barriers
L – Landscaping (Cutting/mowing/thinning)
D – Debris
FT – Foot Traffic/Trampling

Other (devt in field)

RIPARIAN CONDITION DATA

Reach	Section	Bank	25-foot Setback											50-foot Setback									
			% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious	% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious
1	1	LB	65	100	NO	NI		<1.5	RCG	IMP		35	100	Data was not collected for Reach1/Section 1/Stream Left										
1	2	LB	15	80	RA, SS	IMP	60	3+	RCG, SC	IMP		85	90	75	60	RA	IMP	25	3+	RCG	IMP		25	75
1	3	LB	95	10	RA	IMP	60	3+	SC	IMP		5	0	85	30	RA	IMP	90	3+	CB, SB	IMP		15	0
1	4	LB	98	25	W, RA	INT	80	3+	CB, SC, RCG	INT		2	0	100	35	RA	INT	90	3+	CB, OG	INT		0	0
1	5	LB	95	5	SS	INT	90	3+	NU	NI		5	95	75	3	SS	INT	80	3+	OG	INT		25	
1	1	RB	80	15	BC, RA	IMP	70	3+	RCG, SS	IMP		20	40	90	10	BC, RA		70	3+	SB, SS	IMP		10	5
1	2	RB	97	15	BC, SS	INT	95	3+	RCG, SS	INT		3	0	97	0	SS	INT	100	3+	SS	INT		3	0
1	3	RB	100	15	SS	INT	80	3+	NU, SP, SC	INT		0	0	100	0	SS	INT	100	3+	SS	INT		0	0
1	4	RB	100	20	SS	IMP	70	3+	RCG, SB, FLV	IMP		0	0	99	0	SS	IMP	80	3+	WH, FLV, OG	IMP		1	100
1	5	RB	100	5	SS	IMP	85	3+	SB, RCG, FLV	IMP		0	0	100	25	SS	IMP	65	3+	RCG, FLV	IMP		0	0
2	1	RB	99	5	BC, EMA W, SS	IMP	85	3+	SB, LF, RCG	IMP	5	1	100	30	20	BC, EMA	IMP	25	3+	RCG, SB, RA	IMP	2	70	100
2	2	RB	96	3	SS, RA	IMP	85	3+	SB	IMP	5	4	1	5	50	SS	IMP	25	3+	SB, RCG	IMP	2	95	60
2	3	RB	85	80	SS, RA	IMP	85	3+	EMA, RCG	IMP	60	15	100	30	25	SS, RA	IMP	25	3+	EMA, RCG, L	IMP	25	70	100
2	4	RB	25	35	W, SS	IMP	60	3+	SB, RCG, W	IMP	2	75	100	10	0	NO	NI	5		L	IMP	0	90	100
2	5	RB	50	80	W, RA	IMP	65	3+	RCG, R	IMP	0	50	100	2	0	NO	NI	0	0	L	IMP	0	98	100
2	6	RB	80	30	SS, RA	IMP	90	3+	RCG, FLV, GB	IMP	1	20	100	2	9	NO	IMP	0	0	L	IMP	0	98	100
2	7	RB	99		SS	INT	60	3+	RCG, FLV, LF	IMP	0	1	100	98	3	SS	INT	100	3+	FLV, EMA, DC	IMP	2	2	1
2	1	LB	80	15	SS, RA	IMP	80	3+	RA, RCG	IMP	90	20	70	10	1	NO	NI	0	0	RCG, L	IMP	0	90	85
2	2	LB	40	5	SS, RA	IMP	60	3+	EB, SB, EMA, RCG	IMP	0	60	60	0	0	NO	NI	0	0	NU	NI	0	100	100
2	3	LB	50	10	SS, RA	IMP	95	3+	EMA, RCG, LF	IMP	10	50	40	0	0	NO	NI	0	0	NU	NI	0	100	100
2	4	LB	40	10	W, SS	INT	100	3+	RCG, GB, SC	IMP	5	60	60	0	0	NO	NI	0	0	NU	NI	0	100	100
2	5	LB	45	90	EMA, W	IMP	95	3+	RCG	IMP	5	55	70	0	0	NO	NI	0	0	NU	NI	0	100	100
2	6	LB	25	45	SS, RA	IMP	95	3+	RCG	IMP	2	75	50	0	0	NO	NI	0	0	NU	NI	0	100	100
2	7	LB	20		SS	IMP	65	3+	LF, EQ	IMP	60	80		0	0	NO	NI	0	0	NU	NI	0	100	100
3	1	RB	98	35	SS, W	IMP	85	3+	RCG, LF, MG, SC	IMP	1	2	100	100	3	SS, RA, EMA	INT	85	3+	M, GB, OG, LF, CBC, RCG	IMP	1	0	0
3	1	LB	60	8	P	IMP	70	3+	RCG, RA, OG	IMP	2	40	20	5	40	NO	NI	0	0	OG	IMP	1	95	15
3	2	LB	40	5	SS, EMA	IMP	85	3+	OG	IMP	8	60	25	5	30	NO	NI	0	0	OG	IMP	1	95	65
3	2	RB	99	8	SS, EMA	INT	65	3+	LF, EMA, RCG, SB	IMP	0	1	0	90	7	SS, EMA	INT	65	3+	LF, M, SB, L	IMP	0	10	75

RIPARIAN CONDITION DATA

Reach	Section	Bank	25-foot Setback											50-foot Setback									
			% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious	% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious
3	3	RB	100	1	SS, W	IMP	95	3+	M, OG, FL	IMP	0	0	0	100	0	W, SS	IMP	30	3+	M, OG, LF	IMP	2	0	0
3	3	LB	80	15	W, SS	IMP	65	3+	OG, RA	IMP	1	20	0	50		SS, RA	IMP	40	3+	OG	IMP	0	50	0
3	4	RB	30	10	RA, SS, W	INT	10	3+	GB, MG, CP, RCG	IMP	5	70	100	40	50	NO	NI	0	0	OG, L	IMP	5	60	30
3	4	LB	100	15	SS, EMA	IMP	95	3+	NU	NI	70	0	0	90		SS	IMP	98	3+	OG, M	IMP	50	10	5
3	5	LB	25	5	SS	IMP	100	3+	EMA	IMP	95	75	10	0	0	NO	NI	0	0	NU	NI	0	100	35
3	5	RB	70	0	SS, EMA	INT	80	3+	OG, SB, FLV, LF, MG	IMP	5	30	100	15	0	WH, SS, EMA	INT	10	3+	OG, EB	IMP	0	85	100
3	6	RB	100	2	SS, EMA	INT	5	3+	WH, BB, M, RCG	IMP	0	0	0	100	2	SS	IMP	5	3+	OG, L	IMP	0	0	0
3	6	LB	30	50	SS	IMP	80	3+	EMA, CB, SB	IMP	80	70	0	40		SS	IMP	100	3+	NU	NI	80	70	0
3	7	RB	95	0	SS	INT	95	3+	EMA, M, WH, OG	IMP	5	5	100	50		SS	INT	65	3+	OG, EMA, EB	IMP	0	50	100
3	7	LB	45	5	SS	IMP	85	3+	GB, CP, EMA	IMP	80	55	0	15		SS	IMP	100	3+	EMA, FW	IMP	80	85	100
3	8	RB	85	5	SS, EMA, BC	INT	90	3+	RCG, OG, M	IMP	0	15	100	40	5	BC, SS	INT	10	3+	RCG, OG, M	IMP	0	60	100
3	8	LB	5		SS	IMP	40	3+	CB, GB, CP	IMP	5	95	15	0	0	NO	NI	0	0	NU	NI	0	100	100
3	9	LB	20	80	BC, SS, EMA	IMP	5	3+	RCG	IMP	3	80	100	5	1	BC, SS, W	IMP	7	3+	OG	IMP	2	95	100
3	9	RB	15	25	RA	IMP	5	3+	RCG, P	IMP	0	85	100	0	0	NO	NI	0	0	NU	NI	0	100	100
3	10	LB	30	90	SS, EMA	IMP	10	3+	RCG, M	IMP	1	70	100	0	0	NO	NI	0	0	NU	NI	0	100	100
3	10	RB	98	90	SS, EMA, RA	IMP	80	3+	RCG, EMA, OG	IMP	1	2	100	95	5	SS, EMA	IMP	80	3+	OG, RCG	IMP	10	5	100
3	11	LB	65	98	NO	NI	0	0	RCG, FW, RA	IMP	3	35	100	0	0	NO	NI	0	0	NU	NI	0	100	100
3	11	RB	75	95	NO	NI	0	0	RCG, EMA, RA	IMP	0	25	100	0	0	NO	NI	0	0	NU	NI	0	100	100
4	1	LB	30	15	SS	IMP	5	3+	RCG, CP, CB	IMP	0	70	100	0	0	NO	NI	0	0	NU	NI	0	100	100
4	1	RB	75	98	RA, BC, EMA	IMP	95	3+	RCG	IMP	0	25	98	0	0	NO	NI	0	0	NU	NI	0	100	98
4	2	LB	5	15	NO	IMP	0	0	RCG, CB, CP	IMP	0	95	100	0	0	NO	NI	0	0	NU	NI	0	100	100
4	2	RB	50	85	RA, BC, EMA	IMP	80	3+	RCG, CP	IMP	5	50	100	10	2	SS	IMP	100	3+	OG, L	IMP	3	90	100
4	3	LB	5	15	NO	IMP	0	0	RCG, CB, CP	IMP	0	95	100	0	0	NO	NI	0	0	NU	NI	0	100	100
4	3	RB	50	85	BC, EMA	IMP	95	3+	RCG, W, O	IMP	5	50	75	0	0	NO	NI	0	0	NU	NI	0	100	95
4	4	LB	95	15		NI	0	0		IMP	0	5	0	0	0	NO	NI	0	0	NU	NI	0	100	100
4	4	RB	95	25	BC	IMP	95	3+	RCG, W, O	IMP	0	5	0	2		BC	IMP	100	3+	RCG, EMA	IMP	0	98	10
4	5	LB	95	15	NO	NI	0	0	NU	NI	0	5	0	0	0	NO	NI	0	0	NU	NI	0	100	100
4	5	RB	99	15	BC, SS	IMP	90	3+	RCG, W, RA	IMP	3	1	0	5	3	BC	IMP	95	3+	RCG	IMP	0	95	20

