

Riparian Habitat Assessment for Flint Creek and Boulder Creek Granite County, Montana

Environmental Services Contract #SPB-12-2177V

Task Order 1.28



Prepared for

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1.0 BACKGROUND

Watershed Consulting, in partnership with Great West Engineering, was retained by the Natural Resource Damage Program (NRDP) to evaluate riparian health conditions in the Flint Creek watershed south of Drummond, specifically in the main stems of Flint Creek and Boulder Creek. Field assessments were conducted in the summer and fall of 2014 and data collected informs this report, which will assist the NRDP in prioritizing restoration activities in tributaries of the Clark Fork River (CFR).

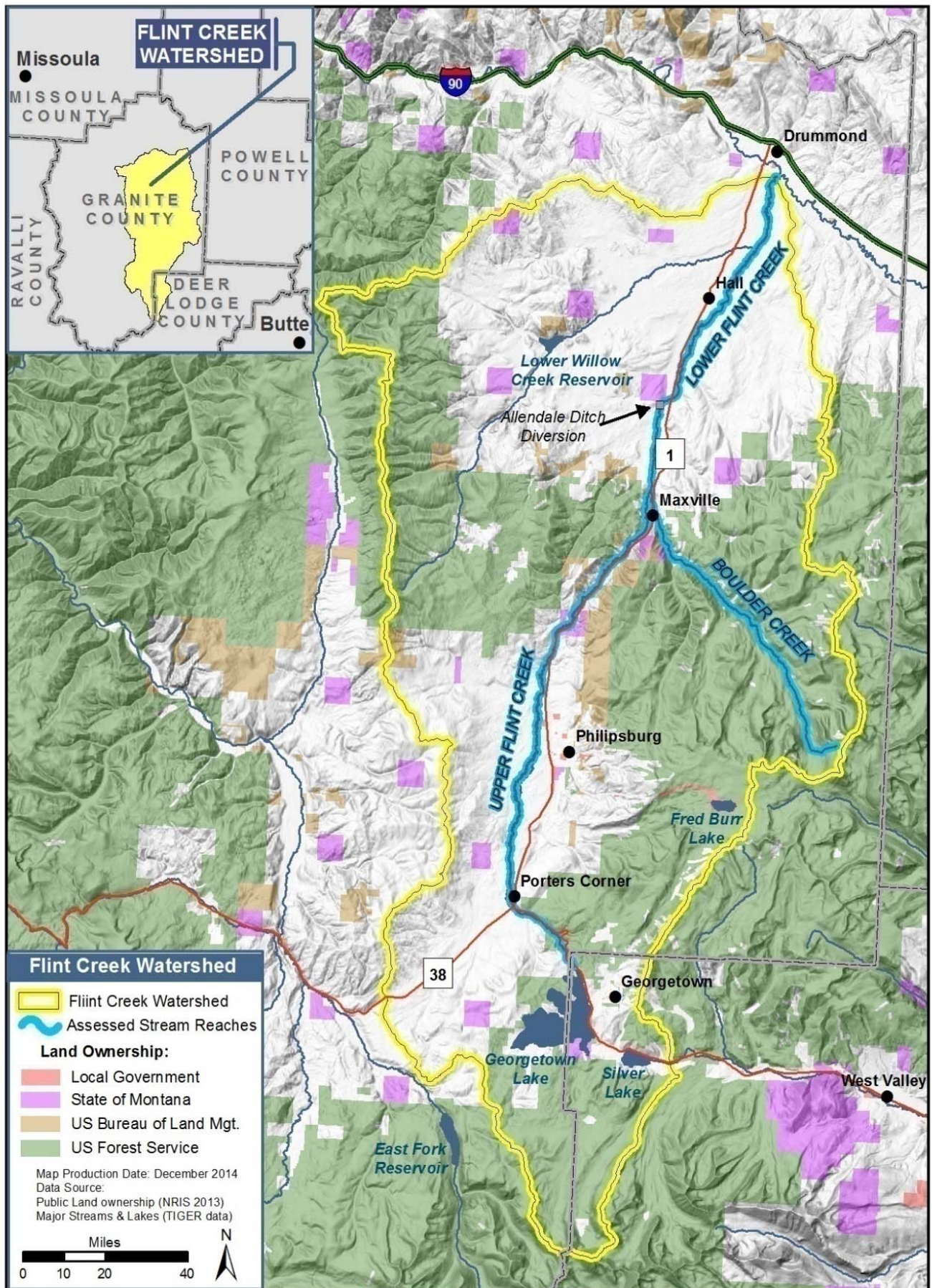
Flint Creek and Boulder Creek are both listed by the Department of Environmental Quality (DEQ) as impaired for different metals as well as sediment (DEQ 2012). The two streams are mentioned for non-pollutant listings as well, specifically for “alteration in streamside vegetation cover” (Flint Creek) and “physical substrate habitat alteration” (Boulder Creek). Low flow alteration was also listed as a concern for the upper section of Flint Creek (DEQ 2012). Field assessment of this watershed was determined in the *Final Upper Clark Fork River Basin Aquatic and Terrestrial Resource Restoration Plan* (NRDP 2012), referred to as the 2012 Restoration Plan, as a necessary step to prioritizing restoration activities to improve aquatic habitat and other impairments to this watershed. That document defines the questions asked in this study as well as the reported results. This report also addresses concerns documented in the Flint Creek Watershed Restoration Plan (Granite Headwaters 2014), which echoes many of the NRDPs findings.

There are two primary objectives for this assessment:

- 1) Evaluate the condition of riparian habitat in Boulder Creek and Flint Creek.
- 2) Identify and rank reach-specific problems and sources as well as opportunities for riparian and in-stream habitat improvements.

This report presents results of riparian habitat assessment conducted through the entire length of Flint Creek and Boulder Creek, both identified as Priority 2 tributaries to the Clark Fork River in the 2012 Restoration Plan. Findings and recommendations in this report will help the NRDP, Watershed Restoration Coalition (WRC) and partners to prioritize projects that address sediment and fisheries-related TMDL priorities, and builds from previous work by Montana Fish, Wildlife and Parks and Trout Unlimited. Metals-related projects were not included in this assessment, though notes related to mining impacts will be delivered to NRDP personnel working on mine-site remediation activities. Figure 1 below shows the project area.

Figure 1. Project Area



The 2012 Restoration Plan lists the following proposed actions (listed in order of priority) for Boulder Creek and Flint Creek, divided into upper and lower sections. Once implemented, these actions will improve the fishery of these waters as well as the main stem of the Clark Fork River.

Flint Creek – Lower

1. Water Quantity: Water quantity concerns are of primary importance in the lower reaches of Flint Creek, defined by NRDP as below the Allendale Diversion. Projects foreseen for this area include water right purchases, water leases, and irrigation efficiency improvements with greater preference given to projects that allow flow protection to the mouth. As this assessment was conducted mostly in the spring, no noticeable water allocation issues were observed. Procedures for pursuing these projects are established in the NRDPs 2012 Plan in section 3.2.1.

2. Fish Entrainment: Previous studies identified irrigation diversions throughout the watershed. These diversions will be evaluated for fish entrainment and screens for diversions will be designed and implemented where warranted.

3. Fish Passage: Previous studies identified 15 crossings and diversions in lower Flint creek. These were ranked and fish passage improvement projects are being designed for the highest priority crossings.

4. Riparian Habitat: Results of this assessment will be used as a first cut to establish riparian habitat improvement projects. Once interest and access is secured for potential projects, further studies will be implemented to determine actual quantities and locations for riparian fencing/protection, woody shrub and tree plantings, off-site watering projects and other projects identified throughout the stream.

Flint Creek – Upper

1. Riparian Habitat: Results of this assessment will be used as a first cut to establish riparian habitat improvement projects. Once access is secured for potential projects, further studies will be implemented to determine actual quantities and locations for riparian fencing/protection, woody shrub and tree plantings, off-site watering projects, railroad grade mitigation and other projects identified throughout the stream.

2. Fish Passage: Previous studies identified 35 crossings and diversions in upper Flint creek. These were ranked and fish passage improvement projects are being designed for the highest priority crossings, with particular attention to passage issues below the mouth of Boulder Creek.

3. Fish Entrainment: All irrigation diversions will be evaluated for fish entrainment. Screens for diversions will be designed and implemented where warranted, with particular attention to passage issues below the mouth of Boulder Creek.

Boulder Creek

1. Fish Entrainment: Previous studies identified 7 crossings and diversions throughout Boulder Creek. These will all be evaluated for fish entrainment. Screens for diversions will be designed

and implemented where warranted, with particular attention to the area between the mouth of Boulder Creek and Maxville.

2. Riparian Habitat: Results of this assessment will be used as a first cut to establish riparian habitat improvement projects. Once access is secured for potential projects, further studies will be implemented to determine actual quantities and locations for riparian fencing/protection, woody shrub and tree plantings, particularly projects downstream of Princeton.

1.1 Existing Conditions

The Flint Creek watershed is bounded by the Flint Creek Range to the east, the Anaconda Range to the south, and the John Long Mountains to the west. Flint Creek drains a total area of approximately 498 square miles. The area is defined by two basins, the Philipsburg valley, ranging from 5,000-6,000 feet in elevation, and Drummond valley, ranging from 4,000-4,600 feet. The two valleys are connected by a narrow canyon. Flint Creek originates at Georgetown Lake, downstream of which flows are dam released and subject to alteration based on electricity needs of the power station. Boulder Creek is considered one of 3 primary tributaries to Flint Creek, draining into Flint Creek in the Philipsburg valley (DEQ 2012).

Philipsburg receives an annual average of 14.8 inches of moisture, compared to 11.8 reported at Drummond. While the hydrograph of tributaries follow typical patterns of peak flows in June with steady declines into the fall, the hydrographs from Flint Creek exhibit a slightly different pattern, with a decline from peak flow being much more gradual and even flattening through some summer months. These somewhat unusual extended high flows and prolonged decline of the hydrograph may reflect the dam management of water releases from Georgetown Lake and the inter-basin transfer of water from the East Fork Reservoir on Rock Creek (which joins Flint Creek at reach F08ra and F08 within the Trout Creek streambed), stored water from the Lower Willow Creek Reservoir (which joins Flint Creek at reach F33ra-1), coupled with the influence of irrigation practices in the valley. Water storage in the East Fork reservoir is approximately half (16,000 acre-feet) of that contained in Georgetown Lake (31,000 acre-feet), and the Lower Willow Creek Reservoir contains a quarter of the E.F. Rock Creek Reservoir, or approximately 4,800 acre-feet (Voeller and Warren 1997). The canyon between the two valleys (Flint Reach 4) is presumed to be a groundwater bottleneck, with all flows from the upper basin entering the lower basin as surface water (DEQ 2012).

Consumptive use of water by agriculture in the Philipsburg valley is approximately about half of what is consumed in the Drummond valley (Voeller and Warren 1997). Another important distinction between the valleys is the shallow nature of the aquifer in the Philipsburg valley, which tends to have faster fall return flows compared to the Drummond valley (Voeller and Warren 1997).

Land use activities in Flint Creek are predominantly cattle and haying in the valleys as well as in the canyon area between the two in some ownerships. The Boulder Creek valley is predominantly in forest and small residential land use with minimal agricultural activities,

primarily due to land use constraints. One valley in the Boulder Creek drainage is cultivated for hay and horse pasture.

The watershed has an extensive history of mining, which impact water quality conditions today. These issues are beyond the scope of this study. Mine site information collected during this survey will be turned over to appropriate NRDP personnel.

2.0 PREVIOUS STUDIES

In addition to the data gathered from this study, previous work was included in the summary and recommendations in this report to facilitate the project prioritization process. Previous studies used include a fish passage and entrainment survey by Trout Unlimited (TU 2013), the DEQ's TMDL documents (DEQ 2012), an FWP/NRDP report of prioritization of fish concerns (Saffel et.al 2011) and the Granite Headwaters Group's Watershed Restoration Plan (Granite Headwaters 2014), which echoes many of the concerns in the NRDPs Restoration Plan and also includes some insights into landowner priorities for restoration in the valley. Other studies consulted for this report include a return flow study (Voeller and Waren 1997) and a report by a local ditch rider explaining irrigation regimes in the valley (Ohrmann 2001).

The locations of specific points of concern found in these previous studies, particularly in relation to fish passage or entrainment issues or water quantity, are shown in reach maps. Relevant information from these reports is included in the description of the relevant sub-reach and reach narratives.

3.0 METHODS

Field methods for this study were focused on evaluating riparian and fish habitat conditions on Boulder and Flint creeks, considering riparian vegetation composition, extent and condition, in-stream fish habitat, bank erosion calculations, floodplain connectivity and notes on associated land uses at the ownership scale. Access to private ownerships was coordinated by WRC and streams were field assessed by ownership, proceeding generally from upstream to downstream.

Initial reaches were determined from aerial images using GIS and based on geomorphologic breaks in the valley as well as ownership boundaries. Sub-reaches were then determined in the field with breaks established based on noticeable changes in stream conditions, habitat or land management. Due to similarity in conditions, sub-reaches may encompass multiple ownerships. The following data were collected within each sub-reach:

- USDA Natural Resources Conservation Service (NRCS) Stream Reach Assessment Form (SRAF) with supplemental fish habitat attributes
- Watershed Restoration Coalition bank erosion inventory
- Photographic documentation
- Remote Sensing
- Identification of restoration opportunities.

All field forms were completed in their entirety in the field at the locations of each sub-reach. Pedro Marques, Restoration Ecologist with Watershed Consulting, and Amy Chadwick, Senior Water Resources Specialist with Great West Engineering each led a team in the field assessment work. Additional team members for the field assessments included: Andrea Stanley, Watershed Scientist with Great West Engineering and Adam Switalski, a road ecologist with Watershed Consulting. Personnel from the WRC, Molly Staats and Sarah Hamblock also accompanied a few reach visits to provide quality control of field interpretation. Molly also provided initial information on how these assessments have been completed in other watersheds in the Upper Clark Fork River Basin.

Two additional quality control visits were made to the project area to confirm field interpretation between the two teams.

3.1 NRCS Riparian Assessments and Fish Habitat Scores

Assessments of riparian and fish habitat parameters was accomplished using the USDA Natural Resources Conservation Service (NRCS) Riparian Assessment Method (NRCS 2012), otherwise known as the SRAF form. Three supplemental questions were included in this study by the WRC, relating specifically to fish habitat considerations and tallied together. Two supplemental attributes for fish habitat from the 2004 version of the NRCS Riparian Assessment Method (NRCS 2004), and an additional fish habitat metric created by Montana Fish, Wildlife, and Parks were incorporated (Lindstrom et al. 2008 and Liermann et al. 2009).

The chosen assessment methodology is intended for rapid assessment of the most noticeable and important functional considerations of a stream and is focused specifically on the riparian corridor and aquatic habitat. The 10 questions on this form require scores for both the potential and actual condition. These scores are totaled and then divided by the total possible points to develop an overall NRCS Assessment score as a percentage departure from the potential. Percentage scores correspond to a stream health rating of Sustainable (80 to 100 percent), At Risk (50 to 80 percent), or Not Sustainable (less than 50 percent) for each sub-reach.

The three scores relating to fish habitat, the 2 supplemental NRCS questions plus the FWP fish habitat metric were tallied together and compared to the potential score for each reach. All three questions had high scores of 10 and low scores of 0, with a potential score of 30 for any reaches in which all questions were assessed. Supplemental question 2 had 5 potential scores, 10,7,5,3, and 0, while supplemental questions 1 and the FWP habitat metric question had four potential habitat scores, 10,7,3,0. Similar to the riparian habitat scores, these three fish habitat scores were tallied together and a percentage score for fish habitat determined. Corresponding ratings for fish habitat used in this assessment are: poor fish habitat (0 to 30%), fair fish habitat (greater 31% to 79%), and good fish habitat quality (80% to 100%).

3.2 Watershed Restoration Coalition (WRC) Bank Erosion Inventory

In addition to riparian and fish habitat scores, an inventory of existing bank erosion was completed for each sub-reach. Methods for this inventory were developed by the WRC in 2011 and revised in 2013 to quantify actively eroding banks in relation to the watershed's sediment supply (Staats and McDowell 2014). Measurements made in the field include the length and height of eroding banks on both banks of the stream as well as the primary source of the erosion. Bank heights were measured from water surface. These values were used to determine the total area (square feet) of eroding bank. Additionally the length of eroding streambank was compared to the total length of the reach (multiplied by 2 to account for both banks), generating a value for the percent of eroding linear bank for each reach. Linear bank erosion ratings were determined based on the following four categories: 0-5%= low; 5.1-10%= moderately low; 10.1-20%= moderately high; 20.1%= high.

3.3 Photographic Documentation

Upstream, downstream and across-stream digital photographs were taken at each sub-reach to show general stream conditions. Field personnel also documented conditions at diversion structures, confluences, or issues in that particular reach that help define potential restoration needs, including typical bank erosion conditions, railroad grade or fenceline issues, corrals or other potential contaminant sources. Each photograph was accompanied by a GPS location and photo descriptions, which provided important input to the sub-reach narratives in the Results portion of this report.

3.4 Additional Site Information

While the scoring and erosion data are the primary data sources for this assessment, some additional information was collected. These data, collected at each sub-reach, include bankfull

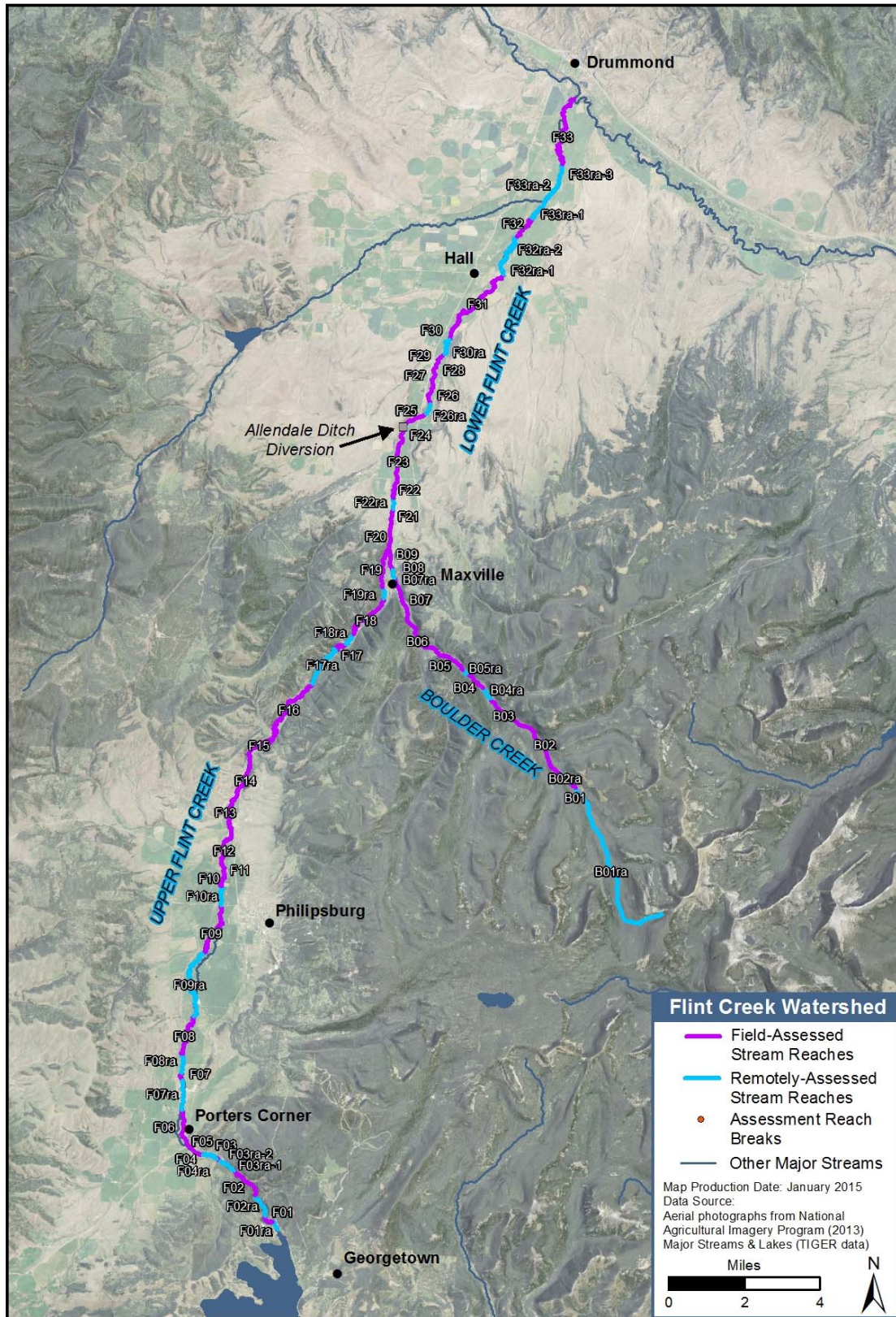
width and depth estimates at riffle cross-sections, as well as corresponding width/depth ratios, channel types based on the Rosgen stream classification method (Rosgen and Silvey 1996), dominant riparian vegetation species as well as a plant community code according to the Nez Perce Riparian Community Type Codes (Overton et al. 1997), as well as notes about channel substrate and primary surrounding land use.

Reach lengths and channel slope and sinuosity were calculated in ARCGIS using aerial photographs. The actual path of the stream was digitized to calculate the sinuosity and 10-meter digital elevation models (DEMs) were used to estimate channel slopes.

3.5 Remote sensing

For sub-reaches in which landowner access was not secured, assessments were done using spatial data sets. These subreaches, denoted with an “ra” after the sub-reach ID, cover the entirety of Flint Creek and Boulder Creek not covered by field assessments. The exception was the uppermost sub-reach of Boulder Creek, B01ra on Forest Service property, which was assessed remotely due to the length of the reach, inaccessibility of the terrain and due to its location in unimpaired forested headwaters. A map of remote and field-assessed subreaches is shown in Figure 2.

Figure 2. Remote and field assessed subreaches



Remote assessment sites used the same field forms as field-assessed sub-reaches, though some parameters were not able to be determined. For example, questions 6 and 9 on the SRAF forms were not able to be determined and received a score of “na” in this study. Fish habitat scores were also not assessed remotely, except on occasion where nearby reaches and stream conditions were known from field assessments upstream and downstream. The potential score for sub-reaches assessed remotely was decreased and overall scores were determined as percentages as with the field assessed sub-reaches.

Data used in the remote assessments included:

- High resolution (3-meter) aerial imagery from 2013 and prior (as available);
- Locations of stream diversions, dams and structures that affect stream flow;
- Previous DEQ monitoring sites and associated data from TMDL sites;
- Field data and photographs from reaches immediately upstream and downstream of the remote reaches.

The following discussion summarizes how available data was interpreted to score each question for remote assessment reaches.

NRCS SRAF Form

Question 1: Stream Incision

This question relates to major headcutting and downcutting of the stream. This type of impairment would be visible throughout the stream and would have been noted in field-assessed sub-reaches.

Question 2: Streambanks with Active Lateral Cutting

Active lateral cutting of streambanks was determined from aerial imagery by comparing most recent images with historic ones as well as by examining bank vegetation. Photographs from field-assessed reaches were also used to confirm suspected bank erosion and riparian vegetation conditions, as the upstream and downstream photographs at the beginning and end of sub-reaches often showed conditions in neighboring reaches. Sometimes active lateral erosion was visible from aerial photographs.

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

Measurements of stream geometry (width, sinuosity), as well as visible indication of sediment deposition on inside meander bends were assessed to determine if sub-reaches were in balance with their sediment supplies.

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

Vegetation with deep, binding root mass is clearly visible with aerial imagery, making possible the necessary calculations to answer this question. Though specific species could not be determined, conditions on Flint Creek and Boulder Creek were predictably consistent, with Lower Flint Creek displaying cottonwood galleries, while upper Flint Creek was typically

dominated by shrubs (in more stable conditions). Conversely, pasture grasses and lawns, which do not have deep binding roots, were also clearly visible.

Question 5: Riparian/Wetland Vegetative Cover

Similar to Question 4, riparian and wetland canopy cover was estimated by comparing aerial imagery of remote sites to field-assessed sites to determine vegetation characteristics of riparian areas. Photographs from field-assessed sites also helped in correlating observed vegetation on the ground with aerial images.

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

In the Flint Creek drainage disturbance-caused undesirable plants were typically pasture grasses from haying or grazing operations. These were clearly visible from aerial imagery and confirmed using field photographs. Pasture grasses present below cottonwood galleries or riparian shrubs could not be determined, so these scores likely under-estimated the percentage of these plants in remote-assessed sub-reaches, however, not in such a way as to alter the overall scoring of those sub-reaches.

Question 8: Woody Species Establishment and Regeneration

The age classes of woody species was estimated based on the estimated size of plants from aerial imagery. Field-assessed photographs were also used, as well as comparison to field-assessed sub-reaches. Often, an abundance of disturbance-caused undesirable plants correlated strongly with high browse pressure and the absence of one or more age class of woody vegetation.

Question 10: Floodplain Characteristics for Dissipating Energy and Capturing Sediment

Present and historical aerial imagery was used to determine the presence of active and overflow channels on the floodplain. Aerial imagery from late fall seasons were particularly helpful in determining the extent of water availability on the floodplain. Field photographs were also used when possible.

Fish Habitat Supplemental Questions 1-3

Scoring of fish habitat questions varied throughout the remote assessment subreaches. Aerial imagery was used to determine existing streamside vegetation or other cover elements, and in some cases in-stream habitat features such as deep pools were also easily determined from aerials or from photographs from field-assessed reaches immediately upstream or downstream from remote reaches. Where visual information was lacking or where there were questions in interpretation of the existing data, fish habitat conditions were not assessed. Similar to the SRAF form, potential scores for fish habitat conditions were reduced from the total potential of 30 based on the number of questions that were answered.

3.6 Quality Control

Field assessment methods required interpretation of landscape and riparian conditions, which was accomplished by two teams simultaneously in different parts of the watershed. Calibration of how certain conditions were interpreted was the primary challenge to assure quality of the collected data.

Quality control was accomplished through several quality assurance visits to similar sites to ensure the two teams were interpreting data similarly. In addition, WRC personnel accompanied field staff on both quality control visits to ensure consistency with previous studies contracted by NRDP in other watersheds.

All field personnel and WRC staff conducted the first two subreach assessments together, taking the time to go over questions in interpretation of bank data. Site F10 was visited by both teams at different times of year and then revisited toward the end of field sampling season by project manager P. Marques and technical lead A. Chadwick to verify that conditions were being interpreted the same way. Some minor issues encountered were percentage estimates of sedge vs. grass cover on banks, but these were not substantial enough to alter rankings or scores significantly. The dam controlled nature of Flint Creek created some differences in interpretation of bank erosion. Water levels were higher in August than in June, so levels of exposed bank and interpretation of active erosion tended to be higher in earlier stream assessments. In subreaches where quality control visits were conducted, the quality control scores for the site were used- this refers to subreaches B05 and F10.

3.6.1 Restoration Opportunities

Restoration priorities for the Flint Creek watershed were determined in the NRDP's 2012 Restoration Plan, which was informed substantially by a 2012 FWP, NRDP prioritization report for restoring fisheries in the Upper Clark Fork River Basin (UCFRB). That report, the Prioritization of Areas in the Upper Clark Fork River Basin for Fishery Enhancement, listed the three fishery goals for the UCFRB: 1) Restore the mainstem trout fishery by improving recruitment of fish from tributaries; 2) Replace lost trout angling in the mainstem by improving trout populations in tributaries; and 3) Maintain or improve native trout populations in the UCFRB to preserve rare and diverse gene pools, and improve the diversity and resiliency of the trout fishery (Saffel et al. 2011). Both upper and lower Flint Creek were rated "Very High" for Goals 1 and 2, citing them as large tributaries with excellent fisheries with the presence of migratory adults, high density of adults and juveniles, and connectivity with the mainstem. Boulder Creek was found to be of "High" priority for Goals 1 and 2, with moderate density of native trout or high density of other trout, with intact connectivity and a significant contributor of trout to another good to excellent tributary fishery. Boulder Creek was also given "Very High" priority rating for Goal 3, citing viable bull trout populations or very productive westslope cutthroat population and low to non-existent non-native fish populations. These findings supported NRDPs project priorities for fish entrainment, fish passage and water quantity projects.

With fish entrainment and fish passage issues determined from other studies, field teams for this report identified opportunities for potential restoration projects based on observable conditions, with an eye for habitat restoration projects that would improve fisheries in the Flint Creek watershed. As field assessments were mostly conducted in the early summer during high flows, field teams were unable to determine the degree to which dewatering affected individual subreaches. Detection of water quantity issues at the reach or subreach level were also complicated due to the dam-controlled nature of flows in Flint Creek. For example, a quality control field visit in late October found flows in lower Flint Creek higher than during summer sampling. Most every subreach appeared to have adequate flows at the time of sampling. Discussion of restoration opportunities and recommendations relating to water quantity are therefore not included in this report.

