Grant Creek Riparian Assessment

SUMMARY OF FIELD WORK CONDUCTED, SUMMER 2021

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1.0 INTRODUCTION

This document presents the results from a 2021 assessment of Grant Creek, an important but sometimes overlooked tributary to the Clark Fork on the west side of the Missoula valley. The assessment was organized by the Clark Fork Coalition (CFC), a non-profit river conservation organization in Missoula. The purpose of this report is to provide current data on the condition of the Grant Creek riparian corridor, including stream health, channel condition, hydrology, and fisheries habitat. It is intended to fill data gaps in our knowledge about the ecological health of Grant Creek, and to provide a tool for planning future conservation and restoration activities.

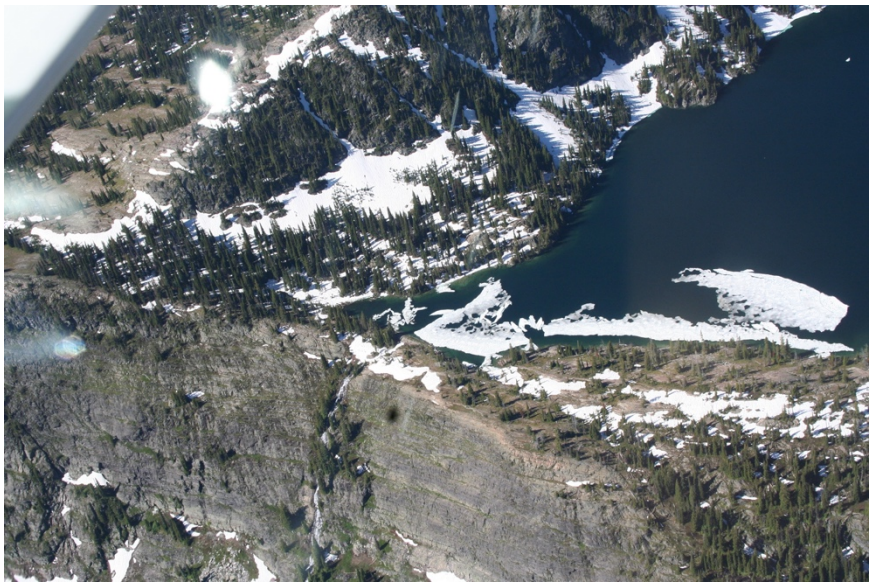
In the sections that follow, this report presents

1. a description of the Grant Creek Watershed;
2. an explanation of why restoration of Grant Creek is a high priority now;
3. method and results from the Clark Fork Coalition's 2021 assessment; and
4. a restoration reach prioritization.

The restoration of Grant Creek will require collaboration between partners in government, the private sector, NGO's, and local citizens, several of which contributed to the assessment presented here. The Clark Fork Coalition hopes this report serve as the basis for restoration planning at a watershed scale will catalyze continued collaboration on behalf of Grant Creek.

2.0 BACKGROUND

2.1 Watershed Description



Grant Creek's origins, high in the Rattlesnake wilderness

Grant Creek begins high in the glacier-carved cirques of the pristine Rattlesnake Wilderness in the Lolo National Forest at nearly 9,000ft elevation; over three thousand feet above the Missoula valley. The creek flows 18 miles to its confluence with the Clark Fork a few miles west of downtown Missoula. Its 30-square-mile watershed is a mix of dense mountain forests, hillside grasslands, suburban residential areas, high-intensity urban commercial-industrial

areas, and irrigated agricultural lands. According to the Montana Department of Environmental Quality (DEQ), “approximately 55% of the watershed is publicly owned (51% USFS, 3% Missoula County Government, and <1% each City of Missoula Government, Montana State Trust Lands, Montana Department of Transportation, and FWP) and the remainder (45%) is privately owned” (DEQ 2014).

Upper Grant Creek provides spawning habitat for westslope cutthroat trout

The uppermost part of the watershed is located within the National Forest and features cold, clean water and abundant native fish and wildlife habitat, including native westslope cutthroat and bull trout (USFS 2013). As noted by HDR Engineering, “[h]istorically, Grant Creek flowed down from its steep headwaters in the Grant Creek watershed and spread out into numerous channels over an alluvial fan in the western Missoula Valley” (HDR 2005). But over the last 150 years of settlement and development in the Missoula Valley, the lower sub-reaches have been significantly altered, with much of the lower six miles channelized along railroads, agricultural fields, and subdivisions. This has resulted in numerous impairments to water quality, stream corridor connectivity, floodplain connectivity and other natural stream functions. Montana DEQ notes that “[t]he original Grant Creek channel can be roughly located…south and west of International Drive” (DEQ 2014), whereas it currently passes through constructed channels west over half a mile along the railroad tracks and then loops south under Broadway, and along the perimeter of agricultural properties and Missoula airport land.

For all these reasons, Grant Creek is identified as an impaired stream by the Montana Department of Environmental Quality and a "Waterbody of Concern" by Montana Fish, Wildlife & Parks (FWP), and Missoula City/County (FWP 2005). Among the key concerns are:

- **Poor water quality** due to:
    - Nutrients (Nitrates and Nitrites)
    - Sedimentation/Siltation
    - High water temperatures

- **Chronic dewatering and low flows** due to:
    - Irrigation withdrawals
- **Degraded aquatic and riparian habitat** due to
    - Loss of connectivity for migratory fish and stream function
    - Straightened, channelized, and rip-rapped banks
    - Loss of natural vegetation, and associated shade, cover, habitat and bank stability

Grazing and dewatering impacts

Some of these impairments, such as channelization, sedimentation, and loss of floodplain connectivity, greatly exacerbated the impacts of a 10-year flood in 1997, ultimately causing flooding and extensive damage at a cost of $6.2 million to homes near Mullan Road in the lower end of the watershed (HDR 2005). A major stream re-naturalization project was planned in 2000-2005 with the objective to: "1) reduce flooding hazards; 2) improve fish passage; 3) improve fish habitat; and 4) improve recreation opportunities and the aesthetic value of the creek." Through a joint effort between U.S. Corps of Engineers, U.S. Fish and Wildlife Service, FWP, Montana Department of Transportation and Missoula County a few small flood prevention infrastructure projects were carried out as a result of this flood event (DEQ 2014).

However, much work remains to fully address the lower watershed flooding issue. It is clear that large-scale stream re-naturalization, including floodplain storage, continues to be a promising, but thus far unrealized, approach to lowering the flood risks in lower Grant Creek (HDR 2005).

2.2 Grant Creek – Why Now?

In the last 20 years, Missoula's urban footprint has surged westward, and it is now a spreading over the middle portion of the Grant Creek watershed. Agriculture is being replaced by

development, while new roads, commercial developments and residential areas are rapidly being built. A brief moment of opportunity exists right now to assure that the Grant Creek corridor can be protected and restored for fish and wildlife habitat and the livability of the Missoula valley.

Missoula's march westward

The Clark Fork Coalition began tracking developments on Grant Creek in 2004, and has supported and advocated for its restoration since that time. But various obstacles over the last 16 years have made it difficult, if not impossible, to pursue the kind of holistic restoration and recovery the creek needs and deserves. However, in 2020, new and exciting opportunities for a community-driven revival of Grant Creek emerged through a formal master planning process for the area. That process resulted in the Sxʷtpqéyn Area Master Plan ("Su-tup-kane," formerly Mullan Area), which presents a vision for residential and commercial development, and some provisions for the restoration of Grant Creek, progressive stormwater management, and a proposed 200-foot riparian buffer on each side of the creek (Missoula County and City of Missoula 2020).

In 2019, as the Master Planning Process was unfolding, Missoula County was able to access a federal BUILD grant for $13M to support infrastructure development within the Sxʷtpqéyn Area, on the lands immediately east of Grant Creek below Broadway (Missoula County BUILD Grant, 2019). Missoula County estimates as many as 6,000 dwelling units and 18-20,000 people will be added to the area in the coming years. Unfortunately, the BUILD Grant funds were inadequate for fully funding the restoration of Grant Creek in the area and a second attempt to secure funding was unsuccessful. As a result, the Master Plan's vision of a restored and protected Grant Creek is mostly aspirational at this point. It will take sustained community engagement to make it a reality.

Fortunately, the Master Plan and BUILD grant have increased community awareness of the potential for a restored Grant Creek and generated considerable momentum for pursuing it further:

- Missoula County's current leadership has a strong commitment to conservation and supports restoration of Grant Creek, and City leaders support it as well.
- Local stakeholder groups and residents of the Grant Creek valley, including the watershed group Friends of Grant Creek (FOGC), have begun coalescing around protecting the creek. These active and knowledgeable stewards are key allies to assist with the kind of outreach and advocacy that will be essential to this campaign.
- Numerous conservation partners share the goal of a holistic plan to restore Grant Creek, including the Montana Fish, Wildlife & Parks, Friends of Grant Creek, National Wildlife Federation (which manages a wildlife reserve in the Grant Creek drainage), Rocky Mountain Elk Foundation (whose headquarters is located on Grant Creek), Trout Unlimited, and the Confederated Salish and Kootenai Tribes, who have a deep and ancient connection to the creek.
- After years of work, a *Central Clark Fork Watershed Restoration Plan*, which includes the Grant Creek drainage, is nearing completion. Once completed and approved by the state, this plan will allow watershed stakeholders (including the Clark Fork Coalition) to apply to state and federal funding programs to improve water quality, aquatic habitat, and watershed function in creeks covered by the plan. This is a critically important source of funding that can make on-the-ground restoration projects possible.

As Missoula continues its rapid growth, Grant Creek presents an excellent opportunity to demonstrate community-driven and ecologically-informed development that provides needed housing and neighborhoods, while preserving and restoring vital natural values. A restored Grant Creek – especially in its hard-hit lower reaches – would create a healthy physical environment that is resilient to change and rich in the natural capital that underpin livable communities. Such a restoration, gusseted by a strong civic commitment to a healthy future for the creek, could provide a template for growth that is grounded in balancing community and ecological needs, and that incorporates safeguarding and reviving natural resources as a core tenet. But we must act soon. For as Missoula's explosive growth continues, the pressure will increase to encroach upon, or even build over the floodplain of this small Clark Fork tributary. And once additional buildings, roads, and sidewalks go in, there will be no going back to re-naturalize lower Grant Creek. It will likely be written off for good.

Complex riparian vegetation in Grant Creek's upper reaches

3.0 Clark Fork Coalition Assessment

Although previous studies of Grant Creek provided ample evidence that Grant Creek has serious issues with flooding, water quality and stream function, no top-to-bottom continuous survey of the current status of the channel conditions, aquatic habitat or riparian resources in the Grant Creek corridor was available. The assessment presented here was intended to begin to close that gap and provide a starting point for prioritizing restoration opportunities in the watershed.

3.1 Methods

Field technician assessing indicators of stream health, such as hydrology, water temperature, riparian conditions, and fish habitat

During the summer of 2021, The Clark Fork Coalition conducted an assessment of hydrology, water temperature, riparian condition, and fish habitat in Grant Creek from the crossing of Snowbowl Road to the creek's confluence with the Clark Fork River. The bulk of the effort was dedicated to riparian assessment, with the assessment team walking along 10 miles of stream from Snowbowl Road to the confluence with the Clark Fork. The team's primary assessment tool was the US Department of Agriculture's Natural Resource Conservation Service riparian assessment protocol, particularly the version developed in Montana (NRCS, 2004).

For the purposes of field riparian assessment, Grant Creek was divided into 4 major segments based on predominant land use, channel type, degree of alteration, and major road crossings. These segments include:

Segment 1: Snowbowl Road to Interstate 90;
Segment 2: Interstate 90 to Broadway;
Segment 3: Broadway to Mullan Road; and
Segment 4: Mullan Road to Confluence (Confluence with the Clark Fork)

The area above Snowbowl Road was not assessed because of its relatively high-quality riparian and aquatic habitat, and the fact that the creek flows through mostly US Forest Service land and federally designated wilderness. Each of these major segments was further divided into smaller sub-reaches based on changes in ownership and land use, channel conditions, and stream type. A total of 38 sub-reaches were identified and the assessment was conducted at the sub-reach scale.

The assessment also included continuous flow measurements during summer and early fall at two sites, and water temperature measurements at four sites in the lower watershed.

The assessment results include the following seven components:

- USDA Natural Resources Conservation Service (NRCS) Riparian Assessments with supplemental attributes for fish habitat at 38 sub-reaches
- Photo Documentation of each sub-reach
- Continuous Flow and Stream Temperature data
- Qualitative Sub-Reach Narratives
- Remote Sensing interpretations of several stream sub-reaches which were not walked
- Restoration Opportunity Assessment
- Supplemental Data – Stream Type and Dominant Plant Community Type; irrigation diversion inventory and notation of crossing structures (bridges, culverts).

Healthy, complex riparian zone – a "sustainable" health rating

3.2 NRCS Riparian Assessments Fish Habitat Scores

The USDA Natural Resources Conservation Service (NRCS) Riparian Assessment Method (NRCS 2004) was the assessment's primary tool for evaluating the health of the creek. The NRCS Riparian Assessment is a relatively rapid method for assessing the sustainability and function of the riparian corridor and aquatic habitat. Resulting assessment scores and sustainability ratings

help identify issues limiting riparian function and aquatic habitat that can be used to develop restoration priorities.

Scores from these assessments are totaled to develop an overall NRCS Assessment score and rating, along with a total fish habitat score, for each assessment sub-reach. The NRCS Assessment produces a score that is calculated as a percent of the maximum score and tied to one of 3 stream health rating categories: Sustainable (80 to 100 percent), At Risk (50 to 80 percent), or Not Sustainable (less than 50 percent). NRCS defines its ratings as follows:

- **Sustainable** describes a stream that "can access its flood plain, transport its sediment load, build banks, store water, and dissipate flood energy in conjunction with a health riparian zone" (NRCS 2004).
- **Not Sustainable** applies when the "stream and riparian area are clearly lacking adequate vegetation and/or functional characteristics and will not be able to dissipate energy, trap sediment, build banks or any of the other processes that are expected for a given potential" (NRCS 2004).
- **At Risk** fits between the two categories above, and it applies "if *most* of the attributes and processes are in place and working. What is lacking, however, is critical to the stability and function of the area" (NRCS 2004).

Widened channel, eroded banks in a highly grazed pasture – an "at risk" rating

Fish habitat was evaluated by using NRCS Supplemental Questions. Like the riparian assessment, the fish habitat questions provide a score based on percent of maximum that is translated into habitat rating: Good (80 to 100 percent), Fair (50 to 80 percent), or Poor (less than 50 percent). A copy of the NRCS riparian assessment worksheet that was used for the assessment in included in **Appendix A**.

3.3 Photographic Documentation

Digital photographs were taken at the upstream and downstream ends of each assessment sub-reach. Additional photographs were taken throughout the assessment sub-reaches to document conditions at key locations such as irrigation diversion structures, fence lines, erosion, and encroachment from agriculture and commercial activity.

3.4 Flow and Water Temperature Measurements

The Clark Fork Coalition installed two HOBO® barometric continuous flow recording devices and four HOBO® continuous water temperature recording devices in the lower half of Grant Creek watershed in early summer 2021. The sites selected for flow measurement were intended to bracket the most important irrigated areas in Grant Creek, to determine the relative impact of agricultural irrigation withdrawals on late summer stream flow.

Monitoring streamflows and water temperatures

Flow and water temperature measurement were calibrated by periodic field measurements, and additional flow measurements were taken to better understand the impact of one key irrigation diversion. All instantaneous flow measurements were made in the field according to the US Geological Survey's techniques, using Hach FH950 digital velocity meters. The water temperature installations were coordinated with Montana FWP fish biologists, who deployed additional water temperature recorders further upstream. Water temperature is a critical habitat quality factor for native cold-water fish, such as cutthroat trout and bull trout, which are both native to the upper Grant Creek watershed.

3.5 Sub-Reach Narrative

Data from riparian assessment, fish habitat assessments, and photographic documentation were used to complete a sub-reach narrative for each assessment sub-reach. Narratives were

drafted in the field by the assessment team. These narratives describe the overall assessment results, existing conditions, key impairments, possible causes of impairment, and potential restoration options associated with each assessment sub-reach.

3.6 Remote Sensing

Existing spatial data sets were used to complete remote assessments of sub-reaches that were inaccessible due to lack of landowner permission. Assessment forms were completed for the remotely assessed sub-reaches.

Remote assessments used the following available spatial data:

- High resolution (0.15 meter) aerial imagery for 2019 from Google Earth DigitalGlobe
- Assessment data from adjacent or similar sub-reaches within the same watershed completed for this report.

Some questions from the NRCS Assessment and fish habitat attributes could not be evaluated using available spatial data, and were noted as "N/A" on assessment forms including: Question 6 (noxious weeds), Question 7 (undesirable weeds), Question 9 (browse utilization), Supplemental Attribute 1 (Substrate habitats), 4 (Flow), and 5 (Nutrients) could not be assessed**.** An overall score was still assigned to each sub-reach, though it excludes the values for the above questions. A full description of the adaptation of the NRCS Riparian Assessment Questions to Remote Sensing is provided in **Appendix B.**

3.7 Restoration Opportunities

For each assessment sub-reach, restoration opportunities were identified based on limiting factors and restoration priorities, as judged by the survey team in the field, and checked by the Restoration Director.

3.8 Supplemental Data

Within each stream reach, field crews measured width to depth ratios and identified Rosgen Stream Type (Rosgen and Silvey 1996). They also characterized the dominant plant community types based on based on the Nez Perce Riparian Community Type Codes (Overton et al. 1997) and noted the locations of irrigation withdrawals and other near/in-stream infrastructure.

The assessment was intended to evaluate current site conditions and identify problems to facilitate prioritization of restoration opportunities for the assessment sub-reaches. Land access was coordinated through individual contacts with landowners owning land adjacent to the creek.

Will McDowell, Clark Fork Coalition Stream Restoration Director, led the field assessment trainings. Seamus Land, University of Montana Environmental Studies Masters student coordinated volunteers and led the field survey team. Field work was completed from late-June to early-August 2021. Volunteers included Bela Garcia-Arce, Robin Chernoff, Sam Olsen, Will Fesperman, Riley Butler, Luke Knaggs, Laura Gonzalez-Mantecón, Max Hanson, Elissa Chott, Dan Spencer, Susan Tietelman, Vicki Watson, Geof Land, Nancy Rucci, and Maya Land. The Clark Fork Coalition would like to express its gratitude to all of the volunteers who assisted with the assessment and to the landowners who granted access to the stream. Their help was indispensable to the success of the project.

4.0 RESULTS

Late fall CFC 2021 tour of Grant Creek – a dewatered reach near the airport

This section summarizes riparian assessment results by major stream segment, with each segment containing from five to twelve distinct but contiguous stream sub-reaches. As described above, these stream segments had generally similar land use and riparian conditions, allowing a single summary of riparian conditions and fish habitat ratings for that segment. The segments are:

Segment 1: Snowbowl Road to Interstate 90;
Segment 2: Interstate 90 to Broadway;
Segment 3: Broadway to Mullan Road; and
Segment 4: Mullan Road to Confluence (Confluence with the Clark Fork)

The results that follow are a summary of conditions for each of the sub-reaches based primarily on the NRCS ratings and a narrative assessment of conditions. Additional information from the assessment is included in the following appendices:

Appendix A: NRCS Riparian Assessment Worksheet
Appendix B: Photos by Reach
Appendix C: Adaptation of NRCS Riparian Assessment Questions to Remote Sensing
Appendix D: Assessment Scores and Narrative by Reach
Appendix E: Grant Creek Irrigation Diversions
Appendix I: Restoration Priorities by Reach (DRAFT)

In general, the assessment indicated that Grant Creek was in good health in the uppermost reach of the between Snowbowl Road and Interstate 90, where land uses are primarily agricultural and low density residential. Between I-90 and Broadway, impacts were more pronounced, and NRCS scores were typically in the "at risk" category. In the two downstream segments, Broadway to Mullan and Mullan to the Mouth, Grant Creek is heavily impacted by development, channel alterations, and agriculture, and most sub-reaches were in the "not sustainable" category of the NRCS rating system.

Figure 4.1 presents the locations of the assessment reaches and color coded results of the NRCS ratings by sub-reach, **Table 4-2** provides location information for by major segment and sub-reach, and **Table 4-2** summarizes results of the assessment by major segment and sub-reach.

Sections 4.1 through **4.4**, below, provide additional details about each of the major stream segments.