RIPARIAN CONDITION DATA

Reach	Section	Bank	25-foot Setback											50-foot Setback									
			% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious	% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious
4	6	RB	100	25	RA, BC, W	INT	90	3+	RCG, W, CP	IMP	2	0	0	98	8	BC, RA, SS	INT	35	3+	RCG	IMP	10	2	0
4	6	LB	100	15	W	IMP	40	3+	TB, RCG,	IMP	10	0	0	0	0	NO	NI	0	0	NU	NI		100	2
4	7	RB	100	90	W, BC	INT	95	3+	RCG, CB, CP	IMP	0	0	0	85	85	RA, W	IMP	40	3+	FW,RCG,CB	IMP	0	15	100
4	7	LB	100	50	W, BC, EMA	INT	25	3+	RCG, TB,	IMP	0	0	0	95	25	W, BC	IMP	30	3+	RCG, TB,	IMP	0	5	0
4	8	RB	100	40	RA, W	INT	90	3+	RCG, SB, SC	INT	0	0	0	98	70	RA, SS, W	INT	70	3+	RCG, CB, R	INT	2	2	0
4	8	LB	100	25	W, EMA	INT	90	3+	RCG, TB, CB	IMP	0	0	0	100	5	W, EMA	INT	95	3+	RCG, TB,	IMP	0	0	0
4	9	RB	100	5	RA, W	INT	100	3+	RCG, SC, LF	INT	0	0	0	100	75	RA, W, BCH	INT	90	3+	FW, R	IMP	0	0	0
4	9	LB	100	70	W, SS	INT	65	3+	RCG	IMP	0	0	0	100	70	W	INT	65	3+	RCG,	IMP	0	0	0
4	10	RB	100	35	RA	INT	85	3+	RCG, SC, SB	IMP	0	0	0	100	60	RA	INT	65	3+	SB, R, EMA	IMP	0	0	0
4	10	LB	100	100	NO	NI	0	0	RCG	IMP	0	0	0	100	99	NO	NI			RCG, FW	IMP	0	0	0
5	1	RB	100	25	RA	INT	90	3+	CB, FW, H	IMP	0	0	0	96	75	RA, SS, EMA	IMP	60	3+	RCG, CB, FW	IMP	4	4	0
5	1	LB	100	100	RA	INT	3	3+	RCG	IMP	0	0	0	100	90	SS	INT	20	3+	RCG	IMP	0	0	0
5	2	RB	80	70	RA, SS, EMA	IMP	100	3+	RCG, BC, FW, H	IMP	8	0	0	92	20	SS	IMP	60	3+	RCG, CB, FW	IMP	8	8	0
5	2	LB	100	100	W, RA	INT	75	3+	RCG	IMP	0	0	0	100	99	W	INT	15	3+	RCG, FW	IMP	0	0	0
5	3	RB	95	90	SS	IMP	40	3+	RCG	IMP	5	5	0	95	10	SS	IMP	55	3+	RCG	IMP	10	5	0
5	3	LB	100	90	W	INT	60	3+	RCG	IMP	18	0	0	100	100	W	INT	15	3+	RCG	IMP	0	0	0
5	4	RB	98	70	SS	IMP	70	3+	RCG, RB, FW	IMP	8	2	0	90	30	SS	IMP	60	3+	RCG, RB	IMP	60	10	0
5	4	LB	100	100	W, RA	INT	5	3+	RCG	IMP	0	0	0	100	100	W, RA	INT	10	3+	RCG	IMP	0	0	0
5	5	RB	100	8	SS, W	IMP	80	3+	RC, RB, F	IMP	20	0	0	60	8	SS, EMA	IMP	55	3+	RCG, CB	IMP	6	40	0
5	5	LB	100	100	W, RA	INT	70	3+	RCG	IMP	0	0	0	100	100	W	INT	50	3+	RCG	IMP	0	0	0
5	6	RB	100	35	W, BCH, SS, RA	IMP	100	3+	RCG, SC	IMP	10	0	0	97	65	SS, W, RA	IMP	30	3+	RCG	IMP	3	3	0
5	6	LB	100	80	W, RA	INT	70	3+	RCG	IMP	20	0	0	100	100	W	INT	5	3+	RCG	IMP	0	0	0
5	7	RB	98	90	W, RA, BCH	IMP	15	3+	RCG, FW	IMP	0	2	0	Data was not collected for Reach 5/Section 7/Stream Right										
5	7	LB	100	100	W, RA	INT	20	3+	RCG	IMP	0	0	0	100	98	SS, RA	IMP	7	3+	RCG, OG	IMP	5	0	0
5	8	RB	100	98	RA	IMP	5	3+	RCG	IMP	0	0	0	60	5	RA, W	IMP	10	3+	RCG, OG	IMP	0	40	100
5	8	LB	100	90	W, RA	INT	30	3+	RCG, BCH, EMA	IMP	5	0	0	100	100	W, RA	INT	45	3+	RCG	IMP	0	0	0
5	9	RB	100	90	RA, SS, W	IMP	30	3+	RCG, OG	IMP	0	0	0	60	0	NO	NI	0	0	OG	IMP	0	40	100
5	9	LB	100	98	RA, W	IMP	20	3+	RCG	IMP	0	0	0	100	100	RA	INT	12	3+	RCG	IMP	0	0	0

RIPARIAN CONDITION DATA

			25-foot Setback											50-foot Setback									
Reach	Section	Bank	% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious	% Veg	% Invasive	Dominant Overstory	Condition Overstory	% Canopy Cover	Veg Height	Dominant Understory	Condition Understory	% Bare Ground	% Devt	% Impervious
5	10	RB	100	25	SS, RA, W, EMA	IMP	85	3+	RCG, FW, BCH	IMP	5	0	0	95	0	NO	NI	0	0	OG	IMP	0	5	100
5	10	LB	100	95	RA, W	INT	80	3+	RCG, EMA, CB, SS	IMP	5	0	0	100	95	RA, W	INT	10	3+	RCG, SC	IMP	5	0	0
5	11	RB	100	60	RA, SS	IMP	5	3+	RCG, FW, OG	IMP	0	0	0	95	0	NO	NI	0	0	OG	IMP	0	5	100
5	11	LB	100	98	RA	INT	95	3+	EMA, RCG, CB	IMP	2	0	0	100	100	W, RA	INT	10	3+	RCG	IMP	0	0	0
5	12	LB	100	60	RA, BCH	INT	90	3+	RCG, BCH	IMP	5	0	0	100	90	BCH, RA, W	INT	75	3+	RCG, BCH	IMP	10	0	0
5	12	RB	100	60	RA, SS, EMA, W	IMP	30	3+	SC, EBC, CBC, LF, RCG, SC, FLV, EMA, SS	IMP	0	0	0	95	20	RA	IMP	20	3+	FW, CBC, RCG, L	IMP	0	5	100
5	13	LB	100	97	RA, W, BCH	INT	90	3+	RCG, BCH	IMP	2	0	0	100	95	RA, BCH, W	INT	65	3+	RCG,	IMP	3	0	0
5	13	RB	100	55	EBC, W, RA	IMP	50	3+	CBC, MM, RCG, SC, HT, EBC	IMP	0	0	0	100	70	EBC, W, RA	IMP	30	3+	FW, RCG, CP, CBC, GB, L	IMP	0	0	0
5	14	LB	100	80	W, RA	INT	90	3+	SC, MM, RCG, EBC	IMP	0	0	0	100	95	W, RA	INT	100	3+	EBC, HT, OG, CP	IMP	0	0	0
5	14	RB	100	30	EMA, EB, RA, W, EBC	INT	70	3+	EB, SC, LF, SB, F, NB, RCG, EBC	IMP	0	0	0	100	30	SS, EBC, RA	INT	70	3+	EBC, SB, CP, LF	IMP	0	0	0
5	15	LB	100	5	W, RA	INT	90	3+	SC, LF, SB, EBC, MM	IMP	0	0	0	100	50	W, RA	INT	35	3+	SC, LF, SB, EBC, MM	IMP	0	0	0
5	15	RB	100	10	RA, SS, EMA	INT	90	3+	RCG, FLV, EMA, NB, M, CP	IMP	0	0	0	100	10	EMA, SS, RA	INT	95	3+	OG, RCG, NB, HT, M	IMP	0	0	0
5	16	LB	100	10	W, RA	INT	90	3+	SC, RCG, HT	IMP	0	0	0	100	5	W, RA	INT	60	3+	MM, RCG, HT	IMP	0	0	0
5	16	RB	100	15	W, SS, RA	INT	75	3+	RCG, D, CBC, CP, NB, SC, LF, FLV	IMP	0	0	0	80	30	SS, RA	IMP	45	3+	EB, RCG, CP, HT, L	IMP	0	20	100
5	17	LB	100	45	RA, W	INT	80	3+	CP, RCG, LF, MM, EB, FLV, SC, FW	IMP	0	0	0	100	55	W, RA	INT	60	3+	RCG, SC, FLV, FW, HT, EMA	IMP	0	0	0
5	17	RB	99	35	RA, W	IMP	30	3+	CP, RCG, HT, GB, EB	IMP	0	1	100	15		NO	NI	0	0	OG, L	IMP	0	85	100
5	18	LB	100	30	W, RA, EBC	INT	45	3+	MM, RCG, SC, CP, FLV, EBC	IMP	0	0	0	100	50	W, RA, WBC	INT	50	3+	RCG, SC, MM	IMP	0	0	0
5	18	RB	100	15	RA, EMA, SS	IMP	40	3+	RCG, LF, SC, GB, NB, FLV	IMP	0	0	0	0	0	NO	NI	0	0	NU	NI	0	100	100
5	19	LB	100	45	W, RA	INT	45	3+	SC, CP, MM, FW, CBC, HT, RCG	IMP	0	0	0	100	30	W, RA	INT	50	3+	LF, MM, RCG, SC, CBC, FLV, HT	IMP	0	0	0
5	19	RB	100	20	W, SS, RA	IMP	30	3+	HT, RCG, FW, EB, CBC, DL	IMP	0	0	0	50		NO	NI	0	0	OG, CBC, DL	IMP	0	50	100
5	20	LB	100	60	RA, W, EBC	INT	90	3+	CP, SS, RCG, CBC, MMG, LLA, FMN, EMA, HT	IMP	0	0	0	100	65	W, RA, EBC	INT	85	3+	CP, LF, RCG, SC, EBC, EMA, SS, GB, FLV	IMP	0	0	0
5	20	RB	100	45	W, EBC, RA	IMP	90	3+	SC, HT, CP, MMG, RCG, LLA	IMP	0	0	0	70	40	NO	NI	0	0	OG, CBC, DL	IMP	0	30	100

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.36596	-134.577779	INV	RCG		
58.36598	-134.577744	INV	RCG		
58.36595	-134.577781	BRG			
58.36587	-134.577662	TRL			
58.3656	-134.577591	TRL			
58.36566	-134.577875	INV	CB		
58.36569	-134.577707	INV	UNK		
58.36515	-134.577987	INV	EMA	1	13
58.36552	-134.577834	INV	EMA	1	18
58.36593	-134.57792	INV	EMA	1	3
58.36592	-134.577918	INV	EMA	1	4
58.36592	-134.577918	INV	EMA	1	1.5
58.36597	-134.577929	INV	EMA	1	7
58.36599	-134.577912	INV	EMA	1	1.5
58.36599	-134.577903	INV	EMA	1	4
58.366	-134.577912	INV	EMA	1	4
58.36601	-134.577916	INV	EMA	1	1.5
58.36588	-134.577856	BRG			
58.36582	-134.578147	INV	EMA	1	2
58.36583	-134.578109	INV	EMA	1	3
58.36585	-134.578122	INV	EMA	1	2.5
58.36585	-134.578131	INV	EMA	1	2
58.36586	-134.578179	INV	EMA	1	1.5
58.36584	-134.57823	INV	EMA	1	5
58.36583	-134.578256	INV	EMA	1	3
58.36583	-134.578256	INV	EMA	1	2.5
58.36567	-134.578198	INV	EMA	1	3.5
58.36566	-134.578097	INV	EMA	1	6
58.36541	-134.578357	INV	EMA	1	1.5
58.36547	-134.578264	INV	EMA	1	1.5
58.36548	-134.578253	INV	EMA	1	1
58.3656	-134.578274	INV	UNK		
58.3656	-134.578257	INV	EMA	1	2
58.36519	-134.578336	INV	EMA	1	5
58.36524	-134.578331	INV	EMA	1	5
58.36525	-134.578351	INV	EMA	1	1
58.36524	-134.578364	INV	EMA	1	0.5
58.36528	-134.578332	INV	EMA	1	0.5
58.36529	-134.578308	INV	EMA	1	0.5
58.36521	-134.578184	INV	EMA	1	0.5
58.36542	-134.578246	INV	EMA	1	1
58.36493	-134.5784536	INV	EMA	1	12
58.36499	-134.5784611	INV	EMA	1	52
58.36491	-134.5784397	INV	EMA	1	6

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.3649	-134.5785556	INV	EMA	1	26
58.36471	-134.5785577	BRG			
58.36474	-134.5787222	UTL			
58.36475	-134.5787007	INV	EMA	1	0.5
58.36471	-134.5787021	INV	EMA	1	0
58.3647	-134.578719	INV	EMA	1	0
58.36468	-134.5786673	INV	EMA	1	0
58.3646	-134.5789848	INV	EMA	17	0
58.36455	-134.5790168	INV	EMA	9	0
58.36459	-134.5789068	INV	EMA	5	0
58.36459	-134.5789141	INV	EMA	5	0
58.36453	-134.5790651	INV	EMA	5	0
58.36454	-134.5790358	INV	EMA	5	0
58.36436	-134.5792349	INV	UNK ROSE		
58.36411	-134.5794344	INV	EMA	3	1
58.36413	-134.5794558	INV	EMA	7	0
58.36415	-134.5794215	INV	EMA	2	0
58.36416	-134.5793677	INV	EMA	4	0
58.36417	-134.57931	INV	EMA	1	1
58.36405	-134.5794321	INV	EMA	1	0
58.36407	-134.5797236	INV	EMA	1	0
58.36407	-134.5796051	INV	EMA	3	0
58.36408	-134.5795787	INV	EMA	5	0
58.36409	-134.5796121	INV	EMA	5	0
58.36408	-134.5797355	INV	EMA	5	1
58.36406	-134.5797973	INV	EMA	5	0
58.36407	-134.5798108	INV	EMA	5	0
58.36406	-134.5798353	INV	EMA	5	0
58.364	-134.5797725	INV	EMA	5	0
58.364	-134.5797572	INV	EMA	5	0
58.36399	-134.5797517	INV	EMA	5	0
58.36393	-134.5797958	INV	EMA	5	0
58.36395	-134.5798348	INV	EMA	5	0
58.36395	-134.579811	INV	EMA	5	0
58.36393	-134.5798257	INV	EMA	5	0
58.36392	-134.5798181	INV	EMA	5	0
58.36393	-134.5797523	INV	EMA	5	0
58.364	-134.5796101	INV	EMA	5	0
58.364	-134.5795492	INV	EMA	1	8
58.36486	-134.5781659	INV	EMA	1	2
58.36492	-134.5780544	INV	EMA	1	5
58.36478	-134.5782316	INV	EMA	1	24
58.36465	-134.5784751	INV	EMA	1	4
58.36466	-134.57847	INV	EMA	1	5