3.6.2 Prioritization and Reach Breaks

In the process of analyzing subreach data, it was determined that stream conditions, impairment sources and severities, and subsequent restoration projects tended to be similar across larger reaches. These reaches also tended to correlate strongly with geomorphic reach breaks as well as general land uses. Flint Creek was determined to have 6 distinct reaches with similar geomorphic land use conditions and correspondingly similar restoration opportunities. The return flow study conducted by the DNRC broke Flint Creek up into 4 reaches based on groundwater hydrology and geologic characteristics, which roughly matched the reach breaks used in this study (Voeller and Maren 1997). Boulder Creek was found to have 3 distinct reaches. Summaries of each reach are provided below in Table 1.

Reaches 1-5 in Flint Creek correspond to the NRDPs Upper Flint Creek and reach 6 corresponds to Lower Flint Creek, separated by the Allendale Diversion. It is hoped that project prioritization at the reach scale will improve the chances of developing integrated approaches to habitat issues across multiple ownerships.

Reach ID	Boundaries	Defining Character
Flint 1	Georgetown Dam to US end F2	Steep side hills and mostly dry channel
Flint 2	US end F2 to US end F3	Forested- below outlet from power plant
Flint 3	US end F3 to US end F13	Ag/irrigation influence; may have some channelization but not generally confined; shallow groundwater table
Flint 4	US end F13 (and very DS end F12) to DS end F19 at Boulder Ck confluence	Confined by Hwy and/or RR grade; includes some naturally confined channel just above downstream end of reach
Flint 5	Boulder Ck confluence to geomorphic break at DS end F24	Some Ag/irrigation influence; naturally entrenched where cutting through alluvial fan
Flint 6	DS end F24 to confluence with CFR	Irrigated hay/croplands
Boulder 1	Upstream end of ck to DS end of B2	Forested and confined by landform
Boulder 2	DS end B2 to DS end B3	Some residential influence, two slope breaks and impaired reaches
Boulder 3	DS end B3 to confluence with Flint Ck.	Urban/residential influence, generally confined and includes more natural area above confluence

Begin and end points for subreaches were determined in the field. Subreaches generally followed property boundaries, but in several cases comprise multiple ownerships where riparian conditions and land use were similar. Ownerships in the Flint Creek watershed tend to be of smaller size than other tributaries of the Clark Fork and this grouping of ownerships was done to facilitate and simplify the restoration prioritization process. A table of all subreaches and ownerships is provided in Appendix I.

Subreaches were assessed and potential restoration projects were scored high, moderate, or low based on these general prioritization criteria:

- Prioritization of projects follows agency priorities to enhance fish habitat and connectivity with the main stem.
- Landowner support
- Feasibility
- Multiple projects per ownership

Landowner participation is always a critical component of watershed restoration and will likely be the starting point for the prioritization of projects in this watershed. Emphasis is given to projects on public lands or on ownerships in which landowners expressed a willingness to implement restoration measures on their property.

3.6.3 **Railroad bed channel constriction**

Reach Flint 4 is characterized by a wide agricultural floodplain partly confined by the historic railroad grade, and to a lesser extent by Highway 1, irrigation infrastructure, and a historic gravel road bed. Due to the controlling influence of the of the railroad bed on Flint Creek in reach Flint 4, investigators conducted an analysis of the degree to which the railroad grade narrows the floodplain. In this analysis, floodplain constriction is based on the natural, or historic floodplain, which differs from the legal floodplain because on Federal Emergency Management Agency (FEMA) floodplain maps the legal floodplain is defined by the railroad bed (i.e., the railroad bed has functioned as a levee in the floodplain analyses). The subreaches included in this analysis, which included the downstream end of subreach F-12 to the downstream end of F-19, were classified into three categories of floodplain constriction: less than 25 percent, 25 to 50 percent, and greater than 50 percent of the floodplain constricted by the railroad bed. Investigators used aerial imagery to measure natural and current floodplain widths at three representative points on each subreach and derived average values for the subreach to determine the overall percentage of floodplain constriction. Investigators also identified and mapped sites where Flint Creek is now eroding the railroad bed and remaining railroad crossings.

4.0 RESULTS: FLINT CREEK

Discussions of each reach and subreach begin with summary tables of the three quantitative metrics used to assess streams in this study: linear bank erosion, NRCS scores and fish habitat scores. These are expressed as average percentages in the reach summary tables. Average scores across entire streams are shown in Table 2 below.

Table 2. Summary data for Flint and Boulder Creek					
	Reach Length (mi)	Total Bank Erosion (ft²)	Percentage of Linear Bank Erosion (%)*	NRCS Score (%)	Fish Habitat Score (%)
Flint Creek	50	123,463	9%	65%	56%
Boulder Creek	16	6,276	4%	93%	90%
* average of field assessed streams					

Maps showing NRCS Habitat score results and bank erosion results for reaches 1 and 2 are shown in Figures 3 and 4 below. Subsequent map results are presented at the beginning of new reach breaks throughout the report.

Figure 3. Flint Creek Reach 1&2 NRCS Habitat Sustainability

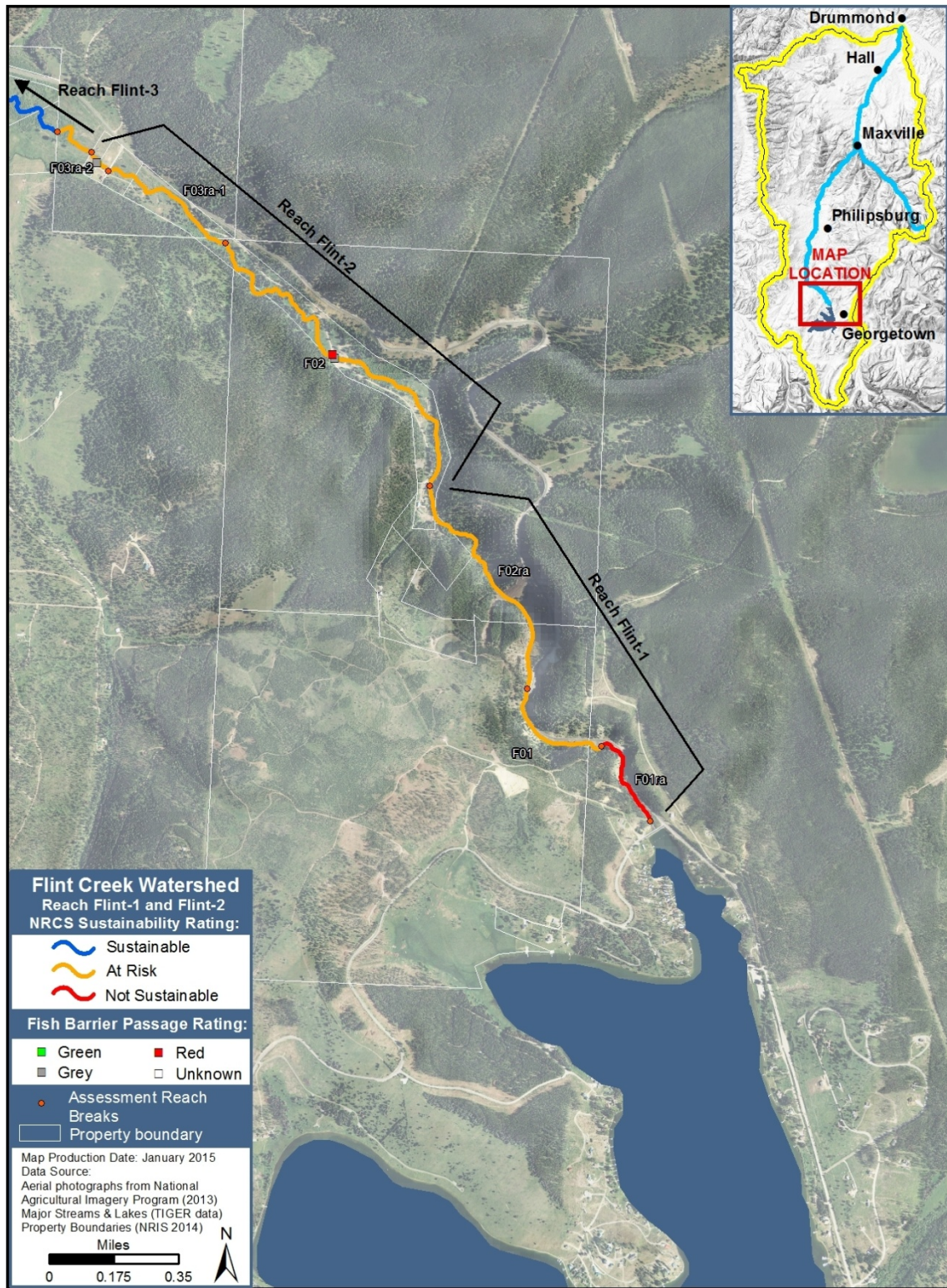
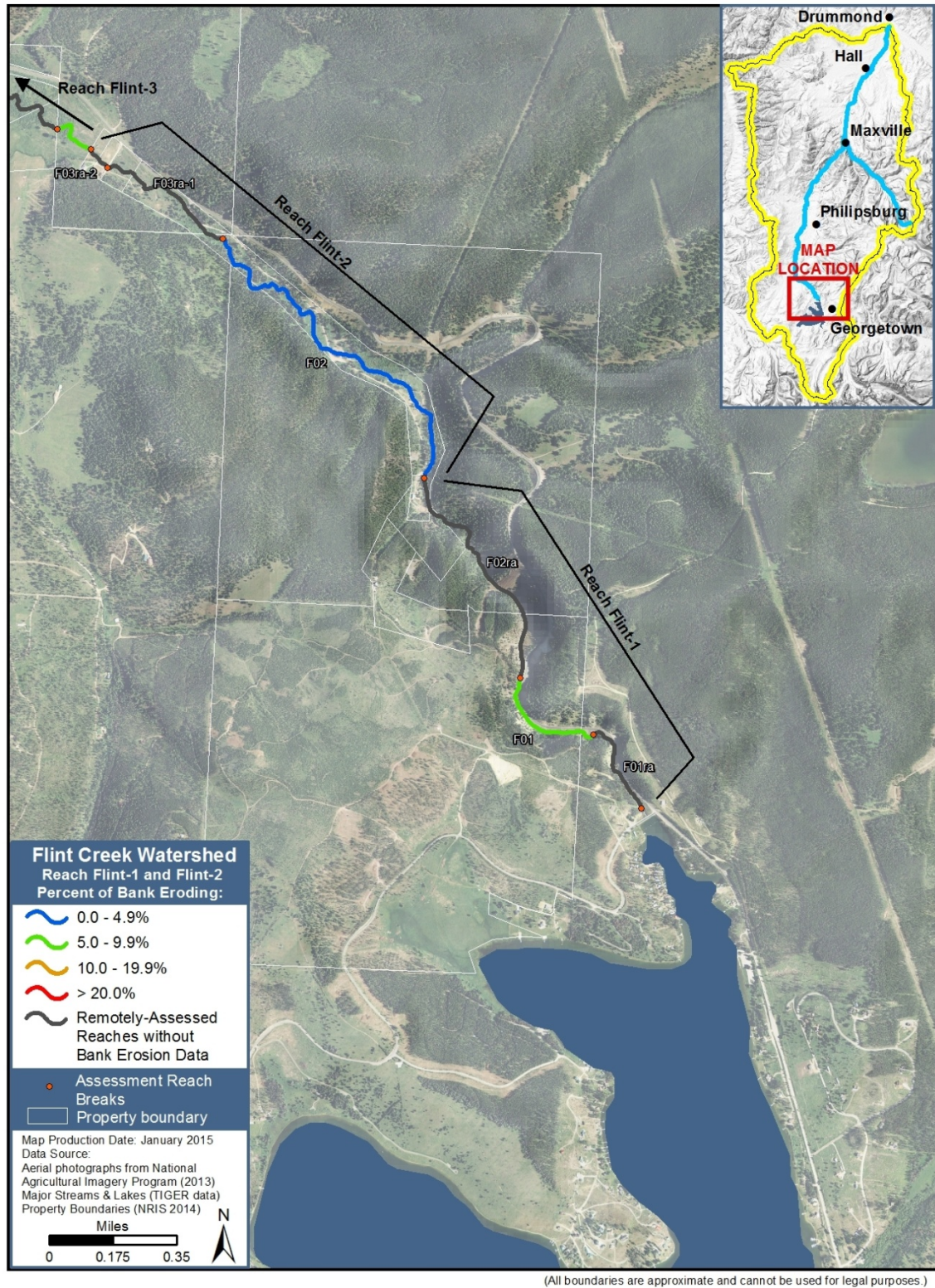


Figure 4. Flint Creek Reach 1 and 2 Bank Erosion



4.1.1 Subreach F01ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	48%	Not Sustainable	30%	Poor	Low

Subreach F01ra is 1486 ft in length and is located adjacent to Highway 1 and immediately downstream of Flint Creek Dam at Georgetown Lake. Flow is heavily altered in this subreach due to the dam at Georgetown Lake and re-routing of most of the stream flow through a large pipe down to Flint Creek Hydroelectric plant, and the main channel of Flint Creek above the power plant has been dry in past years during power plant operation. Subreach F01ra did carry water in the channel during the time of assessment but is dry in aerial photos from 2013.

This subreach was classified as a Rosgen stream type A in the aerial photo interpretation, based on the stream gradient of 4.4%, width/depth ratio of 8.3, and sinuosity of 1.2 estimated from aerial photos and calculated in GIS. The entrenchment ratio is low, based on the land form constraints at the subreach; the channel is partly confined by road bed materials, but would naturally be confined with steep side slopes. Very little natural floodplain exists within this subreach, but there is a section with pooling and a wider floodplain mid-reach.

Based on examination of aerial photos and the view of the reach from Highway 1, the floodplain within this subreach has limited shrub cover and spotty cover of coniferous trees adjacent to the floodplain. The side slopes, comprising the road bed to the east (river right) and very steep hillside to the west (river left), are predominantly bare ground and exhibit areas of historic and recent disturbance. The upstream end has been re-seeded with grass near the spillway below the dam. Erosion of the road bed and direct deposition from the road and road fill are evident in aerial photos. Traction sand placed on the highway likely ends up in the stream, as little to no vegetation buffer exists between the road prism and the stream. Pool habitat is limited in this subreach, as would be expected for this stream type. Deposits of sand or gravel in the main large pool, likely from side hill disturbance, are visible in aerial photos. The limited floodplain lacks shrub and tree cover and large woody debris to dissipate stream energy. This subreach lacks common aquatic habitat cover elements such as accumulations of wood, boulders, undercut bank, or overhanging vegetation.

The condition of this subreach may be in slow decline due to the likely chronic sediment inputs from the highway and severe dewatering, but habitat value would be limited here, regardless of these influences. The dam upstream of this reach and the very long and steep cascade downstream of subreach F01 constitute fish barriers and limit the potential of this subreach for fish habitat, in addition to the constraints posed by dewatering.

Restoration Potential

Restoration of this reach is assigned a low priority due to the low potential habitat value of this subreach and the low feasibility of addressing sediment inputs.

- Recruit woody debris or install other sediment-trapping features in-stream or along the road prism
- Revise sanding practices and road run-off management.



View of F01ra from Georgetown Lake Road, at the dam

Confined channel at the downstream end of subreach F01ra

4.1.2 Subreach F01

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
8.7%	moderate	63.3	At Risk	44.4	Fair	Low

Subreach F01 is 1752 ft in length and is located adjacent to Highway 1 and downstream of Flint Creek Dam at Georgetown Lake. Flow is heavily altered in this subreach due to the dam and re-routing of most of the stream flow through a large pipe down to the Flint Creek Hydroelectric Plant. The channel held water at the time of the assessment but flows are altered due to operation of the power plant, and the main channel of Flint Creek above the power plant has been dry in past years during power plant operation.

Rosgen stream type in this subreach varies with gradient and substrate size from A3 to B4, and has an average gradient of 2.9%, width to depth ratio of 9.2, and sinuosity of 1.3. Construction of Highway 1 through the historic path of Flint Creek in this subreach has confined and partly re-routed the stream channel, although Flint Creek would naturally be somewhat confined by steep side hill slopes in this area. The side slopes, comprising the road bed to the east (river right) and

very steep hillside to the south and west (river left), are predominantly bare ground and exhibit areas of historic and recent disturbance. The width/depth ratio in this reach varies, being both lower and higher than an expected natural ratio. The channel here is altered due to placement of the highway. Stream energy varies with confinement and gradient. Floodplain conditions also vary, from no floodplain and only rocky side slopes to wider areas with limited riparian vegetation. Gravel bars have formed in wider areas where the stream energy slows enough to allow deposition.

Riparian vegetation is sparse; where present, the riparian plant community is dominated by willows and currant, with some elderberry. Conifers provide sparse cover in limited areas along the base of the steep slope south and west of the stream (left bank). Spotted knapweed is the only noxious weed observed, and occurred at the base of the road fill. Weedy annuals and shallow-rooted grasses also grow on the road fill and have colonized drier sites in the riparian area.

Sediment is delivered directly to the stream where the road fill is eroding and where traction sand placed on the highway runs off toward the stream. Sediment delivery to the stream is high because little to no vegetation buffer exists between the road prism and the stream. A well-established riparian community occurs where the stream is less confined and a floodplain has developed, and is generally in condition. Areas without floodplain lack riparian vegetation, channel complexity, and large woody debris to dissipate stream energy. Only limited aquatic habitat cover elements are present, and include limited overhanging riparian vegetation, large rock, and overflow channel in the wider floodplain area. Pools are generally shallow, and limited to lower energy areas.

The dam upstream of subreach F01ra and the very long, steep cascade immediately downstream of this subreach constitute fish barriers; in addition, the channel in this subreach is generally dewatered for power plant operation. Together these factors limit the potential of this subreach for fish habitat. Chronic sediment inputs from the highway and severe dewatering may be resulting in a slow decline of stream channel condition; however, aquatic habitat value is limited by the presence of the dam and highway in this subreach.

Restoration Potential

Restoration of this reach is assigned a low priority due to the low potential habitat value of this subreach, but sediment inputs should be addressed as feasible to prevent delivery to downstream reaches.

- Install sediment-trapping features in-stream or along the road prism, such as sediment traps and filter windrows where feasible along the road fill
- Recruit woody debris or other pool-forming features
- Revise sanding practices and road run-off management



Confined channel and erosion of road fill from Hwy 1 in F01

Tunnel forming the boundary between F01 and F02ra

4.1.3 Subreach F02ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	moderate	76	At Risk	43	Fair	Low

Subreach F02ra is 3701 feet in length and is located along Highway 1 and directly upstream of Flint Creek Hydroelectric Plant. Flow is heavily altered in this subreach because the stream is often routed through a large pipe down to the power plant. The stream channel has been routed through a tunnel in the rock face adjacent to Highway 1, and drops precipitously within the subreach. Average channel gradient is 15.8% and sinuosity averages 1.1%. The channel is very steep and consists of a jumble of angular boulders (Rosgen type A2a+) at the upstream end of the subreach but transitions to a lower-gradient gravel-dominated (Rosgen B4) channel at the downstream end of the subreach, adjacent to the power plant. The channel is confined by steep side slopes, which are largely bare rocky ground, except at the downstream end of the reach. Conifers are present on the upper slopes. The downstream end of this subreach, where the stream is less confined and lower gradient, supports a vigorous riparian shrub community.

Dewatering is the primary limiting factor to aquatic habitat in subreach F02ra. A steep rocky slope approximately 400 feet high separates Highway 1 from Flint Creek in this subreach, but direct runoff from the highway enters Flint Creek at the upstream boundary of the subreach.

Restoration Potential

- Address road runoff and associated sediment delivery from Highway 1.
- Determine if the channel can be re-watered by revising the water management by the dam and power plant



Upstream end of reach, directly below tunnel in F02ra

Runoff and sediment delivery from Hwy. 1 in F02ra

4.1.4 Subreach F02

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
3.2	moderate	58	At Risk	57	Fair	Low

A sediment/habitat study for the TMDL for Flint Creek was done in part of this subreach. Results of that study are presented in Table 3.

Table 3. Selected data summary from TMDL reach FLIN 06-01 (DEQ 2012)							
Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio (ft)	D50 Pebble Count (mm)	Pools/1000 ft	Entrenchment Ratio (ft)
High	6.7	31	97	15	67	5	7.9

Subreach F02 is 5,682 feet in length and is located directly downstream of the outflow from the Flint Creek Hydroelectric Plant. The outflow from the power plant returns water to Flint Creek at the upstream boundary of the reach. This subreach was estimated to be a Rosgen B4 channel type, based on a slope of 2%, a sinuosity of 1.2%, and a width to depth ratio of 11.1. Channel substrate was estimated to be dominated by large gravel, but TMDL studies found cobbles dominant and classified the stream as a potential B3 with fines and gravel in pockets of slow water. This subreach is moderately confined by steep side slopes, and at the upstream end is partially straightened and confined by historic channel alteration, road fill and berm material, designed to prevent a campground from flooding in high water. No headcutting was evident at the site, but aggradation is occurring, primarily in the upstream half of the reach. The stream appears to be adjusting to inputs of sand and gravel from upstream sources. High quality habitat

occurs throughout the reach, although pools are generally shallow due to excessive deposition, generally improving in quality downstream.

There is a moderate amount of human-induced lateral cutting, primarily due to confinement of the channel by berm and road fill, with additional bank erosion in discrete areas from recreation access at the campground. The stream forms a pond above a lowhead dam near the upstream boundary of the campground.

Riparian vegetation is dominated by Douglas-fir, Engelmann spruce, vine maple, red-osier dogwood, currants, and thimbleberry. Riparian shrub regeneration and diversity are suitable for this site, and are browsed moderately by wild ungulates. Upland grasses and weedy annuals are common in the understory. Noxious weeds, which included spotted knapweed and hounds tongue, occurred in the greatest density at the upstream end of the detention pond.

The downstream half of subreach F02 supports vigorous riparian vegetation and has greater channel complexity and habitat forming features such as large woody debris than the upper portion of the subreach, where channel and floodplain alteration have limited these habitat variables. Most of this reach is managed for recreation in the campground.

The lowhead dam at the base of the detention pond may act as a partial barrier to upstream fish passage (Trout Unlimited, 2013) and the crossing of Power House Road directly downstream of the lowhead dam is considered a likely barrier to upstream fish migration. Addressing these fish barriers is considered low priority (Hackathorn, pers. comm.) because there is only a short length of stream between those barriers and fish barriers upstream posed by channel dewatering above the power plant and the long cascade in subreach F02ra.

Restoration Potential

- Noxious weed control



Noxious weeds on berm material in upper portion of subreach F02.



Conditions at downstream end of F02

4.1.5 Subreach F03ra-1

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	66	At Risk	40	Fair	Moderate

Subreach F03ra-1 is 2228 feet in length and extends across two private ownerships, from the property boundary approximately 700 feet upstream of the entrance to Power House Road downstream to the next private drive. This subreach is classified as a Rosgen B4c channel type, potentially altered from a C4 type, based on an average slope of 1.6%, a sinuosity of 1.1%, and an estimated width to depth ratio of 11.5. The stream channel in this subreach has been partially straightened; part of the stream length has been cut off by construction of Highway 1 and the channel now parallels the road bed for part of its length. This subreach appears to be moderately entrenched at the upstream end by landform, and may be entrenched throughout the reach, based on presence of high eroding banks and channel straightening, which often causes channel incision. Channel substrate is dominated by large gravel.

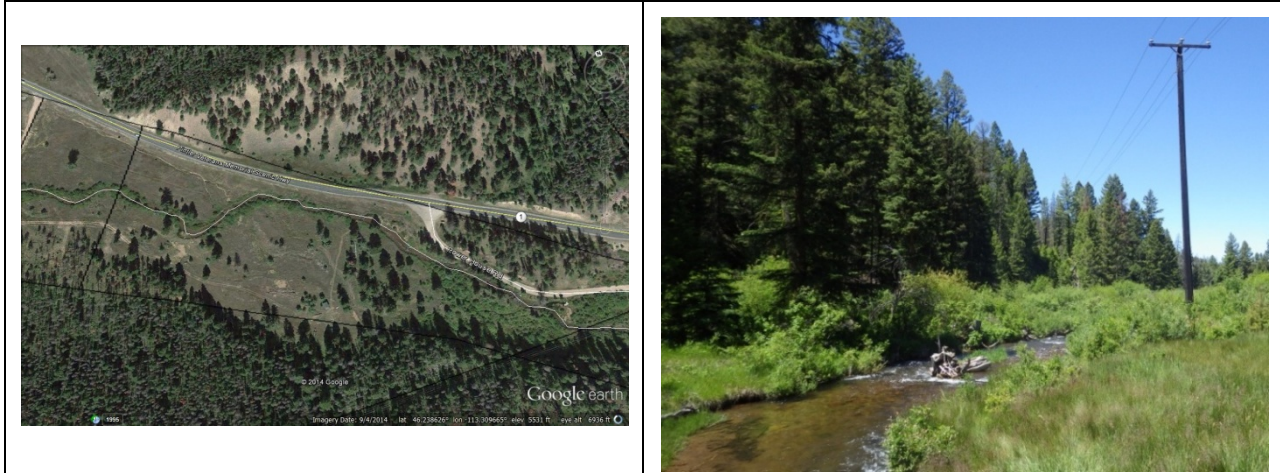
Pools appear to be shallow in general, although a few substantial pools are visible near large wood and at a backwater or spring inflow on the north streambank. The channel is widened due to bank erosion and has very little cover from overhanging vegetation.

There is a moderate amount of human-induced lateral cutting, primarily at outside bends where shrubs do not line the stream, primarily in the upper half of the reach. The extent of the riparian shrub community, where present, varies from forming a consistent cover across the floodplain to forming only a narrow buffer along the stream. The riparian vegetation community includes light cover of conifers, along the south side at the upstream end but in general is dominated by willows.

Restoration Recommendations

This subreach is a moderate priority for restoration, depending on landowner participation, as banks are likely a chronic source of sediment to Flint Creek.

- Low intensity: stabilize banks with bioengineering techniques and riparian planting, and currently are likely a chronic source of sediment to Flint Creek.
- High intensity: channel reconstruction and bioengineering to restore sinuosity and channel length
- Medium intensity: Re-activation of overflow channels



Aerial view of F03ra-1

Conditions at upstream end of F03ra-1

4.1.6 Subreach F03ra-2

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	74	At Risk	50	Fair	Low

Subreach F03ra-2 is 338 feet in length and extends across two private ownerships directly upstream of a U.S. Forest Service parcel. This subreach is classified as a Rosgen B4c channel type, based on an average slope of 1.3%, a sinuosity of 1.1%, and an estimated width to depth ratio of 11.5. The channel appears to have been straightened to some extent for agricultural purposes. Channel substrate is dominated by large gravel. Pools appear to be shallow, but some cover is provided by overhanging vegetation.

A multi-user irrigation diversion is located at the boundary of the two properties. This diversion poses a risk for fish entrainment and is may be a partial barrier for fish passage (TU 2013).

Most of the lateral cutting in this subreach appears to be healing from past erosion. A well-established buffer of riparian shrubs is present along the north streambank on both parcels, but appears to lack riparian vegetation in areas of the south bank, and the channel is widened where the south bank has eroded in the past. The riparian area is fenced with a water gap in the downstream parcel. Riparian vegetation structure is adequate to provide some habitat value and energy-trapping function on the north streambank, but the floodplain and bank on the south side of the stream are highly susceptible to scour.