Figure 4.1 NRCS riparian assessment sustainability ratings results for Grant Creek

Table 4-1. Summary of assessment sub-reach lengths and locations (note the number in the Sub-reach ID indicates miles above mouth)

Assessment Area	Sub-reach ID	Sub-reach Length (ft)	Sub-reach Length (mi)	Upstream Latitude / Longitude		Downstream Latitude / Longitude	
Snowbowl Road							
Grant Creek	10A	1200	0.23	46.9635	-114.0085	46.9598	-114.0116
Grant Creek	10B	1000	0.19	46.9597	-114.0116	46.9554	-114.0129
Grant Creek	10C	900	0.17	46.9553	-114.0127	46.9537	-114.0137
Grant Creek	9A	1800	0.34	46.9535	-114.0136	46.9477	-114.0145
Grant Creek	9B	1200	0.23	46.9476	-114.0150	46.9423	-114.0188
Grant Creek	8A	1000	0.19	46.9420	-114.0192	46.9369	-114.0224
Grant Creek	8B	2640	0.50	46.9367	-114.0226	46.9367	-114.0285
Grant Creek	7A	2112	0.40	46.9303	-114.0285	46.9239	-114.0300
Grant Creek	7B	1200	0.23	46.9238	-114.0300	46.9218	-114.0309
Grant Creek	7C	1200	0.23	46.9217	-114.0311	46.9217	-114.0311
Grant Creek	7D	800	0.15	46.8662	-113.9984	46.9162	-114.0330
Grant Creek	6A	600	0.11	46.9160	-114.0331	46.9146	-114.0337
Interstate 90							
Grant Creek	6B	500	0.09	46.9126	-114.0353	46.9122	-114.0377
Grant Creek	6C	1200	0.23	46.9120	-114.0375	46.9119	-114.0375
Grant Creek	6D	1000	0.19	46.9077	-114.0402	46.9062	-114.0416
Grant Creek	5A	800	0.15	46.9060	-114.0419	46.9045	-114.0520
Grant Creek	5B	600	0.11	46.9044	-114.0455	46.9054	-114.0494
Grant Creek	5C	2700	0.51	46.9054	-114.0498	46.9091	-114.0585
Broadway							
Grant Creek	4A	4000	0.76	46.9089	-114.0592	46.9069	-114.0693
Grant Creek	3A	1000	0.19	46.9069	-114.0693	46.9052	-114.0712
Grant Creek	3B	1400	0.27	46.9652	-114.0711	46.9033	-114.0763
Grant Creek	3C	3500	0.66	46.9033	-114.0763	46.8966	-114.0868
Grant Creek	2A	1400	0.27	46.8961	-114.0876	46.8929	-114.0896
Grant Creek	2B	400	0.11	46.8929	-114.0896	46.8921	-114.0909
Grant Creek	2C	600	0.11	46.8921	-114.0909	46.8893	-114.0936
Grant Creek	2D	600	0.11	46.8893	-114.0936	46.8840	-114.0892
Grant Creek	2E	600	0.11	46.8883	-114.0891	46.8883	-114.0891
Mullan Rd							
Grant Creek	1A	1000	0.19	46.8854	-114.0851	46.8842	-114.0867
Grant Creek	1B	750	0.14	46.8840	-114.0870	46.8840	-114.0894
Grant Creek	1C	750	0.14	46.8836	-114.0893	46.8824	-114.0920
Grant Creek	1D	750	0.14	46.8824	-114.0920	46.8818	-114.0920
Grant Creek	1E	500	0.09	46.8818	-114.0920	46.8808	-114.0920
Grant Creek	0A	1000	0.19	46.8808	-114.0921	46.8802	-114.0946
Grant Creek	0B	500	0.09	46.8802	-114.0946	46.8797	-114.0965
Grant Creek	0C	2200	0.42	46.8797	-114.0964	46.8797	-114.0964
Grant Creek	0D	1000	0.19	46.8757	-114.0975	46.8750	-114.0989
Grant Creek	0E	500	0.09	46.8749	-114.0992	46.8739	-114.1009
Grant Creek	0F	600	0.11	46.8740	-114.1010	46.8729	-114.1005
Confluence with Clark Fork River							

Table 4-2 Summary of the Grant Creek Riparian Assessment sub-reach scores and ratings

Sub-Sub-reach Code	Approx. Length of Sub-reach (ft.):	Channel Type	Land Use	Riparian Score	Riparian Rating	Fish Habitat Score	Fisheries Rating
Snowbowl Road							
10A	1200	B	Agriculture/Residential	97%	Sustainable	100%	Good
10B	1000	B	Agriculture	95%	Sustainable	94%	Good
10C	900	B	Agriculture	97%	Sustainable	94%	Good
9A	1800	B and D	Agriculture	88%	Sustainable	94%	Good
9B	1200	B	Agriculture	95%	Sustainable	88%	Good
8A	1000	B	Agriculture/Residential	85%	Sustainable	88%	Good
8B	2640	B	Agriculture	77%	At Risk	88%	Good
7A	2112	B	Conservation	93%	Sustainable	94%	Good
7B	1200	B	Conservation/Residential	93%	Sustainable	88%	Good
7C	1200	B	Conservation	97%	Sustainable	88%	Good
7D	800	B	Agriculture/Residential	93%	Sustainable	88%	Good
6A	600	B	Agriculture/Residential	90%	Sustainable	88%	Good
Interstate 90							
6B	500	B	/Commercial	68%	At Risk	75%	Fair
6C	1200	B	l/Commercial	57%	At Risk	69%	Fair
6D	1000	B	/Commercial	52%	At Risk	63%	Fair
5A	800	D	/Commercial	63%	At Risk	63%	Fair
5B	600	D	Industrial/Commercial	38%	Not Sustainable	38%	Poor
5C	2700	D/G	Industrial/Commercial	59%	Estimated At Risk	38%	Poor
Broadway							
4A	4000	G	Agriculture	21%	Estimated: Not Sustainable	10%	Poor
3A	1000	G	Agriculture	18%	Not Sustainable	6%	Poor
3B	1400	G	Agriculture	25%	Not Sustainable	25%	Poor
3C	3500	G	Agriculture	27%	Not Sustainable	31%	Poor
2A	1400	G	Agriculture	47%	Not Sustainable	50%	Fair
2B	400	G	Agriculture/Residential	30%	Estimated: Not Sustainable	30%	Poor
2C	600	G	Suburban/Residential	37%	Not Sustainable	25%	Poor
2D	600	G	Suburban/Residential	45%	Not Sustainable	31%	Poor
2E	600	G	Suburban/Residential	52%	At Risk	38%	Poor
Mullan Rd							
1A	1000	G	Residential/Agriculture	70%	Estimated: At Risk	30%	Poor
1B	750	G	Agriculture/Residential	43%	Not Sustainable	31%	Poor
1C	750	G	Agriculture/Residential	28%	Not Sustainable	25%	Poor
1D	750	D	Agriculture	58%	At Risk	44%	Poor
1E	500	C/G	Agriculture	27%	Not Sustainable	56%	Fair
0A	1000	G	Agriculture	30%	Not Sustainable	38%	Poor
0B	500	G	Agriculture	33%	Not Sustainable	44%	Poor
0C	2200	G	Agriculture	35%	Not Sustainable	63%	Fair
0D	1000	F	Agriculture	28%	Not Sustainable	44%	Poor
0E	500	F	Agriculture	62%	Estimated: At Risk	78%	Fair
0F	600	F	Conservation	73%	At Risk	88%	Good
Confluence with Clark Fork River							

4.1 Segment 1: Snowbowl Road to Interstate 90 (Reaches 10B to 6A)

The 3.7 mile-long segment from Snowbowl Road to Interstate 90 represents the land use transition area from the Lolo National Forest in the headwaters to the subdivided residential and commercial land use north of Interstate 90. The twelve sub-reaches surveyed in this segment of the stream had many common characteristics: a) mostly natural Rosgen-type B3 channel forms with cobble substrates, some large woody debris, and connection to forested floodplains; b) healthy cottonwood riparian forest with shrub understory along the stream corridor; and c) agricultural land use and some rural residential developments in or near the riparian corridor.

The low-density suburban land use, where it exists right along the stream, was not causing enough impact to significantly lower the riparian health scores. One sub-reach (8B) within a large ranch showed some "at risk" characteristics; in particular, the riparian forest component was reduced, noxious weeds and invasive grasses formed a significant part of the bank vegetation, and stream banks were not stable.

Nearer to the culvert at Interstate 90, Grant Creek Road and an Army Corps of Engineers levee on the west bank (built to protect bridges and structures from flooding) encroach upon the stream and limit floodplain access. The channel in the lowest sub-reaches of this segment was somewhat entrenched with reduced floodplain access. Nonetheless, riparian assessments scores were generally quite high above I-90, with 10 sub-reaches scoring 90 percent or greater riparian scores, and fish habitat scores varying from 88 percent to 100 percent. Aquatic habitat complexity varied from good to fair, and floodplain noxious weeds were serious in some sub-reaches (**Figure 4.2, Table 4-2**). Ten active irrigation withdrawals exist, and dewatering began to affect the stream in the lower part of this segment later in the summer.

Natural, stable, resilient channel in cottonwood stand below Snowbowl Road

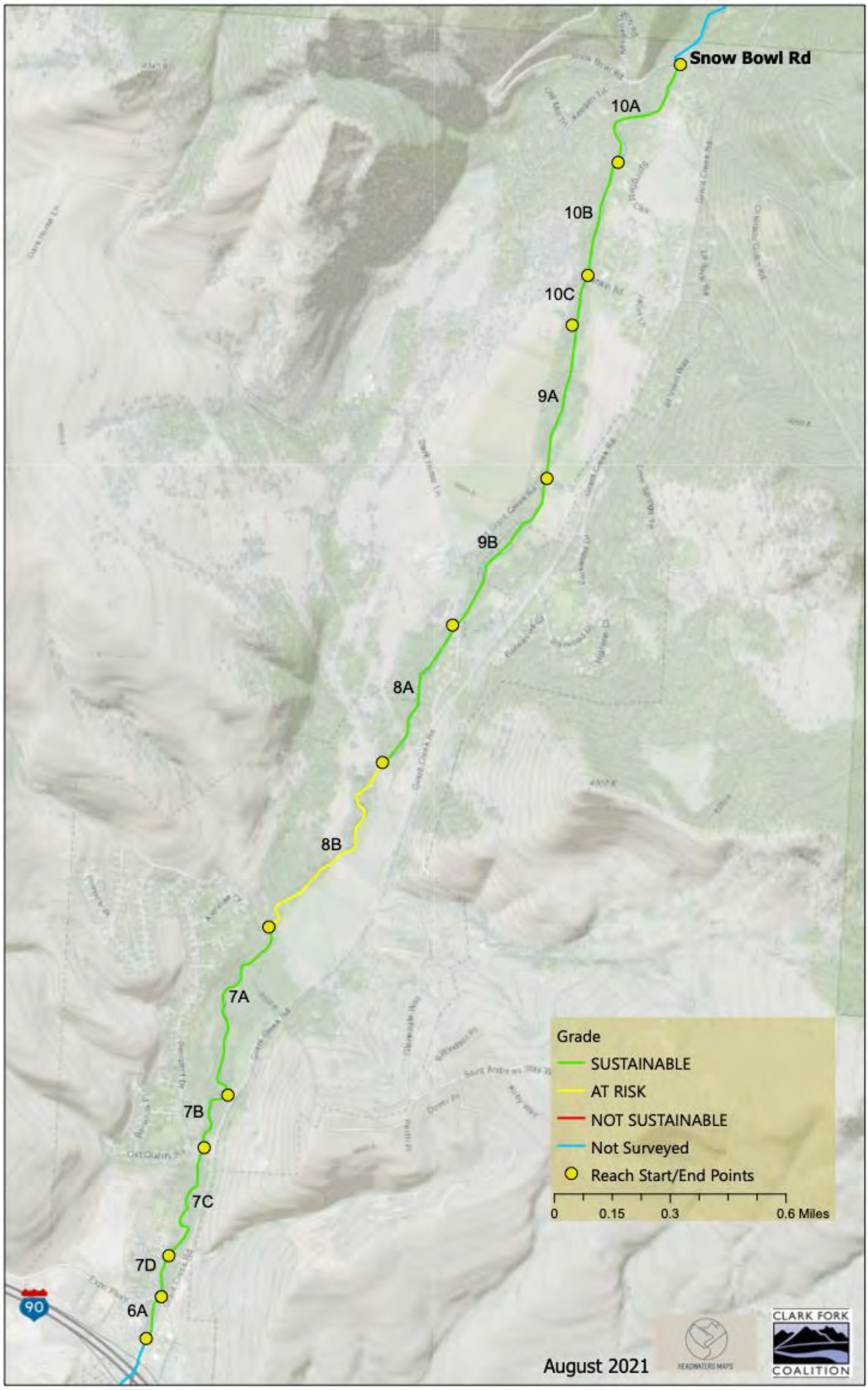


Figure 4.2 NRCS riparian assessment sustainability ratings results for Segment 1: Snowbowl Road to Interstate 90

4.2 Segment 2: Interstate 90 to Broadway (Reaches 6B to 5C)

The 1.5-mile segment from Interstate 90 to Broadway begins by flowing out from under Interstate 90 in an 800 foot-long 12’ wide by 7’ tall concrete box culvert. Our team walked through the culvert, which had some natural channel substrates and “resting” rocks placed to aid fish migration. However, the I-90 culvert was not included as a separate sub-reach in the assessment. The dominant land use in this segment is Industrial/Commercial, and several hotel parking lots or construction sites encroach significantly on the floodplain area. The riparian corridor was very narrow as a result.

Grant Creek flowing through an under-sized culvert

The native trees were primarily cottonwoods and a few ponderosa pine and willows, while invasive forbs or noxious weeds were locally extensive and some landscape plantings encroached on the banks or floodplain. There was land clearing for a mini-storage development occurring to the west of the channel near the upstream end (sub-reaches 6B, 6C, 6D), and other active development. It was unclear whether the developments will maintain a riparian buffer, since the building lots are often completely bare. The sub-reaches were largely artificially constructed B3 channels, although towards the lower sub-reaches the creek’s energy and sediment load evidently exceeded the capacity of the built channel, and has eroded laterally to form a wider Rosgen-type D channel, which is aggrading under the International Drive bridge. Fish habitat was limited by the lack of both pools and large woody debris. The channel was flowing under four public road bridges and one railroad bridge in this segment.

The 6 sub-reaches surveyed in this segment had many common characteristics. Throughout much of the segment there is very little available floodplain to dissipate energy. The channel is constricted by terraces made of gravel fill and sometimes topped with pavement. The lowest riparian score was 38%, or Not Sustainable (5B), while the rest of the sub-reaches were classified as At Risk, with a high score of 68% (**Figure 4.3, Table 4-2**).

When it was surveyed in late July of 2021, Grant Creek went dry just below a large irrigation diversion (Grant Creek Ditch) about 130 feet below International Drive. This diversion uses a 36-inch diameter concrete culvert, and at lower flows (below 5 CFS) takes nearly all the remaining water in the creek. Below this point the fish habitat scores dropped to Poor, due to dewatering. The constructed, entrenched channel flows west/northwest (5B,5C) along the railroad tracks for nearly three-quarters of a mile before passing under a railroad trestle, and then under Broadway in a triple barrel CMP culvert. Historically, the channel of Grant Creek apparently flowed southwest directly across the Broadway alignment near upper end of sub-reach 5B, closer to where the Grant Creek Ditch flows today. The constructed channel along the railroad posed risks to the banks and some infrastructure, and created significant lateral erosion.

Figure 4.3 NRCS riparian assessment sustainability ratings results for Segment 2: Interstate 90 to Broadway

4.3 Segment 3: Broadway to Mullan Road (Reaches 4A to 2E)

The 3.2 miles of Grant Creek downstream of Broadway to Mullan Road begin at a large structural arch pipethat passes under Broadway. The 9 sub-reaches surveyed in this segment can be described in two primary land use categories, Agricultural and Suburban/Residential. It is clear that the channel has been historically ditched and relocated around agricultural fields for this entire segment. As a result, the stream is classified as a Rosgen-type G channel (gully-like) throughout the segment. Its form is highly entrenched, with poor bank stability, lack of floodplain access, and intermittent flow. The substrate is silt, clay and sand, with some patches of cobble present. Historically, the current agricultural land was a large, flat floodplain of lakebed sediments and the natural Grant Creek channel passed through the middle of the current agricultural fields, possibly in a broad, multi-thread form, south-southwesterly towards the Clark Fork River, before the channel was relocated to the western perimeter of the agricultural lands where it is today.

Impacts from livestock grazing

All of these sub-reaches were significantly degraded, with 8 sub-reaches scoring as Not Sustainable, and one sub-reach scoring as low as 18%. Only one (1) sub-reach scored as At Risk, with a fairly low score of 52%, and none of the sub-reaches scored as "Sustainable" (**Figure 4.4, Table 4-2**) Fish habitat was predominantly Poor throughout the segment, in part because this segment was dry, and substrates were silty or clay when surveyed in July, 2021. However, at the top of sub-reach 3B, a large inflow from the Flynn-Lowney Ditch poured water from the Clark Fork into the dry Grant Creek channel. Two laterals of this irrigation ditch entered Grant Creek in two other places, creating unique conditions in and outside of the main channel.

This segment also contained the most significant fish passage barrier in the whole survey: a dam created from pre-cast concrete blocks just below the south end of airport property (upper

Reach 2A), recently built to replace an older check dam, where a water was being backwatered up to a series of pump houses. These pumps provided water to the adjacent hay fields with pivot sprinklers or wheel lines, particularly the fields to the west of Grant Creek. It was not clear whether this dam is permanent or removed seasonally. There was a large constructed wetland to the east of the channel (Reach 2A), just above Hiawatha Road, which may play a role in flood detention.

Further downstream of the primarily agricultural land, below Hiawatha, this segment passes through low- and medium-density residential subdivisions in a deep entrenched ditch. This ditch, which was dry in late summer, provided almost no aquatic habitat value, has no floodplain connection, and posed a significant safety hazard due to its deep form, steep banks, and location in residential back yards.

These sub-reaches downstream of Hiawatha included sites on which significant channel reconstruction has been conducted in the last 20 years in order to mitigate flooding in the Mullan Trail Subdivision. A large detention pond just east of the channel (Reach 2C) is property of the Mullan Trail Subdivision homeowner's association. This detention pond adjacent to the current main channel is serving as overflow relief for floods in the Grant Creek "channel." This off-channel detention pond was not surveyed; rather the assessment focused on the main channel. Current beaver activity was noted in the lower end of this segment (2A to 2C), and may be affecting channel form and local flooding. The segment ends at Mullan Rd, at which point Grant Creek flows into a corrugated metal culvert that passes under the road, and this may act as a partial fish passage barrier.