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.36464	-134.5784835	INV	EMA	1	6
58.36464	-134.5785135	INV	EMA	2	10
58.36453	-134.5786046	INV	EMA	2	10
58.36457	-134.5786262	INV	EMA	1	8
58.36459	-134.5786194	INV	EMA	5	0
58.36456	-134.5787935	INV	EMA	1	2
58.36462	-134.5787908	INV	EMA	1	1
58.36451	-134.5788486	INV	EMA	1	6
58.36449	-134.5788229	INV	EMA	5	0
58.36454	-134.5787959	INV	EMA	5	0
58.36452	-134.5788105	INV	EMA	5	0
58.36451	-134.5788125	INV	EMA	1	5
58.36446	-134.5788956	INV	EMA	5	0
58.36447	-134.578909	INV	EMA	5	0
58.36448	-134.5789335	INV	EMA	1	6
58.36453	-134.5788396	INV	EMA	1	4
58.36447	-134.5789016	INV	EMA	1	3
58.36445	-134.578947	INV	EMA	1	4
58.36447	-134.5789101	INV	EMA	1	2
58.36448	-134.5788984	INV	EMA	1	2
58.36419	-134.5790545	INV	EMA	1	42
58.36415	-134.5790561	INV	EMA	1	53
58.3641	-134.5790741	INV	EMA		95
58.36396	-134.5793338	INV	EMA		
58.364	-134.5791539	INV	EMA	1	4
58.36411	-134.5796922	INV	EMA	1	0.5
58.36397	-134.5791313	INV	EMA	5	0
58.36398	-134.5791377	INV	EMA	5	0
58.36397	-134.579259	INV	EMA	1	0
58.36382	-134.5798139	INV	EMA	1	1
58.36386	-134.5796165	INV	EMA	1	0
58.36391	-134.580437	INV	EMA	1	25
58.3641	-134.58094	INV	EMA	1	1
58.3641	-134.5809447	INV	EMA	1	4
58.36404	-134.5811195	INV	EMA	1	15
58.36404	-134.5809167	INV	EMA	1	6
58.36406	-134.5807625	INV	EMA	1	32
58.36408	-134.581194	INV	EMA	1	1
58.36408	-134.5812192	INV	EMA	1	10
58.36407	-134.5811993	INV	EMA	1	2
58.36407	-134.5811943	INV	EMA	1	2
58.36407	-134.5812095	INV	EMA	1	2
58.36404	-134.5811957	INV	EMA	1	5
58.36386	-134.5814842	INV	EMA	1	2
58.36414	-134.5808526	INV	EMA	1	3
58.36398	-134.5812302	INV	EMA	1	2

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.36249	-134.5815141	INV	EMA	1	10
58.36244	-134.5814942	INV	EMA	1	0
58.36243	-134.5815571	INV	EMA	1	10
58.36244	-134.5815782	INV	EMA	1	15
58.36244	-134.5815572	INV	EMA	1	6
58.36236	-134.5816307	INV	EMA	1	20
58.36242	-134.5816433	INV	EMA	1	65
58.36235	-134.5815811	INV	EMA	1	8
58.36235	-134.5815811	INV	EMA	1	6
58.36229	-134.5815352	INV	EMA	1	4
58.36214	-134.5811972	INV	EMA	1	60
58.36221	-134.5814597	INV	EMA	1	6
58.36214	-134.5814316	INV	EMA	1	6
58.36214	-134.5814316	INV	EMA	1	20
58.36214	-134.5814316	INV	EMA	1	10
58.36197	-134.5811972	INV	EMA	5	0
58.36199	-134.5811905	INV	EMA	5	1
58.36199	-134.5811066	INV	EMA	5	1
58.36174	-134.5811745	INV	EBC	8	0
58.36181	-134.5811475	INV	EMA	1	0
58.36185	-134.581212	INV	EMA	6	0
58.36191	-134.5811504	INV	EMA	1	0
58.36193	-134.5811128	INV	EMA	5	0
58.36195	-134.5810973	INV	EMA	4	0
58.36192	-134.5811909	INV	EMA	6	0
58.36162	-134.581215	INV	EMA	1	2
58.36164	-134.5810899	INV	EMA	2	15
58.36165	-134.5812302	INV	EMA	1	10
58.36159	-134.5811395	INV	EMA	1	0
58.36154	-134.5811342	INV	EMA	2	2
58.36152	-134.5809867	INV	EBC	2	1
58.36152	-134.5810458	INV	EBC	1	1
58.36152	-134.5810458	INV	EBC	1	2
58.36151	-134.5810359	INV	EBC	1	3
58.36152	-134.5811801	INV	EBC	1	12
58.3614	-134.5811353	INV	EBC	1	2
58.36139	-134.5811307	INV	EMA	2	2
58.36133	-134.5810967	INV	EMA	5	0
58.36132	-134.5811143	INV	EMA	1	2
58.36132	-134.5811272	INV	EMA	1	2
58.36092	-134.581182	INV	EMA	1	5
58.36093	-134.581213	INV	EBC	1	12
58.36098	-134.58121	INV	EMA	2	0.5
58.36098	-134.581211	INV	EMA	1	0.5
58.36091	-134.581253	INV	EMA	2	2

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.36091	-134.581201	INV	EMA	1	1
58.36091	-134.581201	INV	EMA	1	0.5
58.3609	-134.581222	INV	EMA	1	1
58.3609	-134.581222	INV	EMA	1	0.5
58.3608	-134.58105	INV	EMA	5	1
58.36081	-134.581043	INV	EMA	3	0
58.36081	-134.581033	INV	EMA	2	2
58.36082	-134.58105	INV	EMA	1	0.5
58.36084	-134.581078	INV	EMA	1	3
58.36084	-134.581086	INV	EMA	1	0.5
58.36084	-134.581093	INV	EMA	1	0.5
58.36084	-134.581093	INV	EMA	1	1
58.36083	-134.5811	INV	EBC	1	3
58.36082	-134.581153	INV	EMA	1	1.5
58.36084	-134.581184	INV	EMA	1	5
58.36082	-134.58117	INV	EMA	1	2
58.36079	-134.581174	INV	EMA	1	2
58.36079	-134.581153	INV	EMA	2	0
58.36079	-134.581151	INV	EMA	2	1
58.36076	-134.581121	INV	EMA	2	1
58.36061	-134.580759	INV	EMA	1	0.5
58.36061	-134.580783	INV	EMA	1	6
58.3606	-134.580797	INV	EMA	3	0.5
58.3606	-134.580797	INV	EMA	3	0.5
58.36061	-134.580785	INV	EMA	1	15
58.36061	-134.580792	INV	EMA	1	1
58.36061	-134.580792	INV	EMA	1	0.5
58.36062	-134.580786	INV	EMA	6	1
58.36062	-134.580791	INV	EMA	1	1
58.36062	-134.580792	INV	EMA	1	3.5
58.36062	-134.580794	INV	EMA	1	4
58.36064	-134.580797	INV	EMA	1	8
58.36064	-134.580798	INV	EMA	1	35
58.36049	-134.580591	INV	EMA	1	16
58.36051	-134.580598	INV	EMA	1	20
58.36051	-134.580599	INV	EMA	1	28
58.3605	-134.580717	INV	EMA	1	10
58.3605	-134.580717	INV	EMA	1	6
58.36132	-134.581226	INV	EMA	1	1.5
58.36135	-134.5811628	INV	EMA	2	0
58.36128	-134.5811099	INV	EMA	1	0.5
58.36129	-134.5810995	INV	EMA	1	0.5
58.36115	-134.5810786	INV	EMA	1	0.5
58.36116	-134.5810155	INV	EMA	1	3

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.3612	-134.5812163	INV	EMA	1	1
58.3612	-134.5812133	INV	EMA	1	1
58.36121	-134.5812146	INV	EMA	1	1
58.36125	-134.5812721	INV	EMA	1	1.5
58.36125	-134.5812832	INV	EMA	3	0.5
58.36124	-134.5812961	INV	EMA	1	1
58.36114	-134.5813368	INV	EMA	2	1
58.36116	-134.5813602	INV	EMA	1	0
58.36117	-134.5813767	INV	EMA	1	2
58.36117	-134.581376	INV	EMA	1	1
58.36041	-134.580531	INV	EMA	1	0.5
58.36042	-134.580499	INV	EMA	1	3
58.36042	-134.580499	INV	EMA	1	3
58.36042	-134.580499	INV	EMA	1	0.5
58.36044	-134.580521	INV	EMA	1	0.5
58.36043	-134.58053	INV	EMA	2	0.5
58.36034	-134.580569	INV	APL	1	20
58.36037	-134.580478	INV	EMA	1	0.5
58.36034	-134.580433	INV	EMA	4	0.5
58.36035	-134.580419	INV	EMA	20	1.5
58.36035	-134.580387	INV	EMA	3	0
58.36036	-134.580357	INV	EMA	1	12
58.36037	-134.580319	INV	EMA	3	0.5
58.36031	-134.58046	INV	EMA	2	0.5
58.3603	-134.580451	INV	MUST	30	0
58.3603	-134.580447	INV	EMA	1	20
58.36028	-134.580439	INV	EMA	1	3
58.36028	-134.580439	INV	EMA	1	5
58.36028	-134.580439	INV	EMA	1	50
58.36029	-134.580386	INV	MUST	3	0
58.36026	-134.580191	INV	EMA	1	0
58.36024	-134.580142	INV	EMA	10	0
58.36024	-134.580054	INV	EMA	1	0.5
58.36017	-134.57989	INV	EMA	1	0
58.36003	-134.579779	INV	EMA	4	0
58.36013	-134.57987	INV	EMA	3	0
58.36008	-134.579731	INV	EMA	3	0
58.35996	-134.579604	INV	EMA	1	25
58.35996	-134.579591	INV	EMA	1	20
58.35987	-134.579441	INV	EMA	1	20
58.3599	-134.578976	INV	EBC	1	8
58.3599	-134.578968	INV	EBC	1	1
58.3599	-134.57896	INV	EBC	1	3
58.3599	-134.57896	INV	EBC	1	2

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.35992	-134.578977	INV	EBC	1	10
58.35992	-134.578998	INV	EMA	1	0.5
58.3599	-134.579004	INV	EMA	1	1
58.35989	-134.578996	INV	EMA	1	2
58.35991	-134.579102	INV	EBC	1	18
58.35984	-134.579294	INV	EMA	1	16
58.35984	-134.579294	INV	EMA	1	15
58.35982	-134.579295	INV	EBC	1	2
58.35985	-134.579302	INV	EBC	1	2
58.35948	-134.578515	INV	EMA	1	0.5
58.35948	-134.578505	INV	EMA	1	0.5
58.35948	-134.578505	INV	EBC	1	2
58.35947	-134.578452	INV	EBC	2	2
58.35944	-134.578281	INV	EMA	1	17
58.36337	-134.5807584	INV	EMA	1	8
58.36336	-134.5808284	INV	EMA	1	0
58.36338	-134.5808208	INV	EMA	1	0
58.36341	-134.5808125	INV	EMA	4	0
58.36334	-134.5807863	INV	EMA	1	15
58.36332	-134.5808176	INV	EMA	1	3
58.36332	-134.5807855	INV	EMA	1	1
58.36331	-134.5807722	INV	EMA	3	0
58.36324	-134.5806813	INV	EMA	3	0
58.36332	-134.5807125	INV	EMA	1	0.5
58.3633	-134.580772	INV	EMA	1	1
58.3633	-134.5808126	INV	EMA	1	1
58.36325	-134.5808598	INV	EBC	2	4
58.36327	-134.5808744	INV	EMA	1	15
58.36319	-134.5808656	INV	EMA	1	30
58.36319	-134.5808573	INV	EMA	1	30
58.36319	-134.5808573	INV	EMA	1	12
58.36316	-134.5808166	INV	EMA	5	1
58.36312	-134.5807707	INV	EMA	1	1
58.36294	-134.5809999	INV	EMA	11	1
58.36119	-134.5807866	INV	EMA	2	10
58.36115	-134.580857	INV	EMA	1	3
58.3612	-134.5808154	INV	EBC	3	1
58.36131	-134.5809689	INV	EMA	1	20
58.36004	-134.57919	INV	EBC	10	0
58.36009	-134.5792356	INV	EMA	1	0.5
58.35997	-134.578641	INV	EBC	1	1
58.35986	-134.5788815	INV	EMA	1	0.5
58.35986	-134.578898	INV	EBC	4	1
58.35986	-134.578898	INV	EBC	1	4