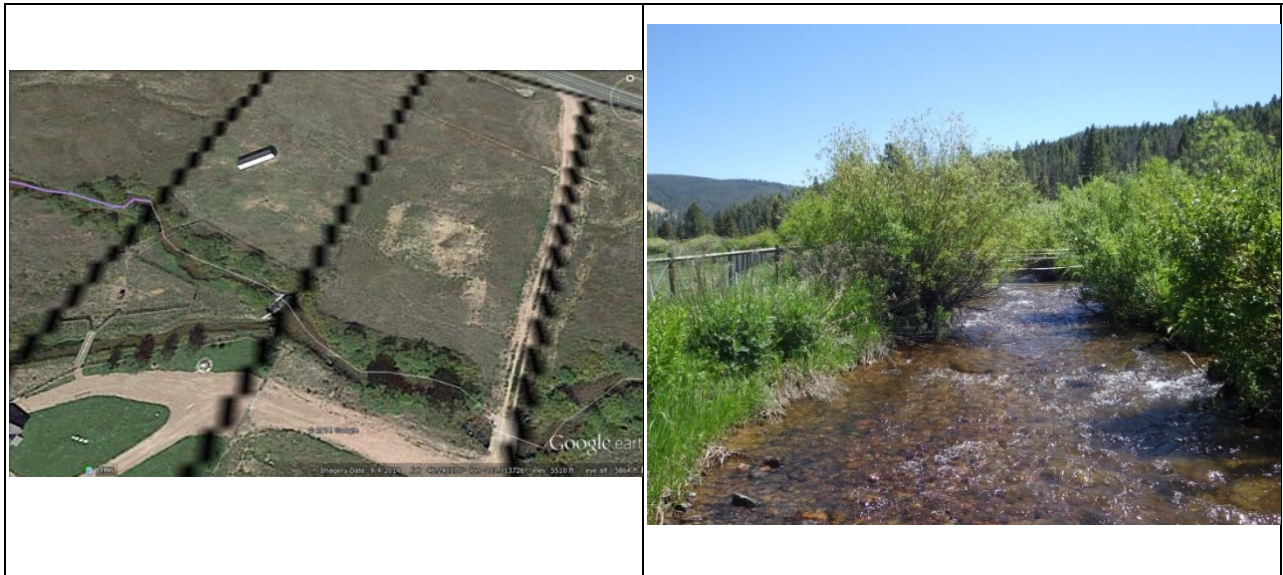
Riparian vegetation is dominated by a mixture trees, shrubs, and sedge, but the south bank in the downstream parcel appears to be dominated by upland grasses. According to a past assessment (TU 2013) noxious weeds are common on disturbed ground along the streambanks near the diversion. A dense patch of common tansy covers a portion of the right bank at the downstream end of the subreach.

Restoration Recommendations

This subreach is a low priority for restoration, depending on landowner interest. An overflow channel is present on the floodplain in this reach, and may have been the original channel. If the landowner is interested in participation, restoration could include restoring channel length by putting the stream back to a natural channel; however, the overflow channel does not have established riparian vegetation. Restoring channel length in this reach might better be achieved by creating some new meanders in the current channel, in order to leave the more stable areas of the current channel intact.

Projects include:

- Upgrade diversion to improve fish passage and prevent entrainment to the ditch;
- Noxious weed control
- Install in-stream aquatic habitat structures with large wood to encourage lateral cutting where riparian vegetation is intact
- Planting of shrubs in areas currently dominated by common tansy
- Install of brush fascine or other similar bioengineering technique, followed by riparian planting, to stabilize and speed recovery of the eroding portion of the south streambank.



Aerial view of F03ra-2

Fenced riparian area at downstream end of F03ra-2. Common tansy on right bank

Figure 5. Flint Creek Reach 3 NRCS Habitat Sustainability

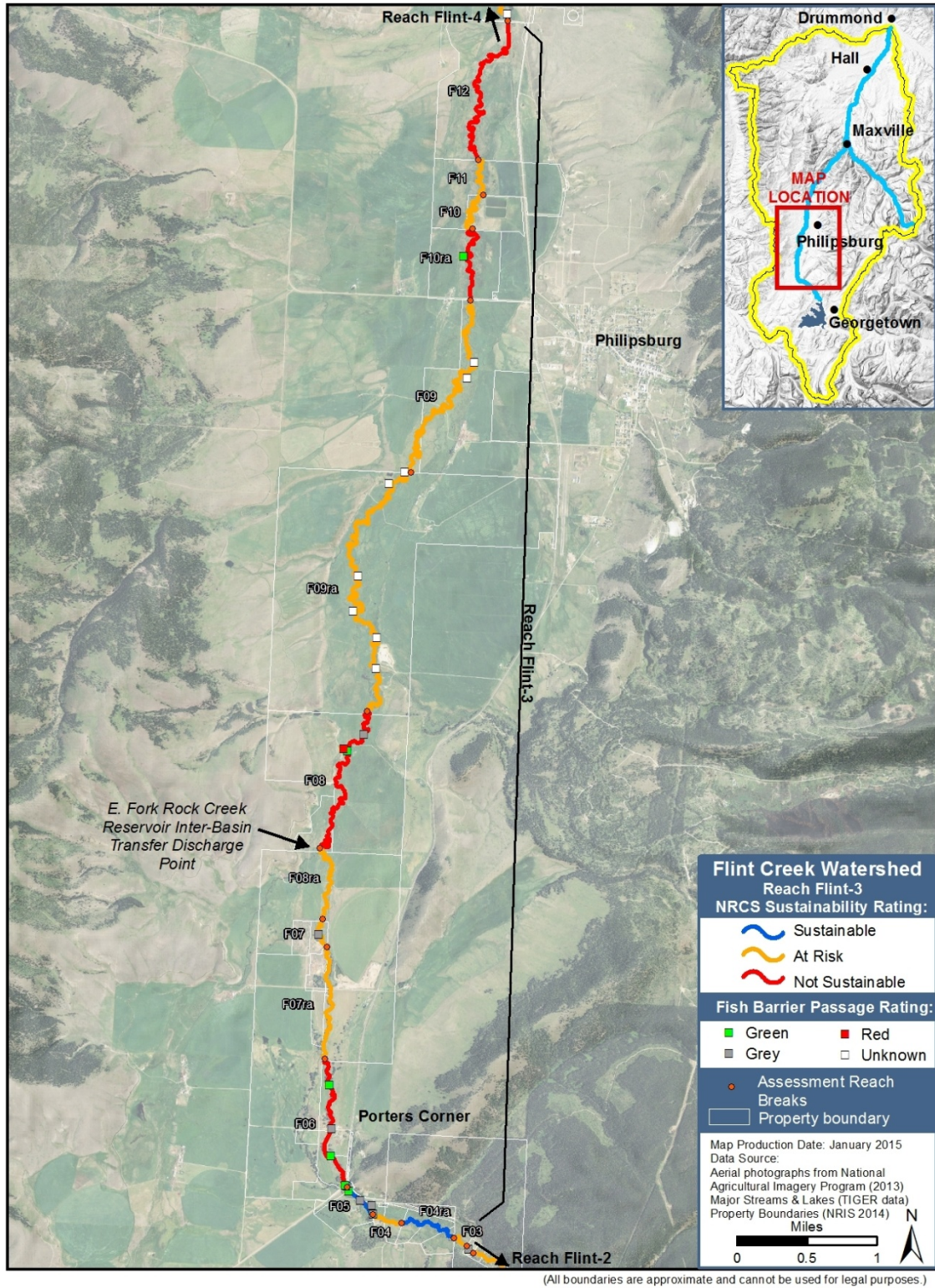
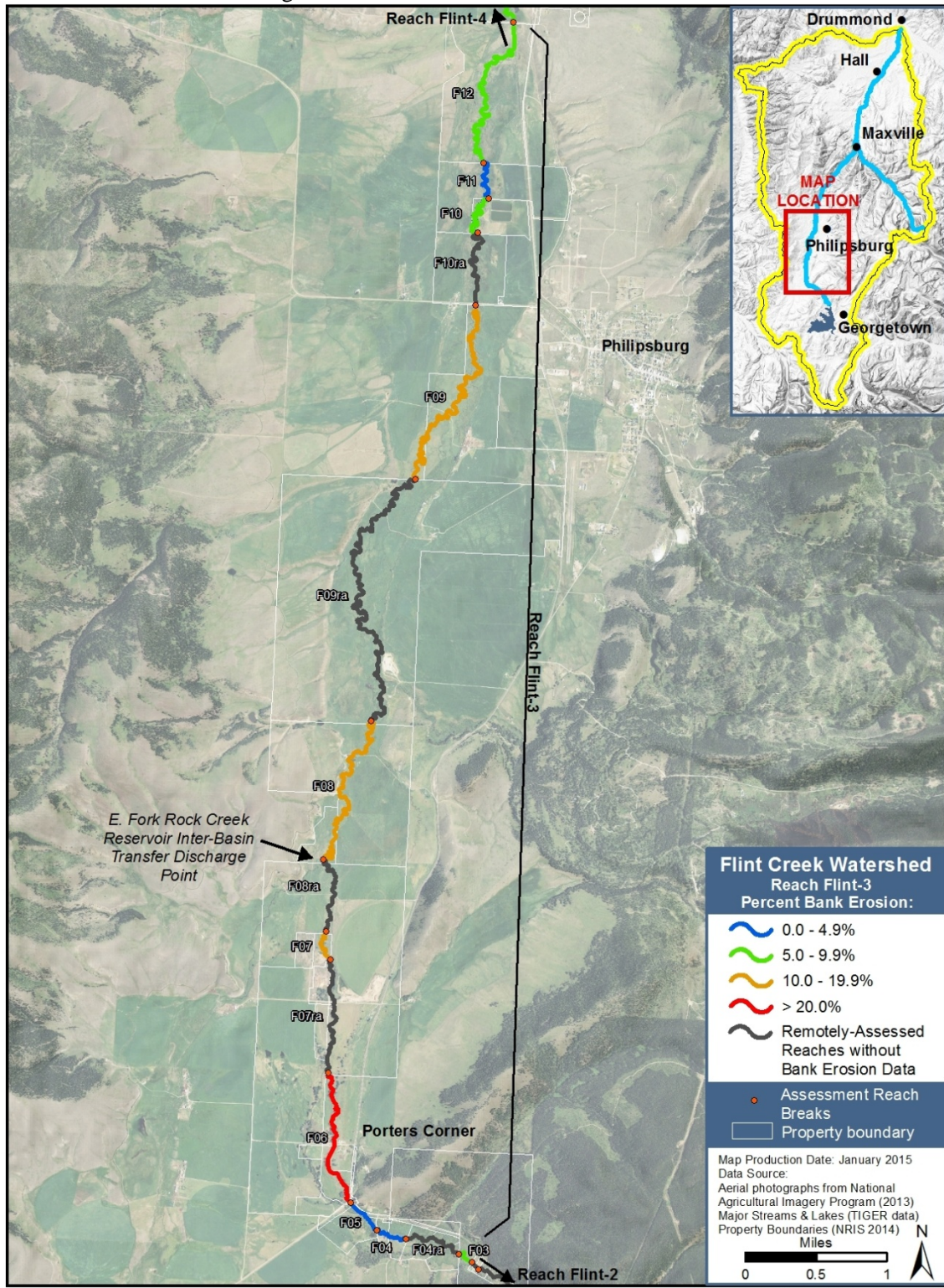


Figure 6. Flint Creek Reach 3 Bank Erosion



4.1.7 Subreach F03

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
6	moderate	68	At Risk	80	Good	Low

Subreach F03 is 774 feet in length and is located approximately halfway between Powerhouse Lane and Traveler's Home Lane. This subreach is classified as a Rosgen C4 channel type, based on an average slope of 1.2%, a sinuosity of 1.4%, and a width to depth ratio of 14.6. The channel is slightly incised, but stable. Channel substrate is dominated by large gravel. The channel is widened in some areas but is confined and straightened over much of the reach.

Human-induced lateral erosion is minimal in this subreach, occurring primarily on portions of streambank without riparian shrubs, where grass and spotted knapweed are dominant. Riparian vegetation is dominated by a mix of willows. Riparian shrub regeneration and diversity are suitable for this site, and browse is minimal. Common tansy is common throughout the subreach. Other noxious weeds present on site include spotted knapweed, Canada thistle, and hounds tongue. Upland grasses dominate the understory in areas not dominated by common tansy.

The floodplain surrounding this subreach has likely supported grazing in the past, but no signs of current or recent grazing were observed at the time of the field assessments. There is some evidence of historic excavation in the floodplain on the north side of the stream.

Riparian vegetation and side channels are the primary floodplain elements present to trap sediment and slow energy. This subreach is mostly lacking large woody debris and deep pools are uncommon, limiting fish habitat conditions.

Restoration Potential

Subreach F03 is a moderate priority for restoration, depending on landowner participation. Potential activities here include:

- Weed control- common tansy is outcompeting and reducing regeneration of native riparian vegetation
- Revegetation of treated areas
- Riparian and floodplain restoration using bioengineering techniques to raise the stream level and reactivate some overflow channels, provided adjacent landowners can tolerate a higher water table
- Construction to increase channel sinuosity- potentially including three subreaches upstream



Conditions at upstream end of F03

Conditions at downstream end of F03

4.1.8 Subreach F04ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	86	Sustainable	70	Fair	Low

Subreach F-04ra is 2872 feet in length and is located approximately one quarter mile upstream of Traveler's Home Lane. This subreach is classified as C4 Rosgen stream type, with an average slope of 1.3%, a sinuosity of 1.4%, and an estimated width to depth ratio of 15.4. Entrenchment appears to be low and the stream well-connected to the floodplain. Channel substrate is dominated by large gravel.

Pool quality appears to be varied, but lateral scour pools under overhanging willows likely provide high quality fish habitat. Multiple side channels and a wide band of riparian shrubs provide sediment-trapping and energy-dissipating functions. Large rock and woody debris are mostly absent from the site. There is a moderate amount of human-induced lateral cutting, likely due to livestock use. Raw cut banks and gravel bars are visible in aerial photos of the subreach.

Riparian vegetation is dominated by willows with grass and some sedge and riparian forbs in the understory, based on examination of aerial photos and additional photographs from field assessments upstream and downstream of the site.

Restoration Potential

This subreach is a low priority for restoration, depending on landowner interest, because habitat is generally in good condition. Recommended actions include:

- Riparian planting and bioengineering to stabilize eroding banks, primarily at the downstream end of the site

- In-channel bioengineered structures such as post and willow lines or barbs to narrow the channel and raise the water table to help re-activate side channels.
- Temporary riparian fencing with a grazing management shift or long-term fencing to protect riparian shrubs.



Conditions at upstream boundary of F04ra

Conditions at downstream boundary of F04ra

4.1.9 Subreach F04

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
5	low	63	At Risk	70	Fair	Moderate

Subreach F04 is 1,532 feet in length and is located directly upstream of Traveler’s Home Lane. This subreach is classified as a Rosgen C4 channel type, based on an average slope of 0.7%, a sinuosity of 1.4%, and a width to depth ratio of 15.4. The channel is slightly incised, and as a result is now a single-thread channel, but appears to have good floodplain access. The stream is partially confined by a high terrace on the south side of the channel, and may have been moved historically to the south side of the floodplain. Channel substrate is dominated by large gravel interspersed with silt and sand. The channel is widened in some areas, and appears to be in adjustment from historic grazing and channel incision. Some areas exhibit excessive scour and deposition.

There is a minimal amount of human-induced lateral cutting, primarily due to grazing pressure and lack of native riparian vegetation on streambanks in some areas. Native riparian vegetation includes Geyer and Bebb’s willow, currants, wild rose, and sedges. Habitat quality is limited by heavy cover of pasture grasses, which dominate streambanks in portions of the subreach, particularly on the north side of the stream. Riparian shrub regeneration and diversity are suitable for this site, and browse by wildlife and livestock is light. Noxious weeds, including spotted knapweed, yellow toadflax, Canada thistle, and hounds tongue, are common in this subreach.

Good quality pools and overhanging shrubs are present in at least half of the subreach. Although high quality habitat is present, this subreach would benefit from more wood and shrub cover. Areas of the floodplain dominated by grass provide limited cover and energy dissipation. One irrigation diversion was noted in this subreach but has an active side channel around it. No mention was made of this diversion being a passage or entrainment problem (Trout Unlimited 2013).

Restoration Potential

Subreach F04 is a moderate priority for restoration, depending on landowner participation. Restoration recommendations include:

- Potential re-connection of stream to historic meander to increase sinuosity
- Riparian shrub planting and browse protection
- Noxious weed control

The two main culverts at Travelers Home Lane may pose a partial barrier to upstream fish migration. This road crossing is not included in the restoration priorities because it is already scheduled for replacement in 2015, and will be upgraded to a large box culvert that spans the channel. The overflow culvert in the most active overflow channel will also be replaced (Great West Engineering 2014).



Conditions at upstream end of F04



Grass-covered banks alternate with willow-dominated areas in F04

4.1.10 Subreach F05

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
2	low	82	Sustainable	92	Good	Low

Subreach F05 is 1,569 feet in length and extends from Traveler's Home Lane downstream to Highway 38. This subreach is classified as a B4 or altered Rosgen C4 channel type, with an average slope of 1.3%, a sinuosity of 1.1%, and a width to depth ratio of 15.7. This subreach exhibits lower sinuosity than expected conditions, due to historic channelization and influence of the highways. Floodplain access is somewhat limited due to mild channel incision and confinement. Channel substrate is dominated by gravel.

Primary land use influences include historic grazing, flow alteration by irrigation, and energy shifts due to irrigation infrastructure, road crossings, and confinement along the highway.

Some signs of excess sediment deposition are present, but aquatic habitat is generally in good condition with a mixture of cover elements and some deep pools. There is a minimal amount of human-induced lateral cutting, primarily due to adjustment from historic channel straightening and confinement.

Riparian vegetation is dominated by willows (Geyer, Booth, and Bebb), currants, rose, and sedges. Riparian shrub regeneration and diversity are suitable for this site, and are browsed minimally by wild ungulates. Upland grasses and weedy annuals occur in the subreach but do not dominate the understory. Noxious weeds are abundant, and include spotted knapweed, common tansy.

Three diversions are located within this reach. The large upstream diversion may pose a partial barrier to upstream fish migration and is a known site for fish entrainment (Trout Unlimited 2013). The smaller diversion located near the downstream end of the subreach poses no impact to fish passage but is a risk for some fish entrainment (Trout Unlimited 2013). The ditch at this lower diversion resembles a natural side channel.

Restoration Potential

Subreach F05 is a low priority for restoration, based on the high function and quality of habitat and the limitations posed by the highways and irrigation infrastructure. Restoration recommendations include:

- Noxious weed control
- Continued rest from grazing
- Replanting of willows or willow staking in the few areas with insufficient cover
- Upgrade irrigation diversions to prevent fish entrainment and improve fish passage



Channel conditions at large diversion mid-reach, F05

Stream flows along Highway 1 near downstream end of subreach F05

4.1.11 Subreach F06

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
24	High	45	Not Sustainable	57	Fair	Moderate

Subreach F-06 is 6,073 feet in length and is located directly downstream of Highway 38. This subreach is classified as a Rosgen C4 channel type, with an average slope of 0.9%, a sinuosity of 1.2%, and a width to depth ratio of 12.9. Entrenchment is low. The channel is mostly stable and only minimally incised for most of the site, but is increasingly incised and more in adjustment in its downstream third. Channel substrate is dominated by large gravel. The channel has lost some sinuosity, particularly where straightened or confined near residences, but some overflow channels appear to be active.

Riparian clearing and hay production, grazing, and dewatering for irrigation are primary land use influences on this subreach. There is a moderate amount of human-induced lateral cutting, primarily due to historic and current livestock use, and a lack of riparian vegetation cover on streambanks. The riparian area is stable and in generally in good condition at the upstream end of the subreach, although the streambank erosion is undercutting a fenceline in one area.

Channel substrate is somewhat embedded with fine sediment and minor sediment deposits are present. Pools are generally shallow. Cottonwoods supply large wood to the stream and floodplain but in most of the subreach the floodplain lacks energy-dissipating features such as riparian shrub cover and channel complexity.

Riparian vegetation in the upstream part of the reach is dominated by cottonwood, and a mix of riparian shrubs, including willows, red-osier dogwood, chokecherry, and alder. The majority of the subreach has lower riparian shrub cover and has an intermittent cover of mature cottonwoods

with an understory dominated by upland pasture grasses. Riparian shrub regeneration and diversity are limited at this site, except at the upstream end, and are browsed heavily by livestock and wild ungulates. Noxious weeds, including Canada thistle, common tansy and hounds tongue occur throughout.

The culvert at Highway 38 is contributing to streambank erosion directly downstream of the crossing. The crossing at Porters Corner Lane may pose a partial barrier to upward migration of fish, due to shallow, high velocity flow in the culvert some times of the year. The culvert is undersized and the road fill around the culvert is eroding due to excessive scour. Two small diversions are present just downstream of Highway 83 but do not appear to have much effect on the channel and are not considered barriers to upstream fish migration. Some fish entrainment was documented at one of these diversions.

Restoration Potential

Subreach F06 is a moderate priority for restoration overall, depending on landowner participation, but replacement of the culvert at Porters Corner Lane is a high priority. Granite County has already had this site surveyed to size a replacement structure, but additional funds are needed to complete replacement. Portions of this subreach are channelized. Outreach is recommended to determine if and where a greater meander belt width would be tolerated within the agricultural operations.

- Upgrade crossing at Porters Corner Lane to a bridge or large bottomless culvert that spans the natural channel width
- Riparian revegetation to stabilize areas disturbed by culvert replacement
- Review riparian grazing management and establish a new riparian fenceline to provide wider buffer. Could include temporary or long-term riparian fencing with water gaps, supplemented with riparian shrub planting in grass-dominated areas in downstream half of the subreach
- Bioengineering and riparian planting to stabilize high eroding streambank at the upstream end of the subreach
- Noxious weed control incorporated with restoration and fencing efforts



Undersized culvert with eroding road fill at Porters Corner Lane, F06

Conditions at land ownership boundary within subreach F06

4.1.12 Subreach F07ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	51	At Risk	50	Fair	Moderate

A sediment/habitat study for the TMDL for Flint Creek was done in this subreach. Results of that study are presented in Table 4.

Table 4. Selected data summary from TMDL reach FLIN 09-02 (DEQ 2012)

Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio (ft)	D50 Pebble Count (mm)	Pools/1000 ft	Entrenchment Ratio (ft)
High	3.2	28	37	31	39	65	6.2

Subreach F07ra is 5,197 feet in length and is bisected by Metesh Lane. This subreach is classified as C4 Rosgen stream type, with an average slope of 1.1%, and a sinuosity of 1.2%. Channel substrate at both ends of this subreach is dominated by large gravel.

Large woody debris accumulations appear to be common in this subreach, based on observations near the upstream and downstream boundaries and examination of aerial photos. Woody debris tallies in the TMDL document are among the highest for Flint Creek of sites sampled (DEQ 2012). The narrow riparian area with some large cottonwoods and pasture grasses is minimally effective for dissipating flood energy. Riparian shrub cover is inadequate to provide habitat and floodplain protection. Parts of the downstream end of this subreach lack riparian vegetation

altogether and the stream flows through multiple channels. Deep pool habitat is infrequent, occurring mostly around large woody debris.

A large irrigation return flow joins Flint Creek within this subreach. Even with the irrigation return, stream flows through this subreach were noticeably reduced at the time of the assessment due to irrigation-related withdrawals. There is a moderate amount of human-induced lateral cutting, due to livestock use and clearing of riparian vegetation over time. Grazing has also brought in weeds to the site.

Restoration Recommendations

This subreach is a moderate priority for restoration, depending on landowner interest. Recommended actions include:

- Riparian planting and bioengineering to restore riparian vegetation to the floodplain, stabilize eroding banks, narrow the stream channel and improve aquatic habitat
- Outreach with landowner to develop a plan for mutually beneficial riparian grazing management



View toward upstream boundary of subreach F07ra. Mature cottonwoods are present but grasses dominate the riparian area

View toward downstream end of reach, F07ra. Widened channel and lack of riparian understory vegetation limit habitat quality

4.1.13 Subreach F07

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
20	Moderately high	55	At Risk	57	Fair	High

Subreach F-07 is 1,638 feet in length and is located approximately halfway between Hackley and Metesh Lane. This subreach is classified as a Rosgen C4 channel type, based on channel shape, but exhibits traits of an E channel, with average slope of 0.8%, a sinuosity of 1.5%, and a width

to depth ratio of 11.8. Parts of this subreach are incised and have signs of historic channelization. Channel substrate is dominated by gravel, often with interspersed silt and sand, but substrate size varies with stream size and energy, as influenced by irrigation.

The channel is over-wide due to riparian vegetation removal. The stream is shallower in part due to irrigation withdrawals, as well as channel widening. There is a moderate amount of human-induced lateral cutting, particularly on outside bends. Streambanks appear to be recovering from historic heavy grazing or riparian clearing. A large weir and two ditches direct flow from the stream in this subreach. The weir may be a partial barrier to upstream fish migration, and fish entrainment has been documented at the site (Trout Unlimited 2013).

Riparian vegetation over most of the subreach is dominated by cottonwood with an understory of tall pasture grasses and some woods rose, and only limited occurrence of other riparian vegetation. Riparian shrub regeneration and diversity are lower than expected natural conditions, but all age classes of cottonwood are present, indicating some successful regeneration. Browse levels are low at this site. Shrub cover is inadequate to dissipate flood energy, and the stream channel and banks do not appear stable under high flows. Pools are mostly shallow and aquatic habitat is limited. Some large wood is provided by the mature cottonwoods on site.

Noxious weeds, which include spotted knapweed, Canada thistle and hounds tongue, are commonly distributed at this site. Reed canary grass is also present, and, although it is not a noxious weed, should be controlled early to prevent further impact to shrub regeneration potential.

Restoration Recommendations

Subreach F07 is a high priority for restoration, depending on landowner participation. Restoration recommendations for this reach should focus on:

- Re-establish cover of riparian shrubs along the stream, which would likely require active planting and temporary or long-term riparian fencing.
- Bioengineering techniques, such as brush fascines or post and woven branch structures would accelerate channel narrowing and improve aquatic habitat
- Upgrade current weir to improve fish passage and function and prevent fish entrainment, depending on interest by irrigators and partnering entities



Diversion and eroding left bank at F07



Conditions at downstream end F07

4.1.14 Subreach F08ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	58	At Risk	50	Fair	Moderate

Subreach F08ra is 4,025 feet in length and is bisected by Hackley Lane. This subreach is classified as an E4 Rosgen stream type, with an average slope of 0.8%, a sinuosity of 1.5%, and an estimated width to depth ratio of 15.4. Entrenchment appears to be low and the stream likely has regular access to the floodplain. Dewatering from irrigation is evident at this site. Channel substrate is dominated by gravel at the upstream and downstream ends of the subreach. The inter-basin transfer from East Fork Rock Creek Reservoir joins Flint Creek at the downstream end of this subreach.

There is a moderate amount of human-induced lateral cutting, primarily related to grazing and removal of riparian vegetation related to grazing and hay production over time. Riparian vegetation is dominated by pasture grasses, with a narrow and intermittent band of willows and cottonwood. The light cover of riparian trees and shrubs limits riparian and floodplain function for dissipating energy of flood flows, but several small overflow channels exist along the main channel. Pools appear to be of variable size and are formed primarily by lateral scour at outside meander bends.

Restoration Potential

This subreach is a moderate priority for restoration, depending on landowner interest.

Recommended actions include:

- Plant riparian shrubs and trees
- Bioengineering to stabilize eroding banks, narrow stream and improve aquatic habitat

- Temporary riparian fencing with revised grazing management or long-term fencing to protect riparian shrubs
- Reactivate side channels in selected areas where doing so will not impact current operations negatively



Conditions at upstream boundary of F08ra, looking downstream into subreach.

Conditions at downstream boundary, looking upstream into subreach F08ra

4.1.15 Subreach F-08

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
20	Moderately high	42	Not Sustainable	40	Poor	High

Subreach F08 is 9,561 feet (approximately 1.8 miles) in length and extends from just below the confluence of the irrigation return from the East Fork Rock Creek Reservoir to approximately 500 feet downstream of the confluence of Spring Creek near Andre Lane. This subreach fluctuates between Rosgen E4 and C4 channel type, has an average slope of 0.4%, a sinuosity of 1.7%, and a width to depth ratio of 12.8. The subreach is heavily influenced by the inter-basin transfer. Entrenchment is low and the stream appears to access the floodplain. Channel substrate is dominated by gravel, interspersed with fine sediment. Aquatic habitat elements are limited, with rare undercut banks and some deep pools. Overflow channels are present to absorb energy of high flows, but the floodplain lacks riparian vegetation, large wood and rock for energy dissipation.

There is a moderate amount of human-induced lateral cutting, mostly in the upstream portion of the subreach and likely due to livestock use and the lack of riparian shrubs. Car bodies once used to protect banks have been washed into the channel and are exposed at two or three point bars in the upper portion of the subreach. The landowners' residence is close to the stream and their lawn extends to the edge of the stream in the highly landscaped area near the house. The

channel is not down-cutting, but is still actively widening at the upstream end of the subreach. The area downstream of the residence has been rested from grazing and is in recovery. Habitat and energy-dissipating elements are uncommon on the floodplain.

Riparian vegetation is dominated by sedges, rushes, and grasses on the lower banks and low terrace; grasses dominate upper banks, with only intermittent willow cover. Historic and recent browse by livestock and wild ungulates, combined with competition from grasses have limited shrub regeneration and cover. Mid-size shrubs do occur in the downstream half of the subreach. Spotted knapweed and yellow toadflax are common on upper banks; Canada thistle and hounds tongue also are common. Some small patches of reed canary grass occur near the residence.