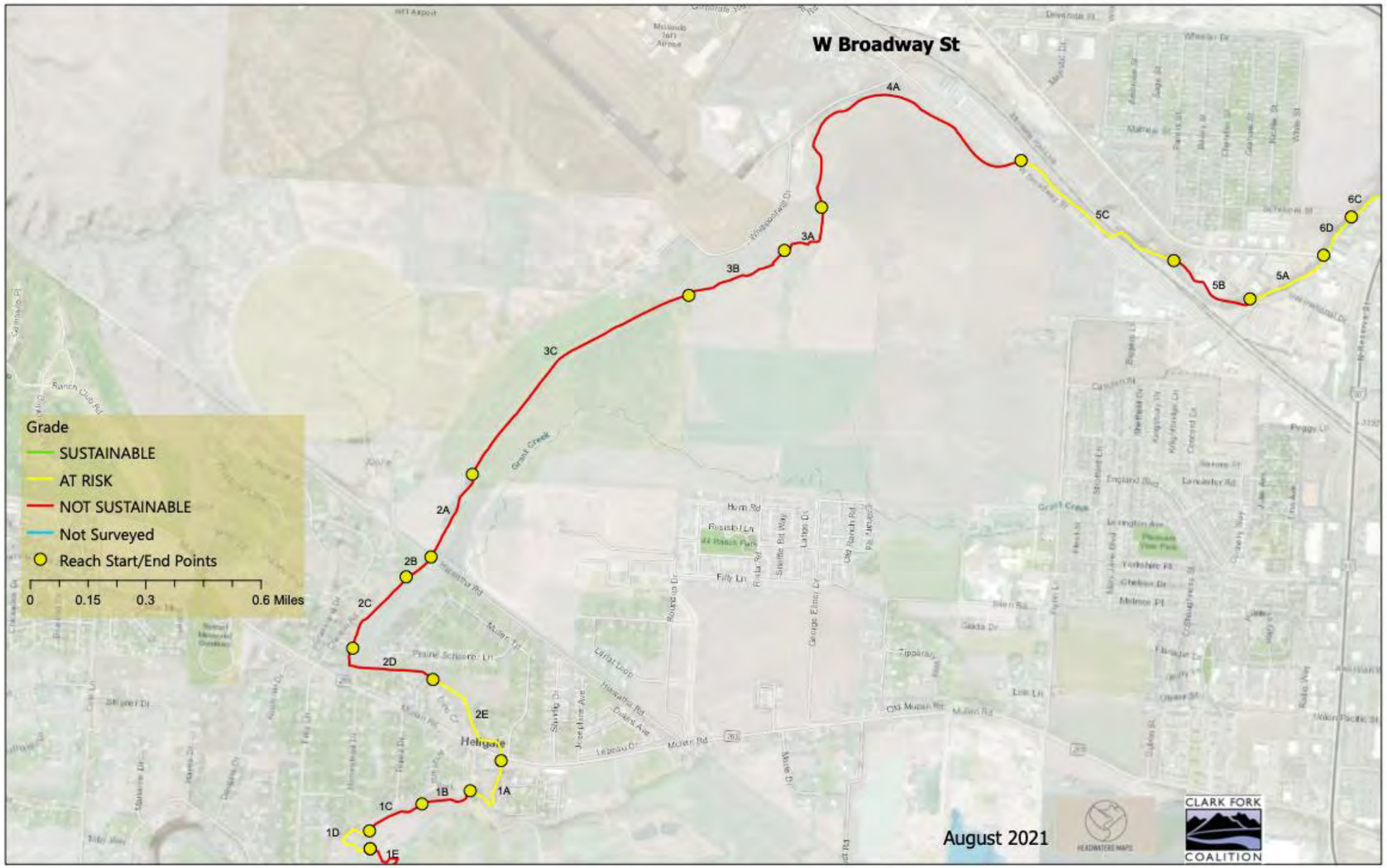


Figure 4.4 NRCS riparian assessment sustainability ratings results for Segment 3: Broadway to Mullan Road

4.4 Segment 4: Mullan Road to Confluence with Clark Fork (Reaches 1A to 0F)

Below Mullan Rd, Grant Creek flows for 1.9 miles through agricultural and recently developed subdivision lands before emptying into the Clark Fork River at Kelly Island Fishing Access Site managed by FWP. The 11 sub-reaches surveyed in this segment varied in their Rosgen channel types between E, G, D, and F, with many sub-reaches having been channelized, and other sub-reaches still approximating a natural channel form. The dominant historical and current land use of this segment is agriculture, although just below Mullan Road there is a trailer park and a new residential subdivision.

Typical conditions of the perennial reach downstream of Mullan Road

Vegetation along the channel included a variety of woody riparian plants, including native and introduced willows, hawthorn, and some cottonwood, especially in the upper sub-reaches. Further downstream, the riparian vegetation was more and more dominated by pasture grasses, with very few woody plants. Over-widening of the channel and ongoing hoof shear and bank erosion was common in some of these pasture-dominated sub-reaches at the lower end of this segment (Reaches 0B to 0D).

When surveyed in July 2021, the upper reaches of this segment were dry, while the lower sub-reaches are fed by a series of springs (especially in Reach 0C), and appeared to flow perennially to the Clark Fork. Riparian assessment scores were generally low, with seven (7) sub-reaches scoring below 50% --Not Sustainable. One reach scored as low as 27% (1E), and it was clear that the decades of historic and current cattle grazing on these sub-reaches of the creek continued to contribute to a declining trend in riparian health (**Figure 4.5, Table 4-2**).

The aquatic habitat varied from Poor in the dry and ditched sub-reaches to Fair where there was perennial water and the presence of some pools. Some of the slow moving spring-fed sub-reaches in the last mile (1E to 0F) appeared to host good fish rearing habitat, with many schools of small fish seen in late summer. One landowner claimed that at least one large bull trout had entered the creek in the recent past. However, the lack of overhead cover and the presence of

abundant eroding banks, over-widened channel, and suspended sediment created detrimental conditions for fish habitat. Beaver in the lower sub-reaches (0D to 0F) have made significant impacts to the floodplain, but have been managed by landowners in recent years.

Figure 4.5 NRCS riparian assessment sustainability ratings results for Segment 4: Mullan Road to Confluence

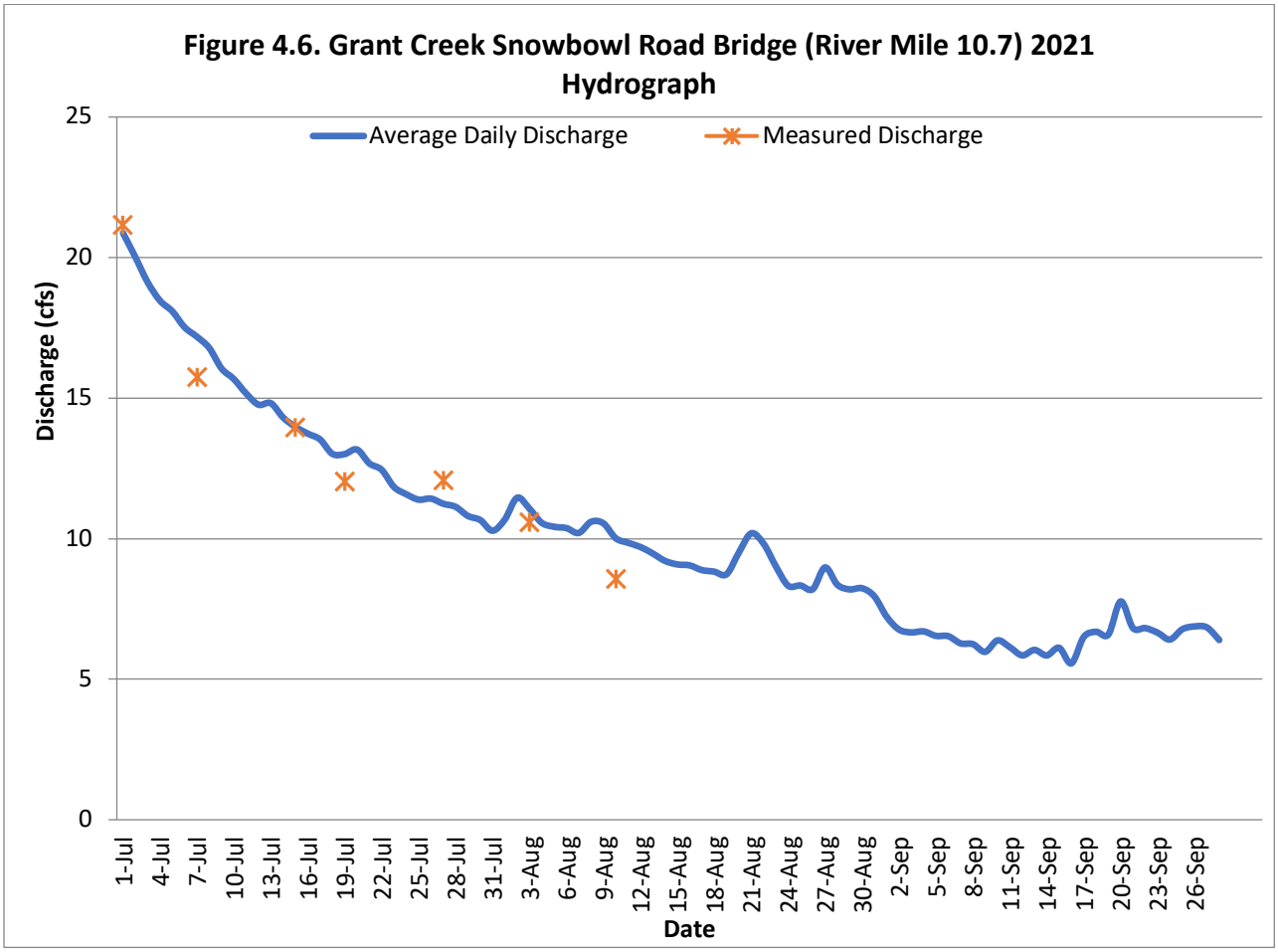
4.5 Stream Flow and Water Temperature Results

As was described in more detail in Section 3.3, CFC deployed continuously recording stream flow devices at 2 locations in Grant Creek and continuously recording stream temperature recorders at 4 locations.

4.5.1 Stream Flow at Snowbowl Road Bridge

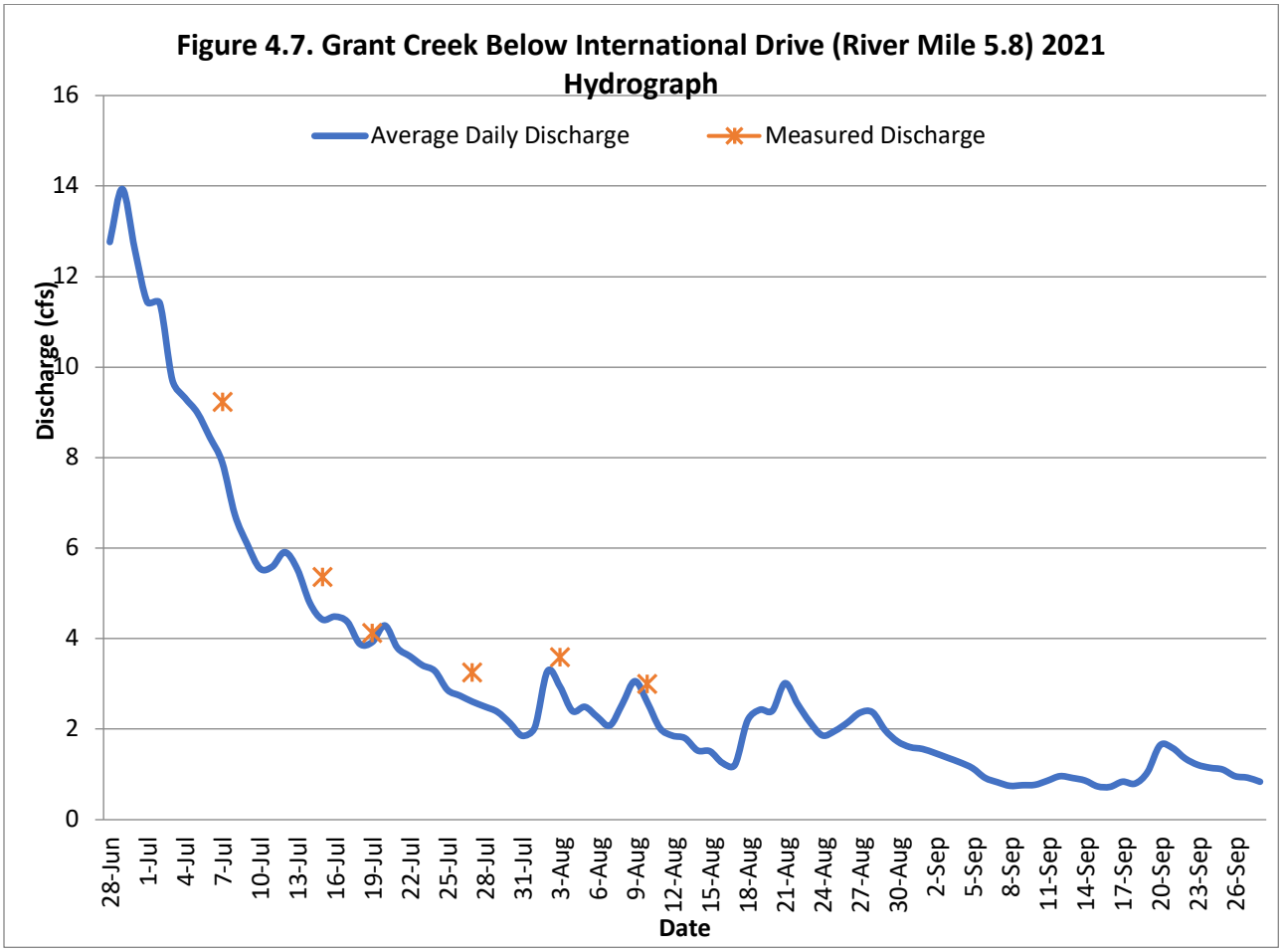
Stream flows at Snowbowl Road Bridge represent conditions during summer 2021 upstream of any irrigation withdrawals (**Figure 4.5**). Across the July 1 to late September period of record, the site saw a recession of flow rate from 21 CFS to 6 CFS, typical of the general pattern expected in a snowmelt-driven western Montana stream. Flows in June were much higher, but could not be easily measured with the available equipment and wading rod technique. A number of surface water diversions and some small pumps were found in the stream between Snowbowl Road and Old Grant Creek Road—these reflect the large number of valid irrigation water rights, although water rights were not verified.

Figure 4.6. Grant Creek Snowbowl Road Bridge (River Mile 10.7) 2021 Hydrograph



4.5.2 Stream Flow near International Drive

The hydrograph for the site "below International Drive" reflects three important factors: first, the flow is diminished from upstream by irrigation withdrawals and by natural infiltration of streamflow into the groundwater; second, the flows at International Drive become very low in late July, and almost disappear by late August; third, just 50 yds. downstream of the measurement point at "below International Drive" there is an active irrigation diversion (rustic rock weir with 36" concrete pipe headgate), which in late July and August was diverting all or nearly all the streamflow, leaving the channel completely dry from that point downstream. Streamflow at this location ranged from approximately 14 CFS in early July to approximately 1 CFS in late September (**Figure 4.6**).



4.5.3 Stream Temperature

Water temperature data were collected continuously at five (5) sites in a partnership between CFC and FWP. From upstream to downstream, these sites were located in the East Fork of Grant

Creek, at Bench Road, and at Snowbowl Road, all of which are upstream of most of the significant impacts to the creek's riparian corridor. Downstream from Snowbowl Road, the next site was located at Prospect Drive, at the lower end of a reach of agricultural and low density residential development. The furthest downstream site was at International Drive in the heart of Grant Creek's most developed reaches. In general, 4 of the sites exhibited stream temperatures that were conducive to the support of cold water native fish. Maximum daily summer water temperatures in the uppermost segments (East Fork Grant Creek, Bench Road, Snowbowl Road) maintained at 16 degrees C. or less throughout the summer, and the Prospect Road gage downstream registered maximum daily summer temperatures between 15 and 18 degrees C. The gage downstream of I-90 at International Drive was significantly warmer, with maximum daily water temperatures between 20 and 22 degrees C. for about two weeks in late July and early August.

5.0 Potential Restoration Actions

This section summarizes potential restoration actions identified for Grant Creek. The desired future condition for the Grant Creek corridor includes a landscape that maximizes ecological site potential by supporting native riparian plant communities; providing preferred habitat for native aquatic and terrestrial species; establishing naturally sustainable river and floodplain morphology in the context of existing constraints; and increasing the connectivity of both aquatic and riparian habitats from the National Forest to the Clark Fork and its protected floodplain at Kelly Island FAS, as a corridor for movement and migration by fish and wildlife from "ridge to river."

Desired future conditions: cold, clean, complex, connected

These desired future conditions are compatible with appropriate floodplain management, flood control, and stormwater management in undeveloped areas of lower Grant Creek, activities being considered in the Sxʷtpqéyn Area Master Plan ("Su-tup-kane," formerly Mullan Area) for roads and utilities between Mullan and Broadway. The establishment of appropriate buffers between the stream and existing and future commercial developments, residential

subdivisions, and other developments is highly desirable as a part of achieving these goals. Appropriate riparian buffer areas can filter sediment and contaminants and support good water quality, while providing fish and wildlife habitat. Riparian buffers are also compatible, in many cases, with a degree of public access through walking trails.

This section describes the potential condition for each segment, the constraints to achieving that condition, and the restoration opportunities identified for achieving the potential conditions.

Sub-reach-specific restoration priority is summarized in **Table 4-4**. Low priority reflects sustainable existing conditions, and high priority reflects unsustainable existing conditions with potential for improvement. Medium priority can reflect unsustainable conditions with perceived severe constraints to any improvement.

Potential conditions, restoration constraints, and restoration actions are described in the following sections by the four riparian segments assessed, from upstream to downstream.

Table 4-3 Restoration Priority Level by Sub-Reach of Grant Creek

Sub-Reach Code	NRCS Score	NRCS Rating	Fish Habitat Score	Fish Habitat Rating	Restoration Priority Level
10A	97%	Sustainable	100%	Good	Low
10B	95%	Sustainable	94%	Good	Low
10C	97%	Sustainable	94%	Good	Low
9A	88%	Sustainable	94%	Good	Low
9B	95%	Sustainable	88%	Good	Low
8A	85%	Sustainable	88%	Good	Low
8B	77%	At Risk	88%	Good	Low to Medium
7A	93%	Sustainable	94%	Good	Low
7B	93%	Sustainable	88%	Good	Low
7C	97%	Sustainable	88%	Good	Low
7D	93%	Sustainable	88%	Good	Low
6A	90%	Sustainable	88%	Good	Low
Interstate 90					
6B	68%	At Risk	75%	Fair	Medium
6C	57%	At Risk	69%	Fair	**High**
6D	52%	At Risk	63%	Fair	Medium
5A	63%	At Risk	63%	Fair	Medium
5B	38%	Not Sustainable	38%	Poor	**High**
5C	55%	Estimated At Risk	38%	Poor	Medium
Broadway					
4A	21%	Estimated: Not Sustainable	10%	Poor	**High**
3A	18%	Not Sustainable	6%	Poor	**High**
3B	25%	Not Sustainable	25%	Poor	**High**
3C	27%	Not Sustainable	31%	Poor	**High**
2A	47%	Not Sustainable	50%	Fair	Medium
2B	26%	Estimated: Not Sustainable	30%	Poor	Medium
2C	37%	Not Sustainable	25%	Poor	Medium
2D	45%	Not Sustainable	31%	Poor	Medium
2E	52%	At Risk	38%	Poor	Medium
Mullan Road					
1A	70%	Estimated: At Risk	30%	Poor	Medium
1B	43%	Not Sustainable	31%	Poor	**High**
1C	28%	Not Sustainable	25%	Poor	**High**
1D	58%	At Risk	44%	Poor	**High**
1E	27%	Not Sustainable	56%	Fair	**High**
0A	30%	Not Sustainable	38%	Poor	**High**
0B	33%	Not Sustainable	44%	Poor	**High**
0C	35%	Not Sustainable	63%	Fair	**High**
0D	28%	Not Sustainable	44%	Poor	**High**
0E	62%	Estimated: At Risk	78%	Fair	Medium
0F	73%	At Risk	88%	Good	Low

5.1 Restoration Potential in Segment 1: Snowbowl Road to Interstate 90

5.1.1 Potential Conditions

This segment begins where Grant Creek emerges from the mountainous US Forest Service land. The potential condition for the 12 sub-reaches surveyed in this segment is primarily a Rosgen-type B channel with cobble substrate, some large woody debris (complexity), good fish habitat, and connection to narrow forested floodplains. However, it is worth noting that as the grade flattens out as it passes from the mountains into the agricultural lands, there is localized potential for a wider, more braided Rosgen-type D channel.

Closer to Interstate 90 where it nears Grant Creek Road, the potential for this segment is likely still a Rosgen-type B stream with cobble substrate, but it possibly approaches a C channel with gravel substrate in some sub-reaches. Riparian potential would include a mix of herbaceous and woody plant communities linked to the elevation from the channel and the soil type. Vegetation communities would include a cottonwood riparian forest with some conifers and a shrub understory along the stream corridor. Potential aquatic habitat would be complex, consisting of diverse hydraulic conditions (depth and velocity), clean substrates for spawning, shady undercut banks, woody debris, frequent pools, and cool water temperatures.

The best representation of this potential condition is Sub-Reach 9A. The creek was allowed a very wide riparian corridor by the land managers, including diverse riparian vegetation, e.g. cottonwood and aspen stands. Large woody debris provided complexity for fish habitat, and assisted in producing some braided overflow channels in the floodplain, as well as pools and undercut banks.

5.1.2 Restoration Constraints

The primary anthropogenic impacts and restoration constraints on the channel are related to land use. They include nearby agriculture (haying and grazing), irrigation withdrawals, encroaching suburban landscaping, noxious weeds, human impacts (trails), and rural residential developments. The haying and grazing have resulted in some banks being denuded of woody riparian species, and in places this has resulted in lateral bank erosion. Some sub-reaches had small recreational access points, and the banks were locally trampled and encroached by noxious weeds. Other relevant constraints include infrastructure, the most significant pieces of which are Grant Creek Road, an Army Corps of Engineers levee, and several bridges. Grant Creek Road pinched and narrowed the creek against the levee, which had been put in place to limit flooding of the developments on the western bank. On the lower reaches near Interstate 90, several

bridges present potential threats of flooding due potential for large woody debris to partially block the flow during flood season.

Despite these features, the trend in nearly all of these sub-reaches was stable or improving with the current management practices, which notably include an emphasis on retaining the natural characteristics of the creek. In summary, the constraints to achieving high quality riparian and stream characteristics are relatively few, given existing land ownership and management.