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.35986	-134.5788273	INV	EMA	1	0.5
58.35988	-134.5788283	INV	EBC	2	2
58.35941	-134.577562	INV	EBC	1	50
58.35939	-134.5776032	INV	EBC	6	1
58.35939	-134.5775855	INV	EBC	1	0.5
58.35939	-134.5775655	INV	EBC	2	5
58.35939	-134.5775655	INV	EBC	1	10
58.35935	-134.5775782	INV	EBC	10	0
58.35934	-134.5776185	INV	EMA	5	0
58.35939	-134.5776478	INV	EBC	1	5
58.35939	-134.5776478	INV	EBC	10	0
58.35941	-134.5776533	INV	EBC	5	0.5
58.35963	-134.578211	INV	EBC	5	1
58.35964	-134.5781977	INV	EBC	6	0
58.35964	-134.5781977	INV	EBC	3	1
58.35965	-134.5781891	INV	EMA	1	0
58.35964	-134.5781778	INV	EMA	1	2
58.3596	-134.5780979	INV	EMA	4	0
58.35958	-134.5781335	INV	EMA	1	1
58.35955	-134.5781501	INV	EMA	1	0
58.35957	-134.5780417	INV	EBC	1	2
58.35959	-134.5780393	INV	EMA	1	0
58.35954	-134.5780165	INV	EMA	10	0
58.35952	-134.5780029	INV	EBC	2	1
58.35951	-134.5780508	INV	EMA	10	0
58.35952	-134.5779593	INV	EBC	1	4
58.35952	-134.5779593	INV	EBC	1	1
58.35948	-134.5780001	INV	EMA	10	0
58.35948	-134.5779072	INV	EBC	1	0.5
58.35949	-134.5779019	INV	EBC	1	1
58.35945	-134.5778962	INV	EMA	1	2
58.3593	-134.5772687	INV	EBC	6	5
58.36389	-134.5801124	INV	EMA	1	29
58.36389	-134.5801375	INV	EMA		3
58.36392	-134.5801276	INV	EMA		3
58.364	-134.580128	INV	EMA	3	1
58.36409	-134.5800608	INV	EMA	1	1
58.36416	-134.5801008	INV	EMA	1	1
58.36416	-134.5801008	INV	EMA	1	7.5
58.36423	-134.5802634	INV	EMA	1	0.5
58.36423	-134.58027	INV	EMA	1	0.5
58.36423	-134.580438	INV	EMA	1	4
58.36421	-134.5804817	INV	EMA	1	6
58.36386	-134.5817487	INV	EMA	1	1

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.36388	-134.5817401	INV	EMA	1	1.5
58.36388	-134.5817181	INV	EMA	1	1
58.36387	-134.5816595	INV	EMA	1	2
58.36387	-134.5816545	INV	EMA	1	1.5
58.36387	-134.5816445	INV	EMA	1	1
58.36392	-134.5815324	INV	EMA	1	2
58.36394	-134.5815246	INV	EMA	1	1.5
58.36393	-134.5815203	INV	EMA	1	2
58.36386	-134.5816821	INV	EMA	1	2
58.36372	-134.5817005	INV	EMA	1	4
58.36372	-134.5817425	INV	EMA	2	0.5
58.36376	-134.5817861	INV	EMA	1	1
58.36376	-134.5817641	INV	EMA	1	1
58.36364	-134.581758	INV	EMA	5	0.5
58.36361	-134.5815902	INV	EMA	3	0.5
58.36358	-134.5814556	INV	EMA	1	0.5
58.36356	-134.5819042	INV	EMA	5	0.5
58.36421	-134.5808795	INV	EMA	1	0
58.35899	-134.5763364	INV	EMA	1	0
58.35885	-134.5758263	INV	EBC	4	1
58.35885	-134.5758263	INV	EBC	1	1.5
58.35885	-134.5758263	INV	EBC	1	2
58.35885	-134.5758263	INV	EBC	6	0
58.35885	-134.5757731	INV	EBC	1	10.5
58.35885	-134.5757731	INV	EBC	3	1.5
58.35885	-134.5757731	INV	EBC	1	2
58.35887	-134.5757963	INV	EBC	3	1.5
58.35887	-134.5757963	INV	EBC	5	1
58.35882	-134.5757392	INV	EBC	3	1
58.35878	-134.5751388	INV	EMA	1	1.5
58.35878	-134.5751388	INV	EMA	2	0.5
58.35878	-134.5751443	INV	EMA	1	1
58.35876	-134.5751389	INV	EMA	1	1
58.35876	-134.5751389	INV	EMA	1	0.5
58.35874	-134.5751311	INV	EBC	1	5
58.3588	-134.5750952	INV	EBC	1	3
58.35878	-134.5750273	INV	EBC	1	2
58.35874	-134.5750082	INV	EBC	1	2
58.35874	-134.5750082	INV	EBC	2	0.5
58.35877	-134.5749836	INV	EBC	1	3
58.35877	-134.5750381	INV	EMA	1	0.5
58.35879	-134.5750287	INV	EMA	1	0.5
58.35929	-134.5777557	INV	EMA	1	15
58.35937	-134.577665	INV	EBC	2	6

Riparian Impacts Data					
Lat	Long	Impact	Plant	Number	Diameter
58.35937	-134.577665	INV	EBC	1	4
58.35937	-134.577665	INV	EBC	1	0.5
58.35937	-134.577665	INV	EBC	1	1
58.35927	-134.5775291	INV	EBC	1	0.5
58.35923	-134.5774659	INV	EBC	1	1
58.35931	-134.5776745	INV	EBC	1	1
58.35929	-134.5777495	INV	EBC	1	11
58.35929	-134.5777495	INV	EBC	1	5
58.35929	-134.5777495	INV	EBC	2	1.5
58.35929	-134.5777495	INV	EBC	1	2
58.35949	-134.5771925	INV	EMA	1	0
58.35939	-134.5772428	INV	EBC	2	0.5
58.35923	-134.5773366	INV	EMA	1	1.5
58.3592	-134.5773601	INV	EMA	2	1
58.35919	-134.5773877	INV	EMA	2	0.5
58.35919	-134.5771097	INV	EBC	3	2
58.35913	-134.5771684	INV	EMA	1	0.5
58.35909	-134.5772384	INV	EBC	1	3
58.35909	-134.5772384	INV	EBC	1	1
58.35911	-134.5773912	INV	EBC	2	1
58.35911	-134.5773912	INV	EBC	2	0.5
58.35905	-134.5772637	INV	EMA	2	1
58.35905	-134.5772637	INV	EMA	2	0.5
58.35918	-134.5771988	INV	EMA	2	0.5
58.35912	-134.5771501	INV	EMA	1	1
58.35898	-134.5770343	INV	EMA	2	0
58.35892	-134.5770632	INV	EMA	1	12
58.35892	-134.5770632	INV	EMA	1	3
58.35892	-134.5770632	INV	EMA	1	2
58.35892	-134.5770255	INV	EMA	1	12
58.35892	-134.5770255	INV	EMA	1	1
58.35896	-134.577032	INV	EMA	1	3
58.35895	-134.5769088	INV	EMA	2	1
58.35888	-134.5767598	INV	EMA	1	1.5
58.35884	-134.5767557	INV	EBC	1	1
58.35884	-134.5767557	INV	EBC	1	0
58.35885	-134.576761	INV	EMA	1	0
58.3589	-134.5766756	INV	EBC	3	1
58.35863	-134.5754179	INV	EBC	1	5
58.35856	-134.5750362	INV	EMA	2	1

Appendix B. Invasive Plant Information from the Alaska Natural Heritage Program

European mountain ash
Sorbus aucuparia L.

Synonyms: *Pyrus aucuparia* (L.) Gaertn., *Sorbus aucuparia* L. var. *xanthocarpa* Hartwig & Rumpler
Other common names: rowan
Family: Rosaceae

Invasiveness Rank: **59** The invasiveness rank is calculated based on a species' ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to native ecosystems and 100 representing a plant that poses a major threat to native ecosystems.

Description
European mountain ash is an upright tree that grows from 7 ½ to 12 m tall with a rounded, open crown. Bark is gray or yellow-green and smooth. Leaves are alternate, pinnately compound, and 13 to 20 cm long with 11 to 15 leaflets per leaf. Leaflets are dark green above and pale green below. Flowers bloom in May and are borne in clusters that are 7 ½ to 13 cm across. They are small and white. Pomes (fruits) are bright orange, small, and persistent. They ripen in September (Welsh 1974).


Flowers and foliage of *Sorbus aucuparia* L. Photo by R. Old.

Similar species: Three *Sorbus* species are native to Alaska: Sitka mountain ash (*Sorbus sitchensis*), Cascade mountain ash (*S. scopulina*), and Siberian mountain ash (*S. sambucifolia*). Sitka mountain ash grows along the Pacific Maritime coast, Cascade mountain ash grows throughout the southern half of Alaska, and Siberian mountain ash grows in the western Aleutian Islands. European mountain ash can be distinguished from all other native *Sorbus* species in Alaska because it is a tree (usually growing taller than 5 m), whereas all native *Sorbus* species are shrubs (usually growing shorter than 5 m). Additionally, European mountain ash can be distinguished from native *Sorbus* species by the presence of leaflets that are unequal and rounded at the base and fruits that are borne in clusters of more than 25.


Sorbus aucuparia L. Photo by R. Old.

Ecological Impact
Impact on community composition, structure, and interactions: The ecological impacts of European mountain ash are largely unknown. This species can integrate into and dominate largely undisturbed, coastal

rainforest communities, such as at Sitka National Historic Park. It has been reported to invade forest communities in Wisconsin (Wisconsin Department of Natural Resources 2003). The fruits are highly desirable to birds; the presence of European mountain ash may alter the abundance and composition of avian fauna (Gilman and Watson 1994). European mountain ash hybridizes with native *S. scopulina* and *S. sitchensis* where their ranges overlap (Pojar and MacKinnon 1994).

Impact on ecosystem processes: The impacts of European mountain ash on ecosystem processes are largely unknown.

Biology and Invasive Potential

Reproductive potential: European mountain ash grows rapidly and can grow up to 10 ¾ m tall in 20 years. It establishes by seeds, cuttings, or bare roots. However, this species does not spread vegetatively (USDA 2010). Seeds are numerous and small (125,000 seeds per pound), and each tree produces many thousands of seeds annually. Seeds have a strong, innate dormancy that lifts gradually over a few years. They can remain viable in the soil for five years or more (Granström 1987).

Role of disturbance in establishment: Unknown.

Potential for long-distance dispersal: Seeds are spread by birds (thrushes and waxwings) and small mammals (Dickinson and Campbell 1991).

Potential to be spread by human activity: European mountain ash is widely planted as an ornamental tree in southern and southeastern Alaska, where it has escaped cultivation (Welsh 1974). It can be spread as a contaminant of horticultural stock (Hodkinson and Thompson 1997).

Germination requirements: Seeds germinate well in Central Sweden in full light when the temperature is 20°C and when they are buried under 2 cm of soil covered with a moss/litter layer (Granström 1987). Cold stratification is necessary for seeds to germinate successfully (USDA 2010).

Growth requirements: European mountain ash is well suited to coarse-textured, moderately fertile soils with pH between 5.5 and 7.5. It does not grow well in fine-textured, anaerobic, calcareous, saline, or dry soils. It is tolerant of some shade (USDA 2010).

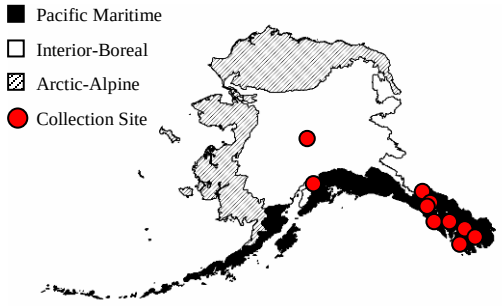
Congeneric weeds: A number of *Sorbus* species have been introduced into North America; however, none are listed as weeds (USDA 2010).

Legal Listings

☒ Has not been declared noxious
☐ Listed noxious in Alaska
☐ Listed noxious by other states
☐ Federal noxious weed
☐ Listed noxious in Canada or other countries

Distribution and Abundance

Native and current distribution: European mountain ash is native to most of Europe, Iceland, northern Africa, and western Asia. It has naturalized in 29 states of the U.S. and much of Canada (USDA 2010). European mountain ash has been documented from the Pacific Maritime and Interior-Boreal ecogeographic regions of Alaska (AKEPIC 2010, UAM 2010).



Distribution of European mountain ash in Alaska

Management

Control measures for European mountain ash are largely untested. It has the ability to resprout after cutting. Many natural seed predators are present in Scandinavia, which likely limits the spread and establishment of this species. It is unknown if these or similar predators are present in Alaska.

References:

AKEPIC database. Alaska Exotic Plant Information Clearinghouse Database. 2010. Available: http://akweeds.uaa.alaska.edu/

Dickinson, T.A. and C.S. Campbell. 1991. Population structure and reproductive ecology in the Maloideae (Rosaceae). Systematic Botany, 16 (2): 350-362.