A large pin and plank diversion backs up water upstream of the residence and allows water to flow into a pond. The diversion is not considered a threat to fish passage. The diversion has a fish ladder, the effectiveness of which is unknown. The culvert at a field crossing downstream of the residence is a likely partial barrier to upstream fish migration, due to stream constriction and high velocities within the culvert (Trout Unlimited 2013).

Restoration Potential

According the landowner the current level of riparian grazing is higher than allowed in the grazing lease. Based on landowner interest and the nature of the restoration opportunities, Subreach F08 is a high priority for restoration activities, which include:

- Remove car bodies and stabilize higher eroding banks using bioengineering techniques
- Bioengineering techniques and riparian planting to narrow the stream channel and improve aquatic habitat
- Re-activate old meander bends (mid-reach) and side channels to improve floodplain function, habitat diversity, and stream sinuosity
- Work with landowner and lessee to revise riparian grazing management.
- Weed control



Conditions at upstream end of F08

Conditions at downstream end of F08

4.1.16 Subreach F09ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	58	At Risk	50	Fair	Moderate

Subreach F09ra is 17,987 feet (approximately 3.4 miles) in length, with the upstream end located approximately one half mile upstream of the confluence of Fred Burr Creek. This subreach is classified as an E4 Rosgen stream type, with an average slope of 0.4%, a sinuosity of 2.0%, and an estimated width to depth ratio of 13.9. Grazing, irrigation, and hay production are the primary land use influences on this subreach. Several diversions are located in this subreach but their function and impact to fish passage are unknown.

Lateral bank erosion is common in this subreach, and the channel appears to be widening in some areas as a result. Entrenchment appears to be low and the stream well-connected to the floodplain. Channel substrate is dominated by gravel. Pools occur in side channels and at outside meander bends. Some undercut banks may provide cover at the outside bends of stable banks. Based on conditions at the upstream and downstream boundaries of this subreach, and examination of aerial photos, streambanks are dominated by pasture grasses, with only sparse cover of cottonwood and willows. Few energy-trapping features are present on the floodplain.

Restoration Potential

This subreach is a moderate priority for restoration, depending on landowner interest.

Recommended actions include:

- Riparian planting and bioengineering to stabilize eroding banks, allow channel narrowing, and reduce loss of pasture
- Temporary riparian fencing with revised grazing management or long-term fencing to protect riparian shrubs
- Landowner outreach to determine interest in upgrading any diversions or headgates to improve function. Any project involving irrigation infrastructure would need to include contingency for maintenance if there are any issues with the new structure



Conditions at upstream boundary of subreach F09ra

Conditions at downstream boundary of subreach F09ra

4.1.17 Subreach F09

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
14	Moderately High	62	At Risk	57	Fair	Moderate

Subreach F09 is 12,820 feet (approximately 2.43 miles) in length and extends from the property boundary upstream of Rocking Chair Ranch Road down to Rock Creek Road. This subreach is classified as a Rosgen E4 channel type, with an average slope of 0.3%, a sinuosity of 1.9%, and a width to depth ratio of 12.8. The stream is well-connected to the floodplain, particularly at the downstream end, where beaver activity on a side flow is backing up water on the floodplain. The channel does not reflect signs of active downcutting, but the stream is still widening and cutting meanders and new channel braids. Channel substrate is dominated by gravel.

Some deep pools, primarily in the middle of the subreach provide fish habitat. Other habitat elements are limited to infrequent large wood accumulations and few areas of overhanging vegetation or undercut banks. Sediment trapping by sedges was observed in many areas. Scattered willow cover and side channels provide energy dissipation function on the floodplain.

Riparian vegetation is dominated by pasture grasses with some rush and sedge, with willow limited primarily to patches on the floodplain at side channels and in the downstream end of the subreach. Sedge occurs primarily on low bars on inside bends and in patches on very lower banks. Canada thistle occurs but is not common in the riparian area. Yellow toadflax and spotted knapweed are in uplands near the stream but were not observed in the riparian area.

Pasture and hay production are primary land uses. There is a moderate amount of human-induced lateral cutting, primarily due to livestock trampling, as evidenced by hummocks on streambanks throughout the subreach. According to the landowner, most of the willows died off several years ago and are now in recovery. Most of the willows present in the reach are very small, and browsed down to grass and sedge height. Most of the subreach is grazed in summer but not fall

and winter, when forage preference shifts increasingly to shrubs; therefore most of the browse on willows may be from wildlife.

Multiple ditches take out from this subreach, but most are at grade and are not associated with diversions that might constitute a fish barrier. One diversion in a side channel may act as a seasonal fish barrier within the side channel. Fish entrainment is likely at these sites (Trout Unlimited 2013).

Restoration Potential

Subreach F09 is a moderate priority for restoration, depending on landowner participation. Restoration recommendations include:

- Bank stabilization with bioengineering to increase sediment trapping and narrow the channel
- Riparian planting in selected areas, and temporary browse protection for riparian shrubs regenerating on site



Conditions in upstream portion of subreach F09

Conditions at downstream end of subreach F09

4.1.18 Subreach F10ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	47	Not Sustainable	50	Fair	Moderate

Subreach F10ra is 4,318 feet in length and stretches from Rock Creek Road downstream to the City property at the wastewater lagoons. This subreach is classified as E4 Rosgen stream type, with an average slope of 0.7%, a sinuosity of 1.6%, and an estimated width to depth ratio of 13.3. The upper third of this subreach has been straightened. The channel appears to be over-widened, likely due to active streambank erosion, which may be accelerated from channelization in the upper third of the subreach.

Entrenchment appears to be low and the stream well-connected to the floodplain. Channel substrate is dominated by gravel. Pools are abundant and occur primarily at outside meander bends. Other than side channels, the floodplain does not have structural elements providing sediment-trapping or energy-dissipating functions. Vegetation on streambanks is dominated by pasture grasses, with limited areas dominated by sedges and rushes.

Hay production and pasture are the primary land uses at this subreach. One ditch originates in this subreach but the point of diversion does not appear to pose a barrier to fish migration.

Restoration Potential

This subreach is a moderate priority for restoration, depending on landowner interest. Potential activities include:

- Restore natural sinuosity to the upper third of this subreach to reduce streambank erosion and channel widening downstream
- Conduct further analysis to determine if a natural sinuosity could be achieved by reconnecting historic meanders still visible in aerial photos
- Plant native riparian shrubs to protect streambanks with temporary riparian fencing with a grazing management shift or long-term fencing
- Bioengineering to stabilize the most severely eroding banks and reduce the channel width is also recommended. Restoration would be supported by



Conditions at upstream boundary of subreach F10ra

Conditions at downstream boundary of subreach F10ra

4.1.19 Subreach F10

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
7	Moderate	62	At Risk	70	Fair	Moderate

This subreach is located west of the Town of Phillipsburg's wastewater lagoons on municipal property. The stream is 3,017 feet in length and was estimated to be a Rosgen E4 channel based

on a slope of 0.6%, high sinuosity of 2.2 and a width/depth ratio of 17.8. The substrate is gravel with fines.

This subreach showed modest amounts of lateral bank erosion, predominantly low scouring below the root zones of the grasses and sedges along its banks. The low gradient and high sinuosity of this channel created frequent deposits of silts and fines on inside meander bends. The floodplain appeared to be easily accessed by the stream in high flows. The groundwater table in this subreach and likely throughout this reach is high, ranging from 1-4 feet below the surface. Water quantity on this reach is clearly affected by discharges from the dam- there was less water in the channel in June than during a quality control visit in August.

Streamside vegetation consists of many riparian forbs, rushes and sedges, which provide bank stability, but pasture grasses (timothy, reed canary, meadow foxtail) predominate and lower habitat scores and potential at this site. Graminoid competition and grazing pressures are limiting the establishment of woody shrubs. Thistle was noted throughout the subreach. Some rose and willow saplings were noted on banks but not in abundance. Existing willows are umbrella-shaped mostly mature or decadent age classes.

Banks of this subreach were undercut to nearly a foot, which, along with some relic beaver structures on banks and some pool habitat, provided some fish habitat.

Restoration Potential

- Town of Philipsburg is in planning process for upgrading their wastewater treatment which may involve use of land around stream here. Good potential for dovetailing restoration with proposed improvements to wastewater treatment.
- Improving character of riparian vegetation would require graminoid suppression and riparian planting
- Grazing management, including exclusion of grazing, particularly in fall and winter



View across stream- sediment deposits and typical riparian vegetation in F10

View downstream from top of subreach F10. Point bar shown in June was underwater in August

4.1.20 Subreach F11

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
3	Low	68	At Risk	57	Fair	Moderate

This subreach has a length of 2,217 feet was classified as a C4c Rosgen stream type with a gravel substrate, based on the stream gradient of 0.6%, width/depth ratio of 17.8, and sinuosity of 1.6 estimated from aerial photos and calculated in GIS. The likely potential for this subreach is an E4 channel, but over-widening and sedimentation of the stream bottom over a century of agricultural activity limits this potential.

This reach displays very similar characteristics to subreach F10 above, though erosion was slightly higher here from oxbows and frequent beaver slides entering the stream, leading to a decreased fish habitat score. This site has ready access to the floodplain and moderately stable banks, though the grass-dominated vegetation raises the potential for bank failures. As with the upstream site, the site is very vulnerable depending on grazing intensity and timing.

Woody vegetation on this site is severely limited by browse, grazing pressure and graminoid competition.

Restoration Potential

- Planting of riparian vegetation or willow stakes with protection (may involve weed matting)
- Grazing management alternatives to remove cattle from banks at critical times



View across channel at downstream end of F11- bank conditions and gravel/fine substrate

View downstream from top of subreach F11

4.1.21 Subreach F12

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
8	moderate	45	Not sustainable	67	Fair	High

Subreach F12 is 9,258 feet (approximately 1.75 miles) in length and extends from approximately one-third mile downstream of the Philipsburg sewage lagoons to Black Pine Road. This subreach is classified as a Rosgen E4 channel type, with an average slope of 0.3%, a sinuosity of 1.7%, and a width to depth ratio of 11. Entrenchment is low and the stream easily accesses the floodplain. Channel substrate is dominated by gravel. The stream is channelized only at the downstream end, where it abuts the historic railroad bed.

There is a minimal amount of human-induced lateral cutting. Lateral bank erosion is slightly accelerated on cut banks due to lack of deep-rooted riparian vegetation on streambanks. Lateral scour pools and undercut banks provide fish habitat, but many banks are unstable. Very little overhanging vegetation or large wood was observed in this subreach. The channel does not exhibit signs of downcutting or aggradation, although the channel is actively widening and cutting new side channels in limited areas. Sedges and grasses on lower banks and point bars are trapping sediment, but little else is present on the floodplain to trap sediment and dissipate energy at high flows.

Sedge and bulrush are the primary deep-rooted riparian species on the streambanks, which otherwise are dominated by hay and pasture grasses. Mature and sapling classes of willows are present, both browsed moderately, but generally are not growing on the streambanks. Some shrub regeneration is occurring on point bars and lower stream banks. Competition from grasses appears to be limiting shrub regeneration. Canada thistle is the only noxious weed observed at the time of the assessment and occurs on less than five percent of the reach.

Hay production and pasture are the primary land uses at this subreach. The proportion of livestock browse, compared to browse by wildlife, is unknown. Little hoof shear by livestock was visible on streambanks. This area appears to have a history of heavier grazing than it has sustained recently.

Restoration Potential

Subreach F12 is a high priority for restoration, depending on landowner participation.

Restoration recommendations include:

- Restoring native riparian shrubs to streambanks, which will benefit the hay fields as well as the stream by reducing bank erosion.
- Temporary fencing of the stream belt width to increase existing shrub density where browse is limiting factor
- Active planting of riparian shrubs where grass competition is heavy, beginning with weed fabric or ground cloth to suppress graminoids
- Improve stream meander and floodplain connectivity by removing railroad grade



Conditions at upstream end of subreach F12



Conditions at downstream end of subreach F12

Figure 7. Flint Creek Reach 4 NRCS Habitat Sustainability

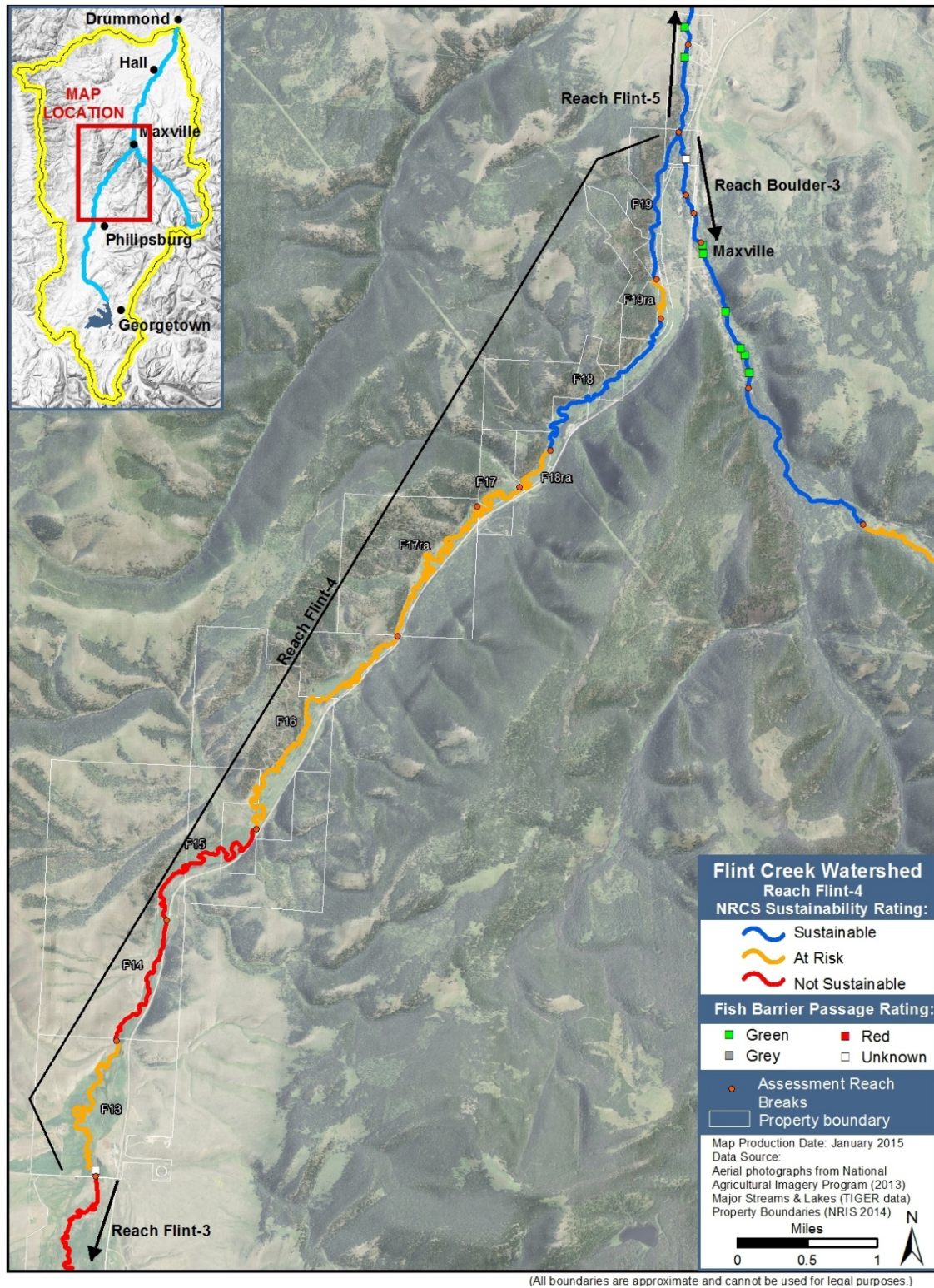
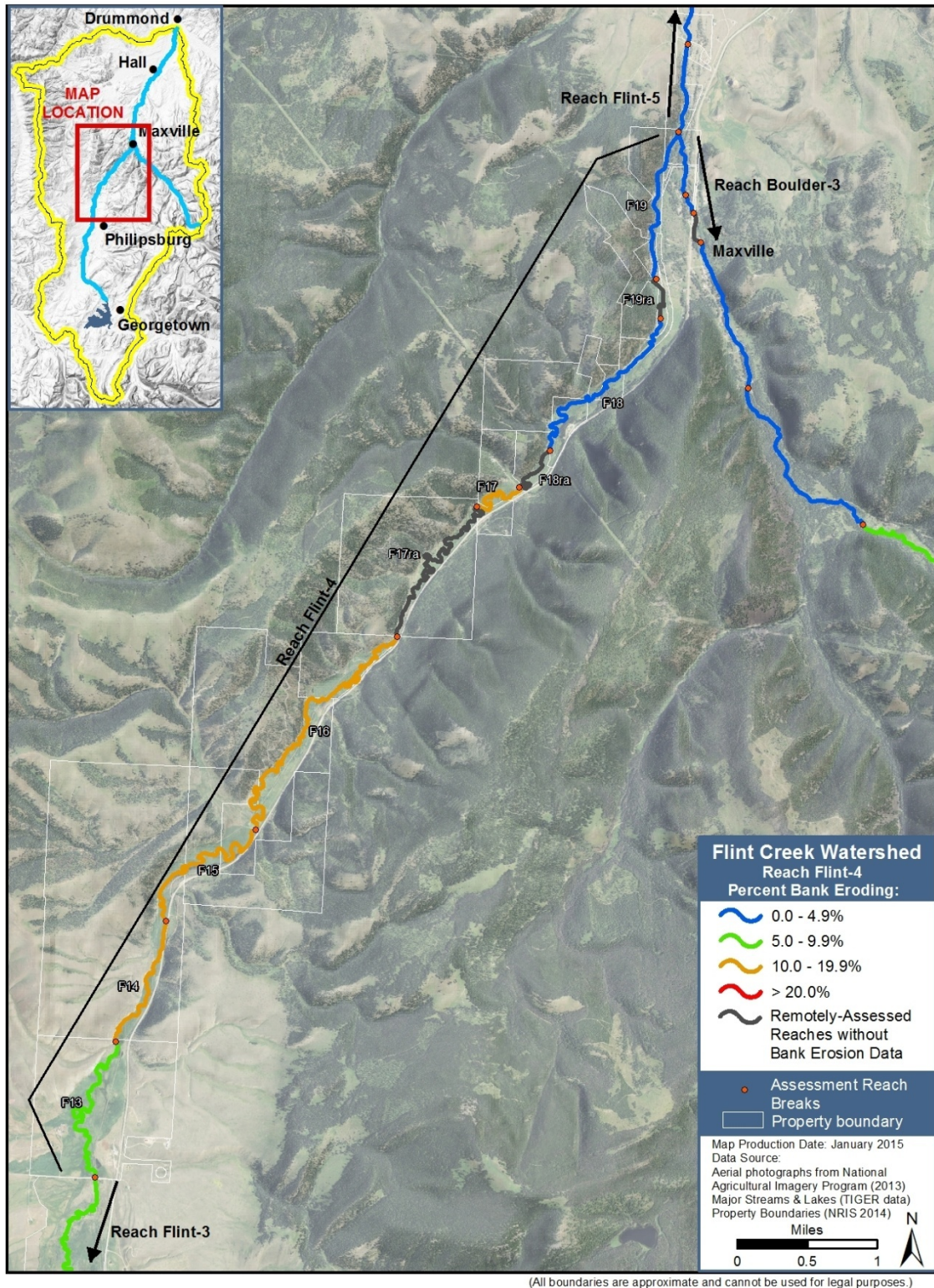


Figure 8. Flint Creek Reach 4 Bank Erosion



4.1.22 Subreach F13

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
9	Moderate	64	At Risk	43	Fair	Moderate

This subreach has a length of 9150 feet was classified as a C4 Rosgen stream type with a gravel substrate, based on the stream gradient of 0.1%, width/depth ratio of 16.7, and sinuosity of 1.8 estimated from aerial photos and calculated in GIS.

The stream is stable in terms of incision with low entrenchment, though the railroad grade acts as a dike and limits access to the floodplain on river right in the upper extent of the subreach. The ground throughout the reach on river right was saturated at the time of the survey, and a small tributary entered the channel toward the bottom of the subreach.

Some stream widening was noted and mid-channel islands were seen, as well as deep sediment deposits on inside bends of the channel, indicating some imbalances with the sediment supply in the system.

Lateral erosion is moderate on the reach, a function of the prevalence of grass on streambanks. There was a complete absence of woody or broadleaf vegetation along streambanks, an indication of both heavy grazing as well as likely broadleaf herbicide application. Forbs and willow were seen along banks in the reach immediately downstream, indications of the impact of land uses on this subreach.

The one stream diversion found on this subreach was not surveyed in the field but is likely at risk for entrainment, though not a passage issue.

Restoration Potential

- Grazing management
- Riparian fencing and woody vegetation establishment on streamside
- Bioengineering treatments for high bank



View downstream from top of subreach F13. Note railroad grade restricting floodplain access on river right

View of most significant grazing-impacted high bank in F13

4.1.23 Subreach F14

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
12	Moderately high	42	Not sustainable	40	Fair	High

Subreach F14 is 5,947 feet (approximately 1.13 miles) in length and is located in a relatively narrow portion of the valley between Highway 1 and steep side slopes west of the stream. This subreach is classified as a Rosgen C4 channel type, with an average slope of 0.7%, a sinuosity of 1.2%, and a width to depth ratio of 15. Floodplain access is somewhat limited due to channel confinement. The channel is stable vertically, with no sign of active downcutting, but exhibits a moderate amount of human-induced lateral cutting as the channel adjusts to historic alteration of the floodplain and channel by construction of the rail road grade and highway. The channel appears to be widening in many areas of the site. Channel substrate is dominated by gravel, but sand is abundant.

Riparian vegetation is dominated by grasses and sedge species. Riparian shrub species such as willows and currants are present but rare, and juniper is beginning to encroach on drier areas at the edge of the floodplain and on the railroad grade. The few riparian shrubs still present are browsed heavily by livestock and wild ungulates. Noxious weeds are abundant in the riparian area, and include spotted knapweed, Canada thistle, and yellow toadflax.

Aquatic habitat and floodplain features for dissipating energy are limited in this reach. Pools are generally shallow and overhanging vegetation and large wood essentially absent from the reach.

The channel lacks the complexity and cover to provide quality habitat. Some scour pools and aquatic vegetation, and limited areas with undercut banks provide some habitat features.

Primary land use effects on this subreach are grazing and confinement from the historic rail bed and the highway. Approximately 1400 feet of the downstream end of the subreach was straightened and runs along the highway. This reach likely has improved over historic conditions of heavier grazing, but competition by pasture grasses is still limiting regeneration of riparian shrubs.

Restoration Potential

Subreach F14 is a high priority for restoration, depending on landowner participation. Restoration recommendations include:

- Riparian shrub planting and browse protection
- Bioengineering of eroding banks
- Install hardened approaches for livestock
- Control of noxious weeds
- Restore meanders and floodplain connectivity in areas constricted by the historic railroad grade



Limited riparian vegetation at the upstream end of the subreach F14

Conditions at downstream end of F14

4.1.24 Subreach F15

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
15	Moderately high	45	Not sustainable	50	Fair	High

A sediment and habitat study was completed for the Flint Creek TMDL in this subreach, results of which are summarized below in Table 5.

Table 5. Selected data summary from TMDL reach FLIN 11-01 (DEQ 2012)

Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio (ft)	D50 Pebble Count (mm)	Pools/1000 ft	Entrenchment Ratio (ft)
High	71.4	0	3	21	34	4	4.2

Subreach F15 is 8,690 feet (approximately 1.65 miles) in length, extending above and below a State parcel, and is located directly upstream of Forest road 1501 near the confluence of Sawmill Creek. This subreach exhibits characteristics of a C4 and over-widened E4 channel types, with an average slope of 0.1%, a sinuosity of 1.8%, and a width to depth ratio of 15. The channel is not incised but is partly limited by channel confinement by the historic railroad bed and, to a lesser extent, by Highway 1. Channel substrate is dominated by gravel.

There is a moderate amount of human-induced lateral cutting, primarily on grass-dominated outside bends, creating long lateral scour pools. Lateral erosion and channel widening are likely adjusting to the higher channel energy coming from the confined subreach directly upstream.

Riparian vegetation is dominated by hay and pasture grasses, but sedge grows in with the grass in many areas and dominates lower energy areas at many inside bends. Native riparian forbs and rush also are common, indicating only light livestock use in recent years. Riparian shrubs are rare through much of the subreach but increase toward the downstream end. Canada thistle occurs throughout the subreach, generally with light cover. Spotted knapweed and yellow toadflax grow on the railroad grade, where conditions are drier. Riparian shrub regeneration and diversity are severely reduced at this site, but shrub regeneration is good in lower and wetter areas of the site. Browse levels vary widely based upon location.

The middle of the subreach supports a vigorous riparian shrub community in a limited area, where the stream also follows a multiple thread channel, however, most of the reach lacks the channel complexity or floodplain features to trap sediment and dissipate stream energy effectively. Aquatic habitat is somewhat limited, with infrequent large wood and overhanging vegetation, but undercut banks are common. Pools are mostly shallow but lateral scour pools and undercut banks provide quality fish habitat.

This site appears to be improving with a management change from heavier historic grazing use, which may also provide opportunities to address railroad grade issues within management goals of livestock operations here.

Restoration Potential

Subreach F15 is a high priority for restoration, depending on landowner participation. At one area of the railroad grade within this subreach the stream has cut almost all of the way through fill placed for the rail road bed and is about seven feet from reconnecting to a historic meander.

- Restore hydrologic function and increase channel length by removal of railroad grade
- Riparian shrub planting and browse protection, with weed matting
- Bank fascines and toe-slope willow stakes to stabilize severely eroding banks.



Stream has washed out railroad grade and nearly reconnected to historic meander in F15

Erosion on low grass-dominated banks in F15

4.1.25 Subreach F16

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
16	Moderately high	70	At Risk	70	Fair	High

Subreach F16 is 15,002 feet (approximately 2.84 miles) in length and is located directly downstream of Forest Road 1501 near the confluence of Sawmill Creek. This subreach is classified as a Rosgen E4 channel type with an average slope of 0.3%, a sinuosity of 1.7%, and a width to depth ratio of 11.2. Entrenchment is low and the stream has access to the floodplain but it is severely constricted by the railroad grade in areas. Channel substrate is dominated by gravel with abundant sand.

There is a moderate amount of human-induced lateral cutting, primarily due to a lack of suitable riparian vegetation and physical trampling by cattle. Erosion is also due to trampling but only where banks are not protected with native riparian shrubs. Beavers are active at this site and are contributing to bank erosion near burrows. High eroding streambanks are present but not widespread, and occur mainly along old road bed and railroad bed. The stream is slightly

widened in some areas with active bank erosion. Large wood is nearly absent from the channel and floodplain at this site. Some habitat is provided by beaver activity, overhanging vegetation, scour pools, and undercut banks.

Riparian vegetation is dominated by mixed riparian shrubs, such as willows and red-osier dogwood, and sedge in much of the subreach but some banks are vegetated only by pasture grass. Riparian shrub regeneration and diversity are suitable for this site, and are browsed moderately by livestock, wild ungulates, and beaver. Upland grasses and weedy annuals are common in the understory. Noxious weeds are abundant at the site and include spotted knapweed, Canada thistle, and yellow toadflax, the last of which occurs primarily at and near the old railroad grade and road bed.

This subreach appears to be in recovery but is limited by periodic grazing use and confinement by the old road bed and railroad grade. Livestock trampling and grazing pressure generally is not high. Livestock were held at this site prior to the assessment.

Restoration Potential

Subreach F16 is a high priority for restoration, depending on landowner participation. Potential restoration here includes:

- Reconnect meanders and restore floodplain connectivity lost by historic railroad grade
- Riparian shrub planting and browse protection, with weed matting
- Bank fascines and toe-slope willow stakes to stabilize severely eroding banks
- Outreach landowner to gauge interest in opportunities to improve water storage and surface flows in Sawmill Creek and other tributaries on the same ownership
- Restoration of wetlands in headwater tributaries with passive restoration techniques to benefit water supply to the creek and agricultural uses.



Recently-grazed pasture at upstream end of F16



Conditions at downstream end of F16

4.1.26 Subreach F17ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	66	At Risk	70	Fair	Moderate

This subreach has a length of 10,632 feet and was classified as a C4 Rosgen stream type with a gravel substrate, based on the stream gradient of 0.1%, width/depth ratio of 16.7, and sinuosity of 1.8 estimated from aerial photos and calculated in GIS.

This subreach is located in the narrowest section of Flint Creek (after the headwaters), and is constrained by the hillslope and utility access road on one side and the railroad grade (and highway) on the other. Stream sinuosity and general erosion conditions are largely determined by the width of robust riparian vegetation on banks. Where thick stands of willow are seen, the stream meanders back and forth across the valley bottom, displaying sinuosity more characteristic of an E channel.