5.1.3 Restoration Actions to Achieve Potential Condition

Restoration actions in this reach are defined as low priority given that the reach is currently managed with an emphasis on natural characteristics, and because the surrounding suburban infrastructure has adequate buffer distance from the stream in most cases. However, minor opportunities exist to improve fish habitat, channel stabilization, and vegetative communities including: a) options to improve instream flow with irrigation water transactions; b) the regeneration of native plants in residential landscaping along creek; c) management of invasive forbs and grasses, including some noxious weeds; and d) very localized bank stabilization through riprap or plantings. Nearly all of these sub-reaches have land managers that are very involved in maintaining the ecological quality of the creek, and these opportunities should be coordinated with their ongoing efforts.

5.2 Restoration Potential in Segment 2: Interstate 90 to Broadway

5.2.1 Potential Conditions

The potential condition of this the six sub-reaches in this segment is primarily a Rosgen-type B channel with cobble substrate, limited large woody debris, and connection to a very narrow forested floodplain. Developed commercial sites will be built out on the terraces just above the floodplain, on both sides of the creek. Most of this channel has been historically reconstructed to accommodate development, with significant encroachment and narrow floodplains. As the gradient flattens out at the lower end of this segment (5A, 5B, and 5C), there is ongoing aggradation, and potential to form a less stable, more braided Rosgen-type D channel, which may require a wider floodplain and/or a more hardened channel with levees. Riparian habitat potential would include a mix of herbaceous and woody plant communities, including cottonwood riparian forest with some conifers (ponderosa pine or Douglas fir) and a shrub understory along the stream corridor. Potential aquatic habitat would have low to moderate complexity, including some pools, diverse hydraulic conditions (depth and velocity), clean cobbly substrates, shady banks, and cool water temperatures.

5.2.2 Restoration Constraints

The primary restoration constraints for this segment are related to the existing commercial land-use, which values property and infrastructure and has confined the channel to a narrow, fairly straight corridor. The channel appears to have been re-constructed, or at least heavily modified, historically for flood control in much of this reach. Much of this stream segment has been narrowed by fill from development and is lacking a significant floodplain, but is still retaining some natural features, such as native cottonwoods along a narrow strip on each side of the low-flow channel. Attempts to restore or retain some natural channel characteristics have been made in a few spots, including narrowing the channel by adding a bankfull bench with willow and horticultural plantings. The FEMA floodplain mapping for this segment is an important constraint for all development, including stream alterations.

Since historical vegetative clearing for development has occurred, noxious weeds are prevalent in many sub-reaches. This has resulted in localized stream banks and terraces that are denuded of vegetation and which are highly unstable and eroding laterally. Since this segment is directly below the narrow valley above Interstate 90, aggradation and channel widening is occurring naturally, and needs to be accommodated to some degree. This segment contains five (5) bridges of varying design and condition. The International Drive bridge is very low above the stream (partly due to ongoing aggradation of channel) and has historically been blocked by debris, leading to flooding during spring runoff.

5.2.3 Restoration Actions to Achieve Potential Condition

In some cases it may be possible to widen the existing narrow floodplain and construct a broader floodplain at an appropriate elevation on at least one side of the stream during forthcoming the development process. This type of constructed floodplain “buffer” could provide significant advantages to commercial developers and the local governments, by storing floodwater and capturing sediments washed out of upper Grant Creek while also providing an amenity, including habitat, natural stream stability, and, at a slightly higher elevation, walking trails. Developing a more natural riffle-pool sequence will be challenging in the developed environment, but opportunities may exist. Recommended restoration actions include:

a) Explore projects to do semi-natural channel and bank stabilization work with commercial landowners, using bio-engineering techniques. Native shrubs and trees

could significantly improve the channel stability, capture sediments in the floodplain, as well as increase the shading and water quality.

b) Expand the floodplain and development of native vegetation buffers on the larger undeveloped commercial properties, especially to the west of Grant Creek. Several commercial landowners have expressed to CFC an openness to this notion. There is considerable opportunity to improve the vegetation communities in these commercial areas, especially if floodplains are established low enough to enable native riparian vegetation to thrive.

c) Improve stormwater and other discharge systems to minimize impact on the creek. These projects may be incorporated into development plans now underway.

d) Enhance instream habitat, especially if Montana FWP biologists are on board, given that the stream is perennial and fish-bearing in this section.

e) Promote best management practices with the commercial landowners to improve landscaping and storm-water runoff, as well as minimizing human impact/trampling of streambanks (hardened access). The one discharge pipe on the stream is within this reach, and it was noted that it is apparently connected to a local algae bloom. However, MT DEQ reports that the landowner "is authorized to discharge noncontact cooling water from a heat exchanger to Grant Creek." (DEQ 2014)

5.3. Restoration Potential in Segment 3: Broadway to Mullan Road

5.3.1 Potential Conditions

The potential condition of this segment is a sinuous, low-gradient narrow stream with a wide floodplain, and good floodplain connection. The flat valley of Lake Missoula has fine lacustrine sediments and may be an appropriate setting for a Rosgen-type E channel, with small cobble to gravel substrate (if sufficient grade exists for a sinuous channel). An appropriate E-type channel would have dense riparian woody plants (willow, alder, dogwood), and a low width-depth ratio. This area does tend to dry up geologically in late summer, so there is limited potential for perennial fish habitat. But wildlife habitat value of a new, broader floodplain is potentially great.

5.3.2 Restoration Constraints

The most significant restoration constraints in this segment are related to the land use, the historical relocation of the channel, and the FEMA regulatory floodplain. Haying and grazing encroachment, along with mechanical manipulation of the channel, have disrupted natural channel formation for many decades in the upper reaches (4A to 3C), and residential housing in the lower part of the segment restricts natural floodplain activity. The channel is functioning essentially as a ditch (Rosgen-type G) -- it lacks meanders and pools and any natural floodplain function.

Restoring natural characteristics to this setting will require a large investment in channel reconstruction. The Missoula Airport, which owns a considerable portion of this segment, has concerns that any restoration activity on their property would encourage large birds (especially waterfowl) in the runway flight path, providing a danger to their operation. The stream's very low gradient through this reach may also be a constraint to re-engineering a naturalized channel.

This segment also contained the most significant fish passage barrier in the whole survey: a dam created from pre-cast concrete blocks, recently built to replace an older check dam, where a water was being backwatered up to a series of pump houses watering the adjacent hay fields, particularly the fields to the west of Grant Creek.

Reach 2A above Hiawatha was part of a Federal Emergency Management Agency project to alleviate flooding potential/extent in the lower Grant Creek, as discussed in a previous section. DEQ assessors noted that "FEMA work re-contoured the channel and put in some natural channel characteristics, including narrowing the channel by adding a bankfull bench with willow plantings" (DEQ 2014). This effort included creating a wetland area now called Hiawatha Lake, along with an overflow detention pond at Mullan Trail subdivision (Reach 2C). When surveyed in 2021, part of the Mullan Trail bench was eroding, allowing greater flow to move into the detention pond, reducing the instream flow. Although restoration is a high priority in this section, the density of suburban landowners, small property sizes, and history of flooding pose significant obstacles and restoration will require a big effort to secure local buy-in.

5.3.3 Restoration Actions to Achieve Potential Condition

The best options for restoration include: a) Re-naturalizing several long sub-reaches of ditched channel in the area currently used for agriculture, especially the area between Broadway and Hiawatha (reaches 4A to 2A). Re-naturalizing these sub-reaches would in-depth geomorphologic, soils, and hydrologic studies to understand the potential for re-building this system using natural channel design principles, before any design work itself was undertaken. It is possible that up to 2.5 miles of channel could be re-naturalized if landowners, local government regulators and other stakeholders can converge on effective designs. b) Another area with potential for re-naturalization of the channel exists between Hiawatha and Mullan, but this area is mostly residential, and property boundaries, low channel gradient and other physical constraints will make channel improvements quite challenging.

It is likely that any channel re-naturalization effort would be expensive and would include the creation of large floodplain benches and intensive revegetation of the banks and floodplain. As noted by the 2014 TMDL report, “efforts should be spent on re-vegetation in these areas” (DEQ 2014). The revegetation would be very important to add shade to the largely denuded channel, and it would support the stands of mature and decadent woody species which still exist. Reaching coexistence between landowners and beavers (which are already present) is an important aspect to the stability of this reach.

The stream energy and flood potential is an important constraint for this reach. Although floodplain restoration is a high priority in this section, the history of flooding and ditching pose significant legal barriers and restoration will require strong local buy-in.

5.4. Restoration Potential in Segment 4: Mullan Road to confluence with the Clark Fork

5.4.1 Potential Conditions

The potential conditions of this segment are varied. Some of the upper sub-reaches are so constrained by intense development that it will be difficult to re-naturalize the channel and reduce severe erosion and sediment production which exists. Some of its current function as an intermittent drainage ditch for Grant Creek floodwaters will need to be maintained. Nonetheless, there are sub-reaches lower down in this segment that could be returned to natural Rosgen-type C and Rosgen-type E channels with natural gravel substrates and woody riparian vegetation if the livestock grazing practices can be improved.

5.4.2 Restoration Constraints

The restoration constraints in this section are predominantly related to land use, including small-scale ranching. Over the course of nine (9) sub-reaches, Grant Creek flows consistently through land that is currently being, or has relatively recently been, grazed by cattle. Where present, the cows are accessing the entire floodplain and are widening the channel, degrading the banks through both hoof-shear and grazing on the few woody species present. Landowners have removed beavers from the lower reaches in recent years due to the flooding of the lowlands. The channel has been manipulated throughout the upper part of the segment. It flows into culverts under farm roads, which might serve as fish barriers or debris jams. Landowner buy-in to channel improvements will be key.

5.4.3 Restoration Actions to Achieve Potential Condition

There is potential to make adjustments to the grazing plans in these sub-reaches using appropriate riparian fencing and off-stream water. This would be beneficial to both the riparian corridor/water quality and to the landowners. Additionally, this segment has relatively few landowners for its length, and several of them showed a deep appreciation for Grant Creek and welcomed conversations about the stream's health. The lowest reach (0F) is held in conservation and might as a valuable reference for these other reaches. Reaching coexistence between landowners and beavers is required for optimum results in this segment.

6.0 REFERENCES

Department of Environmental Quality (DEQ). 2014. Final – Central Clark Fork Basin Tributaries TMDLs and Water Quality Improvement Plan. September 2014, Helena, MT. Accessed August 2021.

HDR Engineering, Inc. 2005. Grant Creek Environmental Restoration / Flood Control. February 2005.

Missoula County and City of Missoula. 2020. Mullan Area Master Plan Final Draft. December 10, 2020. Accessed December 2020. https://www.mullanareamasterplan.com/the-plan

Missoula County BUILD Grant. 2019. Accessed December 2020. https://www.missoulacounty.us/government/community-development/community-planning-services/planning-projects/build-grant

Montana Fish, Wildlife & Parks (FWP). 2005. FWP Dewatering Concern Areas. Revised May 2005.

Overton, K., et al. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. United States Department of Agriculture, Forest Service. Intermountain Research Station General Technical Report INT-GTR-346. May 1997

Rosgen, D., and Silvey, H.L. 1996. Applied River Morphology, Wildland Hydrology, Pagosa Springs, CO. USLC Catalog No. 96-60962.365.

USDA Natural Resources Conservation Service (NRCS). 2004. Riparian Assessment Using the NRCS Riparian Assessment Method. United States Department of Agriculture, Natural Resources Conservation Service, Bozeman, Montana.

APPENDICES:

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

RIPARIAN ASSESSMENT WORKSHEET

NAME OF STREAM:_____ REACH LOC OR ID:_____

DATE:_____ ID TEAM/OBSERVERS:_____

LENGTH OF REACH:_____ LAT/LONG - BEGIN/END:✓_____

MAP OR QUAD NAME:✓_____ PHOTO #S:_____ PRIMARY LAND USE:_____

PLANT COMMUNITY:_____ ROSGEN CHANNEL TYPE:_____ BFDEPTH:_____ BFWIDTH:_____

WIDTH/DEPTH RATIO:_____ CHANNEL SUBSTRATE :_____

Geomorphic Considerations

Question 1. Stream Incisement (Downcutting):

8 = Channel stable, no active downcutting occurring; or, old downcutting apparent but a new, stable riparian area has formed within the incised channel. There is perennial riparian vegetation well established in the riparian area (Stage 1 and 5, Schumm's Model Figure 2).

6 = Channel has evidence of old downcutting that has begun stabilizing, vegetation is beginning to establish, even at the base of the falling banks, soil disturbance evident (Stage 4, Schumm's Model Figure 2).

4 = Small headcut, in early stage, is present. Immediate action may prevent further degradation (Early Stage 2, Schumm's Model Figure 2).

2 = Unstable, channel incised, actively widening, limited new riparian area/floodplain, floodplain not well vegetated. The vegetation that is present is mainly pioneer species. Bank failure is common (Stage 3, Schumm's Model Figure 2).

0 = Channel deeply incised, resembling a gully, little or no riparian area, active downcutting is clearly occurring. Only occasional or rare flood events access the flood plain. Tributaries will also exhibit downcutting or signs of downcutting (Stage 2, Schumm's Model Figure 2).

The presence of active headcuts should nearly always keep the stream reach from being rated Sustainable.

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:_____

Question 2. Streambanks with Active Lateral Cutting (inspect banks on both sides of the stream):

8 = Lateral bank erosion is in balance with the stream and its setting.

5 = There is a minimal amount of human-induced, active lateral bank erosion occurring, primarily limited to outside banks.

3= There is a moderate amount of human-induced active lateral bank erosion occurring on either or both outside and inside banks.

0 = There is extensive human-induced lateral bank erosion occurring on outside and inside banks and straight sections.

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:_____

NAME OF STREAM:_____ REACH ID:_____ DATE:_____

Question 3. The Stream is in Balance with the Water and Sediment Supplied by the Watershed:

6 = The width to depth ratio appears to be appropriate for the stream type and its geomorphic setting. There is no evidence of excess sediment removal or deposition. There are no indications that the stream is widening or getting shallower. There may be some well-washed gravel and cobble bars present. Pools are common. Rosgen "B" and naturally occurring "D" channel types are exceptions.

4 = The stream has widened and/or has become shallower due to disturbances that have caused the banks to become unstable or from dewatering which reduces the amount of water and energy needed to effectively move the sediment through the channel. *(Note: Sediment sources may also be from offsite sources.)* Point bars are often enlarged by gravel with silt and sand common, and new bars are forming. Pools are common, but may be shallow. Rosgen "B" and naturally occurring "D" channel types are exceptions.

2 = The width to depth ratio exceeds what is appropriate for the stream type. Point bars are enlarged by gravel with abundant sand and silt, and new bars are forming that often force lateral movement of the stream. Mid channel bars are often present. For prairie streams there is often a deep layer of sediment on top of the gravel substrate. The frequency of pools is low. Rosgen "B" and naturally occurring "D" channel types are exceptions.

0 = The stream has poor sediment transport capability which is reflected by poor channel definition. The channel is often braided having at least 3 active channels. Naturally occurring Rosgen "D" channels types are exceptions. Pools are filled with sediment or are not existent.

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:_____

Vegetative Considerations

Question 4. Streambank with Vegetation (Kind) having a Deep, Binding Rootmass:
Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the potential score if this question is skipped.
(See Appendix I for stability ratings for most riparian, and other, species.)

6 = The streambank vegetative communities are comprised of at least four plant species with deep, binding root masses.

4 = The streambank vegetative communities are comprised of at least three plant species with deep, binding root masses.

2 = The streambank vegetative communities are comprised of two plant species with deep, binding root masses.

0 = The streambank vegetative communities are comprised of one or no plant species with deep, binding root masses.

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:_____

Question 5. Riparian/Wetland Vegetative Cover (Amount) in the Riparian/Floodplain Area:
Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the potential score if this question is skipped.

6 = More than 85% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

4 =75%-85% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

2 =65%-75% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

0 = Less than 65% of the riparian/wetland canopy cover has a stability rating $\geq$ 6

NOTE: A low score for this item may be enough to keep the stream reach from being rated Sustainable

SCORE: Potential_____ **Actual**_____

NAME OF STREAM:_____ REACH ID:_____ DATE:_____

Question 5. Continued:
Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.
Comments:_____

Question 6. Noxious Weeds in the Riparian Area:

3 = None of the riparian area has noxious weeds present.

2 = Up to 5% of the riparian area has noxious weeds (a few are present).

1 = Up to 10% of the riparian area has noxious weeds present (abundant).

0 = Over 10% of the riparian area has noxious weeds (very apparent and extensive distribution).

SCORE: Potential_____ **Actual**_____
Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.
Comments: (NOTE: List all noxious weed species)_____

Question 7. Disturbance-Caused Undesirable Plants in the Riparian Area:

3 = 5% or less of the riparian area with undesirable plants (very few present).

2 = 5-10% of the riparian area with undesirable plants (few are present).

1 = 10-15% of the riparian area with undesirable plants (commonly distributed).

0 = Over 15% of the riparian area with undesirable plants (abundant over much of the area).

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.
Comments: (NOTE: List all nuisance weeds and undesirable plants)_____

Question 8. Woody Species Establishment and Regeneration: *Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the potential score if this question is skipped.*

8 = All age classes of desirable woody riparian species present (see Table 3).

6 = One age class of desirable woody riparian species is clearly absent, all others well represented. Often, it will be the middle age group(s) absent. For sites with potential for both trees and shrubs there may be one age class of each absent. Having mature individuals and at least one younger age class present indicates the potential for recovery.

4 = Two age classes (seedlings and saplings) of native riparian shrubs and/or two age classes of native riparian trees are clearly absent, or the stand is comprised of mainly mature species. Other age classes well represented.

2 = Disturbance induced, (i.e. facultative, facultative upland species such as rose, or snowberry) or non-riparian species dominate. Woody species present consist of decadent/dying individuals. (Refer back to Question 1 if this is the situation. The channel may have incised.)

0 = A few woody species are present (<10% canopy cover), but herbaceous species dominate (at this point, the site potential should be re-evaluatad to ensure that it has potential for woody vegetation); or, the site has at ≥ 5% canopy cover of Russian olive and/or salt cedar. On sites with long-term manipulation or disturbance, woody species potential is easily underestimated.

NAME OF STREAM:_____ REACH ID:_____ DATE:_____

Question 8. Woody Species Establishment and Regeneration (cont'd.):

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments:_____

Functional Considerations

Question 9. Utilization of Trees and Shrubs: *Note: For stream types where riparian vegetation is not required for sustainability, this question can be skipped and given an N/A, with an explanatory note or comment. Be sure to adjust the potential score if this question is skipped.*

4 = 0-5% of the available second year and older stems are browsed.

3 = 5%-25% of the available second year and older stems are browsed (lightly).

2 = 25%-50% of the available second year and older stems are browsed (moderately..

1 = More than 50% of the available second year and older stems are browsed (heavily). Many of the shrubs have either a "clubbed" growth form, or they are high-lined or umbrella shaped .

0 = There is noticeable use (10% or more) of unpalatable and normally unused woody species

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate

Comments:_____

Question 10. Floodplain Characteristics for Dissipating Energy and Capturing Sediment.

8 = Active flood or overflow channels exist in the floodplain. Large rock, woody debris, and/or riparian vegetation appropriate for the setting are sufficient to adequately dissipate stream energy and trap sediment on the floodplain. There is little evidence of excessive erosion or disturbance that reduces energy dissipation and sediment capture on the floodplain. There are no headcuts where either overland flow and/or flood channel flows return to the main channel.

6 = The floodplain meets the characteristics of the description in Question 8 above, but demonstrates slight limitations in the kind and amount of large rock, woody debris, and/or riparian vegetation present. Riparian vegetation structure is below that required to dissipate energy. There may be occasional evidence of surface erosion and disturbance, but generally not extensive enough to have affected channel development.

4 = Large rock, woody debris, and/or riparian vegetation is present, but generally insufficient (quality or quantity) to fully dissipate stream energy. Some sediment may be captured, but greater evidence of incipient erosion and/or headcuts is readily present.

2 = Inadequate Large rock, woody debris, and/or riparian vegetation is available for dissipation of energy or sediment capture. There is very little evidence of sediment capture. There is some streambank erosion due to human disturbance or alterations, and occasional headcuts where overland flows or flood channel flows return to the main channel.

0 = Floodplain area reflects the following conditions: 1) The floodplain area is very limited or not present and is inadequate to dissipate energy; 2) flood or overflow channels do not exist; and 3) large rock, woody debris, and/or riparian vegetation is not adequate to dissipate stream energy and trap sediment on the floodplain. Streambank and/or floodplain erosion and/or evidence of human alteration are common. "G"- and "F"-type channels (Rosgen) typically reflect these conditions.