Gilman, E.F. and D.G. Watson. 1994. Sorbus aucuparia European Mountain-Ash. Fact Sheet ST-599, Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Granström, A. 1987. Seed viability of fourteen species during five years of storage in a forest soil. Journal of Ecology, 75, p.321-331.

Hodkinson, D., K. Thompson. 1997. Plant dispersal: the role of man. Journal of Applied Ecology, 34: 1484-1496.

Hultén, E. 1968. Flora of Alaska and Neighboring

Territories. Stanford University Press, Stanford, CA. 1008 pp.
Invaders Database System. 2010. University of Montana. Missoula, MT. http://invader.dbs.umt.edu/
ITIS. 2010. Integrated Taxonomic Information System. http://www.itis.gov/
Pojar, J. and A. MacKinnon. 1994. Plants of the Pacific Northwest Coast: Washington, Oregon, British Columbia, and Alaska. B.C. Ministry of Forests and Lone Pine Publishing. Redmond, Washington. 527 pp.
UAM. 2010. University of Alaska Museum, University of Alaska Fairbanks. Available: http://arctos.database.museum/home.cfm
USDA. 2010. The PLANTS Database. National Plant Data Center, Natural Resources Conservation Service, United States Department of Agriculture. Baton Rouge, LA. http://plants.usda.gov
Welsh, S.L. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Brigham University Press. 724 pp.
Wisconsin Department of Natural Resources: abstract. Non-native plants. 2003. http://www.dnr.state.wi.us

European bird cherry
Prunus padus L.

Synonyms: None
Other common names: None
Family: Rosaceae

Invasiveness Rank: **74** The invasiveness rank is calculated based on a species' ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to native ecosystems and 100 representing a plant that poses a major threat to native ecosystems.

Description
European bird cherry is a shrub or small tree that can grow up to 9 meters tall. Bark is purple-gray to green-gray. Leaves are long-petiolated, up to 10 cm long, elliptic to obovate, and sharply serrate. Numerous, showy flowers are arranged in elongate, cylindrical, terminal racemes. Petals are white or cream-colored and usually 4 to 6 mm long. Fruits are black and ovoid (Welsh 1974).

Foliage and flowers of *Prunus padus* L.

Similar species: European bird cherry can be distinguished from other *Prunus* species by the presence of flowers arranged in long, cylindrical spikes.

Ecological Impact
Impact on community composition, structure, and interactions: European bird cherry can create tall shrub layers, eliminating native willow layers and all layers underneath. This species may delay the germination and growth of shade intolerant trees. European bird cherry can reduce the quality of willow-dominated foraging sites for moose. Fruits are desirable to birds (M.L. Carlson – pers. obs., M. Shephard – pers. obs.). This species contains a cyanogenic glycoside and can be toxic to mammals with segmented stomachs (rumens), including moose, deer, sheep, goats, and cattle (Mulligan and Munro 1981, Johnson 2000, Harms 2011). European bird cherry, a closely related non-native species, has been responsible for poisoning moose calves in Anchorage. Poisoning from *Prunus* species usually occurs after the plants freeze (Harms 2011).
Impact on ecosystem processes: European bird cherry likely reduces light, moisture, and nutrient availability for other species (J. Conn – pers. com.). Little is known about the impact of European bird cherry on ecosystem processes.

Infestation of *Prunus padus* L. along a trail in Anchorage, Alaska.

Biology and Invasive Potential
Reproductive potential: European bird cherry reproduces by seeds and bare roots. It can be propagated by cuttings. Each plant produces many seeds (USDA 2002). Seeds remain viable for less than 1 year (Granström 1987).
Role of disturbance in establishment: Unknown.
Potential for long-distance dispersal: Fruits of European bird cherry can be dispersed by birds.
Potential to be spread by human activity: European bird cherry is commonly cultivated as an ornamental plant (Welsh 1974).

Germination requirement: Seeds require cold stratification to germinate (USDA 2002).
Growth requirements: European bird cherry grows in coarse- and medium-textured soils with pH between 5 and 7. It is not tolerant of drought, shade, anaerobic conditions, or high salinity. It is tolerant of high calcium carbonate ($CaCO_3$) content. This species can withstand temperatures down to -36°C, and it requires 110 frost-free days for reproduction (USDA 2002).
Congeneric weeds: Chokecherry (*Prunus virginiana*) is a tracked non-native species in Alaska (AKEPIC 2010).

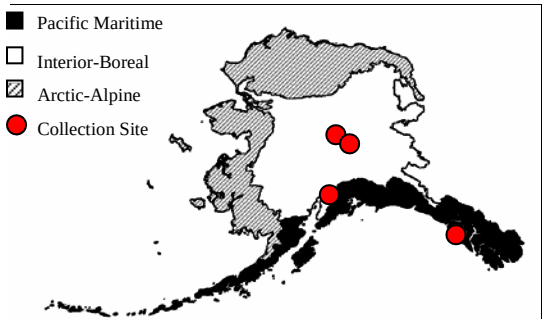
Legal Listings

- ☒ Has not been declared noxious
- ☐ Listed noxious in Alaska
- ☐ Listed noxious by other states
- ☐ Federal noxious weed
- ☐ Listed noxious in Canada or other countries

Distribution and Abundance

European bird cherry is commonly cultivated as an ornamental plant in southern Alaska (Welsh 1974, UAM 2003).

Native and current distribution: European bird cherry is native to Europe, temperate Asia, and northern Africa. It has been introduced into North America and grows in Alaska, Delaware, Illinois, Montana, New York, New Jersey, and Pennsylvania (USDA 2002). This species has been documented from the Pacific Maritime and Interior-Boreal ecogeographic regions of Alaska (UAM 2003, AKEPIC 2010).



Distribution of European bird cherry in Alaska

Management

Control options have not been investigated.

References:

AKEPIC database. Alaska Exotic Plant Information Clearinghouse Database. 2010. Available: http://akweeds.uaa.alaska.edu/

Carlson M.L., Ph.D., Assistant Research Professor – Botany, Alaska Natural Heritage Program, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska. Tel: (907) 257-2790 – Pers. obs.

Conn, J. Weed Scientist, USDA Agricultural Research Service PO Box 757200 Fairbanks, Alaska 99775 tel: (907) 474-7652; fax (907) 474-6184 – Pers. com.

Granström, A. 1987. Seed viability of fourteen species during five years of storage in a forest soil. Journal of Ecology, 75, p.321-331.

Harms, C. 2011. Moose Die from Chokecherry Poisoning. Release No. 11-09. Alaska Department of Fish and Game Press. Juneau, AK.

Invaders Database System. 2010. University of Montana. Missoula, MT. http://invader.dbs.umt.edu/

ITIS. 2010. Integrated Taxonomic Information System. http://www.itis.gov/

Johnson, K. 2000. *Prunus padus*. In: Fire Effects Information System [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. [16 February 2011] Available: http://www.fs.fed.us/database/feis/

Mulligan, G., and D. Munro. 1981. The Biology of Canadian Weeds. 51. *Prunus virginiana* L. and *P. serotina* Ehrh. Canadian Journal of Plant Science. 61(4). 977-992 p.

Shephard, M., Vegetation Ecologist, USDA, Forest Service, Forest Health Protection, State and Private Forestry, 3301 C Street, Suite 202, Anchorage, Alaska 99503 Tel: (907) 743-9454 - Pers. obs.

University of Alaska Museum. University of Alaska Fairbanks. 2003. http://hispida.museum.uaf.edu:8080/home.cfm

USDA (United States Department of Agriculture), NRCS (Natural Resource Conservation Service). 2002. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Welsh, S. L. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Brigham University Press. 724 p.

reed canarygrass
Phalaris arundinacea L.

Synonyms: *Phalaris arundinacea* var. *picta* L., *Phalaroides arundinacea* (L.) Raeusch., *Phalaroides arundinacea* var. *picta* (L.) Tzvelev, *Typhoides arundinacea* (Linnaeus) Moench.
Other common names: canary grass
Family: Poaceae

Invasiveness Rank: **83** The invasiveness rank is calculated based on a species' ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to native ecosystems and 100 representing a plant that poses a major threat to native ecosystems.

Description
Reed canarygrass is a robust, cool-season, sod-forming, perennial grass that produces culms from creeping rhizomes. Culms grow 15 to 152 ½ cm high. Leaf blades are flat, 5 to 15 cm long, and 6 to 12 ½ mm wide. Flowers are arranged in dense, branched panicles. Immature panicles are compact and resemble spikes, but open and become slightly spreading at anthesis (Whitson et al. 2000). This species is morphologically variable, and more than ten varieties have been described.

Panicle of *Phalaris arundinacea* L.

Similar species: Reed canarygrass is unique because it has a single flower per spikelet and a more open, branched inflorescence than a narrow spike like that of timothy grass (*Phleum pratense*).

Infestation of *Phalaris arundinacea* L.

Ecological Impact
Impact on community composition, structure, and interactions: Reed canarygrass forms dense, persistent, monotypic stands in wetlands. These stands exclude and displace other plant species. In Montana, reed canarygrass poses a threat to the endangered aquatic species water howellia (*Howellia aquatilis*). Invasive populations of reed canarygrass are believed to be the result of crosses between cultivated varieties and native North American strains (Merigliano and Lesica 1998). Reed canarygrass grows too densely to provide adequate cover for small mammals and waterfowl. When in flower, it can cause hay fever and allergies.

Impact on ecosystem processes: Dense stands of reed canarygrass promote silt deposition and the consequent constriction of waterways and irrigation canals. Reed canarygrass may alter soil hydrology.

Ligule of *Phalaris arundinacea* L.

Biology and Invasive Potential

Reproductive potential: Reed canarygrass reproduces sexually by seeds and vegetatively from creeping rhizomes.

Role of disturbance in establishment: Invasion is promoted by disturbances, such as ditching of wetlands, stream channelization, overgrazing, alteration of water levels, and intentional planting.

Potential for long-distance dispersal: Seeds have no adaptations for long-distance dispersal. Both rhizome fragments and seeds can be transported with the movement of water along streams and rivers.

Potential to be spread by human activity: Reed canarygrass has been widely planted as a forage crop and for erosion control.

Germination requirements: Seeds germinate most readily immediately following their maturation; they do not require cold-stratification. They germinated well in experimental conditions after soaking in water at 50°C. Mechanical damage, increased light, and increased oxygen availability also promoted germination (Vose 1962).

Growth requirements: Reed canarygrass is adapted to fine- and medium-textured soils with pH from 5.5 to 8. It is highly tolerant of fire and anaerobic soils, but it is intolerant of shade. Reed canarygrass can withstand temperatures as low as -39°C. It requires 120 frost-free days for growth and reproduction (USDA 2002).

Congeneric weeds: Bulbous canarygrass (*Phalaris aquatica*), shortspike canarygrass (*P. brachystachys*), annual canarygrass (*P. canariensis*), sunolgrass (*P. coerulescens*), littleseed canarygrass (*P. minor*), and hood canarygrass (*P. paradoxa*) are known to occur as non-native weeds in North America (USDA 2002).

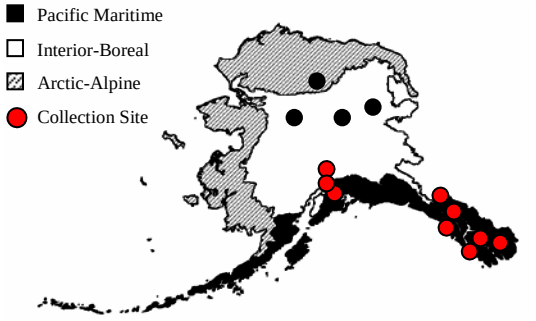
Legal Listings

- ☐ Has not been declared noxious
- ☐ Listed noxious in Alaska
- ☒ Listed noxious by other states (WA)
- ☐ Federal noxious weed
- ☐ Listed noxious in Canada or other countries

Distribution and Abundance

In the United States, the first agronomic trials of reed canarygrass probably began in the 1830s. This species is now widespread in North America. Reed canarygrass is common in stream banks, spring margins, and wet meadows in central Alaska, south-central Alaska, southeastern Alaska, southern Yukon, and northern British Columbia. It has ability to invade and dominate sedge meadows and wet prairies. It may also pose a serious threat to upland oak savannas (Henderson 1991).

Native and current distribution: There is no consensus on the native status of reed canarygrass in North America (Merigliano and Lesica 1998). Hultén (1968) states that it is native to Europe, but some authors view it as native to Asia and North America as well (Welsh 1974). The current range of reed canarygrass extends throughout the world. It is found primarily in northern latitudes. Some populations of reed canarygrass may be native to Alaska. Four hot springs of interior Alaska may harbor native forms: Big Windy, Kanuti, Kilo, and Manley Hot Springs (these locations are denoted by black dots on the map).