Where streamside vegetation is lacking, however, the channel straightens and bank erosion on outside meander bends is noticeable from aerial images. In most locations of eroding outside banks, channel adjustment is noticeable in the form of mid-channel islands on the opposite side of the stream. The channel does appear to be connected to its floodplain on at least one side throughout the subreach.

Fish habitat is likely limited from woody debris and overhanging vegetation. In this low gradient, meandering stream, it is likely that this subreach also sees high levels of sediment deposition on the stream bottom and in pools, also decreasing high quality fish habitat.

The railroad grade in this subreach hugs the toe of the bed of the highway, which may serve as a buffer against stream energy against the highway bed.

Restoration Potential

- Riparian shrub planting and browse protection, with weed matting
- Bank fascines and toe-slope willow stakes to stabilize severely eroding banks



View of downstream character of F17ra

View downstream from top of F17ra

4.1.27 Subreach F17

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
11	Moderately High	72	At Risk	57	Fair	Moderate

This subreach has a length of 3,528 feet and was classified as an E4/5 Rosgen stream type with a gravel to sand substrate and width/depth ratio of 11.5 estimated in the field and stream gradient of 0.5% and sinuosity of 2.0 estimated from aerial photos and calculated in GIS.

This reach is located on private property in a narrow stream corridor, impinged by a utility line and access road to the west and an out-of-service railroad grade to the east. Landowners cultivate hay where feasible on the western side of the channel, which, for an estimated 1500 feet, occurs within 5 feet of the stream.

The eastern side of the stream has access to its floodplain and woody vegetation varies from thick willow and dogwood shrubs with sedges and rushes to a mix of shrubs, sedge and pasture grasses. There are indications that grazing has been removed from this reach recently (within 5 years) and current browse pressure on vegetation is likely from wild ungulates. Thistle, likely originating from the historic railroad grade, was seen intermixed with pasture grasses (brome, timothy).

Lateral bank erosion occurs primarily on banks with compromised riparian vegetation is restricted primarily to outside meander bends. Bank failures have added to sedimentation and widening of the channel, limiting the amount of overhanging vegetation cover and depth of pools for fish habitat. Inside meander bends with thick grasses also limit the quality of fish habitat throughout this subreach.

Restoration Potential

- Expand woody riparian buffer in grass and hay-dominated areas, likely with fencing and weed matting as needed



View downstream showing vegetation character on both banks at F17

View downstream of haying activities to streamside and collapsing banks at F17

4.1.28 Subreach F18ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	70	At Risk	70	Fair	Moderate

This subreach has a length of 2,718 feet and was classified as a C4 Rosgen stream type with a gravel substrate and width/depth ratio of 12.5 and stream gradient of 0.2% and sinuosity of 1.5 estimated from aerial photos and calculated in GIS. Like most subreaches in this extent of Flint Creek, it likely has a potential to be an E4 channel, given ample floodplain and density of woody riparian vegetation.

The subreach begins at a private access bridge with wide meanders that are constricted by a utility access road to the west and the historic railroad grade to the east. Upwards of 25-50% of the historic floodplain of this subreach is constricted by the railroad grade (Appendix 3). High tension electricity lines traverse the stream twice and a tower is located within the floodplain in the upper section of the reach. Woody vegetation in this upper section is a fraction of what it is downstream, likely due in part to utility access.

The channel has access to its floodplain on one side throughout the subreach, but there are signs of stream widening and the development of mid-channel islands in the upper half of the subreach.

Vegetation is comprised of dense willow stands, riparian forbs, sedges and rushes as well as grasses to the banks. Low-lying erosion is evident where woody vegetation is absent on banks. Fish habitat is slightly impacted from lack of vegetation and likely sedimentation of pool habitat.

The railroad grade lies within the floodplain and likely prevents the full expression of the channel in terms of stream length, sinuosity and energy and sediment capture on the floodplain. As with other areas throughout this reach, the railroad grade is also a likely source of weeds.

Restoration Potential

- Expand woody riparian buffer in grass and hay-dominated areas, likely with fencing and weed matting as needed
- Reconnect meanders and restore floodplain connectivity lost by historic railroad grade



View downstream from top of subreach F18ra

View upstream from bottom of subreach F18ra

4.1.29 Subreach F18

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
3	low	83	Sustainable	37	Fair	High

This subreach has a length of 9,480 feet and was classified as C4 Rosgen stream type with a gravel substrate and width/depth ratio of 12.5 from field estimates and stream gradient of 0.2% and sinuosity of 1.5 estimated from aerial photos and calculated in GIS. Like most subreaches in this extent of Flint Creek, it likely has a potential to be an E4 channel, given ample floodplain and density of woody riparian vegetation.

This subreach crosses multiple ownerships whose primary land uses appear to be conservation or recreation. Stream banks are stable and the stream has ready access to its floodplain, but only on the western side of the railroad grade. High flow stream energy is captured by dense stands of willow, chokecherry, birch, riparian forbs, sedges and rushes and side channels and inundated

areas within the floodplain were common at the time of the survey, with an estimated 87% of riparian vegetation comprised of woody shrubs and trees.

The stream did show signs of excess sediment from upstream sources, with inside meanders frequently full of silt, the presence of mid channel bars and some over-widened stretches of stream.

The upstream ownership in this subreach is highly conservation and wildlife oriented and remarked on the high wildlife value of her land, including mountain lion, moose, beaver, eagles, and waterfowl. The largest area of concern to streambanks in the upper ownership was in one location where a large patch of thistle was mowed, along with other vegetation, to the stream. Another small recreational area devoid of woody vegetation showed some bank erosion.

The biggest impairment to this subreach is the railroad grade, both as a vector for thistle and knapweed into the area, as well for its role in cutting off wet marshes and wetlands on its east side to the stream to the west. Inundated areas and cut-off oxbows were common to the east of the railroad grade, and in one location a culvert was seen under the rail bed for transport of excess runoff during high flows, just south of the upstream landowner's property. Despite the culvert, standing water remained to the east of the railroad bed during low flows.

Further downstream, the railroad grade is undercut by the stream, and a 40 foot span of railroad is suspended over the water.

Restoration Potential

Restoration of this subreach was given high priority due to the existing condition of the land and its location just upstream of the Drummond valley, landowner support for potential restoration (at least the upstream landowner), and the potential benefit to sediment capture and water holding potential of restoration activities, which include:

- Connect stream to active floodplain- by removing railroad grade entirely or in specific locations
- Weed control along railroad grade and floodplain
- Enhance existing conservation land use practices



View downstream of typical bank conditions and weed incursions from old railroad bed in F18

Old railroad undermined by stream in F18

4.1.30 Subreach F19ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	70	At Risk	50	Fair	Low

At this subreach, the slow, meandering gradient from above steepens and the creek begins to straighten and accelerate. The stream flows primarily through one private ownership, but has one meander bend through a second private ownership before entering BLM land. This subreach has a length of 2,106 feet and was classified as C4 Rosgen stream type with a gravel substrate and width/depth ratio of 15.0 and stream gradient of 1.1% and sinuosity of 1.0 estimated from aerial photos and calculated in GIS.

The railroad grade visibly constricts the historic floodplain just upstream of a residential area. Ponds and a wetland area define historic oxbows and it is unknown whether this wet area to the east of the railroad grade maintains hydrologic connectivity to the stream.

The stream is constrained by natural topography on river left but has access to its floodplain on river right. A large mid-channel bar and over-widening are indications that the subreach is out of balance with its sediment load from upstream sources. Minimal erosion sources are apparent from within the subreach.

There is dense willow growth on streambanks, increasing in density further downstream on river left. River right approaches a small subdivision with multiple small properties and riparian vegetation on the right bank becomes reduced to a small buffer of 5-10 feet in width, giving way to grass-dominated fields. The field was likely cleared for installation of high tension power lines and is now likely hayed. A two-track is noticeable under the high tension lines to a bridge across the upper section of the subreach.

Restoration Potential

- Connect hydrology on either side of railroad grade where feasible
- Widen riparian buffer in upstream section with plantings and fencing



View downstream from top of subreach F19ra

View upstream from downstream end of subreach F19ra

4.1.31 Subreach F19

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
0	low	88	Sustainable	70	Fair	Low

The character of Flint Creek changes dramatically at this subreach as the floodplain becomes constricted between the railroad grade and the side of the mountain. The stream gradient steepens to 1.8% and sinuosity decreases to 1.1 and width/depth ratio increases to 16.7. It was classified in the field as a B3c Rosgen channel type, which also corresponds to TMDL calculations.

A sediment/habitat assessment was done for the TMDL in this subreach, results of which are summarized below in Table 6:

Table 6. Selected data summary from TMDL reach FLIN 11-04 (DEQ 2012)							
Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio (ft)	D50 Pebble Count (mm)	Pools/1000 ft	Entrenchment Ratio (ft)
Low	0.0	21	94	25.3	164	19	2.1

A vast majority of this subreach runs along BLM land and boasts diverse and mature riparian forest vegetation consisting of Douglas fir, cottonwood and some ponderosa pine, as well as variety of riparian shrubs- red osier dogwood, chokecherry, grasses and forbs. In limited areas the floodplain is constricted by the railroad grade, but due to the steep nature of the valley gradient, the stream lies 10-20 feet below the rail bed, has access to the floodplain on the other side and does not appear to be adversely affected.

The channel bottom is cobble dominated. The long scour pools on outside meander bends typical of upstream subreaches are gone, replaced by numerous shallow step pools. TMDL documents noted few spawning gravels, as stream velocities and the entrenched nature of the channel make it transport reach. Boulders and cobbles line the well-vegetated banks throughout the subreach, leaving the channel mostly confined, though evidence of some over bank deposits was seen on streamside rocks, likely from 2011 high water events. There was some woody debris recruitment in the channel but less than would be expected. As the surrounding forest ages, more woody debris recruitment is foreseen with corresponding improvements to fish habitat conditions.

The main human impact to this site is the old Londonderry mine at the upstream end of the reach, with old access roads on the west side of the stream and old structures and rip-rapped banks. In one location a trickle of water was seen coming from an open adit and orange stained rocks were an obvious metals contamination site. Further downstream on river right an area had been reclaimed, graded and seeded. Riparian vegetation at this site was more grass than forest, but appeared stable. A large old irrigation pipe (30" diameter) runs parallel to the stream from the old mine sites on river left, to river right along the riparian at the confluence property.

At the downstream end of the subreach the channel flows through private property to its confluence with Boulder Creek. The primary differences between the two channels were noticeable in the turbidity of the water. Flint Creek was noticeably turbid and brown-colored, while Boulder Creek flowed clean. The confluence property is beautifully conserved with lush streamside vegetation.

This subreach was ranked a low priority for restoration, although information regarding mine site activity will be relayed to NRDP in separate communications.

Restoration Potential

- Conservation
- Mine site remediation (outside scope of this report)



View downstream from top of subreach F19- old
Londonderry mine site in distance



View upstream near confluence with Boulder Creek in
F19

Figure 9. Flint Creek Reach 5 NRCS Habitat Sustainability

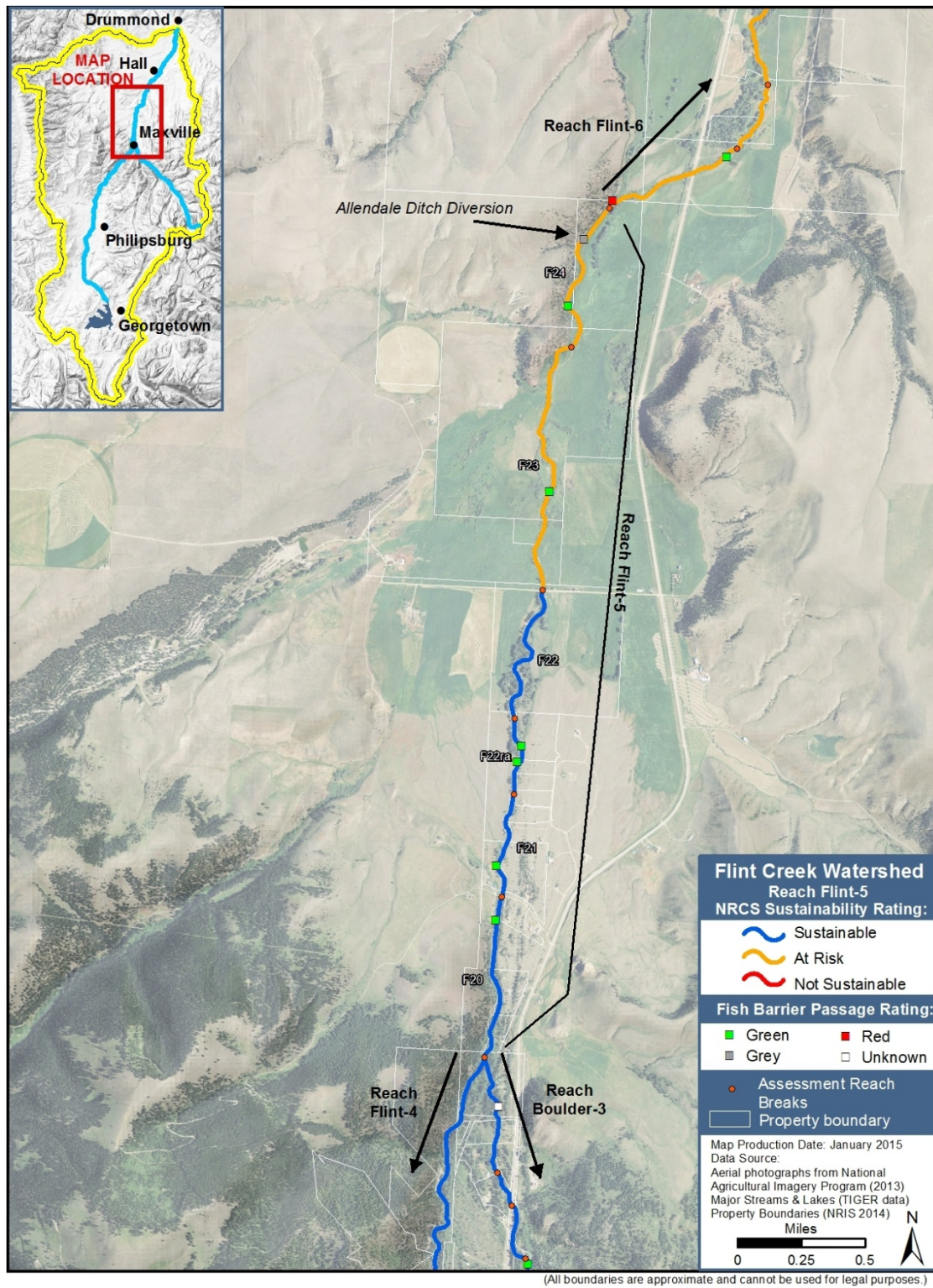
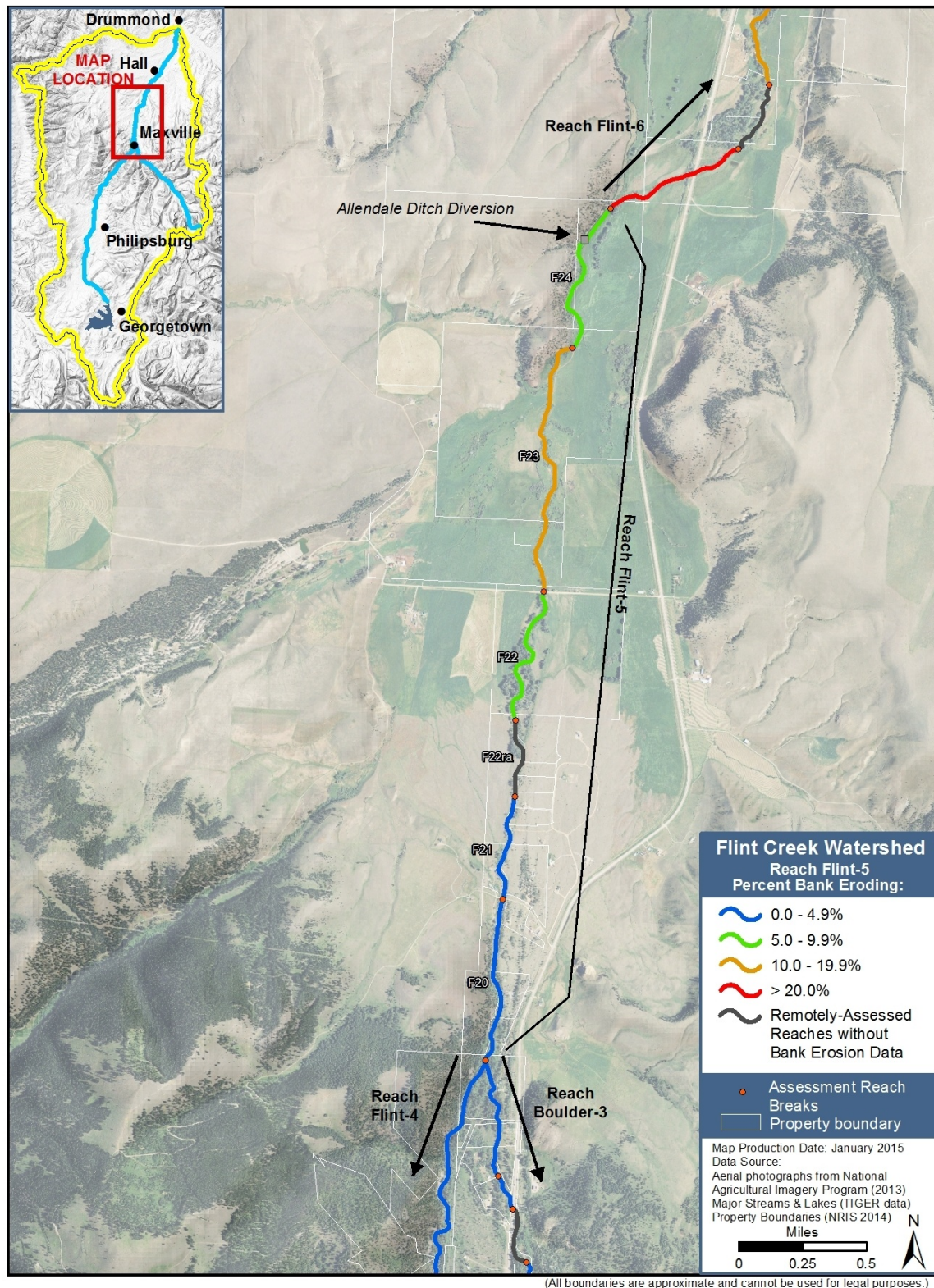


Figure 10. Flint Creek Reach 5 Bank Erosion



4.1.32 Subreach F20

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
0	low	98	Sustainable	80	Good	Low

This subreach is immediately downstream of the confluence of the two creeks and is 3,454 feet in length with a cobble dominated channel bed. It runs through several private properties, with a vacation rental property on most of river left and residential properties on the dry bench above the stream on river right. It was classified in the field as a B3c Rosgen stream type based on a slope of 2%, sinuosity of 1.0 and width/depth ratio of 19.4.

The channel is moderately confined by rip-rap on banks and may have been historically straightened. The dense riparian vegetation appears stable to dissipate energy in high flow events. Landowners appear to maintain streamside vegetation in its current state. The entrenched nature of the channel prevents much expansion of riparian buffer widths beyond where they are now due to the availability of water.

One stream diversion was documented on this reach, posing no passage issues but potentially could entrain fish in the ditch. The location was documented as “prime trout habitat” both up and downstream of the ditch.

Restoration Potential

- Conservation of streamside riparian habitat



“Prime” trout habitat upstream of diversion in F20

View downstream of rip-rapped banks at vacation property on F20

4.1.33 Subreach F21

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
2	low	87	Sustainable	80	Good	Low

This subreach begins at the bridge at road 1501 and ends in the middle of a small subdivision on river right on a high and dry bench. The channel in this subreach is 2,292 feet in length, has a slope of 2%, sinuosity of 1.1 and width/depth ratio of 17.5, classified as a B3c Rosgen channel type dominated by cobbles.

The channel is entrenched in a boulder-lined streambank and narrow riparian area. Banks are stable and adequate to dissipate stream energy with dense woody vegetation ranging from cottonwood and willow to dogwood, rose and chokecherry. The upstream property has rip-rapped its banks on river left just above an irrigation diversion that is also irrigated by Smart Creek to the west. The riparian area doubles in width between the diversion and stream due to increased groundwater infiltration rates on river left.

The diversion was found to have several large fish in the ditch and is a likely entrainment risk but not a passage barrier. As with the subreach upstream, it is noted to be in “prime” trout habitat.

There is minimal bank erosion noticeable in this subreach. The primary human impacts are the horse pasture on the upstream property that is a source of weeds into the riparian area. In the lower half of the subreach, old side channels, possibly remnant irrigation ditches are colonized by upland vegetation and some juniper were seen encroaching on the riparian area.

Restoration Potential

- Conservation of streamside riparian habitat



Stream diversion on river left in F21

Irrigation ditch diversion heading northwest in F21

4.1.34 Subreach F22ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	91	Sustainable	70	Fair	Low

Subreach F22ra is 1671 feet in length and is located two thirds of a mile upstream of Henderson Creek Road. This subreach is classified as a Rosgen stream type B, with an average slope of 1.7%, a sinuosity of 1.1%, and an estimated width to depth ratio of 16. Substrate appears to be dominated by cobble or boulders. Pools are infrequent and shallow, as befits this stream type.

Large rock and some large wood deposits provide habitat value in the active channel and riparian area. Due to stream entrenchment typical of a B channel, the floodplain lies mostly within the channel, and reduction of stream energy and sediment trapping is likely moderate from the woody bank vegetation. There is a minor amount of human-induced lateral cutting, primarily at gaps in cover of riparian trees and shrubs.

Riparian vegetation is dominated by cottonwood with a narrow cover of riparian shrubs. The understory is likely dominated by pasture grass, based on conditions at the upstream and downstream boundaries of the subreach.

The subreach lies within 3 undeveloped subdivision properties on river right and one undeveloped piece on river left, likely historically used for haying. Primary land use impacts affecting this subreach are irrigation and historic clearing for adjacent pastureland. Two irrigation diversions direct flow from this subreach. Neither diversion is considered a barrier to upstream fish migration, but the more downstream diversion may pose a risk of fish entrainment.

Restoration Potential

This subreach is generally stable and is not prioritized for restoration.

- Conservation of streamside riparian habitat
- Irrigation ditch improvements



Downstream boundary of subreach F22ra

Typical riparian habitat and some woody debris at upstream end of subreach F22ra

4.1.35 Subreach F22

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
7	moderate	90	Sustainable	90	Good	Low

This subreach contained FLIN 17-01, a sediment/habitat assessment site for the Flint Creek TMDL. Summary data is provided below in Table 7:

Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio	D50 Pebble Count	Pools /1000 ft	Entrenchment Ratio
Low	0.0	62.2	75.8	34.2	137	15	2

Subreach F22 is 3,212 feet in length and is located directly upstream of Henderson Creek Road along a single ownership. This subreach is classified as a Rosgen B2 channel type, shifting to a B3 type, with an average slope of 1.9%, a sinuosity of 1.2%, and a width to depth ratio of 14. The stream channel is slightly entrenched but not incised. Channel substrate is dominated by boulders and cobble. The channel is very stable and well-armored, with no down-cutting and few widened areas, which are partly due to natural scour.

The floodplain near the stream contains a variety of elements for habitat and energy dissipation, including shrubs, large rock, and large wood. The channel is generally straight and is not connected to side channels. This is a high-energy transport reach, in which most fine substrate

sizes are flushed through and do not accumulate. Overhanging vegetation is slightly limited by browse. Large wood likely washed through without accumulating in the reach. Deep pools would not be expected in this stream type but good scour pools occur downstream of some large boulders.

Riparian vegetation is dominated by cottonwood, mixed willow, red osier dogwood, alder, and other riparian shrubs. Riparian shrub regeneration and diversity are suitable for this site, with only light browse. The riparian is fenced on both sides. Pasture grasses comprise a minor component of the understory. Noxious weeds are present but not common, and include Canada thistle and common tansy.

The primary land uses affecting this subreach are grazing and historic clearing for adjacent pasture. Bank erosion is very minimal, only occurring at wildlife trails and livestock approaches.

Restoration Potential

Subreach F22 is a low priority for restoration because habitat is in good condition.

- Conservation of streamside riparian habitat



Conditions at upstream end of subreach F22

Conditions at downstream end of F22

4.1.36 Subreach F23

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
13	Moderately High	53	At Risk	57	Fair	Moderate

Subreach F23 is 5,577 feet (approximately 1.06 miles) in length and is located directly downstream of Henderson Creek Road. This subreach is classified as a Rosgen C3 channel type, with an average slope of 1.2%, a sinuosity of 1.1%, and a width to depth ratio of 14.

Entrenchment in this subreach is low but floodplain access is somewhat limited due to channel incision. Channel substrate is dominated by cobble and small boulders and the channel is stable, although it has widened in several discrete areas. There is a moderate amount of human-induced lateral cutting at outside bends where grass dominates banks or livestock access the stream.

Two properties compose this subreach. The upstream property exhibits more impact from grazing use and a declining trend in riparian condition, with higher cover of grass in the understory compared to the downstream property. The smaller portion of the subreach within the downstream property appears to be in a recovery trend, based on greater diversity and regeneration of shrubs. Banks are sheared by livestock to some extent but are healing and the understory has a greater diversity of riparian forbs and less grass cover.

Riparian vegetation is dominated by shrub species that are somewhat resistant to grazing pressure, and include water birch, hawthorn, woods rose, alder, and chokecherry. Pasture grasses dominate the understory. Except in a few areas not easily accessible to livestock, shrub regeneration is limited by browse. Competition from grasses and the natural lack of scour surfaces and point bars also limit shrub regeneration; most shrubs in the subreach are late-mature to decadent. Noxious weeds, including Canada thistle, common tansy, spotted knapweed, and hounds tongue, are abundant throughout the site.

Grazing is the primary land use affecting the site. This may be a wintering area, based on the lack of more palatable riparian shrubs and the presence of a manure layer on much of the upper left bank in the upstream property. One diversion has been assessed in this subreach, and does not constitute a barrier to fish migration (Trout Unlimited 2013).

Some large wood is present but not abundant to provide aquatic habitat. Undercut bank habitat is rare and few deep pools are present, as would be expected for this stream type. Beavers are active on a side channel and tributary, and have raised the water table locally on the floodplain.

Restoration Potential

Subreach F23 is a moderate priority for restoration, and the highest priority subreach within reach 5. Restoration considerations for this subreach include:

- Review of grazing management to encourage shrub regeneration
- Install hardened crossings in the downstream half of the reach
- Install browse protection and additional riparian shrubs, particularly in the downstream half of the site.
- Stabilization of high eroding banks only with techniques effective under high energy flows, and which will re-establish riparian shrubs.
- Upgrade irrigation diversion to improve function and habitat value.



Conditions above property boundary within subreach F23

Conditions at downstream end of F23

4.1.37 Subreach F24

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
7	Moderate	70	At risk	67	Fair	Low

Site FLIN 18-02 in the sediment habitat assessment for the TMDL was contained within this subreach, results from which are summarized below in Table 8.

Table 8. Selected data summary from TMDL reach FLIN 18-02 (DEQ 2012)

Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio	D50 Pebble Count	Pools/1000 ft	Entrenchment Ratio
Low	0.0	3.6	92.2	27.6	81	7	1.9

Subreach F24 is 3,451 feet in length and its downstream boundary is located at a diversion approximately one half mile upstream of the crossing of Highway 1 and Flint Creek downstream of the Allendale diversion. This subreach is classified as a Rosgen C3 channel type, with an average slope of 0.5%, a sinuosity of 1.2%, and a width to depth ratio of 14. Floodplain access is limited due to channel confinement. Channel substrate is dominated by cobble mixed with gravel and boulders. The channel has been straightened and confined at the downstream end of the reach below the Allendale diversion and is slightly confined. An older channel bed to the east

was likely abandoned to expand haying operations long ago, which has pinched the channel against the hillslope.

Deep pools, undercut banks, and overhanging vegetation are limited, especially in the straightened portion of the subreach. Large rock, large woody debris, and riparian shrubs and trees are present to dissipate stream energy and capture sediment but are slightly limited in this subreach due to historic riparian clearing and channel straightening associated with irrigation infrastructure.

The riparian canopy contains a good mixture of riparian trees and shrubs but does not provide consistent cover throughout the subreach. The understory is dominated by pasture grasses, although sedges are present on some lower banks. Riparian shrub regeneration and diversity are suitable for this site, and are browsed moderately by livestock and wild ungulates. Noxious weeds, which include Canada thistle and common tansy in the lower riparian area and spotted knapweed and hounds tongue in the upland fringe, are common throughout the subreach.