SCORE: Potential_____ **Actual**_____

Please clarify the rationale for your score, including comments regarding *potential* and *capability* and document with photograph if appropriate.

Comments: _____

SUMMARY

		SCORE POTENTIAL	SCORE ACTUAL	POSSIBLE
QUESTION 1:	Stream Inclsement	____	____	0, 2, 4, 6, 8
QUESTION 2:	Lateral Cutting	____	____	0, 3, 5, 8
QUESTION 3:	Stream Balance	____	____	0, 2, 4, 6
QUESTION 4:	Deep, Binding Rootmass	____	____	N/A, 0, 2, 4, 6
QUESTION 5:	Riparian/Wetland Vegetative Cover *	____	____	N/A, 0, 2, 4, 6
QUESTION 6:	Noxious Weeds	____	____	0, 1, 2, 3
QUESTION 7:	Undesirable Plants	____	____	0, 1, 2, 3
QUESTION 8:	Woody Species Establishment	____	____	N/A, 0, 2, 4, 6, 8
QUESTION 9:	Browse Utilization	____	____	N/A, 0, 1, 2, 3, 4
QUESTION 10:	Riparian Area/Floodplain Characteristics *	____	____	N/A, 0, 2, 4, 6, 8
	TOTAL	____	____	(60 total possible)

(PDTENTIAL SCORE FOR MOST BEDROCK OR BOULDER STREAMS) (36)
(questions 1, 2, 3, 6, 7, 10)
(POTENTIAL SCORE FOR MOST LOW ENERGY "E" STREAMS) (48)
(questions 1 – 7, 10)

RATING: = $\frac{\text{Actual Score}}{\text{Potential Score}}$ X 100 = % rating

80-100% = SUSTAINABLE
50-80% = AT RISK
LESS THAN 50% = NOT SUSTAINABLE

* Only in certain, specific situations can both of these receive an "N/A".

Please clarify the rationale for your rating, including comments regarding potential. Can the limitations be addressed by the decisionmaker?

NOTES _____

TREND: Does the reach appear to be improving or declining? Explain. _____

FISH HABITAT: (see questions)

1) Substrate Habitat _____ (0-3)
2) Fish Habitat _____ (0-4)
3) Temperature _____ (0-2)
4) Flow _____ (0-4)
5) Nutrients _____ (0-3)

Total = ____ out of 16 max.

MODIFIED R1/R4 USFS Fish Habitat Data Sheet:

Date: Legal: T R Sec. Survey Direction: Down Up

Stream: Basin: Observers:

LENGTH OF REACH:

Upper Boundary: Lower Boundary:

GPS: GPS:

Reach #	Tape (ft)	Rosgen Types:	Fish Habitat Types:		Pool Max D (ft)	Tailout D (ft)	Bank Erosion (ft)		LWDebris	Riparian	Additional Da
		Type:	Overall	Pools			L:	R:	#	Comm.	Physical
Subtotals			No. Pools		Mean:	Mean:	Total:	Total:			
	Notes:										

DATA ENTRY FORM:

Summary of Channel Morphology (ROSGEN LEVEL II)

Stream: Basin: Date:

Approximate drainage area (mi2):

Site Description:

GPS: Observers:

Township: Range: Section: Qtr:

MORPHOLOGICAL CHARACTERISTICS:			
Bankfull Width (ft):			
Bankfull Mean Depth (ft):			
Width/Depth Ratio:			
Bankfull Maximum Depth (ft):			
Flood Prone Area Width (ft):			
Entrenchment RATIO:			
Channel Slope (ft/ft):			
Valley Slope (ft/ft):			
Sinuosity:			
Channel Materials:	D15(mm):	D50(mm):	D84(mm):

REMARKS:

PHOTOS (insert):

WOODY SPECIES REGENERATION: Winward, 2000, USFS RMRS-GTR-47 Modified

Date: Location:

Stream: Basin: Observers:

MONITORING REACH

Upper Bdn: Lower Boundary:

GPS: GPS:

Species (or Genus):	Seedling/Sprout (<2' high)			Sapling (2-8' high)			Mature (>8' high)			Decadent/Dead:	
	Lbank	Rbank		Lbank	Rbank		Lbank	Rbank		Lbank	Rbank
Willow											
Aspen											
Juniper											
Dogwood											
Cottonwd											
Alder											
Cherry											
Hawthorne											
TOTALS:											

NOTES:

APPENDIX B. PHOTOS BY REACH

A. Segment 1: Snowbowl road to Interstate 90

Reach 10A Start

Reach 10A End

Reach 10B Start

Reach 10B End

Reach 10C Start

Reach 10C End

Reach 9A Start

Reach 9A End

Reach 9B Start

Reach 9B End

Reach 8A Start

Reach 8A End

Reach 8B Start

Reach 8B End

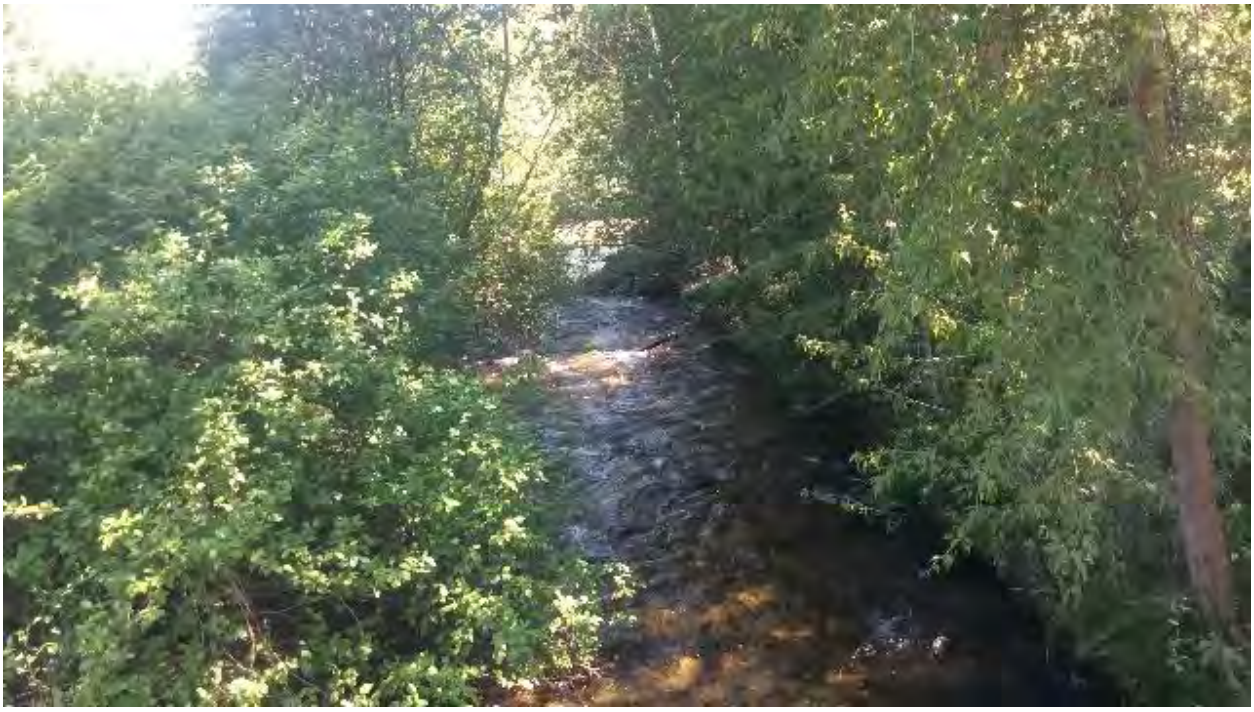
Reach 7A Start

Reach 7A End

Reach 7B Start

Reach 7B End

Reach 7C Start



Reach 7C End

Not Available

Reach 7D Start

Reach 7D End

Reach 6A Start

Reach 6A End

B. Segment 2: Interstate 90 to Broadway

Reach 6B Start

Reach 6B End

Reach 6C Start

Reach 6C End

Reach 6D Start

Reach 6D End

Reach 5A Start

Reach 5A End

Reach 5B Start

Reach 5B End

Reach 5C *Remotely Assessed*

C. Segment 3: Broadway to Mullan Road

Reach 4A *Remotely Assessed*

Reach 3A Start

Reach 3A End

Reach 3B Start

Reach 3B End

Reach 3C Start

Reach 3C End

Reach 2A Start

Reach 2A End

Reach 2B *Remotely Assessed*

Reach 2C Start

Reach 2C End

Reach 2D Start

Reach 2D Start

Reach 2E Start

Reach 2E End

Reach 1A *Remotely Assessed*

Reach 1B Start

Reach 1B End

Reach 1C Start

Reach 1C End

Reach 1D Start

Reach 1D End

Reach 1E Start

Reach 1E End

Not available

Reach 0A Start

Reach 0A End

Reach 0B Start

Reach 0B End

Reach 0C Start

Reach 0C End

Reach 0D Start

Reach 0D End

Reach 0E *Assessed Remotely*

Reach 0F Start

Reach 0F End

APPENDIX C: ADAPTATION OF NRCS RIPARIAN ASSESSMENT QUESTIONS TO REMOTE SENSING (for sites with no access granted)

Question 1: Stream Incision

Indications of incision such as head-cuts, channel widening, and the presence of developing riparian areas were identified through aerial imagery.

Question 2: Streambanks with Active Lateral Cutting

The presence and severity of lateral bank erosion were identified through repeat aerial imagery (i.e. comparing available historical imagery with current imagery). Some types of bank erosion were visible simply on current imagery.

Question 3: The Stream is in Balance with the Water and Sediment Supplied by the Watershed

Metrics related to channel width, presence/absence of depositional features, were assessed using current aerial imagery.

Question 4: Streambank with Vegetation having a Deep, Binding Root Mass

The presence of woody, near-bank vegetation was assessed from current aerial photographs to inform conclusions regarding the presence of the deep, binding root mass. Species diversity could not be reliably assessed; however, general vegetation cover types (shrub, deciduous, conifer, sedge/rush, grass) were evaluated.

Question 5: Riparian/Wetland Vegetative Cover

Riparian and wetland canopy cover was assessed using aerial imagery and stability ratings were estimated by comparing observed general vegetation cover types and data from similar sites that were assessed on the ground.

Question 7: Disturbance-Caused Undesirable Plants in the Riparian Area

The presence of disturbance-caused undesirable plants was estimated based on trends observed in adjacent reaches and land use evident on current aerial photographs. In certain reaches this could not be determined, and the question was scored as an N/A.

Question 8: Woody Species Establishment and Regeneration

The presence/absence of woody species was evaluated using current aerial photographs and the individual age classes were estimated by observing the apparent size of woody vegetation.

Question 10: Floodplain Characteristics for Dissipating Energy and Capturing Sediment

The presence of active or overflow channels and larger floodplain debris was evaluated from current aerial photographs.

Fish Habitat Assessment

Only general fish habitat using the metric shown in the 2004 NRCS report was estimated using aerial photographs. The existing vegetation community visible on current aerial photographs was to determine woody debris, overhanging vegetation, or other cover elements. The presence of pools was estimated based on the channel pattern and data from adjacent reaches that were evaluated in the field.

APPENDIX D. SCORE AND NARRATIVE BY REACH

Segment 1: Snowbowl Road to Interstate 90

4.2.1 Sub-Reach 10A

NRCS Score: 97% - Sustainable; Fish Habitat Score: 100% - Good

Narrative: Walked from Snowbowl Rd bridge down to a clearing on the left bank with a residential property nearby. Rosgen-type B, with mostly low-gradient riffles with cobble substrate. Channel very stable throughout sub-reach. Fish habitat is healthy throughout and includes complexity from woody debris along with plunge and scour pools. High diversity of shrubs, forbs, and trees, dominated by cottonwood. All woody plant age classes represented. Many deep pools (2-3 ft. deep). Four to five lightly trafficked human access points and seating areas. Some clearing of vegetation evident but minor. Two large sections near development (road) on the left bank showing bank erosion off of a tall bank. Some clearing of trees presumed. Two small (3-5 HP) pumps pulling water. Dark Horse creek head-gate is open on right bank, with rocks stacked to guide water into diversion. Dippers present. Moss on cobble banks. Lots of macroinvertebrates visible on cobble. Some side channel overflows.

Trend: Trend is stable.

Restoration Potential: Low priority due to high ecological quality. Minor opportunities could include returning Dark Horse Creek flow and allowing residential clearings to regenerate.

4.1.2 Sub-Reach 10B

NRCS Score: 95% - Sustainable; Fish Habitat Score: 94% - Good

Narrative: Walked from the upper end of a residential property to the Rankin Road bridge. Rosgen-type B, with mostly low-gradient riffles with cobble substrate. Creek very stable with plentiful woody vegetative cover of various age classes, dominated by cottonwood trees. Fish habitat is healthy throughout and includes complexity from woody debris along with plunge and scour pools. Several major exceptions: 3-4 large human access points showed signs of trampling or past clearings, and some woody plant age classes are missing as a result. Some shrub/forb mix absent at these sites as well. Lawn grasses and landscaping encroaching on banks. Two small pumps--one active and one not--and one tarped and rock-dammed head-gate pulling in around a quarter of the flow from the creek on the right bank (visually assessed). Flow noticeably diminished but still relatively full channel flow.

Trend: Trend is stable.

Restoration Potential: Low priority due to high ecological quality. Minor restoration opportunities could include returning flow from diversions and reducing the impacts from adjacent landscaped residences.

4.1.3 Sub-Reach 10C

NRCS Score: 97% - Sustainable; Fish Habitat Score: 94% - Good

Narrative: Sub-reach was from Rankin Road bridge to the fence line that marks a property boundary. Rosgen-type B, with mostly low-gradient riffles with cobble substrate. Many woody species with a deep-binding root-mass, including diverse shrub cover, of multiple age-classes, with cottonwood dominant. Fish habitat is healthy throughout and includes complexity from woody debris along with plunge and scour pools, some 1-2 ft deep. Some sparse exotic grasses encroaching. Exposed cobble showed on the banks, implying the potential of old down-cutting. One older/inactive diversion present, with dimensioned lumber in creek, possibly washed down from flood event. An old head-gate was present on left bank at that site but is out-of-use and flows were too low to access it. The ditch beyond headgate it is still present.

Trend: Trend is stable, no evident pressures on the stream, nor visible threats.

Restoration Potential: Low priority due to high ecological quality.

4.1.4 Sub-Reach 9A

NRCS Score: 88% - Sustainable; Fish Habitat Score: 94% - Good

Narrative: Walked from the fenced property boundary down to the bridge at Old Grant Creek Road. Channel changed from a Rosgen-type B to D, becoming braided and complex channel with lots of cottonwood debris in channel. Low gradient riffles, dominantly cobble, though some gravel showed through. High quality fish habitat due to the numbers of pools and the degree complexity from woody debris. Signs of recent channel formation evident, as green grass was below the water. The channel left bank included portions both in and out of hay fields, with accompanying bank erosion. It was difficult to assess the age of all channels and the subsequent regeneration. Noxious and undesirable weeds on outer banks, some hay grasses even in "islands" in between channels. High quality fish habitat in pools and good channel form complexity and pool forming features. Good stable woody tree/shrub cover, dominated by large cottonwoods, except for the old ranch land that is now in the floodplain, which is mostly still clear of large cover. Site was initially scored low due in part to wide/complex channel, but the complexity was

beneficial overall. Surveyors reviewed the aerial photos and adjusted scores to include this last feature. Algae showed up below the hay/ranch fields.

Trend: Stable. Braiding and adjusting in an ecologically beneficial way.

Restoration Potential: Low priority due to high ecological quality. Despite signs of erosion, the natural woody debris and the wide buffer allowed for the creek by the land managers provide for healthy channel succession. Minor restoration opportunities could include management of invasive forbs and reduction of nutrient inputs.

4.1.5 Sub-Reach 9B

NRCS Score: 95% - Sustainable; Fish Habitat Score: 88% - Good

Narrative: Walked from Old Grant Creek Road bridge to the residential cul-de-sac at the end of the southern Old Grant Creek Road. Rosgen-type B channel, with occasional braiding. Low gradient cobble dominated, with some gravel bars. High quality fish habitat due to the numbers of pools and the complexity offered by large woody debris under a cottonwood canopy. Some erosion showed on a section of steep bank. Intermittent signs of old human impacts: clearing, grazing/ranching, undesirables and noxious present. Signs of old channels, now disconnected. Built impacts of note: dimensioned lumber in channel, 2 small HP pumps (not active), small cattle water access (jack-leg fence), chairs and paths, ornamental trees occasional. Consistent fish habitat present with woody debris and low, overhanging limbs providing cover. Channel seems slightly artificially narrowed as the northern Old Grant Creek Road encroaches. A lawn encroaches near the bottom of the sub-reach, where 2-3 clearings show mowing within 10 feet of bank, though a healthy riparian corridor is still present. Along the bottom stretch, a high berm on the left bank rises, hosting Ponderosa pines. At bottom of sub-reach, Old Grant Creek Rd cul-de-sac is visible off left bank and sits on a concrete footing. Undesirable grasses widespread there. On right bank, nearby hay field is clear of trees, some undesirable/noxious forbs present, along with riprap.

Trend: Trend is stable

Restoration Potential: Low priority due to high ecological quality. The primary risks are the erosion on the steep bank next to Old Grant Creek Road and the open area at the bottom of the sub-reach hosting extensive invasive weeds.

4.1.6 Sub-Reach 8A

NRCS Score: 85% - Sustainable; Fish Habitat Score: 88% - Good

Narrative: Walked from residential cul-de-sac at the end of the southern Old Grant Creek Road on the left bank, down to the bottom of the neighborhood. The right bank was a ranch, though the impacts seemed minimal. The left bank was a series of houses and yards. The stream appears stable. Rosgen-type B channel, cobble dominated, with some evidence of old down-cutting, though the new woody plant growth supports stable banks, and a sustainable channel. Low gradient riffles with high quality fish habitat due to the presence of pools and woody debris. Diverse species of trees and age classes through the sub-reach, dominated by cottonwoods. Dominant impacts include: human access points, simplification of sections of banks, lawns eroding, and some invasive plants. Several overflow channels widen the creek. Some areas of presumed ranching lacking in tree age classes (sapling and pole). One large tarped diversion leads into an open head-gate on the left bank near the bottom of the sub-reach. Some houses on the left bank are much closer than others, and some others show deliberate bank stabilization efforts such as riprap and plantings.

Trend: Trend is stable. Depends somewhat on the private landowner management of erosion.

Restoration Potential: Low priority due to high ecological quality. There are opportunities to communicate improved bank management to the homeowners who appeared intimately familiar with their properties and are generally supportive of the health of the creek. These might include plantings, vegetative regeneration, and greener riprap (cuttings).

4.1.7 Sub-Reach 8B

NRCS Score: 77% - At Risk; Fish Habitat Score: 88% - Good

Narrative: Started downstream of the last neighborhood houses at a cattle-fence crossing creek. Just below the fence is a large clearing and road-crossing under high power lines. Side channel and wide open, cleared meadow that looks to be regenerating, but with shrub/tree age classes missing. Cottonwood dominate the riparian area, but ponderosa pines also present. Rosgen-type B channel, low-gradient riffle and cobble-dominated. Although cover was lacking in places, the fish habitat quality was high due to the presence of pools and plenty of large woody debris. Through most of the sub-reach, the right bank rises to a flat terrace being grazed by cattle. Some channel access points are eroding with hoof-shear. Left bank has sparse, erratic woody vegetation and deep-binding root-mass near hay fields. Left bank is often steep and eroded, but the floodplain is continuing to store sediment, and behave naturally. A few 3'-5' deep pools forming near logjams with overpour scour. A 10'-15' tall and 100’ long eroding bank on the right bank is bare and grassy and evidently used as pasture. Old, possibly abandoned vehicle crossing there as well. Downstream, an old, inaccessible side-channel on right bank connects with seep below the uppermost homeowners association houses to form flowing side-channel.

Trend: Trend appears to be improving, aside from areas of active bank erosion. Land use is likely less intensive than in the past. Not yet sustainable.

Restoration Potential: Restoration potential is low to medium. The channel is likely improving without the need for intensive restoration, and the eroding banks pose a difficult problem that may not all be feasible to repair (cost-benefit). However, there are certainly opportunities to work with the land managers, and if there is interest, there could be resource benefits from vegetating and reducing erosion on selected banks that are adjacent to hay fields and pastures.