Distribution of reed canarygrass in Alaska

Management

Mechanical control methods may be feasible, but they are labor intensive and require a long-term time investment. No herbicides are selective enough to be used in wetlands without risking the injury of native

species. Plants reestablish quickly from seeds after control methods are used. No biological control methods are known that are feasible for use in natural areas.

References:

AKEPIC database. Alaska Exotic Plant Information Clearinghouse Database. 2010. Available: http://akweeds.uaa.alaska.edu/

eFloras. 2008. Published on the Internet http://www.efloras.org [accessed 19 October 2010]. Missouri Botanical Garden, St. Louis, MO & Harvard University Herbaria, Cambridge, MA.

Henderson, R.A. 1991. Reed canarygrass poses threat to oak savanna, restoration and maintenance (Wisconsin). Restoration & Management Notes 9(1): 32.

Hultén, E. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA. 1008 pp.

Invaders Database System. 2010. University of Montana. Missoula, MT. http://invader.dbs.umt.edu/

ITIS. 2010. Integrated Taxonomic Information System. http://www.itis.gov/

Merigliano, M.F. and P. Lesica. 1998. The native status of reed canarygrass (*Phalaris arundinacea* L.) in the inland Northwest U.S.A. Natural Areas Journal 18 (3): 223-230.

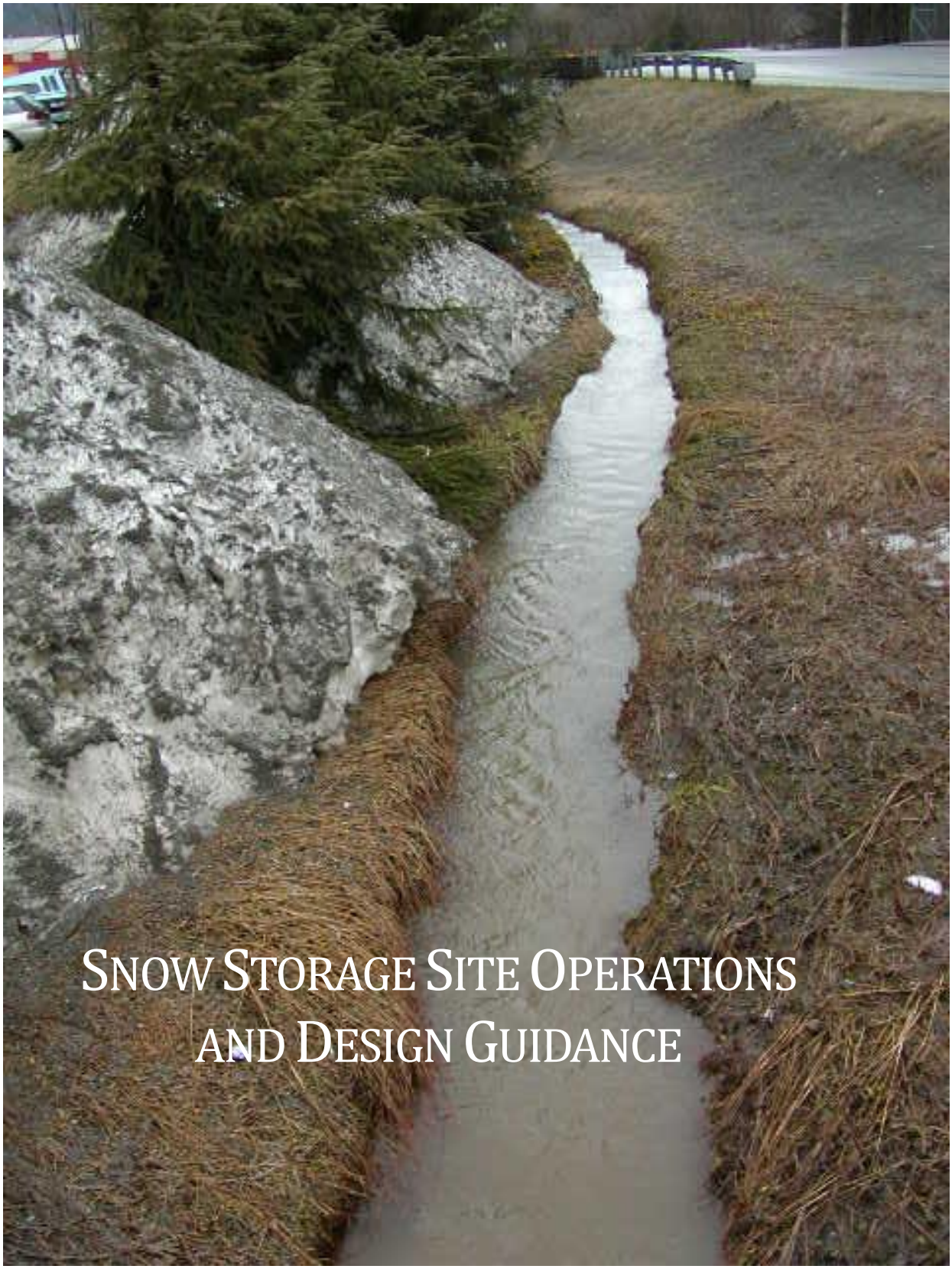
USDA (United States Department of Agriculture), NRCS (Natural Resource Conservation Service). 2002. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Vose, P. 1962. Delayed Germination in Reed Canary-Grass *Phalaris arundinacea* L. Annals of Botany. 26(2). 197-206 pp.

Welsh, S. L. 1974. Anderson's flora of Alaska and adjacent parts of Canada. Brigham University Press. 724 pp.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

Appendix C. Snow Storage Best Management Practices



Snow Storage Site Operations and Design Guidance

JUNEAU
WATERSHED PARTNERSHIP

JUNEAU WATERSHED PARTNERSHIP

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

Organization Name:	Juneau Watershed Partnership
Contact:	Amy Sumner, Project Coordinator
Mailing Address:	PO Box 35132 Juneau, AK 99803-5132
Email:	juneauwatersheds@gmail.com

This BMP guidance was funded with qualified outer continental shelf oil and gas revenues by the Coastal Impact Assistance Program, Fish and Wildlife Service, U.S. Department of Interior

GRANT # 10 – CIAP – 030 CFDA 15.688

Snow Storage Site Operations and Design Guidance

Purpose and Description

The purpose of this guidance is to improve water quality in Juneau's watersheds by providing snow storage site design and operational best management practices (BMPs) to control pollutant loading resulting from snow storage sites.

Snow is plowed from our streets and parking areas to ensure public safety. However, snow removal and storage can present serious challenges particularly in Juneau where snowfall is 97 inches annually. In trying to find places to place snow, poor winter maintenance practices such as pushing snow directly into anadromous streams and siting snow storage areas adjacent to anadromous streams have become widespread. Streams and riparian areas are often used for snow storage because they are low lying areas that are not useful for parking or driving, and the thought is that the snow will just melt and "go away" in the stream.

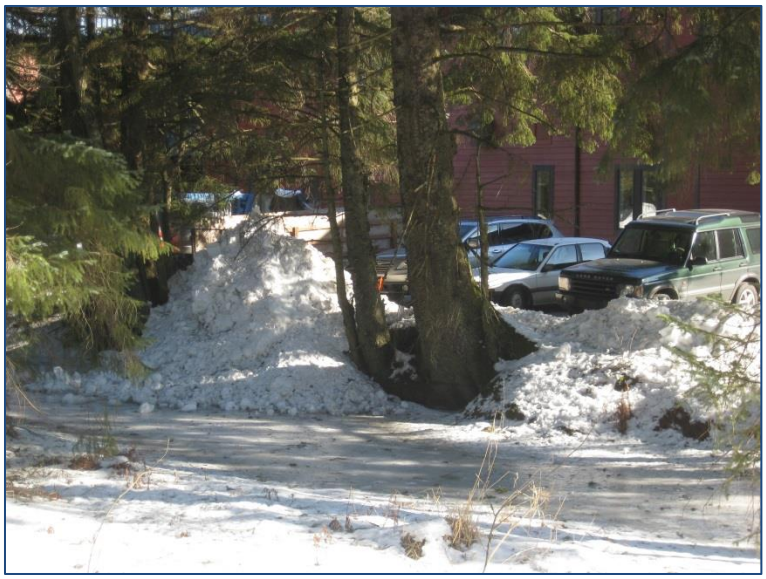


Figure 1. Snow being pushed into Jordan Creek.

However, plowed snow can contain a variety of pollutants such as petroleum and heavy metals from fuels, chloride from deicers, and sediment from gravel treatment and unpaved areas. In Juneau, pollutant laden meltwater has contributed to the degradation of our local waterways. Four of Juneau's waterbodies (Duck Creek, Jordan Creek, Lemon Creek and Vanderbilt Creek) are listed as impaired due to pollutants conveyed in stormwater, which includes meltwater from snow.

Figure 2. Snow plowed from our streets and parking lots isn't pretty. Snow and meltwater convey a variety of pollutants into our waterways.

Snow storage site design and operational practices can be used to divert meltwater away from streams and manipulate melting processes to reduce pollutants in meltwater. Sediment loading can be controlled through the geometry of the snowfill and the site.

Chloride and other water-soluble pollutants (hydrocarbons, phosphorous, nitrogen, and heavy metals) are best controlled through detention/passive filtration, as well as sediment retention.

This Guidance is primarily intended for private on-site snow storage in residential, commercial and industrial areas where there is a potential for meltwater to discharge into a stream, lake or wetland. Private on-site snow storage refers to areas used for storing snow that accumulates on the same property. Examples of these sites include snow plowed from a parking lot being stored in a corner of that parking lot or snow plowed by a home-owners association being stored on the residential property.

Private on-site snow storage is currently not regulated by the City and Borough of Juneau (CBJ). Therefore, best management practices (BMPs) are completely voluntary and there is little incentive for operators of these sites to implement BMPs, which are often thought to be expensive. This guidance provides a series of practices ranging from inexpensive to moderately expensive that can be implemented in a variety of combinations to suit the site-specific conditions and the operating budget of the landowner. Implementing even just a few of these BMPs would go a long way to protect our local waterways.

However, this Guidance can be useful for private snow storage basins where there is a potential for meltwater to discharge into a stream, lake or wetland. Snow storage basins are regulated by the CBJ and are defined as "a designated area to store snow that comes from off-site…[which includes] grading and drainage improvements to treat meltwater." This Guidance could help operators of snow storage basins develop a site and operations plan, since many of the same practices can be used. However, operators of these sites must defer to CBJ's requirements.

Applicability

The snowfill operation BMPs are applicable to any snow storage site, regardless of size, and are used primarily to reduce sediment conveyed in meltwater, though some chloride may be reduced as well. These operational BMPs can be used with or without the site design BMPs, though the combination produces better results.

The site design BMPs are applicable to any snow storage, though the perimeter control measures specified in Appendix A are only applicable for sites up to 3 acres. Site delineation measures can be implemented on any site regardless of size. Depending on the selected design BMPs employed, there is potential to reduce sediment, chloride (from deicing chemicals, hydrocarbons and other water-soluble pollutants (phosphorous, nitrogen, and heavy metals) in meltwater and to reduce meltwater directly discharging into waterbodies.

CBJ Land Use and Permitting

The CBJ regulates *snow storage basins* under the Land Use Code. Snow storage basins are defined as "a designated area to store snow that comes from off-site…[which includes] grading and drainage improvements to treat meltwater." This does not include "areas that are occasionally or temporarily used for snow storage which do not have drainage improvements" or "areas used for storage of snow that accumulates on the same property" [49.80.120].

Regulation snow storage basins began in 2010 in anticipation that upland snow storage sites will eventually be developed to comply with environmental regulations. The Land Use Code now identifies zoning districts in which off-site snow disposal is an allowed use and when these sites must operate

under a Conditional Use Permit. Permitting is based on size and zoning district, as summarized in the Table below. Off-site snow storage sites of any size are prohibited in Mixed Use zoning districts.

Size	Zoning District	Permit
Neighborhood (less than ½ acre)	Industrial, including Waterfront Industrial General Commercial,	None – CDD Staff review
	Residential (RR and D-1 only)	Conditional Use
	Waterfront Commercial Light Commercial Residential (D-3 and higher densities)	Conditional Use*
Regional (½ to 1 acre)	Industrial, including Waterfront Industrial	None – CDD Staff review
	Residential (RR and D-1)	Conditional Use
	Waterfront Commercial Light Commercial Residential (D-3 only)	Conditional Use*
	Residential (D-5 and higher densities)	Prohibited
Areawide (more than 1 acre)	Industrial, including Waterfront Industrial Residential (RR only)	Conditional Use
	General Commercial Residential (D-1 and D-3 only)	Conditional Use*
	Residential (D-5 and higher densities) Light Commercial Waterfront Commercial	Prohibited

Implementation

Snow storage sites should be selected and prepared prior to snowfall. In some cases, this process may need to start in early spring so that all selected site design best management practices (BMPs) such as bioswales or other infiltration measures can be in place before snow storage operations begin. At a minimum, this process should begin a month prior to the first anticipated snow fall, providing enough time to at least identify an appropriate site and delineate the snow storage area.