Hay production, grazing, and irrigation are the primary land uses affecting this subreach. Two diversions direct flow from this subreach. The smaller diversion upstream is not considered a barrier to fish migration (Trout Unlimited 2013). The large Allendale diversion appeared to remove roughly half of the stream flow from the channel at the time of the assessment, and may constitute a partial barrier to fish passage. Human-induced lateral cutting is minimal at this site.

Restoration Potential

Subreach F-24 is a low priority for restoration, unless water users support upgrading the Allendale diversion to improve fish passage. The potential for restoring natural channel form and dynamics is limited by the irrigation infrastructure. Other restoration would include:

- Restoring riparian shrubs at discrete sites with eroding banks
- Establish a riparian vegetation buffer where none currently exists along hay fields



Straightened stretch between diversions in subreach F24

Diversion forming downstream boundary of subreach F24

Figure 11. Flint Creek Reach 6 NRCS Habitat Sustainability

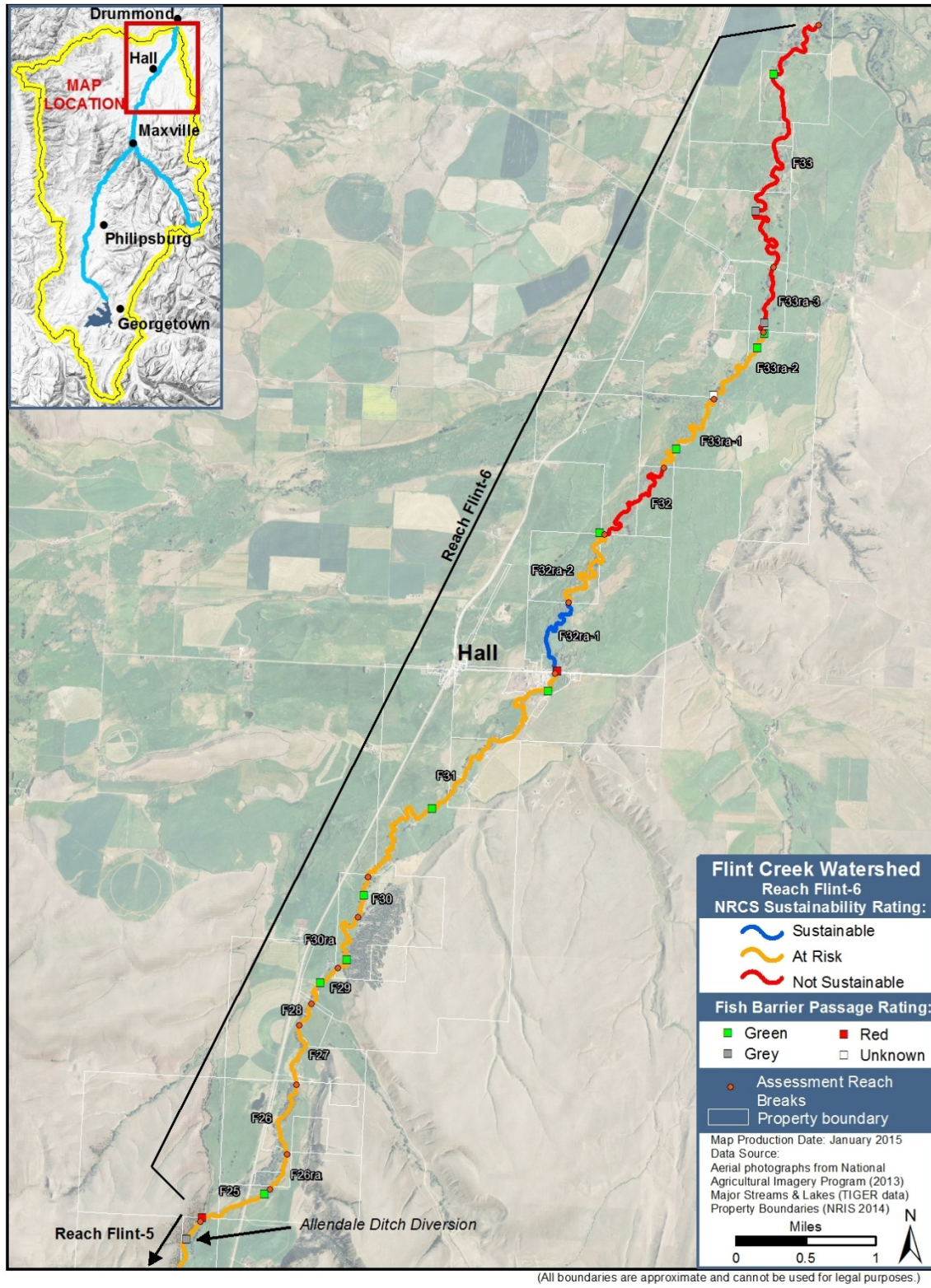
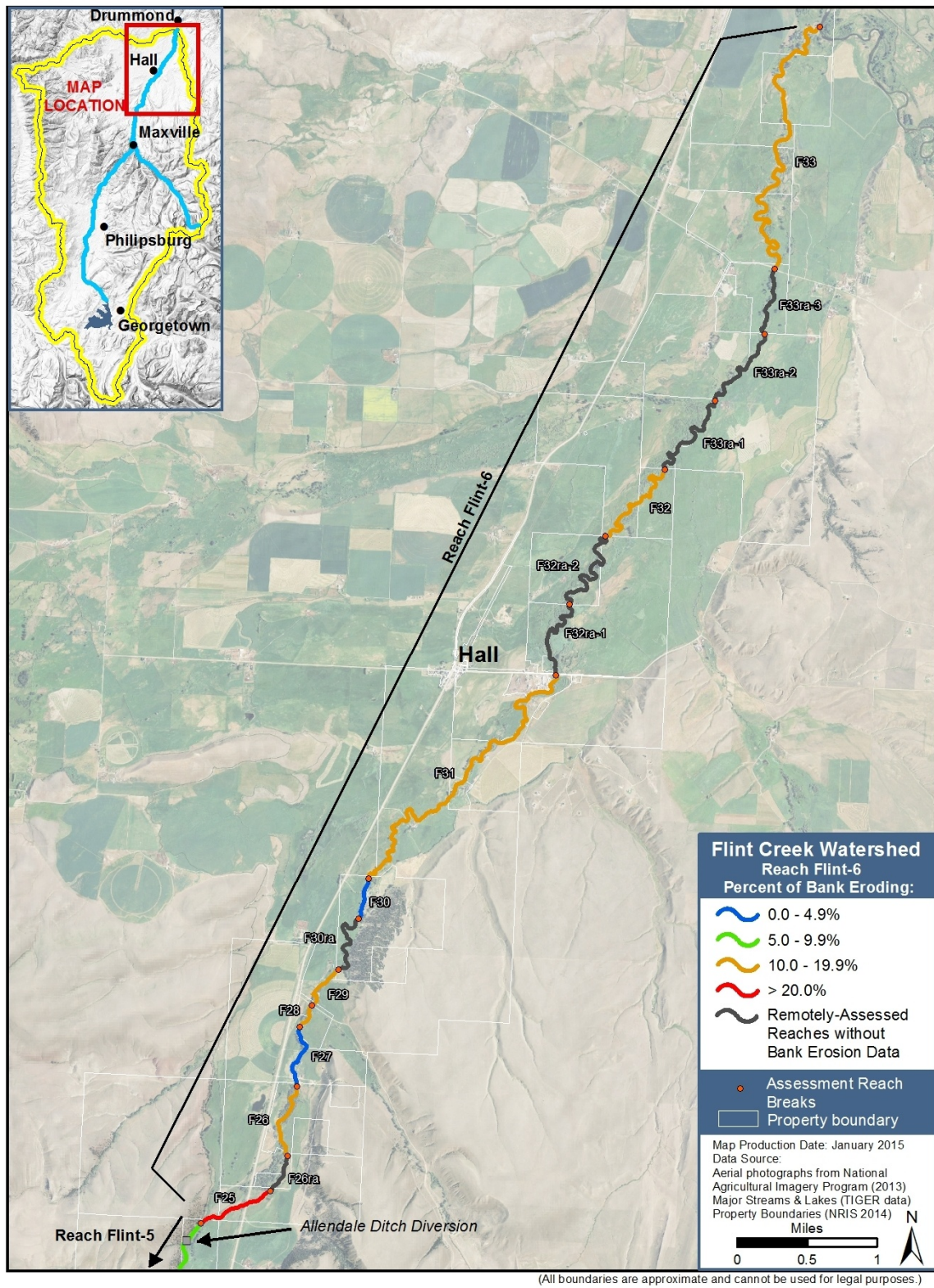


Figure 12. Flint Creek Reach 6 Bank Erosion



4.1.38 Subreach F25

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
23	High	53	At Risk	57	Fair	High

Subreach F25 is 3,045 feet in length and is bisected by the crossing of Highway 1 and Flint Creek upstream of Hall, Montana. This subreach is classified as a Rosgen C3b channel type, with an average slope of 2.1%, a sinuosity of 1.0%, and a width to depth ratio of 20. The channel is naturally well-armored, with substrate dominated by cobble and boulders. Gravel and sand deposits are common. A portion of the channel in this subreach has been straightened in the past to accommodate irrigation and road infrastructure.

There is a moderate amount of human-induced lateral cutting, primarily downstream of the crossing of Highway 1, due to grazing and haying influences over time. The channel is widened, and appears still to be widening through active lateral cutting. Land use impacts have reduced the complexity of the riparian and floodplain habitat to an extent that sediment-trapping and energy-dissipating features such as large wood, structural diversity of vegetation, and side channels are limited; pastures and hay fields with low shrub cover lie adjacent to much of the subreach.

Riparian vegetation is dominated by cottonwood and mixed riparian shrubs, with pasture grass dominating the understory in most areas. Riparian shrub regeneration is occurring, but mid-size shrubs are nearly absent, potentially indicating that newly-established shrubs generally do not survive to maturity. Browse by livestock and wild ungulates is heavy enough to affect shrub growth form and diversity; the most palatable shrub species are nearly absent from the site. Upland grasses and weedy annuals are common in the understory. Noxious weeds are abundant at the site, and include Canada thistle and common tansy.

Grazing and hay production are the primary land use influences within the subreach, but large irrigation withdrawals upstream of this subreach have changed flow dynamics at this site greatly. Aquatic habitat is limited, with few deep pools, undercut banks, large wood deposits, or overhanging vegetation. Large boulders provide some pool habitat. Channel widening and dewatering have reduced the quality of habitat.

Two diversions were noted on the site, one of which was cited as a fish passage barrier (Trout Unlimited 2013).

Restoration Potential

Subreach F-25 is a high priority for restoration, depending on landowner participation. Potential to increase channel sinuosity is limited by the irrigation and road infrastructure. Actions here should include:

- Grazing management- rest the riparian area from livestock use for a few years
- Outreach with landowner to develop a revised grazing management approach before any active restoration
- Installing browse protection for riparian shrubs
- Addition of large wood and bioengineering banks to improve aquatic habitat
- Improve diversion at the upstream end of the subreach to improve fish passage



Wide channel and sparse riparian shrubs cover to hold banks along hay fields in F25

Conditions at downstream end of subreach F25

4.1.39 Subreach F26ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	62	At risk	50	Fair	Moderate

Subreach F26ra is 1,614 feet in length and is located approximately 1,100 feet downstream of the crossing of Highway 1 and Flint Creek upstream of Hall, Montana. This subreach is classified as a C3 Rosgen stream type, with an average slope of 0.8%, a sinuosity of 1.1%, and an estimated width to depth ratio of 17.5. Channel substrate appears to be dominated by cobble, based on examination of aerial photographs and conditions observed from upstream and downstream ends of the subreach. This subreach appears to be entrenched and removed from the original channel, based on presence of a meandering remnant channel still visible in aerial photos. The channel may have been relocated when the highway was built.

There appears to be a moderate amount of human-induced lateral cutting, likely due to livestock use, based on examination of aerial photos. The stream is over-widened at this site and pools

appear generally to be shallow. Riparian vegetation is dominated by cottonwood and mixed riparian shrubs, with pasture grass dominating the understory in most areas.

Restoration Potential

This subreach is a moderate priority for restoration. Restoration of this subreach would involve:

- Reconnect original channel as the primary channel to restore sinuosity to Flint Creek; the connection point may best be located upstream of this site, in subreach F-25
- Streambank stabilization using bioengineering techniques
- Riparian shrub planting and protection where streambanks lack them



View upstream from downstream end of subreach F26ra

Conditions at upstream end of subreach F26ra

4.1.40 Subreach F26

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
15	Moderately High	63	At Risk	70	Fair	Moderate

Subreach F26 is 3,168 feet in length and is classified as a Rosgen C4c channel type based on a width/depth ratio of 16.7 and gravel dominated channel bed with some cobble, as calculated in the field and a slope of 0.8%, and sinuosity of 1.2, which were calculated from aerial imagery in GIS.

The stream is located within a single ownership engaged in hay production, but to a large extent the riparian area has been fenced, providing a 150 foot riparian buffer from land use activities in its downstream half. The stream, particularly in the lowest half of the reach is in balance with the water and sediment supplied by the watershed and has ready access to the floodplain.

Despite the dense stands of cottonwood, willow and other riparian shrubs, escaped pasture grasses remain a significant component of streamside vegetation, particularly dense stands of reed canary grass. This grass is fiercely competitive with desirable riparian shrubs and preventing their establishment along streambanks. Deer browse and some streamside access by horses is also limiting some regeneration of desirable streamside vegetation.

Due to the abundance of streamside grasses, bank erosion rates in this subreach are moderately high. Half of the length of eroding bank was seen in a side channel that, at the time of the survey was flowing, but was dry in late summer aerial images from 2013. Some areas near properties on river right had a smaller riparian buffer and in one location vegetation was entirely pasture grasses. Canopy cover, the narrowed and stable stream in its lower extent and downed woody debris provide good fish habitat conditions in this subreach.

Restoration Potential

- Weed matting on reed canary grass and riparian planting (after 2 seasons)
- Widen and increase density of riparian vegetation buffer in upper half of subreach



View upstream in subreach F26 showing desired vegetation and bank conditions on right and reed canary grass on left



View downstream of typical bank conditions in lower part of F26

4.1.41 Subreach F27

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
1	Low	62	At Risk	70	Fair	Moderate

Subreach F-27 is 2,634 feet in length and is classified as a Rosgen C4c channel type based on a width/depth ratio of 15.6 and gravel dominated channel bed, as estimated in the field and a slope of 0.8%, and sinuosity of 1.2, which were calculated from aerial imagery in GIS. Actual pebble counts done at TMDL site found substrate to be more cobble dominated and documented the reach as a C3, varying at times to a B3c channel. Other summary data collected from the TMDL survey is shown below in Table 9.

Table 9. Selected data summary from TMDL reach FLIN 18-05 (DEQ 2012)							
Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio	D50 Pebble Count	Pools/1000 ft	Entrenchment Ratio
Moderate	2.8	19.2	60.2	28.8	89	5	3.1

This subreach runs through grazing land within a single ownership that includes riparian fencing. The subreach's riparian area and streambanks are recovering from a history of more intense grazing pressure and human impacts were considered to be minimal.

Erosion sources were predominantly from natural undercut banks where grasses were prevalent from historic grazing and agriculture practices. Woody debris on the banks provides some protection. Bank vegetation, covering over 60% of banks, consists primarily of alder, cottonwood and willow species, whose density improves further downstream in the subreach. Reed canary grass is still prevalent on streambanks and likely out-competes some shrub and tree regeneration.

Toward the top of the subreach a corral area is within 10 feet of the stream, with a small vegetated buffer zone between the two. In heavy rains or high water, this location is likely a nutrient loader but land owners mentioned that the structure was only used briefly three times a year.

Restoration Potential

- Weed matting to suppress reed canary grass followed by riparian planting



View downstream of typical bank conditions at subreach F27

View upstream near top of reach of corral and watering structure in F27

4.1.42 Subreach F28

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
15	Moderately High	52	At Risk	57	Fair	High

This was the first subreach assessed for this project, which was accompanied by WRC personnel to review assessment protocol. Land use surrounding this subreach is primarily agricultural with cattle having a large impact on the riparian area.

Subreach F-28 is 1,020 feet in length and is classified as a Rosgen C4c channel type based on a width/depth ratio of 15.6 and gravel dominated channel bed, as calculated in the field and a slope of 0.8%, and sinuosity of 1.1, which were calculated from aerial imagery in GIS.

Lateral bank erosion is moderately high on this reach due to heavy grazing and the abundance of pasture grass as the dominant vegetation on streambanks, particularly on river right by a large hay field. Low-lying bank erosion was commonly seen where woody vegetation was absent from banks. Due to the high water level at the time of sampling, it is likely that active bank erosion rates were underestimated for this subreach. The stream does have access to its floodplain and there was evidence of overbank deposits of woody material within the cottonwood stands in the floodplain.

Woody riparian vegetation was found in patches throughout the subreach, primarily consisting of alder, willow and cottonwood. Pasture grasses, including reed canary grass, was found growing vigorously throughout, even under cottonwood stands and other woody species such as alder and willow, river birch and an occasional hawthorne. Riparian fencing installed on both sides of the channel does little to offer prevent browse within the riparian buffer, where stands of cottonwood are mature to decadent and regeneration is stifled by herbivory.

Restoration Potential

- Decrease grazing pressure on banks with fencing, grazing management
- Riparian planting and plant protection
- Bank stabilization with fascines



View upstream at typical conditions in subreach F28.

View across channel at decadent stand of cottonwood and grass-covered banks in F28

4.1.43 Subreach F29

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
11	Moderately High	78	At Risk	70	Fair	Moderate

Subreach F29 is 1,945 feet in length and is classified as a Rosgen C4c channel type based on a width/depth ratio of 19.4 and gravel dominated channel bed, as estimated in the field and a slope of 0.8%, and sinuosity of 1.2, which were calculated from aerial imagery in GIS.

This subreach maintains good connection with its floodplain, particularly on inside meander bends and was seen as generally in a stable condition in relation to its sediment load and channel dimensions. Aerial image interpretation suggest the subreach was likely straightened historically to accommodate agriculture activities.

The riparian area is mostly fenced off from hay fields, providing a narrow but stable buffer zone and good fish habitat conditions from overhanging vegetation and some woody debris recruitment. Alder, willows and river birch are the dominant species on the banks, with some cottonwood stands in the riparian.

One area just downstream of the Douglas Creek bridge on river right is lacking woody bank vegetation and pasture grasses (reed canary) is the dominant vegetation. Banks in this area are actively eroding and contribute much of the erosion seen in this subreach.

One irrigation diversion was documented in this subreach but determined to not be of concern to fish passage or entrainment.

Restoration Potential

- Weed mat and riparian planting with bank stabilization in upper section of reach where grasses are heavy
- Conservation of riparian buffer



View upstream of typical bank vegetation in lower part of subreach F29

Upper section of subreach F29 where grasses are dominant, unstable vegetation.

4.1.44 Subreach F30ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	77	At Risk	NA	NA	Moderate

Subreach F30ra is 3,386 feet in length and is classified as a Rosgen C3c channel type based on a width/depth ratio of 16.7 and cobble dominated channel bed, a slope of 0.6%, and sinuosity of 1.6, which were calculated from aerial imagery in GIS.

This subreach is within the same ownership as subreach F-30, but was listed as a no access site at the time of field surveys. Similar to site F30 below, the hillslope constrains the stream in places on river right and haying activities are the primary land use on both sides of the channel. Despite riparian fencing along parts of the channel, haying activities extend to the edge of the stream in several locations where grasses are the dominant riparian vegetation. Lateral bank erosion was noticeable in these locations, with exposed cobbles on banks (or potentially rip-rap) visible from aerial imagery.

These exposed and eroding banks likely contribute to stream widening and the formation of enlarged point bars and some mid-channel bars.

Riparian fencing is present on much of this subreach, however the buffer zone provided is narrow (30-50 feet max), limiting recruitment and resilience of woody vegetation. Some small decadent cottonwood stands were visible from the upstream reach. The decreased amount of streamside vegetation limits the overstory and understory cover on this subreach, as well as limits long-term woody debris recruitment for fish habitat.

A stream diversion halfway through the reach is located on a side channel and was found to pose little concern for fish passage. The non-lockable headgate may be an entrainment issue.

Restoration Potential

- Riparian planting, weed matting (for reed canary grass) and plant protection



View downstream into top of reach F30ra

View upstream into bottom of reach F30ra

4.1.45 Subreach F30

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
5	Low	70	At Risk	57	Fair	Moderate

Subreach F-30 is 1,628 feet in length and is classified as a Rosgen C3 channel type based on a width/depth ratio of 19.4 and cobble dominated channel bed, as calculated in the field and a slope of 1.0%, and sinuosity of 1.1, which were calculated from aerial imagery in GIS.

This subreach is within a single ownership involved in hay operations. The channel is constrained in places on river right by the hillslope and substantial rip-rap on banks to protect structures and a car lot. The channel was likely straightened historically. The stream does have ample access to its floodplain on river left and is mostly in balance with its sediment load, though some indications of widened were noted.

Lateral bank erosion in the subreach comes mostly from bare banks above and below stream armoring on river right close to home sight. Pasture grasses, including reed canary grass are

intermixed with mature and sapling woody riparian vegetation including alder, willows and cottonwood galleries in the lower extent of the subreach. The riparian area is fenced but some browse was observed from horses and mules on the property, as well as wildlife. Browse intensity overall was light and cottonwood and willow regeneration was high.

One irrigation diversion was noted on site, which was determined to likely be a high entrainment concern. Armored banks, decreased understory cover and a lack of woody debris in the channel were noted as limiting factors for fish habitat.

Restoration Potential

- Conservation of streamside fencing
- Stabilization of high and bare banks on river right with bioengineering techniques, willow staking



Armored bank on river right to protect property at F30.

Typical bank conditions in F30

4.1.46 Subreach F31

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
16	Moderately High	53	At Risk	57	Fair	High

Subreach F31 is 14,771 feet in length and is classified as a Rosgen C4c channel type based on a width/depth ratio of 19.4 and gravel dominated channel bed with some cobbles, as calculated in the field and a slope of 0.6%, and sinuosity of 1.4, which were calculated from aerial imagery in GIS.

This subreach is comprised of several ownerships with similar riparian and fish habitat characteristics and similar restoration priority concerns. Grazing patterns are consistent

throughout the ownerships and have significant impacts on the riparian vegetative community. The stream has moderate to high levels of lateral bank erosion, particularly on outside meander bends. These conditions have led the stream to be over-widened in many areas, perpetuated by cattle-trampled banks and minimal woody riparian vegetation. Lacking robust vegetation, banks of outside bends were regularly found cleaving off and falling into the stream. Mid-channel bars indicate a stream out of balance with its sediment and in places excessive algae was noted growing in the channel.

In the downstream-most ownership by the lumber operation, streambanks are heavily rip-rapped to protect structures and the stream may have been straightened in the past. Banks in this southernmost ownership do not exhibit the active erosion observed upstream and are stable. The stream has ready access to its floodplain on the river right.

The corrals just east of the Tuning Fork road crossing is a heavy cattle-use area with active bank erosion throughout and, in places, high eroding banks and no woody riparian vegetation. Between the Tuning Fork road and this high use area, a small length of riparian fencing on both banks provides some relief from grazing pressures and riparian vegetation is dramatically improved. This fencing is likely installed due to concern over downstream structures near the stream.

Bank vegetation is dominated by escaped pasture grasses, with sporadic clumps of willows and river birch. Rose and hawthorne are also present throughout, an indication of the heavy browse pressure in this subreach. Cottonwood stands are small and far between, comprised primarily of mature individuals with heavy cattle use underneath them. Downstream of these cottonwood stands, piles of woody debris against banks are providing some stabilization as well as improving fish habitat conditions. Fish habitat is otherwise fair throughout this subreach, with a noticeable lack of overhanging vegetation and deep pool habitat.

Two irrigation diversions were found in this subreach. The uppermost diversion was closed and determined to be old, but still leaking water and likely posing an entrainment problem. The lower diversion, also showing its age was determined to be a high risk for entrainment.

Restoration Potential

- Riparian fencing or fencing of cottonwood and willow stands to promote regeneration
- Grazing management including off-site water, decreased intensity on riparian areas
- Fish screens or removal of diversions



Heavy cattle use area in F31

View upstream near lumber operation and rip-rapped banks in F31

4.1.47 Subreach F32ra-1

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	92	Sustainable	NA	NA	Moderate

Subreach F32ra-1 is 4,162 feet in length and located primarily within one ownership, with one small inholding at its uppermost extent. This subreach was classified as a Rosgen C4c channel with a channel bed substrate of gravel, slope of 0.3%, sinuosity of 1.5 and an estimated width/depth ratio of 13.9, as interpreted from aerial imagery and GIS.

Land owners in this subreach appear to have left the riparian area in a largely natural state, with a high density of large woody riparian shrubs dominating most of the subreach length widths range from over 100 feet to over 500 feet.

Other than the dense riparian buffer, the main distinguishing feature of this subreach is a narrower channel, likely due to the stabilizing impact of riparian vegetation. In contrast to the bankfull width, however, long riffle sections are noticeably shallow from the August 2013 imagery used for this interpretation. Stream depths are impacted by an irrigation diversion at the top of the reach, which was determined to be impassable for fish in its current configuration because of a lack of fish bypass structure.

Restoration Potential

- Conservation/Preservation of existing riparian vegetation (easement?)
- Improve fish passage at diversion



Aerial view of subreach F32ra-1

View downstream from top of reach showing dense riparian vegetation in F32ra-1

4.1.48 Subreach F32ra-2

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	66	At Risk	NA	NA	High

Subreach F32ra-2 is 5,696 feet in length and located within one ownership that does not appear from aerial images to be actively haying near the stream. This subreach was classified as a Rosgen C4c channel with a channel bed substrate of gravel, slope of 0.6%, sinuosity of 2.0 and an estimated width/depth ratio of 17.8, as interpreted from aerial imagery and GIS.

The slightly increased sinuosity of this reach is likely due to increased bank stability (relative to downstream subreaches) from the woody riparian vegetation along its banks throughout most of the reach. The width of the riparian vegetation buffer ranges from 100 ft. to well over 250 ft, filling the landscape at most sharp bends in the river. Riparian vegetation conditions degrade by the downstream end of the reach.

Grazing is the primary land use activity on this subreach. Despite some dense willow growth, sign of cattle accessing the stream throughout the subreach is readily visible from aerial images. At the outside bend of the stream closest to the corral area, as well as in other areas, banks show signs of active erosion and woody vegetation is noticeably decreased.

The stream here appears to be out of balance with its sediment supply, with large point bar formation visible and some mid-channel bars present. The subreach is likely over-widened in places and pool habitat conditions are assumed to be slightly to moderately impacted (i.e. shallow).

Restoration Potential

- Offsite water by corrals
- Riparian fencing and planting (particularly river right)
- Grazing management



Aerial view of subreach F32ra-2

View upstream from downstream end of F32ra-2

4.1.49 Subreach F32

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
16	Moderately High	50	Not Sustainable	57	Fair	High

Subreach F32 is 5,134 feet in length and is classified as a Rosgen C4c channel type with a width/depth ratio of 26.7 with a gravel dominated channel bed, as calculated in the field, and a slope of 0.6%, sinuosity of 1.6, which were calculated from aerial imagery in GIS.

The subreach is located across two private properties dominated by hay production. The upper ownership's activities are on river left, with river right dominated by patches of willows. The downstream property is haying on river right with a flood irrigation system from Barnes Creek from the east. At the time of the survey the hay field on the downstream property was saturated in 4-6 inches of standing water. The channel has ready access to its floodplain, evidenced by recently deposited woody debris on the banks of inside meander bends. Outside bends are consistently unstable and in varying stages of active erosion, from collapsed banks growing new vegetation to attached banks starting to cleave off. Bank conditions, the presence of mid-channel bars and primarily shallow pools indicate some imbalance in the stream's sediment load. Ice scour likely contributes to bank erosion.

Bank stability is correlated strongly with bank vegetation, which is dominated by a mix of sedge, rush and pasture grasses (timothy, red top, among others) with grasses dominant. There are

some patches of mature willow communities on the banks of river right, but regeneration of woody species is low due to grazing and grass and sedge competition. Woody bank vegetation density is low and dominated by less palatable species such as currants, rose and snowberry.

Fish habitat in this subreach is severely limited by overhanging vegetation, woody debris recruitment and the low number of mostly shallow pool habitat elements. One diversion was recorded on this reach, spanning 100% of a creek's side channel. It was found to be a potential fish barrier at lower flows and likely entrains fish at higher flows.