4.1.8 Sub-Reach 7A

NRCS Score: 93% - Sustainable; Fish Habitat Score: 94% - Good

Narrative: Walked from the end of the ranch land to the upper end of a homeowner's association common area through a Missoula City nature preserve, down to the Grant Creek Trail footbridge. Several side-channels in floodplain, but largely a typical Rosgen-type B single thread channel, cobbles dominant. Some bank erosion where meanders hit grassy banks. Low gradient riffles throughout, with high quality fish habitat, pools and woody debris common. Extensive and diverse woody cottonwood-aspen forest with extensive shrub cover (alder, hawthorn, chokecherry, dogwood, and gooseberry) on moist banks and floodplain—no grazing history evident. Occasional gravel bars with large cobble in parts of floodplain. Large woody debris instream, especially of cottonwood trunks. Irrigation diversions include one large, though inactive, head-gate diversion. Right bank is more impacted, partly due to the human foot traffic and weed impact.

Trend: Mostly stable or possibly improving.

Restoration Potential: Low priority due to high ecological quality, and because the land managers are evidently engaged in supporting the health of the channel through weed abatement and in minimizing access impacts.

4.1.9 Sub-Reach 7B

NRCS Score: 93% - Sustainable; Fish Habitat Score: 88% - Good

Narrative: Walked from the Grant Creek Trail footbridge to the Prospect Drive bridge. Walked on the established foot path, notably clean of litter. Rosgen-type B channel, cobbles dominant. Low gradient riffles throughout, with high quality fish habitat, some pools and woody debris common. The 3-4 human access points on right bank have some trampling and erosion, along with noxious weeds. Riprap from the road-base from Grant Creek Rd. shows on left bank in

some places. Rocks and big boulders have been placed and are protecting Prospect Dr. bridge abutments, especially on the left bank where there has been historical erosion. On the human access points, banks worn down to dirt. Sunny patches near the landscaping near the bridge, with reduced cover and age class diversity. Some newly downed alder trees adding to debris piles in channel. Some pools and riffles, but sub-reach is largely run-dominated. However, fish habitat quality is still high. Small channel inputs return flow water, presumably from Dark Horse creek diversion and irrigation ditch.

Trend: Stable. Well maintained by HOA and citizens. Trampling and old levee limitations are primary limitations from higher quality stream succession.

Restoration Potential: Low priority due to high ecological quality, and because the land managers are evidently engaged in supporting the health of the channel through weed abatement and in minimizing access impacts. Primary concerns surround the Prospect Dr. bridge stability in high flows, along with the potential to become blocked with accumulated debris from decadent cottonwoods and other trees.

4.1.10 Sub-Reach 7C

NRCS Score: 97% - Sustainable; Fish Habitat Score: 88% - Good

Narrative: Began at Prospect Drive bridge and walked down to the Stonebridge Road bridge. Cobble dominated Rosgen B channel. Some pools and good complexity for fish habitat, but the sub-reach is also fairly run-dominated. There is a sunny patch with erosion off grassy right bank at top of sub-reach. Further erosion occurring on riprap as Grant Creek Road encroaches. Input from a side-channel or brook (uncertain origin). Several locally impacted access points, including a heavily-trafficked spot on the right bank with a large non-native willow. One big tree-fall with a deep pool downstream. Creek gets narrow, fast, and deep against road, pinched as well by the Grant Creek Trail that sits on top of an Army Corps levee. However, deep cottonwood roots appear to be binding bank and riprap is helping. Bridges have some erosion, but the creek flows through well and they appear to be wide enough for most flow. Accumulation of debris may be of some concern. The creek floodplain was certainly wider before Army Corps levee work, but it nonetheless the existing floodplain appears to be functioning and stable.

Trend: Stable. Concern is of debris upstream of bridges.

Restoration Potential: Low priority due to high ecological quality, and because the land managers are evidently engaged in supporting the health of the channel through weed abatement and in minimizing access impacts. Primary concerns surround the Stonebridge Rd. bridge

stability in high flows (mentioned as an issue by residents during last large flood), along with the potential to become blocked with debris from decadent cottonwoods.

4.1.11 Sub-Reach 7D

NRCS Score: 93% - Sustainable; Fish Habitat Score: 88% - Good

Narrative: Walked from the bridge at Stonebridge Rd. to Expo Parkway. Bridges were notably surrounded by riprap and built features. Rosgen-type B channel, cobble dominated by low gradient riffles. Channel is confined, and floodplain negligible due to levee and roadway. Flow looks stable throughout sub-reach, and fish habitat quality is fairly good due to the presence of some pools and woody debris. Dense canopy cover and binding root-mass of cottonwood forest are strong points. Noxious and undesirable weeds were patchy and mostly centralized at areas of human access points or disturbances. Erosion occurring where road or levee encroach on the channel. High risk of erosion in two 40'-50' sections on the left bank by road. Little to no vegetation to stabilize banks under landscaping and lawn cover. Concrete blocks appear intermittently in the channel. Signs exist of an old diversion and possible even a dam. A head-gate diversion is present, and though it is closed and out of use it is still affecting the flow through the debris and concrete drop structure. Small diversion ditch continues parallel to downstream channel. Diversion enters a culvert at Expo. The large dropoff from the concrete blocks could be disrupting fish passage. Metal farm equipment appeared consistently on the old terrace off the left bank. Old cottonwoods growing around and through them.

Trend: Trend is stable despite the floodplain likely being narrowed by the road and levee.

Restoration Potential: Low priority due to dominantly high ecological quality. Primary concerns surround road riprap stability and the narrowing due to the trail levee, however this infrastructure is very established and the opportunity and feasibility of improvement are low. Other potential improvements include removal of the concrete or old manmade debris to improve fish passage.

4.1.12 Sub-Reach 6A

NRCS Score: 90% - Sustainable; Fish Habitat Score: 88% - Good

Narrative: Walked from Expo Parkway bridge to box culvert at Interstate 90. Primarily cobble dominated Rosgen-type B with low-gradient riffles, though Grant Creek Road and Grant Creek Trail encroach and narrow the channel and restrict the floodplain, at one point down to just 4.5' wide and forcing channel to almost a Rosgen G type. This run-dominated channel form limits the diversity of pools and fish habitat complexity. However, cottonwoods with deep binding root

mass, shading, and boulders are consistent enough to support largely stable fish habitat conditions. Noxious weeds and undesirable invasive plants are extensive on the perimeter of the floodplain and on the edges of the road/trail area, but are shaded out of the primary riparian corridor. Channel shows potential to incise, but short-term/mid-term stable. Boulder riprap on both bridges ~50' long, harboring some noxious weeds. The Interstate concrete box culvert is 7' x 12' and is flat-bottomed with wide and shallow flow, with some natural channel gravels. Some debris visible downstream. Old diversion emerges out of Expo bridge culvert and was dry for 50' before it returned to channel along with a drainage pipe from under Grant Creek Rd. on left bank. Survey of this sub-reach did not include any of the culvert in this assessment score.

Trend: Trend is largely stable, but artificial narrowing shows potential to incise and erode at high flow rates.

Restoration Potential: Low priority due to fairly high ecological quality, and limited potential for improvement due to confinement between road and trail. Primary concerns surround road riprap stability and the narrowing due to the trail levee, however this infrastructure is very established and the opportunity and feasibility of improvement are low. There could be a limited expansion of floodplain within the deeper channel to support greater fish habitat complexity.

Segment 2: Interstate 90 to Broadway

4.1.13 Sub-Reach 6B

NRCS Score: 68% - At Risk; Fish Habitat Score: 75% - Fair

Narrative: Walked from lower end of the Interstate box culvert to the Michael Rd bridge. The channel widens after running out of the culvert. This is a cobble dominated Rosgen-type B channel dominated by low-gradient riffles. Pools and woody debris are limited, which decreases the quality of fish habitat. The riparian corridor is in part limited by hotel development and the berm from the Interstate off-ramp, however incision is not obvious. Erosion of gravelly, cobble banks and riprap occur towards the hotel patio; 30' long by 6' tall eroded section on left bank. Cottonwood dominant in the canopy, mostly comprised of saplings and seedlings with mature trees limited. Wide, shallow flow over the cobble substrate. Some human-caused trash and impact on banks. At bottom of sub-reach, boulder/riprap at concrete bridge show for ~30' on both banks. Concrete blocks beneath the bridge. Seems wide enough to accommodate a large flow. A large developing property approaches on the right bank and converges at the lower bridge.

Trend: Trend is moderately stable, though declining in patches of active bank erosion.

Restoration Potential: Medium priority restoration potential. Patches of bank erosion indicate imbalance with sediment load, and are encroaching on private commercial property. This may create a potential mutual benefit for a bio-engineered restoration effort melding property protection and ecological integrity. Improved woody plant regeneration on impacted banks is necessary. Other opportunities could include an expansion of the floodplain into the developing lot on the right bank, as it appears that the development will be offset from the corridor. Possibly through channel reconstruction, construction of inset floodplain and planting.

4.1.14 Sub-Reach 6C

NRCS Score: 57% - At Risk; Fish Habitat Score: 69% - Fair

Narrative: Walked from Michael St. bridge to Schramm St. bridge. Long sub-reach but consistently impacted by development and human access. Low gradient riffles and cobble dominated. The Rosgen-type B channel is artificially straightened and narrowed by fill leading to incising and separation of water table from an older bench with mature trees and leading to excessive energy such that high flow creates intermittent widening and erosion on outer banks. Pools and woody debris are limited, which decreases the quality of fish habitat. Human waste and access consistent, along with built rock barriers, perhaps recreational, but may be limiting fish habitat. Channel needs a wider floodplain. Vegetation (shrubs and forbs) limited in high-

impact areas. Patches of medium-age cottonwoods show limited diversity and lack age classes (sapling and mature lacking). Creek approaches paved parking lots of hotels, which are partly protected by steep banks with boulder riprap. One inflow of runoff to the creek shows evidence of nutrient input from hotel. Active "homeless" residences exist throughout sub-reach, evidenced by paths, clearings, and built structures. Schramm Road bridge has a box culvert of 7ft tall with a cobble bottom.

Trend: Trend is declining. Stream needs a wider well-vegetated floodplain and perhaps overflow channels to reduce bank erosion and incising.

Restoration Potential: High priority restoration potential. Patches of bank erosion are detrimental, dumping sediment into the channel and threatening private commercial property, setting up a potential mutual benefit for a restoration effort, and possibly for a trail. Additionally, there is potential to expand the floodplain into the developing lot on the right bank, as it appears that the development will be set back from the corridor. Appropriate riparian floodplain conditions could be supported through channel reconstruction and planting.

4.1.15 Sub-Reach 6D

NRCS Score: 52% - At Risk; Fish Habitat Score: 63% - Fair

Narrative: Schramm Street bridge to Expressway bridge. Cobble dominant, with gravel showing in bars. Straight Rosgen-type B channel, constructed channel lined by cottonwoods and encroached on both sides by fill. Limited fish habitat with few pools. A few willow and dogwood are establishing. Tansy and knapweed common and sometimes prevalent. Floodplain is small or absent, but deposition is occurring naturally. This reach is pinched between fill slopes with no opportunity for floodplain development. This reach needs a constructed revegetated floodplain.

Trend: Possibly improved from the original constructed channel, which looks like ~40 years ago by size of cottonwoods.

Restoration Potential: Medium priority for restoration. This sub-reach is currently at risk due to the heavily manipulated channel, which is not appropriate for the broader conditions and its location in the watershed. There is opportunity to improve the woody plant habitat on the semi-managed hotel pathway. More significant would be to expand the floodplain into the empty lot on the right bank to encourage a renaturalized floodplain formation. However there will still be significant limitations due to the small distance between the two road bridges that bound this sub-reach.

4.1.16 Sub-Reach 5A

NRCS Score: 63% - At Risk; Fish Habitat Score: 63% - Fair

Narrative: Walked from Expressway bridge to International Drive bridge. Channel was very straight with fill material encroaching on banks near the industrial lots. Cobble dominated Rosgen-type D channel, wider and eroding laterally likely due to deposition of substantial sediment load carried by energy from upstream channelization. Flow is shallow and lacks pools for fish habitat. Recent debris falls add complexity, though the trend is uncertain due to the limitations of the low bridge on International Drive (affected by aggradation). Berms at the lower end of the sub-reach are low and wide. Cottonwoods dominant, though lacking diversity of age classes. Minimal shrub presence. Old head-gate and creek crossing present, and though not active, the old concrete diversion infrastructure was still impacting the flow. Recent landscaping on the right bank was un-vegetated and crumbling from human impacts. Below the crossing the channel appears to widen, likely towards the natural condition for a depositional reach. Residual conditions from past channelization (old cottonwoods and un-vegetated banks) imply lack of current equilibrium. Some significant human impacts coming from the nearby brewery patio and access, such as erosion and trampling of vegetation.

Trend: Trend likely improving as the floodplain widens. More complexity is needed to dissipate energy, and the management strategy is unclear regarding the debris and the bridge.

Restoration Potential: Medium priority. This sub-reach is improving and there is opportunity to further improve ecological quality here. However, the low bridge of International Drive appears to be affected by channel aggradation, and poses challenges to the feasibility, and its potential to clog threatens the road at higher flows. Revegetation of the banks would be very beneficial to creating a water quality buffer and enhance the floodplain, but the questions of limiting human impact, of abundant woody debris need to be addressed, given the bridge just downstream. There appears to be a need for a cohesive management strategy on this sub-reach, which addresses channel form and stability, given the large sediment supply from upstream.

4.1.17 Sub-Reach 5B

NRCS Score: 38% - Not Sustainable; Fish Habitat Score: 38% - Poor

Narrative: Walked from the International Drive bridge to the end of a commercial property (Pepsi) with a manager from the company. Cobble dominated Rosgen-type D channel, flowing slow, wide, and low near International Drive bridge. Fish habitat is poor because of the lack of pools, and because nearly all of the flow is diverted by a permanent rock/debris structure into a ditch by a 36-inch concrete culvert along with loose rock diversion about 130 feet below International Drive. A small amount of flow persists in some braided channels before completely

dissipating into the large cobbles of the stream bed. From this point the flow is seasonally intermittent. Channel appears has been manipulated and re-formed by high-flow runoff events, and is widening through lateral erosion. Some braiding is occurring but fill includes some riprap on left (outside) bank. Some mature cottonwoods present, dominantly on the left bank. Little regeneration occurring. No shrubs. Noxious weeds are extensive on the large eroding bank with no management evident. The erosion threatens the private company's fence-line, which has already been moved back to the cost of $10k. Train tracks on a base of constructed fill converge towards the creek off of the left bank.

Trend: Trend is declining, especially during high flow events. Fish impact is severe because of dewatering.

Restoration Potential: Restoration potential is of High priority. Bank stabilization through construction and revegetation would be of mutual benefit to the private landowner and the creek habitat, and presents an opportunity for collaboration. The opportunities to work with the water right owner to return flow and with the railroad company to improve their bank are less clear, but should be pursued in order to support the channel sustainability and the fish habitat through native plan revegetation, management of invasives, and more consistent flow.

4.1.18 Sub-Reach 5C

NRCS Score: 55% - Estimated At Risk; Fish Habitat Score: 38% - Estimated Poor

Narrative: Assessed from aerial imagery of this sub-reach on Google Earth, the latest photo being 8/3/2019. Was inaccessible because landowner (MRL) did not grant permission in the timeline of the survey effort. Based on this and the adjacent survey, as well as what is visible from Broadway, this is an artificially maintained channel, which dewatered during summer. Channel form estimated as a Rosgen G, likely cobble dominated. The historical ditching for the railway and the lack of habitat complexity and energy dissipation, have resulted in poor channel and fish habitat conditions. The growth of cottonwoods has been beneficial to the channel over the last 20 years, though the stands lack diversity of both species and age classes. The creek has also been channelized along the train tracks and floodplain artificially narrowed. The creek goes under one bridge holding two lines of tracks--the erodibility/stability of this significant stream channel bend is unclear. Suspect that significant riprap or bank treatments are being used by the railroad on this site. The right bank is evidently eroding as it turns and enters the culvert above Broadway.

Trend: Trend is uncertain. There is channel incisement, but the cottonwoods are likely providing some natural bank stabilization for this channelized sub-reach.

Restoration Potential: Restoration potential is Medium priority, with some doubt as to whether the landowner has sufficient physical space, or inclination, to do any re-naturalization of this heavily manipulated channel. The channel banks are evidently in poor condition and the behavior at higher flows likely threatens some of the crucial infrastructure on the rail lines and around the road. There is ample room for improvement in riparian vegetation as well, including species and age class diversity. These clear resource benefits, however, are juxtaposed with the challenge of feasibility in working with the railway company. This reach should be included in conversations about the adjacent sub-reaches included in the city's Master Plan, as the conditions on this sub-reach will affect the dynamics below Broadway.

Segment 3: Broadway to Mullan Road

4.1.19 Sub-Reach 4A

NRCS Score: 21% - Estimated Not Sustainable; Fish Habitat Score: 10% - Estimated Poor

Narrative: Remotely assessed via Google Earth 8/3/2019 imagery and observations from the road and from adjacent sub-reaches. This large agricultural property was inaccessible because private landowner refused permission—property is for sale. Historical imagery shows extensive ditch clearing over 20-40 years, as well as heavy agricultural use and encroachment. Channel estimated to be Rosgen-type G; a large berm on the downstream side of the channel indicates that this is a constructed channel form in a location intended to minimize interference with haying. The impacts are visible presently as ditching, incision, erosion, noxious and undesirable vegetation, and dewatering. For these reasons, fish habitat is estimated poor. Recent years of cottonwood regeneration has supported localized bank stability, but a large effort will be required to relocate the stream, and restore channel condition, form and function. Hay production currently occurs very close to the channel. Also, near Whippoorwill Rd. there is a culvert input from Broadway that shows a large head-cut on the right bank. Lower end of sub-reach has a fence crossing that is partly obstructed by debris.

Trend: Trend is likely declining, though recent revegetation by cottonwoods is beneficial. Re-watering post sale has potential to benefit the sub-reach. Significant restoration needed to de-gully.

Restoration Potential: Restoration potential is High priority. This sub-reach is in very poor condition and is in need of support in order to maintain any resource benefits such as native vegetation and fish habitat. Increased opportunities are also emerging with the support of restoration in the Sx^{w}tpqyen Master Plan, such as the proposed 200ft buffer on each side of stream for any, along with the interest in developing parks, trails and green spaces in the neighborhoods proposed to be built here in the near future. Restoration work would need to be holistic and continuous (upstream and downstream) to be sustainable. Beneficial actions would include channel re-construction, revegetation, and irrigation return. The culvert under Broadway is considered to be a fish passage barrier. The historical creek path likely diverges widely from the existing ditched channel, and this should be considered in any channel construction efforts.

4.1.20 Sub-Reach 3A

NRCS Score: 18% - Not Sustainable; Fish Habitat Score: 6% - Poor

Narrative: Walked from the upstream edge of the airport property at the boundary with the private ranch to the first fenced stream crossing. Intermittent pools at 1-2ft depth, but no active

flow existed (July survey). Channel fairly bare of natural vegetation and deeply incised (4-6ft throughout) in a clay soil. The substrate appears clay and silt dominated, with some sand, in a Rosgen-type G channel. No fish habitat at present. Non-native herbs abundant. Grasses from hay/grazing dominate on top of banks. The few native plants include *Juncus*, mint, some willow. Several old hawthorn exist at the end of the sub-reach, off the bank edge. One old overflow channel is completely inaccessible. Human land management for cattle grazing is the dominant feature of the channel condition, though not all management practices apparent. Some slumping. Silty clay banks have a cracking pattern. Unclear when there was a last representative flow.

Trend: Trend indicates decline for all the reasons listed.

Restoration Potential: High priority. This sub-reach is in severely damaged and declining condition, and the channel and habitat conditions are unsustainable. Restoration would require a careful geomorphologic and engineering approach and would likely include full channel re-construction, bank and floodplain revegetation, and possibly irrigation management (the City of Missoula is proposing to buy most of the irrigation rights in this area). Although the challenge is substantial, the restoration opportunities are intriguing. A comprehensive integrated restoration plan linking reaches 4A, 3A, 3B, 3C, and 2A would be advisable. The airport will require that any restoration of these reaches supports the safety and security of all their operations, which may include various constraints on habitat types, restoration process and access. However, the Sx^{w}tpqyen Master Plan likely leads City-County planners to seriously consider how restoration of Grant Creek would complement public interest in parks, trails and green spaces in the adjacent proposed neighborhoods. Further challenges include the difference between the existing channel and the likely future FEMA floodplain area, along with the threat that enhanced bird habitat might pose to the airport.