The general procedure for preparing snow storage sites is as follows:

1) Identify an appropriate site* (Section A)
2) Install selected perimeter controls and BMPs treating meltwater discharge (Section B)
3) Delineate the setback from the perimeter controls or, if no perimeter controls are installed, the limits of the snow storage site* (Section B)
4) Perform the snowfill operations appropriate for the selected site conditions while the snow storage site is in use* (Section C)
5) Inspect and maintain the snow storage site* (Section D)

At a minimum, implement the BMPs with an asterisk (*).

A. Site Selection

Locate new snow storage area according to the below recommended criteria. For existing snow storage areas, determine whether it is feasible to re-locate snow storage to a different location if the existing location does not meet the recommended criteria. If it is not feasible to relocate snow storage, implement other BMPs described in Section B (Site Design) and Section C (Snowfill Operations) to minimize impacts to adjacent waterbodies as practicable.

Recommended site selection criteria

- The site should be sized to accommodate the expected volume of snow from the plowed area. A one-acre site in Juneau has a useable capacity of about 17,000 cubic yards of snow.
- When possible, select a site in an upland location that is unlikely to impact a stream or wetland.
- Select a flat site with well-drained soils to allow filtration, absorption and microbial activity.
- If flat site is not available, select a site that is concave (a low point) or is gently sloping (1-2 percent).Where possible, the slope should be oriented so that the higher end melts first (usually south to north, but can be site dependent) in order to control the melting process and discharge meltwater in a manner that reduces sediment.
- If a pervious surface is not available, select a location on an impervious surface where meltwater can be safely conveyed to a storm water treatment BMP (if one is available).

Sites to avoid

- Avoid sites that are steeply sloped or mounded.
- Avoid sites in wetlands and avoid disposing of snow in streams and riparian areas.
- Avoid sites that are in parks or playgrounds where direct contact recreation occurs after the snow season. Accidental ingestion of soils contaminated with metals can be detrimental to human health, particularly in children.
- Avoid sites where ground water is used for drinking water. Where wellhead protection areas have been defined for public water supplies, snow disposal sites should not be located in the protection area. Where wellhead protection areas are not designated, it is recommended snow storage sites are located at least 150 feet up-gradient of private and Class C wells and at least 200 feet from class A or B public water systems. See DEC's policies regarding siting snow storage areas near drinking water sources (provided in Resources section at end of this document).

B. Site Design

On-site snow storage areas can be designed to minimize pollutant loading by preventing direct plowing into the stream and riparian area, allowing sediment to settle, infiltrating of meltwater and redirecting meltwater flows away from streams. One or more of the following design elements can be implemented in any combination to allow for flexibility given site specific conditions. At a minimum, the snow storage site should be delineated and a vegetated buffer should be maintained between the snow storage site and any nearby waterbodies as described below.

Recommended practices

- Site Delineation: At a minimum, snow storage sites near a waterbody should have the limits of the storage area delineated along the 50-foot setback for anadromous streams. If no other measures are implemented, this will at least alert the operator and discourage placing or pushing of snow into the riparian area and stream. Where perimeter controls are implemented, the site should be delineated along a 5-foot (minimum) setback from the perimeter control in order to alert the operator and discourage placing or pushing of snow into the perimeter control measures and damaging them. The site should be delineated with highly visible flagging or snow poles placed every 20 to 30 feet.

- Perimeter Control: Snow storage sites near waterbodies should maintain a vegetated buffer between the snow storage site and the waterbody. Where feasible, the vegetated buffer should at least encompass the 50-foot setback from anadromous streams. In areas where vegetative buffer is lacking (e.g. in developed areas), perimeter control should be installed between the

waterbody and the snow storage site. However perimeter control is strongly recommended for any snow storage site near a waterbody, even those with vegetative buffers.

Perimeter control is not necessarily needed along the entire perimeter, but should be placed where it would function to intercept and divert meltwater flows away from streams and other sensitive areas (e.g. wetlands). Recommended options include a diversion dike or a stabilized channel. An equivalent, alternative perimeter control can be considered given cost and feasibility. However, silt fences are NOT recommended for perimeter control in this application, since they are often damaged by snow storage and plowing activities and difficult to install in frozen ground.

- Treatment of Discharge: Where possible, meltwater should be discharged from the site to a stormwater treatment structure that allows infiltration (e.g. bioswale), particularly where such BMPs are not being used as perimeter controls.

C. Snowfill Operations

These snowfill operations describe how to place snow on a storage site to manipulate melting processes to control pollutants in meltwater. These practices primarily help reduce the amount of sediment conveyed in meltwater, but can also reduce the amount of chloride. These operational practices can be implemented on any snow storage site, including those located on paved surfaces. If used in combination with perimeter control and/or the treatment of the site's discharge, the water quality benefits are increased.

Recommended practices

- Place snow in a single, compact pile with steep side-slopes (1:1.5 or steeper) and a flat top.
- Place snow in piles that have larger footprints (cover a larger area) but do not exceed pile depths (height) of 20 feet. If deicing chemicals were used, this method will minimize chloride in snowmelt.
- When storing snow on sloped sites, place snow on the downslope portion first and then progress uphill.
- Maintain a minimum of a 5-foot set back from any perimeter controls (Section B).

Practices that should be avoided

- Do not plow or store snow or ice into streams or wetlands or onto stream or wetland buffers.
- Do not plow snow and ice into storm drain catch basins, ditches or other conveyance structures such as swales. Snow and debris may block drainage and cause localized flooding. This may also allow sediment, debris, and other pollutants to be quickly conveyed through the storm water system and into a nearby waterbody.
- Do not plow snow or ice to public land such as roads or sidewalks.
- When using a bioswale or ditch as perimeter control, DO NOT push or plow snow into these areas as it may affect drainage and infiltration.

D. Maintenance and Inspection

Snow storage sites will require periodic inspection and maintenance during and after snow storage operations to ensure implemented measures are working as intended.

During snow storage operations

- Periodically collect loose debris and garbage around the site to prevent it from being transported off-site in meltwater.
- Ensure nearby storm drain catch basins, ditches and other drainage structures are free of snow and ice.
- Check that selected perimeter control measures have not been damaged and, if they are, repair them as soon as practicable.
- When clearing the area of accumulated sand/gravel, do not sweep the sand/gravel into ponded water.

After snow storage operations

- Clean area of accumulated sand/gravel, trash and debris.
- Where vegetation is damaged in the riparian area or in the vegetated buffer, the area should be re-vegetated in the spring and summer.

Implementation Costs

The cost associated with setting aside land for on-site snow storage is difficult to determine, as it is not necessarily tied to the cost of the land. For example, on-site snow storage sites in commercial areas have the potential to eliminate customer parking, but how much this lost parking costs a business depends on variables such as the size of the parking lot and how often the parking lot is filled to capacity (e.g. a parking lot that is only ever half-filled on the busiest day will not necessarily lose money if snow is plowed to the furthest quarter of the lot). On-site snow storage in a residential area may not necessarily have monetary costs, but could affect residents through associated noise, loss of convenient parking, and blocked walking paths.

The cost associated with setting aside land for off-site snow storage would directly tie to the cost of the property, since the site would be a designated snow storage area, and would include the costs of permitting the site as a snow storage basin. This can be expensive.

Outside of the property costs, the BMPs recommended in this guidance range from relatively inexpensive to moderately expensive to implement. Snowfill operations are relatively easy and cost-effective to implement. There should be little to no cost associated with implementing this BMP. Since care has to be taken to ensure operations are conducted in accordance to this guidance, any cost will be associated with the potential increase in operator time while they transition to operating per this guidance. However, any potential cost should be short-term.

The various site design BMPs range in cost, as shown in the Table below. Site delineation methods are relatively inexpensive. Berms are the most cost-effective perimeter control. In addition, they require less space. Bioswales can become quite expensive depending on the size of the site. These also require more space. However, bioswales are the most effective in treating meltwater.

Measure	Cost
Site Delineation	
Flagging	$6 for 600-ft roll of flagging tape (estimate from Home Depot)
Snow Poles	$15 each for a 8 ft. pole 1.3 in. in diameter (estimate from Interwest Safety Supply, LLC; does not include shipping)
Perimeter control	
Gravel berm	$15 - $55 per linear foot (estimate from the EPA)
Bioswale	$200 - $625 per 100 feet of channel length (estimate from the EPA, assumes a 1.5-ft deep channel with a 2-ft wide bottom and 3:1 side slopes)

Partnering to reduce costs: The Juneau Watershed Partnership (JWP) and the Southeast Alaska Watershed Coalition (SAWC) are willing to partner with landowners interested in implementing snow storage site BMPs on their property. As non-profit organizations, we are able to seek grant funding and can solicit volunteers from our membership to pursue these projects at little to no cost to the landowner. While we cannot guarantee funding, we will work with interested landowners in any way we can to assist in implementing these measures.

Resources

Alaska Department of Environmental Conservation (DEC). Nd. Snow Disposal on Marine Ice and in Open Marine Water. https://dec.alaska.gov/water/wnpspc/pdfs/dec_policy_snowdisposal_marine.pdf

---. Snow Disposal Area Siting Guidance. https://dec.alaska.gov/water/wnpspc/pdfs/dec_snowdisposal_siting_guidance.pdf

Alaska Department of Transportation and Public Facilities (DOT&PF). 2012. Emerging Practices in Highway Maintenance. http://dot.alaska.gov/stwdmno/Winter_Maintenance.pdf

Carlson, R.F.; Barnes, D.L.; Vaughan, N.; and A. Forsstrom. 2003. Synthesis of Best Management Practices for Snow Storage Areas. Prepared for the Alaska Department of Transportation, Statewide Research Office. http://www.dot.state.ak.us/stwddes/research/assets/pdf/fhwa_ak_rd_03_04.pdf

Dowl HKM. 2010. Snow Management Assessment and Planning. Prepared for the City and Borough of Juneau. http://www.juneau.org/engineering/Snow_Storage/documents/Final_Report_1-66.pdf

Tetra Tech Alaska. 2010. Manual of Stormwater Best Management Practices. Prepared for the City and Borough of Juneau (CBJ). http://www.juneau.org/engineering/SW_BMP/documents/Aug_2010_Manual_Stormwater_BMPs_000.pdf

Wheaton, S.R. and W.J. Rice. 2003. Siting Design and Operational Controls for Snow Disposal Sites. 1st International Conference on Urban Drainage and Highway Runoff in Cold Climate. http://anchoragestormwater.com/Documents/siting_design_ops_snowdisp_sites.pdf

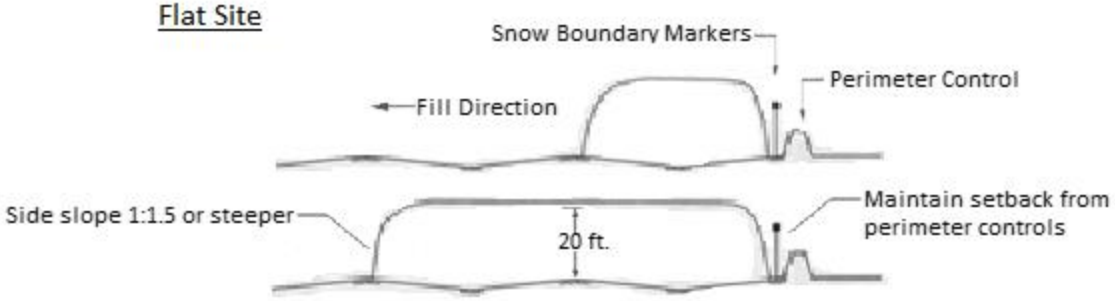
Wheaton, S.R. 2003. Private Snow Disposal Sites (On-Site Snow Storage Only) Operations Guidance (DRAFT). Municipality of Anchorage Watershed Management Services. http://anchoragestormwater.com/Documents/privtsnobmps.pdf

APPENDIX A:

Standard Drawings for Snow Site Operations and Design

Snow Site Fill Procedure

Flat Site

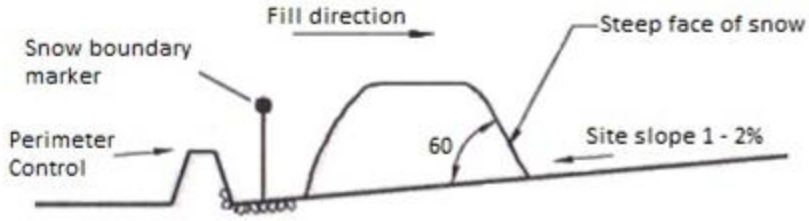


Notes:
1. Place snow in a compact mass with a flat top and uniform thickness (not exceeding 20 ft).