Restoration Potential

- Examine water use efficiency
- Riparian fencing
- Bank stabilization with woody plantings and weed matting



View upstream of typical stream conditions in F32: mid-channel bar, eroding banks, grass/sedge banks

View downstream of typical eroding outside bend and grass-dominated riparian vegetation in F32

4.1.50 Subreach F33ra-1

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	66	At Risk	NA	NA	High

Subreach F33ra-1 is 5,034 feet in length and has different ownerships along its right and left banks, with noticeable land use differences and associated impacts. Lower Willow Creek flows into Flint Creek at the lower extent of this subreach.

This subreach was classified as a Rosgen C4c channel with a slope of 0.4%, sinuosity of 1.6 and a width/depth ratio of 26.7, and likely has a channel bed substrate of coarse gravel, as interpreted from aerial imagery and GIS.

Floodplain willow communities on river left appear to be healthy, indicating a stream that regularly accesses its floodplain and is some indication of a stream in balance with its sediment load. However, this vegetation does not regularly extend into the immediate riparian area on river left, and riparian vegetation appears mostly absent on river right. A closer look at aerial images shows numerous cattle tracks accessing the riparian area, likely limiting the regeneration potential of woody vegetation in the subreach and long-term bank stability.

One irrigation diversion was identified on this subreach but it was not surveyed.

Restoration Potential

- Riparian planting and plant protection
- Bank stabilization on active bank erosion



Aerial image of subreach F33ra-1

View downstream from top of subreach F33ra-1 showing typical riparian vegetation and bank condition

4.1.51 Subreach F33ra-2

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	58	At Risk	NA	NA	High

Subreach F33ra-2 is 3,973 feet in length and is classified as a Rosgen C4c channel type with a slope of 0.4%, sinuosity of 1.3 and an estimated width/depth ratio of 25.0 with a coarse gravel dominated channel bed, calculated from aerial imagery in GIS.

This site is located on private land and has remote assessed reaches both upstream and downstream and no nearby roads, so no visual references were available from the field. However, aerial imagery shows the site to be under similar land uses to those seen throughout the lower Drummond valley, namely hay production and cattle ranching, with predictable impacts to the stream's riparian habitat.

The reach appears to be in a moderately stable condition in regards to its sediment load, with regularly spaced meander intervals and noticeable point bar formation, although older overflow channels and oxbows have been cut off from the stream.

There are two irrigation diversions in the reach, neither of which pose a barrier to fish passage, although one was noted as a potential risk for entrainment. The fish passage and entrainment study also confirms observations made from aerial interpretation, that streambanks on river right have very little riparian vegetation with deep, binding root mass, with estimates that less than 65% of banks for the whole stream contain adequate riparian vegetation. Grazing activities and bank erosion are significant impairments to the stream.

Restoration Potential

- Riparian planting and buffer expansion
- Mitigate entrainment risk at diversions



Aerial image of subreach F33ra-2

4.1.52 Subreach F33ra-3

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	58	Not Sustainable	40	Fair	High

Subreach F33ra-3 is 2,855 feet in length and is classified as a Rosgen C4c channel type with a slope of 0.7%, sinuosity of 1.1 and a width/depth ratio of 30.0 with a coarse gravel dominated channel bed, calculated from aerial imagery in GIS. Reach FLINT 19-01 from the sediment TMDL for Flint Creek was sampled in the lower 2/3 of this subreach, data from which is summarized below in Table 10.

Table 10. Selected data summary from TMDL reach FLIN 19-01 (DEQ 2012)							
Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio	D50 Pebble Count	Pools/1000 ft	Entrenchment Ratio
Moderate	23.6	18	4.2	31.2	48	5	3.5

This subreach is on private property whose primary land use is hay and pasture fields on river right. River left of this subreach has riparian fencing, allowing for a buffer of 10-100', although there was evidence of historic grazing and riparian vegetation cover is very low. While the channel generally appears to have recovered and stabilized from historic grazing impacts, it is over-widened in places and actively eroding banks are common, including vertical banks covered by pasture grasses, some sedges and no woody vegetation. Patches of cottonwood stands are present, but limited to the floodplain and mostly absent from the immediate streamside.

Assessment from the TMDL described one section of stream with 80-100' of rip-rap with a fence falling into the stream channel. Progressing downstream the channel becomes more entrenched and access to the floodplain decreases as the stream approaches its downstream extent under the Mullan road bridge.

One diversion has been identified in this subreach, which appears to be clear for fish passage but likely presents an entrainment risk.

Restoration Potential

- Riparian planting and buffer expansion
- Mitigate entrainment risk at diversions



Aerial image of subreach F33ra-3

4.1.53 Subreach F33

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
17	Moderately High	43	Not Sustainable	57	Fair	High

Subreach F-33 is 14,783 ft in length and the lowest extent of Flint Creek, containing its confluence with the Clark Fork River. This subreach is significant in its role for connectivity of desirable fish populations between the Clark Fork and Flint creek. Historically this subreach was likely a large delta with multiple braided channels and a wide confluence zone that remains wet for much of the year. Some evidence of older channels is evident from aerial photographs.

This subreach was classified as a Rosgen C4c channel type with a slope of 0.4%, a sinuosity of 1.6, a width/depth ratio of 33.3 and a coarse gravel-dominated channel bed. The channel does not show signs of downcutting and displays ready access to its floodplain on inside meander bends. However, lateral erosion of streambanks along outside bends is consistent throughout the reach and the channel appears over-widened in areas, with mid-channel bars and islands and large point bars, showing evidence of a system out of balance with its sediment load. Of particular concern to fish passage is the width of the channel and shallow depth of the stream at the confluence.

This reach flows entirely through agricultural lands, and much of the riparian area shows significant impacts from cattle grazing. Bank vegetation is dominated by pasture grasses with very low density of vegetation with deep binding root mass. Some of the highest abundance and diversity of weed species in the whole stream were found in this reach. Existing cottonwood stands tend to be outside of the immediate riparian area, although one point bar was entirely covered by cottonwood seedlings. In several stretches of the stream an abundance of aquatic vascular plants and algae indicate likely water quality impairments.

In several locations along the lower and mid sections of the subreach, earthen and rock berms were installed by the landowner, straightening the stream in places and limiting the stream's access to its large floodplain. According to the landowner's son, ice scour is a concern and cause of bank erosion in this subreach.

This subreach also includes two stream diversions, both of which require closer examination to determine if they pose a barrier to fish. The lowest diversion was determined to be dry or only for high water events and likely not a barrier to fish while the upper diversion has, "enough of a gap in the headgate boards to entrain fish, possibly even large fish" (Trout Unlimited, 2013).

Restoration Potential

Restoration activities along this reach were assigned a high priority level due to its confluence with the Clark Fork River and associated potential to improve initial connectivity for fish populations with the main stem. Restoration activities for this subreach include:

- Grazing management off stream
- Riparian fencing and revegetation
- Bioengineering structures on outside meander bends
- Assessment and mitigation of streamside berms for floodplain connectivity



View downstream at confluence of F33 and Clark Fork River

View downstream of typical eroding outside bend and grass-dominated riparian vegetation in F33

4.2 RESULTS: BOULDER CREEK

Figure 13. Boulder Creek Reaches 1 & 2 NRCS Habitat Sustainability

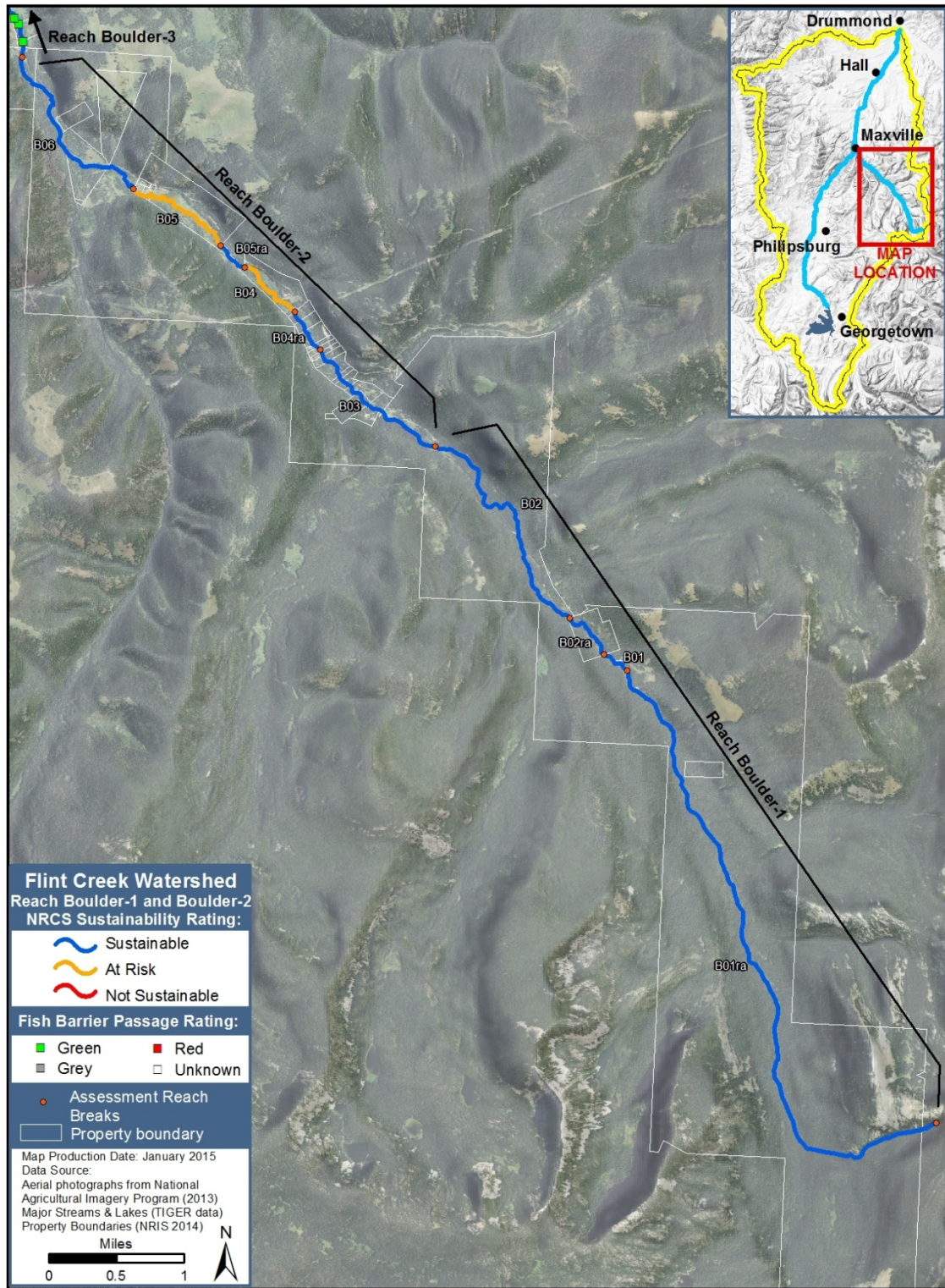
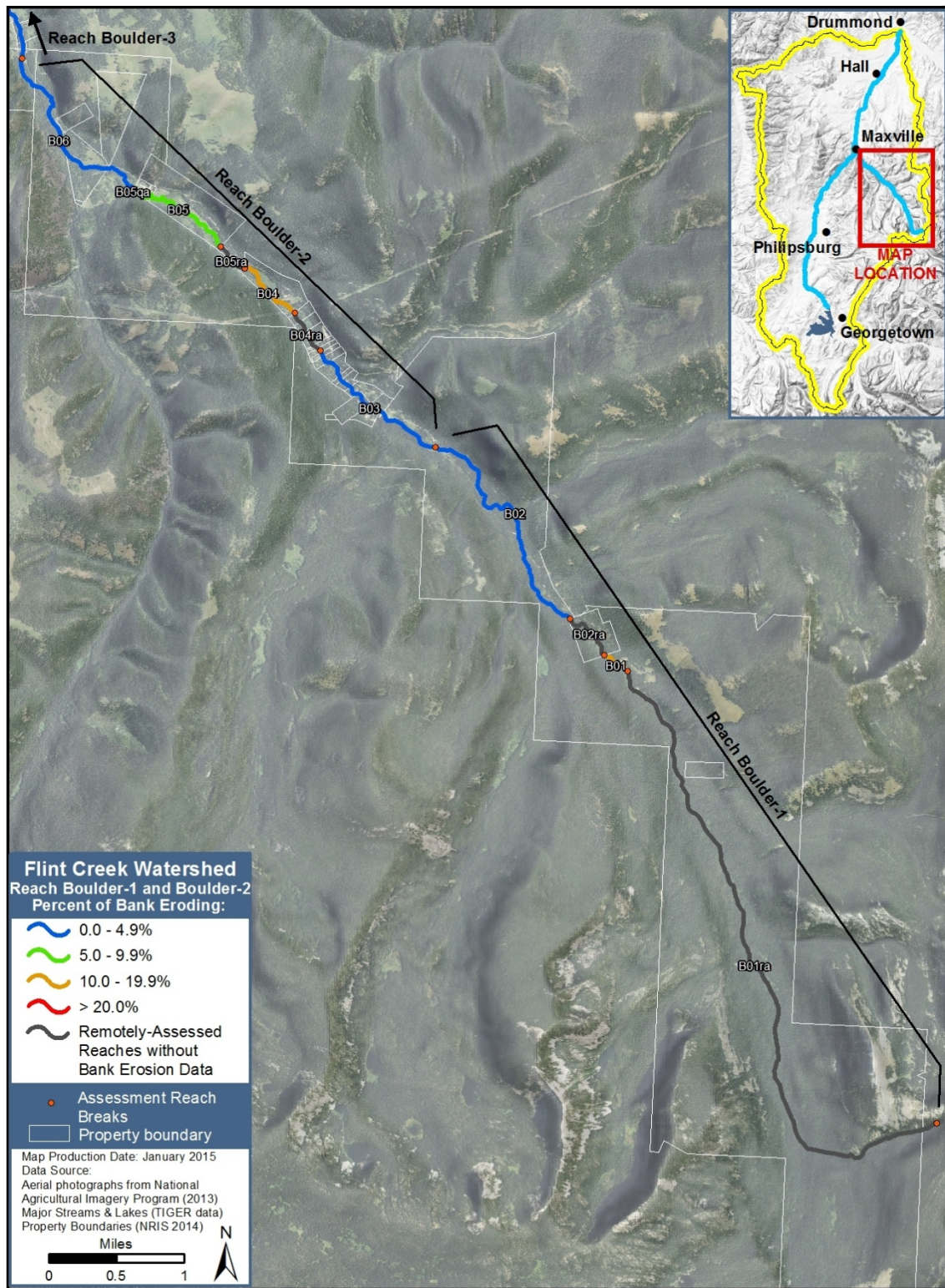


Figure 14. Boulder Creek Reaches 1 & 2 Bank Erosion



4.2.1 Subreach B01ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	100	Sustainable	100	Good	Low

Subreach B01ra is the headwaters of Boulder Creek and is 26,762 feet (5 miles) in length and is entirely within US Forest Service lands in a natural setting. It has a slope of 7.8%, sinuosity of 1.3 and width/depth ratio of 10, classified as an A2 channel with boulders as the dominant substrate.

Though historic mining activities upstream may impact water quality from tributaries or side drainages, riparian habitat and in-stream habitat conditions are in a natural setting.

Restoration Potential

- There are no restoration needs for this subreach



Aerial image of B01ra

View upstream from mine site at bottom of subreach B01ra

4.2.2 Subreach B01

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
10	Moderate	98	Sustainable	90	Good	Low

Subreach B01 begins at the historic Berkeley mine and ends below a private in-holding 1,215 feet downstream. It is entirely within US Forest Service lands and has a slope of 5.9%, sinuosity of 1.1 and width/depth ratio of 10, classified as an A2 channel with boulders as the dominant substrate.

Conditions in this subreach are similar to those of subreach B01ra, save for the restoration work that took place in the upper reaches of the stream by the abandoned mine site. Restoration at the mine site likely involved tailings removal and floodplain grading and a geo-textile was noted on the surface with an abundance of upland grass seeds, clearly part of a restoration seed mix. An old road bed running from the historic mine was seen undermined by the channel, exposing irrigation pipe, which lay within the wetted width of the channel. Some natural hillslope erosion is also evident on this reach but there were no signs of excess sedimentation in this fast-moving channel.

Forest cover was primarily spruce, fir, alder, currants and dogwood and present in sufficient diversity and density to dissipate stream energy at high flow. Pools and excellent trout habitat were ubiquitous in this subreach.

Restoration Potential

- Conservation of existing riparian habitat



View downstream from top of B01

Old mining-related pipe at upstream end of B01

4.2.3 Subreach B02ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	100	Sustainable	100	Good	Low

Subreach B02ra is contained within the channel below a private in-holding, covering approximately 2,321 feet of channel. It has a slope of 4.4%, sinuosity of 1.2 and width/depth ratio of 10, classified as an A2 channel with boulders as the dominant substrate, as determined from aerial images and calculated in GIS.

There do not appear to be any human impacts to the stream based on image analysis. There appear to be rock outcrops by the stream which may contribute a low amount of natural hillslope

erosion to the stream. Woody debris is prevalent throughout the stream, creating abundant in-stream habitat and energy-dissipating features in the channel.

As is typical of these headwaters channel types, there is limited floodplain access but riparian vegetation is dense conifer forest with shrub undergrowth, enough to dissipate high stream energy.

Restoration Potential

- Conservation of existing riparian habitat



Aerial image of subreach B02ra



View upstream at downstream end of B02ra

4.2.4 Subreach B02

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
0	Low	97	Sustainable	90	Good	Low

Reach BOUL 16-01, assessed for the TMDL for this drainage was located within this subreach, results of which are summarized below in Table 11.

Table 11. Selected data summary from TMDL reach BOUL 16-01 (DEQ 2012)							
Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio	D50 Pebble Count	Pools/1000 ft	Entrenchment Ratio
Low	0	51	97	21	110	16	2.5

This subreach is in a natural setting on US Forest Service land, beginning at the end of the private in-holding in a steep valley and ending at a lower gradient at a bridge crossing just above

the community of Princeton. The subreach has an average slope of 4.7%, a sinuosity of 1.2 and width/depth ratio of 12.0 and was estimated to be a B2 channel in the field, though pebble counts in the TMDL document site the subreach as a B3, cobble-dominated system.

Riparian habitat conditions are similar to reaches upstream with spruce and fir, although toward its downstream sections, coniferous riparian vegetation gives way to alder and willows. The stream has ready access to a narrow floodplain in its upper extent and riparian vegetation and woody debris in the channel are sufficient to dissipate stream energy. There was no visible erosion in the channel due to boulder-lined banks and thick riparian cover. Ground water emerging from limestone rock outcrops toward the bottom of the subreach on river right provide an excellent source of cold water to the system.

Several impacts to the stream were noted in this subreach, though they did not affect riparian habitat or fish habitat scores.

Along the road above the stream at the confluence of Royal Gold Creek, a culvert failure led to a large amount of sediment washing down and across the road, dispersing Royal Gold Creek across the floodplain by Boulder Creek. The single channel that used to contain Royal Gold Creek was mostly dry and that tributary was dispersed across the floodplain, entering Boulder Creek in multiple locations. Some headcutting was noted at these new confluences.

Just upstream of the Royal Gold Creek confluence on the bench above the stream, three sediment detention ponds were examined for their impacts to the stream. No immediate impacts were seen, though two earthen dikes were created along an outside meander bend of the channel to prevent high water events from accessing the floodplain and potentially disturbing the material settling in the ponds. These ponds are beyond the scope of this study.

Between the lower two ponds, a small dirt road crosses the stream and becomes a deeply incised two-track for access to Boulder Lakes. This road is contributing a moderate amount of sediment to the stream and should be considered for maintenance and sediment mitigation.

Campgrounds at the downstream end of the subreach are minimally impacting the stream.

Restoration Potential

- Mitigate sediment delivery from Royal Gold culvert and bridge crossing at ATV trail



View downstream at confluence with Copper Creek
in B02

Bank vegetation in lower extent of B02

4.2.5 Subreach B03

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
0	Low	90	Sustainable	100	Good	Low

This subreach runs quickly through the community of Princeton, a collection of small ownerships with short lengths of riverfront access. The channel has a slope of 2.9%, sinuosity of 1.1 and width/depth ratio estimated at 13.3 and has a cobble substrate.

The channel is only slightly entrenched here, with access to its floodplain, which is dominated by thick forest and shrub cover and boulder and cobble lining the banks. It is a step-pool system, sometimes transitioning to a riffle/run system depending on slope, evidenced in a few discreet locations by some point bar formation. Generally, the subreach has adequate energy-dissipating riparian structure, though there was a noted lack of woody debris. Residents here mentioned high water events in 2011 as being substantial, with sustained overbank flows.

Impacts from that flooding event were only noticeable in areas where residents had removed streamside vegetation for lawns, seating or views. Some minimal erosion was noted on a few properties but roots from larger trees and shrubs held banks together and kept erosion to a minimum.

Impacts to this subreach were minimal, pertaining only to small-scale streamside vegetation removal on small lengths of private property. One landowner remarked that streamside vegetation was removed for fire hazard mitigation.

Restoration Potential

This subreach was given a low restoration potential. Actions on this short stretch could only include:

- Planting riparian shrubs and trees where they were removed



Dense riparian vegetation in B03

Boulder Creek on private property with some vegetation removal on river left in B03

4.2.6 Subreach B04ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	94	Sustainable	100	Good	Low

This subreach runs through a series of private ownerships where the valley gradient decreases to 1.5%, but the stream maintains its sinuosity of 1.1 and width/depth ratio of 13.3. The channel here is buffered on both sides by diverse riparian habitat comprised of riparian shrubs and conifers and a boulder-lined channel.

The subreach appears to be in balance with its sediment load. There is evidence of point bar formation in one section of the channel, due to the rapid change in slope and decreased stream energy. There are no indications of lateral erosion occurring in this subreach.

The only impacts to this subreach noted are located at the transition to the next subreach downstream, discussed in the next section.

Restoration Potential

- Conservation of existing riparian habitat



View downstream at top of subreach B04ra

View upstream into riparian forest at bottom of subreach B04ra. Location of new channel in downstream subreach (old channel in top right of image)

4.2.7 Subreach B04

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
13	Moderate	70	At Risk	70	Fair	High

This subreach runs through a single ownership in a location that appears to have been impacted dramatically by flood events of 2011. The slope of the channel was calculated in GIS to be 1.5% and the sinuosity at 1.1, with similar width/depth ratio of 13.3. The subreach was documented as a B3 channel based on the above dimensions, but is in a noticeable state of transition.

2011 high water events pushed the stream out of its historic channel against the hillslope and across an open meadow upstream of the landowner's property. The old channel appears to have similar to conditions in subreaches upstream- thick forested riparian with a cobble-dominated system and deep scour pools under root wads and pocket pools behind boulders. The new location for the stream is currently running through a meadow of predominantly grasses and sedges, with some conifers and scarce shrubs. Banks of the new channel were somewhat stabilized but show signs of being slowly undermined by high flows.

The home site was built in 2009 above a small pond that had previously been created by an earthen berm. The berm was fed from small diversions upstream and groundwater. 2011 flood events turned the pond into a catchment area for sediment and overtopped the earth berm in two locations. The new channel cut off the landowner's access to a patch of forest from which he collected firewood, so he installed a small bridge over the channel. The bridge appears undersized and constricts the stream, evidenced by several hundred feet of sediment deposits and bank erosion downstream of the bridge, until the new channel enters its old channel again. The downstream end of the subreach below this confluence is stable.

At the second site where the berm failed, the landowner had it rebuilt, but installed two ~24inch culverts. The culverts were intended to transport pond overflow into a complex of wetlands and beaver ponds north of the stream channel, but according to the landowner, high flows rarely access the culverts as they used to. He also mentioned his pond silting up since the changes in 2011 and the quantity and size of fish in the pond has decreased dramatically since these events.

After this effort, the landowner is resistant to the idea of allowing the stream to return to its original channel and expressed interest in a project that would enhance the bank stability of his new channel and provide improved drainage to the wetland and beaver pond complexes north of the channel on the downstream side of the new culverts.

Restoration Potential

This subreach is given a very high priority for restoration. A project here could not only address the new hydrologic challenges posed by 2011 flooding, but could enhance the water-holding and sediment retaining functions of the wetland complex downstream of the pond structure. A project could be designed that would:

- Stabilize new channel banks by planting and protecting riparian vegetation (this would likely include weed matting and appropriate bioengineering techniques on banks)
- Engineer pond hydrology to allow overflow into side channels and wetlands downstream
- Assess bridge crossing and mitigate channel constriction where necessary



Boulder Creek in its new channel near top of subreach B04

View from landowner property of new stream channel and pond in B04

4.2.8 Subreach B05ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	94	Sustainable	100	Good	Low

This subreach is 1,330 feet in length and displays the same channel dimensions as the B04. It is located within the same ownership as B04 but miscommunication with maps and property lines led to it becoming a remote assessment reach.

This subreach is in healthy condition, with an accessible floodplain, willow and alder-dominated riparian vegetation with an overstory of conifers, and some woody debris in the channel. The channel appears to be stable and reflects conditions similar to the abandoned channel in B04.

Restoration Potential

- Conservation of existing riparian habitat



View downstream from top of channel B05ra

View upstream from bottom of channel in B05ra

4.2.9 Subreach B05

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
9	Moderate	72	At Risk	70	Fair	High

Subreach B05 flows through several ownerships in the community of Princeton, where the stream flows through a grazing and haying pasture. The channel here was assessed in the field as a B3 Rosgen channel but shows signs of a C3 channel in places. It has a slope of 1.1%, sinuosity of 1.2 and width/depth ratio of 13.9.

Land use activities here include a history of haying activities, which removed streamside vegetation over the years. The channel has access to its floodplain on the south end of the stream, but comes up on high raw banks on the north side of the stream by the pasture. Active lateral cutting of the banks was noticeable in numerous locations and correlated strongly to banks without woody streamside vegetation. Typically grass banks would erode around large alder trees, leaving banks with a “scalloped” appearance. Some woody debris in the channel provided additional bank stability, but this debris was typically found on the southern side of the channel by dense willow stands. During high flows, the southern end of the stream had side channels through the willows to dissipate some energy.

Bank vegetation on the northern end of the stream was insufficient to dissipate stream energy and trends for the channel were declining in regards to stability of the riparian area into the pasture. Landowners had previously installed some high rock berms on the floodplain, but these activities tended to bring in weeds.

Landowners on this property showed concern after high water events in 2011 and showed interest in restoration possibilities on their property. They lost a bridge and rip-rapped banks where the channel makes a sharp turn near a home. Downstream landowners have lawns down to the streamside and some have rip-rapped banks.

Restoration Potential

Restoration of this subreach is given a high priority as it comprises one of two areas of sediment contribution to the drainage and landowners appear willing to improve conditions on their land.

Projects on the upper ownership of this subreach could include:

- Riparian planting and fencing on north side of stream
- Appropriately sized bioengineering structures to enhance bank stability
- Reconnection of stream with side channels to absorb stream energy upstream and decrease risk to downstream properties
- Landowner outreach to adjust grazing, haying



High bank erosion through meadow in B05

Sharp bend and riprapped banks by home in B05

4.2.10 Subreach B06

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
2	Low	97	Sustainable	100	Excellent	Low

Table 12 below shows summary results of sediment/habitat study done in a part of this subreach for the TMDL (BOUL 21-02).

Table 12. Selected data summary from TMDL reach BOUL 21-02 (DEQ 2012)							
Erosion Rate	Sediment Load per 1000 ft from actively eroding banks (tons/year)	Avg. Overstory Cover (%)	Avg. Understory Cover (%)	Width/Depth Ratio	D50 Pebble Count	Pools/1000 ft	Entrenchment Ratio
Low	0	51	43	26	75	7	4.0

This subreach is 8,155 feet in length, running primarily through Forest Service land from the end of residences in Princeton to the beginning of residential properties in Maxville. The subreach runs through one private ownership with no houses or structures and which appears to be in a natural setting. The valley slope resumes its steeper gradient to 2% and the width/depth ratio was estimated to decrease to 12.8, while sinuosity remained at 1.2. The channel was estimated to be a B3 channel with cobble substrate, though at times resembles a C3 channel.

This subreach begins in a wet meadow dominated by willow and lodgepole, with multiple inundation areas and signs of beaver activity. Below this, the channel shows signs of adjusting to sediment inputs from the two impacted upstream sites B04 and B05, with cobble deposits on

point bars in the upper section of the channel. Below the first 1,000 feet, however, the stream showed all indication of balance with its sediment load.