4.1.21 Sub-Reach 3B

NRCS Score: 25% - Not Sustainable; Fish Habitat Score: 25% - Poor

Narrative: Walked from fence-line to lower fence-line at a management change from grazing to haying. A small irrigation input comes in at the top of the sub-reach, determined to be excess Flynn-Lowney Ditch water (from Clark Fork river). This is also a Rosgen-type G channel with a silty and sandy substrate. The water was slow and turbid, and though it was deep there was little cover and likely reflects poor fish habitat. Stands of willows and cottonwood on right bank provided some stability and cover. Cattle impacts are significant throughout the sub-reach, and they include slumping, gouging, browse, and intermittent widening. Some beaver signs at cottonwood stand. Human impacts evident include trash, old vegetative clearing, haying, and cattle. Channel became straight, obviously ditched. At the bottom of the sub-reach, a heavy metal gate across the creek was covered by long-term debris accumulation. Fence marked the

separation between cattle and active haying. Small burrows exist in the banks, potentially of muskrat. Left bank is almost absent of shrubs and trees. Water in ditch later found to be backwatering from lower in the property, hence the increase in flow through the sub-reach. Some raptor habitat exists in cottonwoods and willows (hawks, owls and eagles seen).

Trend: Trend declining.

Restoration Potential: High priority. This sub-reach is in severely damaged and declining condition, and the channel and habitat conditions are unsustainable. Restoration would require a careful geomorphologic and engineering approach and would likely include full channel/floodplain re-construction, bank and floodplain revegetation, and possibly irrigation management (the City of Missoula is proposing to buy most of the irrigation rights in this area). Although the challenge is substantial, the restoration opportunities are intriguing. A comprehensive integrated restoration plan linking reaches 4A, 3A, 3B, 3C, and 2A would be advisable. The airport will require that any restoration of these reaches supports the safety and security of all their operations, which may include various constraints on habitat types, restoration process and access. However, the Sx^{w}tpqyen Master Plan likely leads City-County planners to seriously consider how restoration of Grant Creek would complement public interest in parks, trails and green spaces in the adjacent proposed neighborhoods. Further challenges include the difference between the existing channel and the likely future FEMA floodplain area, along with the threat that enhanced bird habitat might pose to the airport.

4.1.22 Sub-Reach 3C

NRCS Score: 27% - Not Sustainable; Fish Habitat Score: 31 % - Poor

Narrative: The transformation of Grant Creek into a ditch is eminently obvious throughout this sub-reach. Walked from fence crossing down to concrete dam on lower end of property. Dam made of pre-cast concrete blocks is elevated one foot above accumulated upstream silt, approximately 4' drop to water surface on downstream side. This was apparently built recently in place of an older check dam. The sub-reach was a Rosgen-type G with a silty and sandy substrate. Some minnows visible, but water is exposed and lacks complexity so it is uncertain how good of fish habitat this is beyond some rearing habitat. Some woody vegetation at top of sub-reach but channel dominantly bare, with only hay/exotics present. Three (3) pump houses pulling water for pivots and grass/alfalfa, two of these recently buttressed by concrete foundations. One active tractor-crossing bridge. Water of fairly consistent depth, up to 5' with slow change in depth. Buffer of uncut hay provides some habitat, notably for birds and squirrels. Flushed three owls out of hawthorns. Bank somewhat stable due to lack of flow. At the bottom of the sub-reach, at the dam, an inflow from the Flynn-Lowney Ditch enters from left. Mostly silt, clay, some cobble substrate visible near bridge and riprap. Water backwatering up to

increase the depth at the pumps. Learned from the ranch manager of the long family history of ownership, and the subsequent leasing from airport since 2000. People have homesteaded the property since the 1800s. They had seen weasels, badgers, and many bird species.

Trend: Somewhat stable due to lack of high flow, but trend of habitat is declining.

Restoration Potential: High priority. This sub-reach is in severely damaged and declining condition, and the channel and habitat conditions are unsustainable.

4.1.23 Sub-Reach 2A

NRCS Score: 47% - Not Sustainable; Fish Habitat Score: 50% - Fair

Narrative: Walked from concrete dam at the lower boundary of the airport property to the bridge at Hiawatha Road—the old Milwaukee rail line. Channel is deeply ditched and the water is stagnant. Rosgen-type G channel with a silty substrate. Small outflow channel ditch leaves on left bank and follows Hiawatha road towards Mullan Rd. Tansy and hounds tongue are present. Uncertain how to include adjacent constructed wetland into Riparian Assessment, so we left it un-surveyed. With this note, fish connectivity is uncertain, but largely appears to be poor through main channel. Large cottonwoods form a canopy, though age class limited to mature and decadent. Intermittent hawthorn and snowberries and sedge on banks. Some old trees fallen with extensive beaver activity present. Large slumps visible. Deep silt on bottom. In clearings, hay encroaching onto the banks. A levee on left bank separates channel from the constructed wetland (now vegetated mostly with cattails). Channel connects to wetland at low flow, at which point the channel goes dry until wetland outflow reconnects at lower end of sub-reach. This wetland is known as "Hiawatha Lake," and was constructed during flood reduction efforts in the early 2005 to 2008 period.

Trend: Erosion present, but channel somewhat stable in the mid-term due to slow/no flow. Cottonwoods mature and decadent. Lacking pole/sapling age classes, and with beaver damage there is a risk of losing this limited cover.

Restoration Potential: High priority. The ditched channel is heavily manipulated, and is being used as a sort of reservoir during irrigation season, for Clark Fork river water. Like the two reaches above, restoration would require a careful geomorphologic and engineering approach and would likely include full channel/floodplain re-construction, bank and floodplain revegetation, and possibly irrigation management (the City of Missoula is proposing to buy most of the irrigation rights in this area). Although the challenge is substantial, the restoration opportunities are intriguing. A comprehensive integrated restoration plan linking reaches 4A, 3A, 3B, 3C, and 2A would be advisable. The airport will ask that any restoration of these reaches

supports the safety and security of all their operations, which may include various constraints on habitat types, restoration process and access. However, the Sx^{w}tpqyen Master Plan likely leads City-County planners to seriously consider how restoration of Grant Creek and its floodplain would complement public interest in parks, trails and green spaces in the adjacent proposed neighborhoods. Further challenges include the difference between the existing channel and the likely future FEMA floodplain area, along with the threat that enhanced bird habitat might pose to the airport.

4.1.24 Sub-Reach 2B

NRCS Score: 26% - Estimated Not Sustainable; Fish Habitat Score: 30% - Estimated Poor

Narrative: Assessed this sub-reach remotely from aerial imagery via Google Earth, the latest being 8/9/2019. This sub-reach extended from the Hiawatha Rd. converted railroad bridge to the upper end of a homeowner's association common area. The dominant channel structure is heavily ditched, resulting in an estimated Rosgen-type G channel. The substrate at the low end is silt/clay while at the top there is cobble showing. While there is water in this sub-reach, the fish habitat is estimated poor due to passage barriers, dewatering, and lack of cover. Some old trees are present, though some are non-native willows, and the ditch is wide open in other places. These conditions are lingering from the days when a Ditch Authority would come clear the channel. This sub-reach is largely one private property that extends across the creek. The property includes a portion of a constructed detention pond for Mullan Trail subdivision, but there is erosion and a breach occurring in the levee that has allowed the high flows to flow more freely into this detention pond. There was a beaver dam in this sub-reach which was holding the last of the water flowing through from Hiawatha Rd. This of course is just Flynn-Lowney water in July, although flow was connected throughout Grant Creek in early sumemr. No pools evident, and the fish habitat and passage are likely poor. Bank erosion is a concern, and the channel form is likely very unstable at higher flows. Some horse grazing and irrigation occurring on the property. No contact with landowner yet.

Trend: Trend is declining. Stream needs overflow channels and a wider floodplain to prevent erosion and incision.

Restoration Potential: Medium priority. The channel is heavily manipulated and is unsustainable as a result. There could be beneficial revegetation and beaver mitigation efforts to support bank stability, however the primary causes of degradation remain the channelization from the levees. These features would be challenges to the feasibility of the effort. Additionally, the history of flooding and the extensive flood reduction efforts carried out in the past 20 years would need to be recognized both as prior conditions and as reasons for local landowners to be involved in further alterations. A vision of a naturalized channel is distant, but needed.

4.1.25 Sub-Reach 2C

NRCS Score: 37% - Not Sustainable; Fish Habitat Score: 25% - Poor

Narrative: Walked from the homeowner's association common area to a property boundary between two Prairie Schooner Lane houses. This is a constructed straight Rosgen-type G channel with silt substrate. Above the sub-reach a beaver dam is visible, holding water while the channel below is dry/puddled, obviously lacking fish habitat. Deeply ditched and eroding throughout, with one overflow point eroding the levee separating the channel from the detention pond, which is now all dry. Many invasive plants and trash present in channel. Several old non-native willows, but all other vegetation has grown since the Ditch Authority days ended. Some frogs and killdeer present, along with tracks of deer and raccoons. Levee top is fenced with barbed wire. Detention pond apparently was once a hay field.

Trend: Declining. The levee is at risk of degrading during high flows.

Restoration Potential: Medium priority. The channel is heavily constructed and is unsustainable as a result. There could be beneficial revegetation and beaver mitigation efforts to support bank stability, however the primary causes of degradation remain the channelization from the levees. These features would be challenges to the feasibility of the effort. Additionally, the history of flooding and the extensive flood reduction efforts carried out in the past 20 years would need to be recognized both as prior conditions and as reasons for local landowners to be involved in designing further alterations. Some landowners show support, but a vision of a naturalized channel is distant, though clearly needed.

4.1.26 Sub-Reach 2D

NRCS Score: 45% - Not Sustainable; Fish Habitat Score: 31% - Poor

Narrative: Walked from a large willow off of the Prairie Schooner properties to a remnant beaver dam below the outflow of the detention pond. Channel is a ditched Rosgen-type G with a silt substrate. Channel currently dry, and no fish habitat present. The levee on the left bank separating the creek from a settling pond is fairly vegetated, though it hosts lots of tansy. Immature willows stabilizing to some degree, but slumping and some widening is common. The channel veers 90 degrees East at a riprapped bend. Property lines and fences encroach on the banks, and grass clippings are dumped into the channel in several places. A small pump is still in the channel. Connects with settling pond, likely the outflow but possibly also a backwater at times. Undesirable grasses abundant. Tracks in the mud include deer, raccoon, and coyote, with consistent beaver sign 6+ months old. One 24" drainage outflow stuck with willow growth.

Trend: Moderately improving given the ditching due to the willow growth, but overall the ditch-like qualities render the channel distinctly un-natural, difficult to maintain and probably unsustainable.

Restoration Potential: Medium priority. The channel is heavily constructed and is unsustainable as a result. There could be beneficial revegetation and beaver mitigation efforts to support bank stability, however the primary causes of degradation remain the channelization from the levees and the damage done by private landowners. These features would be challenges to the feasibility of the effort. Additionally, the history of flooding and the extensive flood reduction efforts carried out in the past 20 years would need to be recognized both as prior conditions and as reasons for local landowners to be skeptical of further alterations. A vision of a naturalized channel is distant, but needed.

4.1.27 Sub-Reach 2E

NRCS Score: 52% - At Risk; Fish Habitat Score: 38% - Poor

Narrative: Walked the continuation of ditch down to the Mullan Road culvert. Rosgen-type G channel with silt substrate. No water present and fish habitat poor. Sandbar and golden willows prevalent, with some rose and cottonwoods assisting bank stability, but erosion was common especially at backyard clearings and lawn encroachment. Clearing, access, pumps, and dumping are among local impacts. Root mats extensive where present. Moderate cover through sub-reach. Some overflow channels revealing that at high flow there is excessive energy beyond what the channelization can handle. Some older trees but many recently planted or have sprouted since the end of the committed ditch work. Riprap present near the road. A large overflow flood relief feature provides additional culverts under Mullan Road for high flow, but it isn't clear how often this is accessed. Many small minnows dying in the corrugated culvert under Mullan Rd. Remnant beaver dam at upper end of sub-reach caused some widening, aiding in some floodplain formation.

Trend: Moderately stable, though much is dependent on private land management.

Restoration Potential: Medium priority. The channel is heavily constructed and is at risk as a result. There could be beneficial revegetation and beaver mitigation efforts to support bank stability, however the primary causes of degradation remain the channelization from the levees and the damage done by private landowners. These features would be challenges to the feasibility of the effort. Additionally, the history of flooding and the extensive flood reduction

efforts carried out in the past 20 years would need to be recognized both as prior conditions and as reasons for local landowners to be involved in future alterations. A vision of a naturalized channel is distant, but needed.

Segment 4: Mullan Road to Clark Fork

4.1.28 Sub-Reach 1A

NRCS Score: 70% - Estimated At Risk; Fish Habitat Score: 30% - Estimated Poor

Narrative: Assessed from aerial imagery on Google Earth, the latest being 8/3/2019. Was inaccessible because landowner did not grant permission in the timeline of the survey effort. The heavily manipulated and channelized upper reach is estimated Rosgen-type G channel transitioning to an E channel. There is a trailer court on the left bank in the upper end, which constrains the channel. The stream is currently dry and lacking fish habitat. The old imagery showed a history of heavier human impacts and alterations to channel, such as vehicle crossings, narrowing of the riparian corridor, and significant ditching at the emergence from Mullan Rd. The impacts of the corrugated culvert and crossings are likely more evident on the ground, and they are likely significant to fish habitat but they weren't so readily registered via satellite. Some stability is apparent through the increased vegetative cover, likely due to the decreased intensity of management in recent years. A network of piping is visible from the aerial image but it isn't clear what water use occurs on this property. The sub-reach ends at upper end of David Miller's property, and the management changes distinctly at a fence-line.

Trend: Trend likely improving with the increase in vegetative cover and the removal of intensive management practices like haying, driving, and clearing. Dewatering is significant still.

Restoration Potential: Medium priority. It is difficult to assess what might be feasible from aerial imagery, but recovery to higher quality ecological condition from past clearing and widening is likely needed for this sub-reach. The exact land management of this sub-reach is significant to understanding the restoration opportunities and feasibility. The culvert to Mullan Road and the encroaching developments likely pose challenges to a naturalized channel.

4.1.29 Sub-Reach 1B

NRCS Score: 43% - Not Sustainable; Fish Habitat Score: 31% - Poor

Narrative: Active wooden footbridge at start of sub-reach site. Incised, old, constructed channel, Rosgen-type G with gravel/cobble substrate. Channel is bone dry and lacking fish habitat. Bed down-cutting apparent. Lateral cutting more severe on upper end, i.e. the lateral cutting question (#2) scored 0 on the upper end and 2 on the lower. Some small flood plains forming. This is a straightened constructed channel from 25-50 years ago. There are willows and some younger cottonwood on the banks. There are remnant eroding levees on downhill side of the channel. Abundant steep and eroding banks, especially where grasses dominate.

Trend: Perhaps slow improvement.

Restoration Potential: Medium restoration priority. This sub-reach is degraded primarily due to the historic land management, namely the ditching. There is a high potential for small changes, such as planting woody riparian species to benefit the channel's ecological condition. Although it would be less feasible, a floodplain reconstruction could help the channel return to a more geomorphically stable condition, but the reaches immediately upstream and downstream would need to be incorporated in the design. Additionally, there would be mutual benefits from the improved channel sustainability for the sole landowner and their constituents who recreate on this land, making the factor of landowner interest important.

4.1.30 Sub-Reach 1C

NRCS Score: 28% - Not Sustainable; Fish Habitat Score: 25 % - Poor

Narrative: Old pasture with heavy historic grazing impact; the channel may have been historically relocated to this area. Lots of direct and indirect signs (plant communities, soil) of livestock impact. Incised Rosgen-type G channel with gravel/sand substrate. No water, so fish habitat is low. Tansy, spurge, knapweed present. Two age classes of shrubs are missing (due to historic overgrazing), and hawthorn is the dominant shrub. A few floodplain features exist to accomodate large floods only, no newer inset floodplains exist.

Trend: Not improving.

Restoration Potential: High restoration priority. This sub-reach is degraded primarily due to the land management, namely the historical cattle impacts. There is a high potential for small changes, such as reducing cattle impacts in the creek planting woody riparian species to benefit the channel's ecological condition. Although it would be less feasible, a floodplain reconstruction could help the channel return to geomorphically stable condition. Additionally, there would be mutual benefits from improved channel sustainability for the sole landowner making the assessment of landowner interest the critical factor.

4.1.31 Sub-Reach 1D

NRCS Score: 58% - At Risk; Fish Habitat Score: 44% - Poor

Narrative: Deep constriction pool at beginning of channel caused by woody debris, the channel then takes on a natural plan form. Some riprap on corners. Wider Rosgen-type D channel with gravel substrate. Tansy, spurge, knapweed, thistle. Naturalized channel with pools, riffles, some

debris jams, but fish habitat is still limited. Large cottonwoods everywhere. Pools of stagnant water now appearing after a substantial upstream distance with no water in channel.

Trend: Static

Restoration Potential: High restoration priority. This sub-reach is degraded primarily due to the land management, namely the historical cattle impacts. There is a high potential for small changes, such as planting woody riparian species to benefit the channel's ecological condition. Although it would be less feasible, a floodplain reconstruction could help the channel return to prior dynamic condition. Additionally, there would be mutual benefits from the improved channel sustainability for the sole landowner making the assessment of landowner interest critical.

4.1.32 Sub-Reach 1E

NRCS Score: 27% - Not Sustainable; Fish Habitat Score: 56% - Fair

Narrative: Walked from property line between two properties down around a curve to where the stream re-enters the upstream property owner's land. Rosgen-type C/G--gullying present though widened due to cattle activity. Some gravel bars and channels exist. Channel mostly dry then incorporates a large spring coming in on left bank. Multiple schools of minnow-size fish present; some 50-60 individuals, one school of ~500 1" fish—this area has rearing habitat. Upper end is partly dry, with intermittent stagnant pools and one hawthorn stand. Mostly grassy banks, slumping banks common, extremely heavy hoof-shear eroding the banks--cattle present in channel today. Large input of perennial spring at east end (left) of the major channel bend. Heavy browse on willows and grass. Multiple pastures fenced, most very over-grazed. Fence at the bottom was accumulating flood debris. There are 2' deep pools. Hay grasses predominate on banks of the stream, thistles common on higher surfaces. Some native moist area plants—e.g. sedge.

Trend: Trend is declining due to cattle impacts on banks and vegetation.

Restoration Potential: High restoration priority. This sub-reach is degraded primarily due to the land management, namely the cattle grazing practices. There is a high potential for small changes, such as limiting cattle water access along with planting woody riparian species, to benefit the channel's ecological condition. Additionally, there would be mutual benefits from the improved channel sustainability for the sole landowner, making the assessment of landowner interest an important next step.

4.1.33 Sub-Reach 0A

NRCS Score: 30% - Not Sustainable; Fish Habitat Score: 38% - Poor

Narrative: Started on fenced upstream boundary of the property. Cattle were in the creek across the fence. Walked along the well-defined channel, which was consistently incised 2-3 feet below the hay-fields. Rosgen-type G channel, primarily silt with sand and small cobbles. Water is plentiful enough to host fish, but water quality and temperature appear to be poor. Banks slumping throughout, with no shrub or tree presence. Some human debris included tires and concrete slabs. No grazing indicators, though historical grazing impact is likely. Extensive algal carpets. Water somewhat clear though is clouded by silt. One bridge. At bottom of sub-reach the channel is fenced above the water. Measured one deeper pool, but W/D ratio in run was greater than 12. Flow is too slow to move any sediment, and it is unclear what this sub-reach is like at higher flows. Slumping may lead to channel widening.

Trend: Moderately improving, presumably due to lack of active grazing and haying, though no recruitment of woody vegetation is likely without intervention.

Restoration Potential: High restoration priority. This sub-reach is degraded primarily due to the land management, namely the historical presence of cattle and haying. However, the landowner has removed these in the interest of the creek. There is a high potential for additional small changes, such as planting woody riparian species, to benefit the channel's ecological condition. The sole landowner is vocally interested and invested in the mutual benefits that could come from an improved channel condition and sustainability.

4.1.34 Sub-Reach 0B

NRCS Score: 33% - Sustainable; Fish Habitat Score: 44% - Poor

Narrative: Walked between fences but presumably this portion of the property was the same management as 0A. Channel slightly narrower and had deeper banks, though still a Rosgen-type G channel, dominantly silt with sand and small cobbles. One 1ft fish, showing that water is plentiful enough to host fish, but the lack of cover decreased final score. One water pipe crossing the creek with makeshift concrete supports. Two small water inputs, clear-flowing and likely spring-fed. Some cobbles rose through the silt bottom. Algae is extensive throughout. A line of cottonwoods stands at the bottom of the sub-reach, ~30' up from the channel, perhaps indicating a long abandoned channel. Hay grasses dominant.

Trend: Minimal changes detectable, though widening may lead to channel improvement. Banks will remain unstable without woody species recruitment.