2. Maintain steep side slopes and a relatively broad base.

3. Maintain setback from perimeter control or site limits.

Sloped Site



Notes:
1. Install perimeter control on downhill side so it is operational before the first snow fall.

2. Sequence placement of snow on downhill side of site and filling uphill.

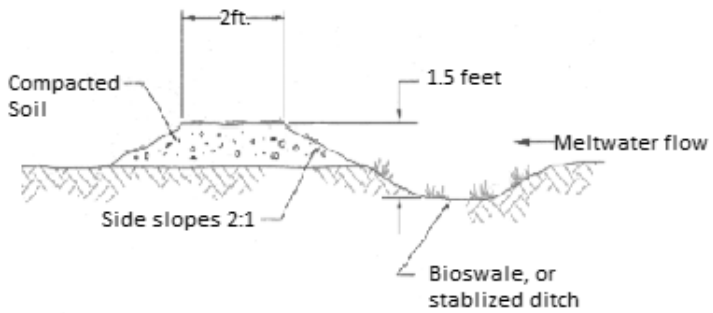
3. Maintain the snowfill in a compact mass.

4. The advancing face of the snow mass should be steep to keep the footprint of the snow as small as possible.

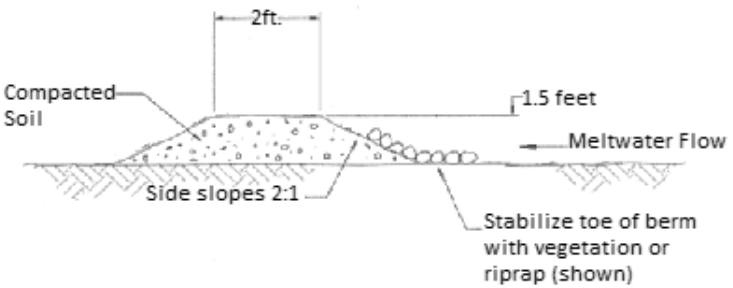
Perimeter Control Options

Diversion Dike

A. With a Stabilized Ditch



B. Berm Only

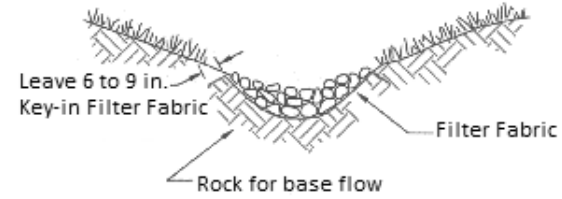


Notes:
1. Install perimeter control so it is operational before the first snowfall
2. Berm should be adequately compacted to prevent failure.
3. Stabilize berm with rock or vegetation.
4. When using a diversion ditch, the channel should have parabolic or trapezoidal shape and be stabilized with rock or vegetation

Stabilized Channel

A. Grass-lined Channel

B. Grass-lined Channel with Rock



Notes:
1. Install perimeter control so it is operational before the first snowfall
2. Rock should be used for base flow where higher velocities are expected or with "V" shaped channels that are difficult to vegetate
3. Filter fabric can be used as a channel liner to provide stability until vegetation has established

APPENDIX B:

Construction Specifications for Snow Site Design

TEMPORARY DIVERSION DIKE

Definition: A temporary ridge of compacted soil constructed around the perimeter of a disturbed area or snow storage site. The diversion dike can consist solely of an earthen berm or a berm in conjunction with a stabilized ditch.

Purposes:

- To divert storm runoff from drainage areas away from adjacent areas and slopes to a stabilized outlet.
- To divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin.
- To assure that sediment-laden runoff will not leave the site without treatment.

Planning Considerations:

- It is very important that a diversion dike be stabilized immediately following installation with temporary or permanent vegetation to prevent erosion of the dike itself. The gradient must have a positive grade to assure drainage, but if the gradient is too great, precautions must be taken to prevent erosion due to high velocity channel flow behind the dike.
- This practice can use material available on the site and can usually be constructed with equipment needed for site grading. The useful life of the practice can be extended by stabilizing the dike with vegetation. Diversion dikes are preferable to silt fence because they are more durable, less expensive, and require much less maintenance when constructed properly.
- Temporary diversion dikes are often used as a perimeter control in association with a sediment trap or a sediment basin, or a series of sediment-trapping facilities, on moderate to large construction sites. If installed properly and in the first phase of grading, maintenance costs are very low.

Design Considerations:

Drainage Area: 5 acres or less

Velocity: maximum permissible velocity

***Recommended Design*:**

Berm

side slope:	2:1 or flatter
width:	2 foot (.6 m) (top width)
height:	1.5 feet (.5 m)
freeboard:	0.5 feet (.2 m)

Channel

shape:	parabolic or trapezoidal recommended
side slope:	2:1 or flatter
stabilization:	vegetation or riprap

Grade**:** The channel behind the berm shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is required. If the slope is greater than 2%, the channel shall be stabilized.

Outlet**:** Divert sediment-laden water into a temporary sediment trap or sediment basin when possible. Runoff should empty into an outlet protection unless well stabilized natural outlets exist.

***Construction Specifications*:**

- Temporary diversion dikes must be installed and must be functional prior to storing snow onsite.
- The berm should be adequately compacted to prevent failure.
- Temporary or permanent seeding and mulch should be applied to the dike immediately following its construction.
- The dike should be located to minimize damages by snow operations and traffic.

Inspection and Maintenance:

- Once every two weeks, inspect and make repairs to the berm, flow channel, outlet or sediment trapping facility, as necessary.
- Diversion Dikes used to trap sediment shall be inspected and cleaned out after every significant storm.
- Damages caused by traffic or other activity should be repaired before the end of the day damage was noted.
- If vegetation has not been established, reseed damaged and sparse areas immediately.

GRASSED-LINED CHANNELS

Definition: Vegetation lining a natural or constructed waterway, swale or dike to protect it from erosion.

Purpose: Grass protection of drainage-ways reduces erosion by lowering water velocity over the soil surface and by binding soil particles with roots. The drainage-way is any ground surface over which concentrated runoff travels. It is typically a manmade waterway, swale or ditch. It may also be the upslope flow of water and directs the concentrated flow along the surface of the barrier.

Grass-lined channels should be used where:

- a vegetative lining can provide sufficient stability for the channel grade by increasing maximum permissible velocity;
- slopes are generally less than 5%;
- site conditions required to establish vegetation i.e., climate, soils and topography are present.

Design Considerations:

- Grass-lined channels resemble natural systems and are usually preferred where design velocities are suitable. Select appropriate vegetation and construct channels early in the construction schedule before grading and paving increase runoff rates.
- Generally, grass-lined channels are constructed in stable, low areas to conform with the natural drainage system, but they may also be needed along roadways or property boundary. To reduce erosion potential, design the channel to avoid sharp bends and steep grades.
- The channel cross section should be wide and shallow with relatively flat side slopes so surface water can enter over the vegetated banks without erosion. Riprap may be needed to protect the channel banks at intersections where flow velocities approach allowable limits and turbulence may occur. Cross-section designs include:

V-shaped channels are generally used where the quantity of water is relatively small, such as roadside ditches. The V-shaped cross section is desirable because of difficulty stabilizing the bottom, where velocities may be high. A grass or sod lining will suffice where velocities are low or rock or riprap lining may be necessary.

Parabolic grass channels are often used where larger flows are expected and sufficient space is available. The shape is pleasing and may best fit site conditions. Riprap should be used where higher velocities are expected and where some dissipation of energy (velocity) is desired. Combinations of grass with riprap centers or turf reinforcement mat centers are useful where there is a continuous low flow in the channel.

Trapezoidal grass channels are used where runoff volumes are large and slope is low so that velocities are non-erosive to vegetated linings. Trapezoidal channels generally have concrete or riprap lined center for low flow.

- Grass-lined channels must not be subject to sedimentation from disturbed areas.
- An established grass-lined channel resembles natural drainage systems and is usually preferred if design velocities are below 5 ft/sec.
- Outlets should function with a minimum of erosion.
- Channels with design velocities greater than 2 ft/sec. will require that turf reinforcement mats, erosion control blankets, fiberglass roving or straw and netting be installed at the time of seeding to provide stability until the vegetation is fully established. It may also be necessary to divert water from the channel until vegetation is established or to line the channel with sod.
- Whenever design velocities exceed 4 ft/sec. a permanent type of erosion control blanket or turf reinforcement mat will be necessary.
- Sediment traps may be needed at channel inlets and outlets to prevent sedimentation.

Design Criteria:

Capacity: Sufficient to convey 10 year - 24 hour storm.

Velocity: The allowable design velocity for grass-lined channels is based on soil conditions, type of vegetation, and method of establishment. If design velocity of a channel to be vegetated exceeds 2-4 ft./sec., a channel liner is required.

Depth: The design water surface elevation or a channel receiving water from diversions or other tributary channels shall be equal to or less than the design water surface elevation of the diversion or other tributary channel at the point of intersection. The top width of parabolic and V-shaped, grass-lined channels shall not exceed 30 feet, and the bottom width of trapezoidal, grass-lined channels shall not exceed 15 feet unless multiple or divided waterways, riprap center, or other means are provided to control meandering of low flows.

Cross-section: The channel shape may be parabolic, trapezoidal, or V-shaped, depending on need and site conditions.

Side slopes: Grassed channel side slopes generally are constructed 3:1 or flatter to aid in the establishment of vegetation and for maintenance.

Grade: Generally restricted to slopes 5% or less. Either a uniform or gradually increasing grade is preferred to avoid sedimentation.

Construction Specifications:

- Excavate channel to desired design specifications.
- Install filter fabric according to manufacturer specifications, if needed. Ensure that:
    - Filter fabric overlaps in so that seam faces away from flow.

    - Filter fabric is keyed-in at top of the channel to anchor the fabric.
- If using rock, install in bottom of the channel.
- Place top soil
- Seed

Inspection and Maintenance:

- During the initial establishment, grass-lined channels should be repaired and grass re-established if necessary.
- After grass has become established, the channel should be checked periodically to determine if the channel is withstanding flow velocities without damage.
- Check the channel for debris, scour, or erosion and immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes and make repairs immediately.
- Remove all significant sediment accumulations to maintain the designed carrying capacity.
- Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel.
- Permanent grassed waterways should be seasonally maintained by mowing or irrigating, depending on the type of vegetation selected.

APPENDIX C:

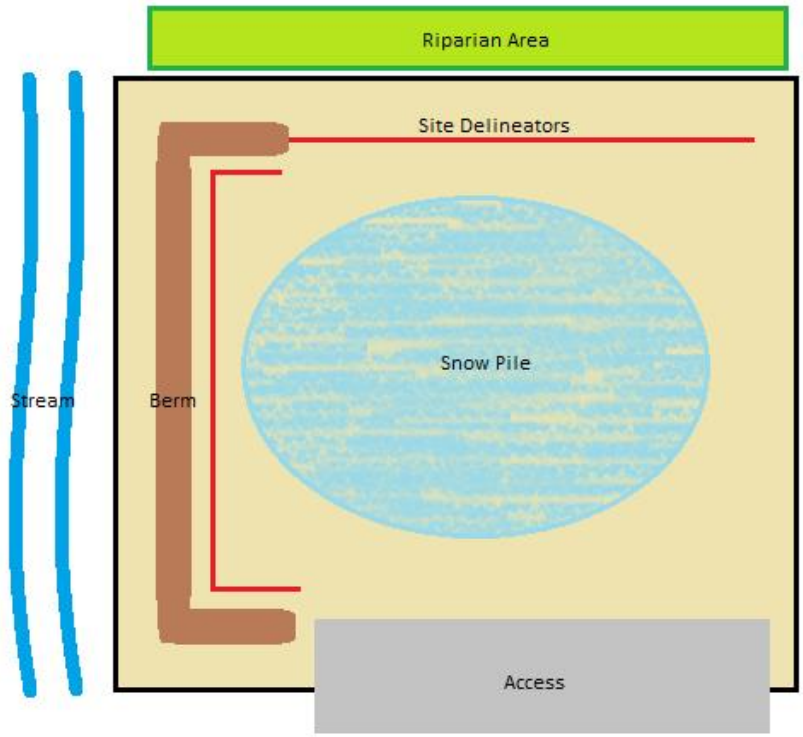
Example Snow Site Design

Switzer Village Snow Storage Site on East Creek

Existing conditions:

Snow storage operations are impacting the stream and riparian vegetation. Sediment is discharging into the stream and trees are being damaged from having snow plowed up against their trunks. A berm would be most appropriate perimeter control option on this site, since it is small and has limited storage space.

Conceptual Design for Site:



Notes:

1. Delineate the site to protect riparian area and berm.
2. Place berm along stream-side of site, wrapping ends along top and bottom to direct flow away from stream and prevent meltwater from circumventing the berm.
3. Re-vegetate disturbed areas from previous snow storage operations.
4. Consider vegetating the embankment using live staking or pole plantings.