Restoration Potential: High restoration priority. This sub-reach is degraded primarily due to the land management, namely the historical presence of cattle and haying. However, the landowner has removed these in the interest of the creek. There is a high potential for additional small changes, such as planting woody riparian species, to benefit the channel's ecological condition. The sole landowner is vocally interested and invested in the mutual benefits that could come from the improved channel sustainability.

4.1.35 Sub-Reach 0C

NRCS Score: 35% - Not Sustainable; Fish Habitat Score: 63% - Fair

Narrative: Walked from the upper boundary of the active grazing area to the lower end of the Frey property. Significant grazing impacts and intermittent crossings widen the channel. Rosgen-type G channel. Cobbles dominate, but some stretches share channel and substrate characteristics with 0A and 0B. One 4-5ft deep pool where the landowner has caught bull trout. Lack of cover and complexity still reduces overall fish habitat. More woody vegetation, especially at one big hawthorn stand. ~30 head of cattle resting in the shade. Western bank bordered and elevated bench, showing dry vegetation. Some willows, hay grasses with some native sedges intermixed. Lower boundary has hanging barbed wire fence with some debris caught. About 5-10 large cattle-crossings damage the stream banks. One muskrat seen swimming into burrow.

Trend: Generally stable in low flow, but cattle impacts severely threaten several sections.

Restoration Potential: High restoration priority. This sub-reach is degraded primarily due to the land management, namely the historical presence of cattle. The cattle remain, but there is a high potential for additional small changes, such as focused cattle access points and the planting of woody riparian species, to benefit the channel's ecological condition. The sole landowner is vocally interested and invested in the mutual benefits that could come from the improved channel sustainability.

4.1.36 Sub-Reach 0D

NRCS Score: 28% - Not Sustainable; Fish Habitat Score: 44% - Poor

Narrative: Walked from upper end of a property at fence crossing to lower boundary fence—one landowner for whole sub-reach. Rosgen-type F channel, substrate is clay and patches of sand, slow flow. Debris piled up on lower boundary and some small fish present, but the overall fish habitat score is low due to lack of cover and complexity. Cattle access and impact extensive throughout the sub-reach, banks sheared and slumping. Some fencing present for grazing

management. Large patches of filamentous algae present. Water flows clear at low flow. Driver of channel condition is unclear, but there is evidence of high flow, with debris at 3.5' above current flow caught in a fence. Active pump on right bank. Banks dominantly grasses, some snowberry on outer banks. One dry overflow channel with some remnant woody cover. Learned from landowner of beaver dam flooding the lowlands--explains high water level though perhaps relatively low flow.

Trend: Declining due to cattle activity. Flow is not driving the channel condition.

Restoration Potential: High restoration priority. This sub-reach is degraded primarily due to the land management, namely the historical presence of cattle. The cattle remain, but there is a high potential for additional small changes, such as focused cattle access points and the planting of woody riparian species, to benefit the channel's ecological condition. The sole landowner and manager makes the opportunity to clarify mutual benefit of such restoration options much simpler.

4.1.37 Sub-Reach 0E

NRCS Score: 62% - Estimated At Risk; Fish Habitat Score: 78% - Estimated Fair

Narrative: Assessed from aerial imagery from Google Earth, the latest being 8/3/19. Was inaccessible because landowner did not grant permission in the timeline of the survey effort. Based on this and the adjacent surveys, the channel was scored. Estimated Rosgen-type G channel, likely substrate is clay and patches of sand. The overall fish habitat score was estimated fair due to stability of channel and management. This sub-reach is the gap between the heavily grazed private piece and the public FWP Kelly Island access that is very minimally impacted by humans. The area is lacking slightly in shrub/tree cover, age classes, and diversity, but roses and sedges are likely. The most significant piece that is not fully captured by the aerial survey is the large/wide flow input or backwater coming from the right bank at the last bend. From the aerial it appears to be spring fed, and potentially even represents a long term historical remnant channel. It appears overall that this sub-reach was historically grazed or hayed and that it is recovering slowly from these impacts as they have been removed. The removal of beavers last year is an important piece of this story as well.

Trend: Trend likely increasing w/o much grazing or industrial impacts.

Restoration Potential: Medium restoration priority. Until this sub-reach is assessed on the ground, there will remain several primary uncertainties, including the channel dynamics at the large backwater/inflow channel. Additionally, the land management impacts appear to be fairly minor, though there are likely historical impacts that remain and could be repaired with revegetation. Opportunity to work with the sole landowner improves the feasibility.

4.1.38 Sub-Reach 0F

NRCS Score: 73% - At Risk; Fish Habitat Score: 88% - Good

Narrative: Walked from lower boundary of private property through MT Fish, Wildlife, and Parks land that had been donated to a current adjacent landowner's family. Limited human walking impact despite fishing access. Rosgen-type F channel, predominantly silt substrate. Little fish present at the confluence, but fish habitat appears to be good. Woody vegetation predominantly on the right bank. Abundant beaver signs on alders. Some seemed to be recent, possibly this spring. Banks semi-stable at low flow with some slumping and erosion occurring below grasses. Predominantly silt with consistent quillwort. At confluence, water enters slow-flowing and wide channel. Gravel bar islands visible at Kelly Island complex. Right bank floodplain narrow to the edge of a steep and dry hillside hosting Ponderosa pines. More signs of wildlife (rodent tracks, cats, deer, beaver, raccoon, and blue herons). Small input from channel on the left bank from a seep. Public access but low impacts.

Trend: Improving, generally stable.

Restoration Potential: Low restoration priority. This area is managed and protected by MT FWP and is not threatened by heavy land use or even recreation impacts. However, the management of the beavers in this sub-reach is a significant feature for the multi-sub-reach flood dynamics on the bottom 5 sub-reaches. Getting clarity on the approach towards beaver conflict should be a priority.

APPENDIX E: Grant Creek Irrigation Diversions

Reach ID	GPS Coordinates		Kind	Status	Bank	Size	Description
10A	46.9631	-114.0091	Headgate diversion	Active	Right	~2' wide	This is the diversion to what people have called Dark Horse Creek. Rocks stacked to divert water. One input returns in Prospect HOA area
10A			Small pump	Active	Left	3HP, 2 inch pipe	Small, likely residential use.
10A			Small pump	Inactive	Left	3HP, 2 inch pipe	Small, likely residential use.
10B	46.9563	-114.0130	Dammed diversion	Active	Right	~2' wide	Tarped, appeared to be pulling ~1/4 of creek's flow. Flows towards house, appears on aerial imagery to flow into large pond.
10B			Small pump	Active	Right	3HP, 2 inch pipe	Small, likely residential use.
10B			Small pump	Inactive	Right	3HP, 2 inch pipe	Small, likely residential use.
10C	46.9548	-114.0130	Headgate diversion	Inactive	Left	~3' wide	Some lumber in creek indicated that the diversion had washed out. May only function at high flow.
8A	46.9372	-114.0216	Headgate diversion	Active	Left	~2' wide	Tarped. This diversion provides water for a pump that powers Grant Creek Ranch's haying.
7D	46.9169	-114.0324	Headgate Diversion	Inactive	Left	~2' wide	Small amount of seepage enters ditch. Ditch enters culvert under Expo Pkway and then returns to creek
5A	46.9050	-114.0434	Headgate diversion	Inactive	Left	~2' wide	Old road crossing with concrete foundation. Brackets on the concrete to possibly divert flow. Headgate closed. Recently rebuilt boards provide driving access over it.
5B	46.9042	-114.0458	Cement culvet	Active	Left	36 inches diameter	36-inch cement pipe diverts into Dougherty water right. Evidence of recent fill and erosion around this pipe. At low flow, this captures nearly all the water in the stream.
3C	46.9017	-114.0808	Pumphouse	Active	Right	N/A	Clark Fork water from Flynn-Lowney ditch backwatering up to pumps.
3C	46.9002	-114.0835	Pumphouse	Active	Left	N/A	Clark Fork water from Flynn-Lowney ditch backwatering up to pumps. Recently rebuilt foundation.

APPENDIX E: Grant Creek Irrigation Diversions

Reach ID	GPS Coordinates		Kind	Status	Bank	Size	Description
3C	46.9000	-114.0840	Pumphouse	Active	Right	N/A	Clark Fork water from Flynn-Lowney ditch backwatering up to pumps. Recently rebuilt foundation.
2D	46.8886	-114.0920	Small pump	Inactive	Right	3HP, 2 inch pipe	No water, but pipe is still in the creek
2E	46.8866	-114.0867	Small pump	Inactive	Left	3HP, 2 inch pipe	Residential pump
0D	46.8757	-114.0977	Pumphouse	Active	Right	N/A	Fenced to prevent cattle impacts. Less than 5 years old.
	Shading indicates approximation based on Google Earth						

GRANT CREEK									
Sub-Reach Code	Date	Observers	Primary Land Use	Plant Community	Rosgen Type	BF Depth (ft)	BF Width (ft)	W/D Ratio	Channel Substrate
10A	7/19/21	SL, BGA, RB	Forest	BB2	B	0.9	23	25.6	Cobble
10B	7/19/21	SL, BGA, RB	Forest	BB2	B	0.55	18.8	34.2	Cobble
10C	6/22/21	SL WM MH BGA	Forest	BB2	B	0.85	28.5	33.5	Cobble with some gravel
9A	6/22/21	SL WM MH BGA	Forest with some Ag	BB2	B and D	1	25	25.0	Cobble dominant, but many smaller sizes (sand) present.
9B	6/29/21	SL, SO, BGA, WF	Forest	BB2	B	0.975	21.5	22.1	Cobble
8A	7/20/21	SL, BGA	Forest	BB2	B	0.8	25.2	31.5	Cobble
8B	6/29/21	SL, SO, BGA, WF	Forest	BB2	B	0.825	22.2	26.9	Cobble, some boulder
7A	6/9/21	SL WM	Forest	BB2	B	1.675	20	11.9	Cobble
7B	6/22/21	WM, SL, PJ, VW, DS, WF, RC, ST	Forest	BB2	B	1.075	26	24.2	Cobble
7C	6/23/21	WM afternoon trainees	Forest	BB2	B	1.025	20	19.5	Cobble
7D	7/6/21	SL, BGA	Forest	BB2	B	0.725	22.4	30.9	Cobble with some boulders
6A	7/6/21	SL, BGA	Forest	BB2	B	1.05	14.2	13.5	Cobble
Interstate 90									
6B	7/20/21	SL, BGA	Forest/Commercial	BB2	B	0.625	20	32.0	Cobble
6C	7/20/21	SL, BGA	Industrial/Commercial	BB2	B	1.025	17.6	17.2	Cobble
6D	6/9/21	SL WM	Industrial/Commercial	BB4	B	1.275	24.5	19.2	Cobble
5A	7/20/21	SL, BGA	Industrial/Commercial	BB4	D	0.375	41	109.3	Cobble
5B	7/20/21	SL, BGA	Industrial/Commercial	BB4	D	0.55	23.5	42.7	Cobble
5C	8/4/21	SL	Industrial/Commercial	BB4	D/G	N/A	N/A	N/A	N/A
Broadway									
4A	8/4/21	SL	Agriculture	BB4 into SR2	G	N/A	N/A	N/A	
3A	7/5/21	SL, RC, BGA	Agriculture	GR4	G	0.725	15.8	21.8	Sand with some silt
3B	7/5/21	SL, RC, BGA	Agriculture	GR4	G	1.225	15.7	12.8	Silt
3C	7/5/21	SL, RC, BGA	Agriculture	GR4	G	2.15	23.2	10.8	Silt
2A	7/6/21	SL, BGA	Forest	B2 into GR4 hawthor	G	2.525	17.6	7.0	Silt with some sand
2B	8/9/21	SL	Agriculture	SR2	G	N/A	N/A	N/A	Silt with some sand
2C	7/22/21	SL	Suburban/Residential	SR4	G	1.2	19.4	16.2	Sand/silt
2D	7/22/21	SL, EC	Suburban/Residential	SR2	G	1.25	12.6	10.1	Sand/silt
2E	7/22/21	SL	Suburban/Residential	SR2	G	1.45	12.2	8.4	Gravel
Mullan Road									
1A	8/4/21	SL	Suburban/Forested	BB2	E	N/A	N/A	N/A	N/A
1B	7/13/21	WCM, RC	Agriculture	BB2	G	0.8	8.5	10.6	Cobble, gravel
1C	7/13/21	WCM, RC	Agriculture	SR2	G	0.8	12.5	15.6	Gravel with sand
1D	7/13/21	WCM, RC	Agriculture	BB2	D	0.75	17.5	23.3	Gravel
1E	7/21/21	SL, WCM	Agriculture/Pasture	GRD	C/G	0.6	16.6	27.7	Gravel with some cobble and mud
0A	6/30/21	SL, LGM	Agriculture	GR4	sted as F, but possibly	0.875	17.2	19.7	Sand dominant
0B	6/30/21	SL, LGM	Agriculture	GR4	sted as F, but possibly	1.55	15.4	9.9	sand with rocky patches
0C	6/30/21	SL, LGM	Agriculture	GRD	sted as F, but possibly	0.925	18	19.5	Cobble
0D	7/16/21	SL, GL, NR, ML, LK	Agriculture	GRD	F	1.55	26.9	17.4	Sand
0E	8/4/21	SL	Agriculture	SR4	F	N/A	N/A	N/A	Sand/Silt
0F	7/16/21	SL, GL, NR, ML, LK	Forest	SR4	F	1.9	33.1	17.4	Sand

GRANT CREEK

Sub-Reach Code	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	NRCS Score	NRCS Rating	Q1	Q2	Q3	Q4	Q5	Rating	Fish Habitat Rating
10A	8	7	6	6	6	2	3	8	4	8	97%	Sustainable	3	4	2	4	3	100%	Good
10B	8	8	6	6	6	2	2	7	4	8	95%	Sustainable	3	4	2	3	3	94%	Good
10C	8	8	6	6	6	2	2	8	4	8	97%	Sustainable	3	3	2	4	3	94%	Good
9A	8	7	5	6	4	2	1	8	4	8	88%	Sustainable	3	4	2	4	2	94%	Good
9B	8	7	6	6	6	2	2	8	4	8	95%	Sustainable	3	4	2	4	1	88%	Good
8A	8	6	6	4	4	2	2	7	4	8	85%	Sustainable	3	4	2	3	2	88%	Good
8B	6	5	6	6	3	1	1	7	3	8	77%	At Risk	3	4	1	4	2	88%	Good
7A	8	8	6	4	6	2	2	8	4	8	93%	Sustainable	3	3	2	4	3	94%	Good
7B	8	8	6	6	6	2	1	8	4	7	93%	Sustainable	3	3	2	4	2	88%	Good
7C	8	8	6	6	6	2	2	8	4	8	97%	Sustainable	3	3	2	4	2	88%	Good
7D	8	6	6	6	6	2	2	8	4	8	93%	Sustainable	3	3	2	3	3	88%	Good
6A	8	8	6	4	6	1	3	6	4	8	90%	Sustainable	3	2	2	4	3	88%	Good
Interstate 90																			
6B	8	5	4	2	4	1	2	5	4	6	68%	At Risk	3	1	2	4	2	75%	Fair
6C	5	3	3	4	4	2	2	5	4	2	57%	At Risk	3	1	1	4	2	69%	Fair
6D	6	5	2	2	2	0	0	8	4	2	52%	At Risk	2	2	1	3	2	63%	Fair
5A	6	5	4	0	4	2	2	5	4	6	63%	At Risk	3	2	1	2	2	63%	Fair
5B	6	2	4	0	0	0	2	3	4	2	38%	Not Sustainable	3	1	1	0	1	38%	Poor
5C	6	3	4	2	4	N/A	2	4	N/A	4	55%	Estimated At Risk	3	1	1	0	N/A	38%	Poor
Broadway																			
4A	2	2	2	2	1	N/A	0	2	N/A	0	21%	Estimated: Not Sustainable	N/A	1	0	0	N/A	10%	Poor
3A	2	3	2	0	0	0	0	0	4	0	18%	Not Sustainable	0	0	0	0	1	6%	Poor
3B	2	1	1	4	0	2	0	3	2	0	25%	Not Sustainable	0	2	0	1	1	25%	Poor
3C	3	3	4	1	0	1	0	0	4	0	27%	Not Sustainable	0	2	0	2	1	31%	Poor
2A	4	3	4	4	2	1	0	4	4	2	47%	Not Sustainable	0	3	1	2	2	50%	Fair
2B	3	3	2	2	0	N/A	N/A	1	N/A	2	26%	Estimated: Not Sustainable	N/A	1	1	1	N/A	30%	Poor
2C	3	3	2	2	2	0	1	2	4	3	37%	Not Sustainable	0	1	1	0	2	25%	Poor
2D	5	3	2	2	4	1	1	4	4	1	45%	Not Sustainable	0	1	1	0	3	31%	Poor
2E	4	2	3	3	4	1	2	4	4	4	52%	At Risk	2	1	1	0	2	38%	Poor
Mullan Road																			
1A	5	6	4	4	6	N/A	N/A	6	N/A	4	70%	Estimated: At Risk	N/A	1	2	0	N/A	30%	Poor
1B	2	0	4	6	2	2	0	6	4	0	43%	Not Sustainable	2	1	0	0	2	31%	Poor
1C	2	3	2	2	2	0	0	2	4	0	28%	Not Sustainable	2	1	0	0	1	25%	Poor
1D	6	3	4	4	2	1	1	4	4	6	58%	At Risk	3	2	0	0	2	44%	Poor
1E	2	1	4	2	0	2	0	1	2	2	27%	Not Sustainable	2	3	0	3	1	56%	Fair
0A	5	3	2	0	0	2	0	0	4	2	30%	Not Sustainable	0	2	0	4	0	38%	Poor
0B	5	3	4	0	0	2	0	0	4	2	33%	Not Sustainable	0	3	0	4	0	44%	Poor
0C	6	2	2	2	0	1	0	0	4	4	35%	Not Sustainable	2	3	0	4	1	63%	Fair
0D	5	1	2	0	0	2	0	0	4	3	28%	Not Sustainable	0	2	0	4	1	44%	Poor
0E	8	6	4	2	0	N/A	N/A	4	N/A	6	62%	Estimated: At Risk	3	3	1	N/A	N/A	78%	Fair
0F	8	6	4	6	2	2	2	4	4	6	73%	At Risk	3	3	1	4	3	88%	Good

APPENDIX I:

GRANT CREEK RESTORATION PRIORITIES BY REACH (DRAFT)

Sub-Reach Code	NRCS Score	NRCS Rating	Fish Habitat Score	Fish Habitat Rating	Restoration Priority Level
10A	97%	Sustainable	100%	Good	Low
10B	95%	Sustainable	94%	Good	Low
10C	97%	Sustainable	94%	Good	Low
9A	88%	Sustainable	94%	Good	Low
9B	95%	Sustainable	88%	Good	Low
8A	85%	Sustainable	88%	Good	Low
8B	77%	At Risk	88%	Good	Low to Medium
7A	93%	Sustainable	94%	Good	Low
7B	93%	Sustainable	88%	Good	Low
7C	97%	Sustainable	88%	Good	Low
7D	93%	Sustainable	88%	Good	Low
6A	90%	Sustainable	88%	Good	Low
Interstate 90					
6B	68%	At Risk	75%	Fair	Medium
6C	57%	At Risk	69%	Fair	High
6D	52%	At Risk	63%	Fair	Medium
5A	63%	At Risk	63%	Fair	Medium
5B	38%	Not Sustainable	38%	Poor	High
5C	55%	Estimated At Risk	38%	Poor	Medium
Broadway					
4A	21%	Estimated: Not Sustainable	10%	Poor	High
3A	18%	Not Sustainable	6%	Poor	High
3B	25%	Not Sustainable	25%	Poor	High
3C	27%	Not Sustainable	31%	Poor	High
2A	47%	Not Sustainable	50%	Fair	Medium
2B	26%	Estimated: Not Sustainable	30%	Poor	Medium
2C	37%	Not Sustainable	25%	Poor	Medium
2D	45%	Not Sustainable	31%	Poor	Medium
2E	52%	At Risk	38%	Poor	Medium
Mullan Road					
1A	70%	Estimated: At Risk	30%	Poor	Medium
1B	43%	Not Sustainable	31%	Poor	High
1C	28%	Not Sustainable	25%	Poor	High
1D	58%	At Risk	44%	Poor	High
1E	27%	Not Sustainable	56%	Fair	High
0A	30%	Not Sustainable	38%	Poor	High
0B	33%	Not Sustainable	44%	Poor	High
0C	35%	Not Sustainable	63%	Fair	High
0D	28%	Not Sustainable	44%	Poor	High
0E	62%	Estimated: At Risk	78%	Fair	Medium
0F	73%	At Risk	88%	Good	Low