The only sign of lateral erosion on the property was at the site of a side channel where an old picnic site had been set up in the past. Impacts to the channel were minimal here. Riparian vegetation consists of alder and willow in the meadow area, transitioning to a lodgepole pine, spruce community. Some beetle-killed lodgepole have fallen and provide additional habitat features in the channel. The one diversion in this subreach was determined to not be a passage issue.

The primary impact to this subreach is where the road and stream approach each other. Rip-rap protects the road grade and minimal sediment was noted being delivered to the channel.

Restoration Potential

- Conservation of existing riparian habitat



One of two areas where stream approaches road in
B06

Typical bank conditions in B06

Figure 15. Boulder Creek Reach 3 NRCS Habitat Sustainability

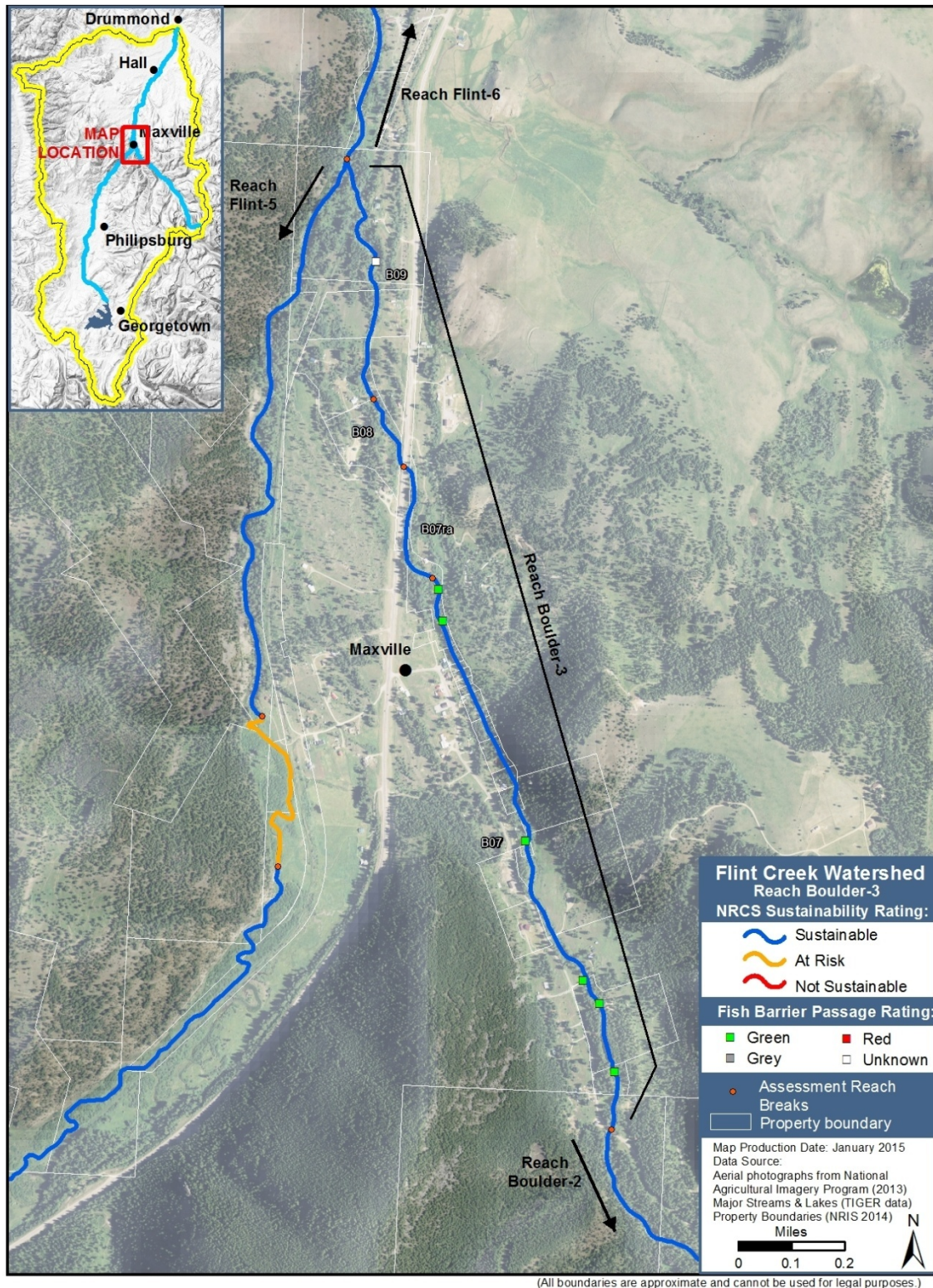
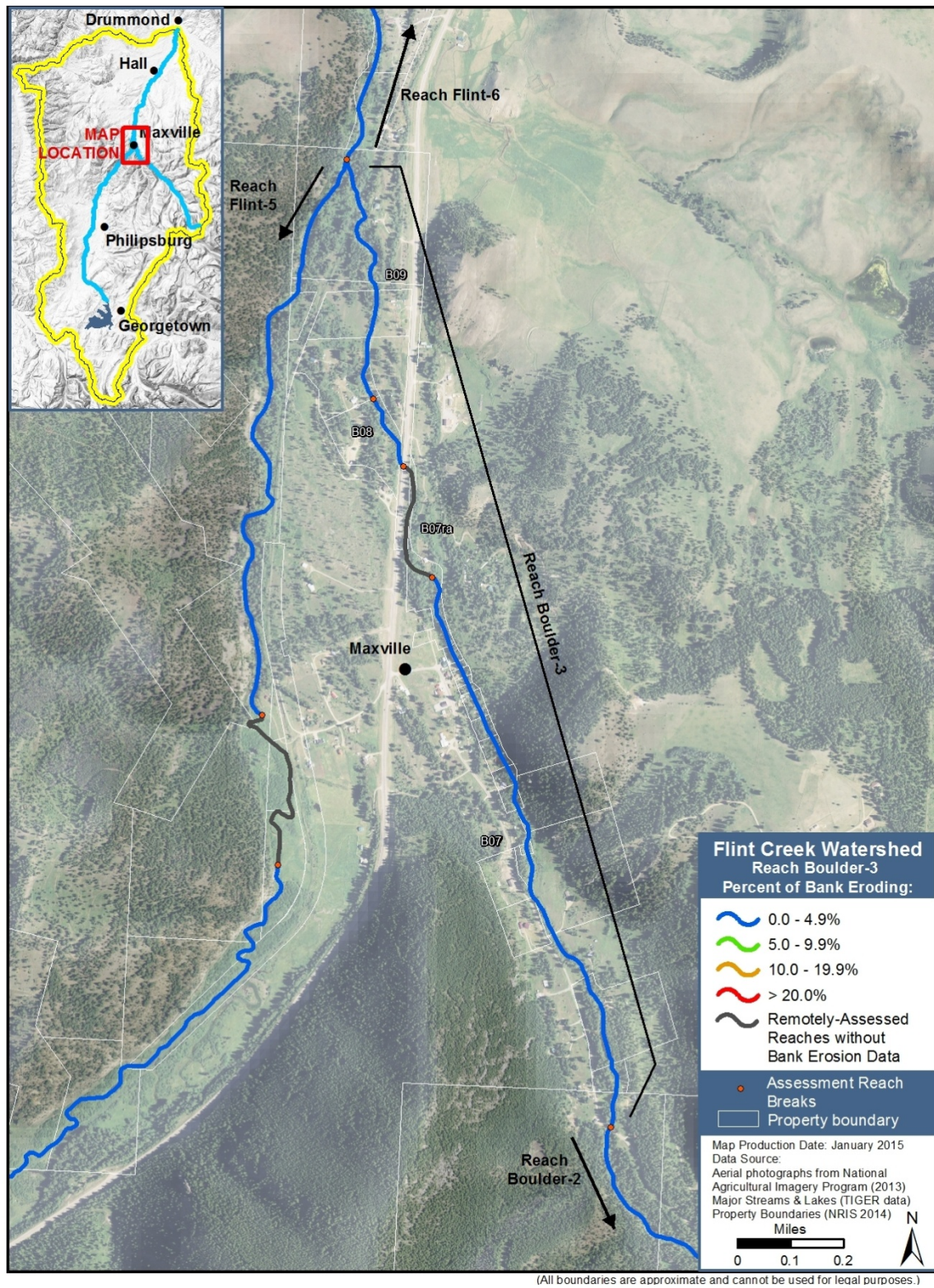


Figure 16. Boulder Creek Reach 3 Bank Erosion



4.2.11 Subreach B07

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
2	Low	97	Sustainable	80	Good	Low

This subreach runs directly through the town of Maxville through numerous private ownerships. It is constrained by the hillslope to the north and the backyards of residences to the south. The channel may have been historically straightened as the town was developed and highway established, but does not show signs of being out of balance with its sediment supply.

The channel in this subreach is 6,034 feet in length with a slope of 1.9% and sinuosity of 1.0. It was classified in the field as a Rosgen B3 channel with a cobble-dominated substrate.

The channel has adequate access to its limited floodplain, which lies within the channel prism, as is typical of a B channel. The existing riparian vegetation, consisting of a variety of riparian shrubs (alder, willow) to spruce and fir and further downstream some cottonwood, grows densely on banks and displays all age classes. Browse by wildlife is minimal throughout this reach due to the difficulty of the terrain and large human presence in the area.

Impacts to the channel are minimal and vary depending on the ownership. Most habitat impairments involve lawns down to the banks of the stream behind homes, but the total length of those don't amount to more than 2% of the channel. There are numerous diversions in this subreach, none of which was deemed a passage issue for fish.

Restoration Potential

There is little need for restoration of habitat on this reach, limited only to:

- Riparian planting to replace lawns where permissible



Typical vegetation conditions through Maxville in B07

Headgate at downstream end of subreach in B07

4.2.12 Subreach B07ra

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
NA	NA	94	Sustainable	100	Good	Low

Mapping errors led this reach to be assessed remotely. Conditions here resemble conditions upstream and downstream. The subreach is 1,303 feet in length and has a slope of 1.5% and sinuosity of 1.1 with a cobble substrate, corresponding to a B3 Rosgen channel type. This subreach lies within the last ownership on Boulder Creek east of Highway 1.

The channel is predominantly impacted by the highway grade, which straightens and diverts flow to the north until the overpass on Highway 1. Some deposits of cobbles and gravels are noticeable on river right, but likely do not indicate conditions of imbalance.

Riparian vegetation is limited by the highway grade to the west, but there is a thick cover of cottonwood, alder and other riparian shrubs to the west. Diversions in the upstream reach may have impacted water quantity on this reach.

Restoration Potential

This subreach was given a low priority for restoration. Potential activities could include:

- Expand riparian buffer width on highway side of channel



View downstream at bottom of subreach B07ra



Substrate at downstream end of reach below Highway 1 in B07ra

4.2.13 Subreach B08

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
4	Low	97	Sustainable	90	Good	Low

This short subreach begins on the downstream end of Highway 1 and flows for 779 feet through thick riparian vegetation on a single ownership. The channel has a slope of 2% and sinuosity of 1.1 and was classified in the field as a B3 Rosgen channel.

The stream had a diverse complement of streamside vegetation consisting of fir trees, cottonwood, alder, birch and willow as well as forb communities. Banks were lined with large cobbles and boulders and the stream appeared to be in balance with its sediment load, with plenty of floodplain access.

One small area at the downstream end of the subreach was noted for having a lawn down to the streambank and some riparian vegetation removed.

Restoration Potential

- Conservation of existing riparian habitat



Typical bank conditions downstream in B08

Typical bank conditions upstream in B08

4.2.14 Subreach B09

Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
0	Low	95	Sustainable	80	Good	Low

This is the confluence reach of Boulder Creek with Flint Creek, running through 3 private ownerships. Conditions across all ownerships are similar and the stream here is in excellent shape. The subreach runs 2600 feet with a slope of 2.8% and sinuosity of 1.1. As above the

channel was classified as a Rosgen B3 type, and shows consistent habitat conditions to the subreaches upstream.

The stream has access to a well forested floodplain through almost its entire length, other than a few small areas where riparian vegetation has been removed to improve landowner access to the stream. Vegetation consists of Douglas fir, alder, dogwood, rocky mountain maple and numerous forbs growing around well armored streambanks. There were no signs of bank instability throughout the reach.

Impacts to the channel were seen in the lower ownership where an old irrigation pipe and the railroad cross over the stream. Rip-rap in areas and the trestle structure caused the stream to adjust and one area of heavy deposits were seen downstream, but this area was stable at the time of this survey.

One diversion was identified in this subreach but its passage and entrainment condition is unknown.

Restoration Potential

Restoration on this subreach was given low priority, though some small projects would involve:

- Widening of riparian buffer by planting shrubs/trees on river right on private ownerships where vegetation was removed.



Old pipe suspended over stream runs along banks throughout reach in B09



Typical stream and bank conditions above confluence with Flint Creek in B09

4.3 RESULTS SUMMARY

Flint 1

Reach Flint 1 is located immediately downstream of Flint Creek Dam and Georgetown Lake. Flow is heavily altered in this reach due to flow regulation by the dam at Georgetown Lake and re-routing of most of the stream flow through a large pipe down to the Flint Creek Hydroelectric Plant. The channel in this reach is naturally confined by steep side hills, with additional confinement by Highway 1. This reach contains a large fish barrier downstream of the dam, where the channel drops precipitously and consists of a jumble of angular boulders with only subsurface flow. This reach has an average slope of 7.7%, sinuosity of 1.2 and a width/depth ratio of 8.8. Bank erosion rating in this reach was considered moderate in the one subreach assessed in the field, which comprises 25% of the length of the reach. 79% of the stream length of this reach received an At Risk NRCS rating and 21% of the reach length was considered Not Sustainable. 100% of the field-assessed reaches received a Fair fish habitat rating.

Flint 2

Reach Flint 2 is located downstream of the outflow from the Flint Creek Hydroelectric Plant and is characterized by a narrow valley between forested side slopes. The primary land use influences in this reach are recreation use and historical channel alteration in the upstream half of the reach, and agricultural use in the downstream portion of the reach. The reach averages a slope of 1.7%, average sinuosity of 1.1 and a width/depth ratio of 11.4. 100% of the riparian habitat in this reach was found to be At Risk. Fish habitat in this reach was ranked Fair (100%). Bank erosion in this reach was ranked Low for the one sub-reach assessed in the field (68% of total length).

Flint 3

Reach Flint 3 flows through agricultural land in the Philipsburg valley and reflects influence of agricultural-related activities such as irrigation, hay production, and grazing. Channelization (straightening or confinement) is not common in the reach but does affect some subreaches. Riparian vegetation is dominated by pasture grasses and sedges, and, in more limited areas, by willows. Portions of this reach are affected by dewatering for irrigation and reflect an imbalance in sediment and water transport. Several diversions and road crossings in this reach have been identified as likely fish barriers. The valley slope in this reach decreases to an average of 0.8%, while sinuosity increases to an average of 1.6 and the width/depth ratio increases to 15.2.

Riparian habitat conditions reflect the more intensive land uses in this reach, with 59% of the reach length ranking as At Risk for habitat and 35% ranking Not Sustainable. Fish habitat conditions were similarly impaired, with 97% of the reach ranking as Fair and 3% ranking as Good.

Flint 4

Reach Flint 4 extends from the upstream end of subreach F13 at Black Pine Road to the downstream end of subreach F19 at the Boulder Creek confluence. This reach is characterized by a narrow, low gradient floodplain between two wide agricultural valleys. This area has high wildlife value for its connectivity between two ranges on either side of Flint Creek. Its defining character is the confinement of its floodplain by foothills and a historic gravel roadbed to the west, and an out-of-use railroad grade, and to a lesser extent by Highway 1 to the east. Stream alterations and erosion from high water events in 2011 were noticeable throughout this reach.

The valley slope in this reach averages 0.5%, while sinuosity averages 1.6, with the stream's width/depth ratio averaging 14.3. These channel dimensions and ocular estimates of entrenchment classify this reach as fluctuating between a C4 and an E4, with its potential likely being an E channel. The railroad grade detrimentally impacts reach Flint 4 not only by disrupting natural hydrology and sediment deposition, but it remains the primary vector for weeds.

As a percentage of linear feet of stream, 59% of this reach was ranked as At Risk in the SRAF survey and 20% of the reach ranked Not Sustainable for riparian habitat. In terms of fish habitat, scored using the three supplemental questions, 100% of the reach ranked Fair. Correspondingly, 45% of field-surveyed stream length ranked Moderately High for erosion, with 21% ranking low and 12% moderate.

Flint 5

This reach of Flint Creek runs from the confluence with Boulder Creek to a geomorphic break coinciding with the Allendale ditch diversion just above the intensively cultivated Drummond valley. This reach is primarily a transport reach characterized by higher gradient, large cobble and boulder-dominated channel bed and lower sinuosity than both upstream and downstream reaches. Land use on this reach is primarily residential in its upper half and agricultural in its lower half, with smaller holdings and mostly small vacation properties and small subdivisions. Several of the subreaches in this reach are comprised of groups of small private properties. The cold water, low turbidity influence of Boulder Creek is noticeable in this reach and its upper half is mostly non-irrigated. The average stream gradient in this reach is 1.5%, with a sinuosity of 1.1 and width/depth ratio of 15.8, reflecting B3 to C3 Rosgen stream characteristics.

As a percentage of linear feet of stream, 54% of this reach was ranked as Sustainable in the SRAF survey and 46% of the reach ranked At Risk for riparian habitat. There were no Not Sustainable rankings for habitat in this reach. In terms of fish habitat, 46% of the linear extent of the reach scored Good and 54% scored Fair using the three supplemental questions. Bank erosion scores were similarly positive, with 29% scoring Low and 34% scoring Moderate, with only 28% of the reach scoring Moderately High for erosion and none scoring High. Only 8% of the linear extent of this reach was assessed remotely and was not accounted for in erosion scores.

Flint 6

This reach of Flint Creek is of primary importance for fish passage and connectivity between the Clark Fork River and spawning tributaries in this watershed. Flowing through the Drummond valley, the entire reach lies within land in agriculture, primarily cattle pastures, some horse pastures, and hay production. The reach begins at the Allendale ditch diversion, falling 450 feet in 14 miles to its confluence with the Clark Fork. This reach corresponds to the NRDP's Lower Flint Creek priority area, where water quantity, fish passage, fish entrainment and habitat restoration are the driving concerns, in that order.

As a percentage of linear feet of stream, 64% of this reach was ranked as At Risk in the SRAF survey and 30% of the reach ranked Not Sustainable for riparian habitat. In terms of fish habitat, scored using the three supplemental questions, 70% of the reach ranked Fair, with 30% of the total reach length not assessed for fish habitat due to remote reaches. Bank erosion scores followed these numbers, with 55% of field assessed reaches ranking Moderately High and 4% of reaches ranking High, while only 6% of assessed reaches ranked Low for erosion.

Boulder 1

This headwaters reach of Boulder Creek extends from high mountain rocky peaks to a bridge crossing upstream of the community of Princeton. The entire reach is located on public forest land, with the exception of an in-holding on a mining claim perched above the stream.

The stream channel is in a natural, forested condition, with an average slope of 5.7%, a sinuosity of 1.2 and a width/depth ratio of 10.5. The entire reach was ranked Sustainable in the NRCS Ranking metric, and 100% of the linear extent of the reach was ranked Good for fish habitat. While a majority of the linear extent of the reach (72%) was not surveyed in the field, erosion rates are estimated to be low for the entire reach.

Boulder 2

This reach is where Boulder Creek's gradient decreases and residential development begins in the drainage. It begins on Forest Service land near a series of campgrounds and ends on Forest Service property just upstream of Maxville. The stream has an average gradient of 1.8%, a sinuosity of 1.1 and a width/depth ratio of 13.3 with cobble substrate as the dominant channel bed feature. It is classified as a B3 channel throughout the reach.

A large extent of this reach has excellent habitat conditions both in stream and in the riparian area. NRCS rankings for habitat were ranked Sustainable for 69% of the length of the stream, but two ownerships, comprising 31% of the reach's stream length, were ranked as At Risk. Those same two ownerships were ranked Fair for fish habitat and Moderate for bank erosion, while the remaining 69% of the reach length was ranked Good for fish habitat.

Boulder 3

Reach 3 on Boulder Creek runs through the town of Maxville and under MT Highway 1 to the confluence with Flint Creek. The stream supports quality fish habitat and stable banks

throughout its length and minimal restoration needs were seen for this section of stream. The channel maintains a slope of 2% and sinuosity of 1.1.

In relation to its length, 100% of the subreach was ranked as having Sustainable riparian habitat. Fish habitat was rated high as well, with 100% ranked Good. All field assessed subreaches ranked Low for erosion. There are minimal restoration needs in this reach other than conservation of existing riparian habitat.

Summary information about each reach is provided in Table 13 below, scores and restoration priority rankings are shown by subreach in Table 14.

Table 13. Summary results by Reach						
Reach	Length (miles)	Length (feet)	Total Bank Erosion (ft ²)	Percentage of Linear Bank Erosion (%)	NRCS Score (%)	Fish Habitat Score (%)
Flint 1	1	6,939	9,775	9 (Moderate)	62 (At Risk)	39 (Fair)
Flint 2	2	8,298	1,118	3 (Low)	58 (At Risk)	49 (Fair)
Flint 3	16	82,856	25,1116	11 (Moderately High)	66 (At Risk)	61 (Fair)
Flint 4	14	73,471	49,205	9 (Moderate)	74 (At Risk)	56 (Fair)
Flint 5	4	19,658	7,925	9 (Moderate)	66 (At Risk)	74 (Fair)
Flint 6	14	74,847	30,326	13 (Moderately High)	68 (At Risk)	58 (Fair)
Boulder 1	8	40,451	843	5 (Low)	99 (Sustainable)	95% (Good)
Boulder 2	1.23	6,502	81	6 (Moderate)	90 (Sustainable)	100% (Good)
Boulder 3	0.35	1,871	NA	2 (Low)	94 (Sustainable)	100% (Good)

Table 14. Flint Creek summary of scores and restoration priority by subreach

Reach	Subreach ID	Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
Flint 1	<i>F01ra</i>	NA	NA	48	<i>Not Sustainable</i>	30	<i>Poor</i>	<i>Low</i>
	F01	9	moderate	63	At Risk	44	Fair	Low
	<i>F02ra</i>	NA	NA	76	<i>At Risk</i>	43	<i>Fair</i>	<i>Low</i>
Flint 2	F02	3	low	58	At Risk	57	Fair	Low
	<i>F03ra-1</i>	NA	NA	66	<i>At Risk</i>	40	<i>Fair</i>	<i>Moderate</i>
	<i>F03ra-2</i>	NA	NA	74	<i>At Risk</i>	50	<i>Fair</i>	<i>Low</i>
Flint 3	F03	6	moderate	68	At Risk	80	Good	Low
	<i>F04ra</i>	NA	NA	86	<i>Sustainable</i>	70	<i>Fair</i>	<i>Low</i>
	F04	5	low	63	At Risk	70	Fair	Moderate
	F05	2	low	82	Sustainable	90	Good	Low
	F06	24	high	45	<i>Not Sustainable</i>	57	Fair	Moderate
	<i>F07ra</i>	NA	NA	51	<i>At Risk</i>	50	<i>Fair</i>	<i>Moderate</i>
	F07	20	moderately high	55	At Risk	57	Fair	High
	<i>F08ra</i>	NA	NA	58	<i>At Risk</i>	50	<i>Fair</i>	<i>Moderate</i>
	F08	20	moderately high	42	<i>Not Sustainable</i>	40	Fair	High
	<i>F09ra</i>	NA	NA	58	<i>At Risk</i>	50	<i>Fair</i>	<i>Moderate</i>
	F09	14	moderately high	62	At Risk	57	Fair	Moderate
	<i>F10ra</i>	NA	NA	47	<i>Not Sustainable</i>	50	<i>Fair</i>	<i>Moderate</i>
	F10	7	moderate	62	At Risk	70	Fair	Moderate
Flint 4	F11	3	low	68	At Risk	57	Fair	Moderate
	F12	8	moderate	45	<i>Not Sustainable</i>	67	Fair	High
	F13	9	moderate	64	At Risk	43	Fair	Moderate
	F14	12	moderately high	42	<i>Not Sustainable</i>	40	Fair	High
	F15	15	moderately high	45	<i>Not Sustainable</i>	50	Fair	High
	F16	16	moderately high	70	At Risk	70	Fair	High
	<i>F17ra</i>	NA	NA	66	<i>At Risk</i>	70	<i>Fair</i>	<i>Moderate</i>
	F17	11	moderately high	72	At Risk	57	Fair	Moderate
	<i>F18ra</i>	NA	NA	70	<i>At Risk</i>	70	<i>Fair</i>	<i>Moderate</i>
	F18	3	low	83	Sustainable	37	Fair	High
	<i>F19ra</i>	NA	NA	70	<i>At Risk</i>	50	<i>Fair</i>	<i>Low</i>
	F19	0	low	88	Sustainable	70	Fair	Low

Table 14. Flint Creek summary of scores and restoration priority by subreach

Reach	Subreach ID	Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
Flint 5	F20	0	low	98	Sustainable	80	Good	Low
	F21	2	low	87	Sustainable	80	Good	Low
	<i>F22ra</i>	NA	NA	91	<i>Sustainable</i>	70	<i>Fair</i>	<i>Low</i>
	F22	7	moderate	90	Sustainable	90	Good	Low
	F23	13	moderately high	53	At Risk	57	Fair	Moderate
	F24	7	moderate	70	At Risk	67	Fair	Low
Flint 6	F25	23	high	55	At Risk	57	Fair	High
	<i>F26ra</i>	NA	NA	62	<i>At Risk</i>	50	<i>Fair</i>	<i>Moderate</i>
	F26	15	moderately high	63	At Risk	70	Fair	Moderate
	F27	1	low	62	At Risk	70	Fair	Moderate
	F28	15	moderately high	52	At Risk	57	Fair	High
	F29	11	moderately high	78	At Risk	70	Fair	Moderate
	<i>F30ra</i>	NA	NA	77	<i>At Risk</i>	NA	NA	<i>Moderate</i>
	F30	5	low	70	At Risk	57	Fair	Moderate
	F31	16	moderately high	53	At Risk	57	Fair	High
	<i>F32ra-1</i>	NA	NA	92	<i>Sustainable</i>	NA	NA	<i>Moderate</i>
	<i>F32ra-2</i>	NA	NA	66	<i>At Risk</i>	NA	NA	<i>High</i>
	F32	16	moderately high	50	Not Sustainable	57	Fair	High
	<i>F33ra-1</i>	NA	NA	66	<i>At Risk</i>	NA	NA	<i>High</i>
	<i>F33ra-2</i>	NA	NA	58	<i>At Risk</i>	NA	NA	<i>High</i>
	<i>F33ra-3</i>	NA	NA	51	<i>Not Sustainable</i>	40	<i>Fair</i>	<i>High</i>
	F33	17	moderately high	43	Not Sustainable	57	Fair	High

* Remote assessed subreaches shown in italics

Reach	Subreach ID	Percentage of Linear Bank Erosion (%)	Erosion rating	NRCS Score (%)	NRCS rating	Fish Habitat Score (%)	Fish Habitat Rating	Restoration Priority Ranking
Boulder 1	<i>B01ra</i>	NA	NA	100	<i>Sustainable</i>	100	<i>Good</i>	<i>Low</i>
	B01	10	moderate	98	Sustainable	90	Good	Low
	<i>B02ra</i>	NA	NA	100	<i>Sustainable</i>	100	<i>Good</i>	<i>Low</i>
	B02	0	low	97	Sustainable	90	Good	Low
Boulder 2	B03	0	low	90	Sustainable	100	Good	Low
	<i>B04ra</i>	NA	NA	94	<i>Sustainable</i>	100	<i>Good</i>	<i>Low</i>
	B04	13	moderate	70	At Risk	70	Fair	High
	<i>B05ra</i>	NA	NA	94	<i>Sustainable</i>	100	<i>Good</i>	<i>Low</i>
	B05	9	moderate	72	At Risk	70	Fair	High
	B06	2	low	97	Sustainable	100	Good	Low
Boulder 3	B07	2	low	97	Sustainable	80	Good	Low
	<i>B07ra</i>	NA	NA	94	<i>Sustainable</i>	100	<i>Good</i>	<i>Low</i>
	B08	4	low	97	Sustainable	90	Good	Low
	B09	0	low	95	Sustainable	80	Good	Low

* Remote assessed subreaches shown in italics

4.3.1 Results of floodplain constriction assessment

Flint Creek Reach 4 is defined by the length of Flint Creek within the constriction point between the Philipsburg and Drummond valleys. As both the TMDL and a return flow study suggest, this area is important in the hydrology of the basin, where water from one large agricultural valley is transported to a larger one downstream, mostly through surface flow (DEQ 2012; Voeller and Waren 1997). Constriction of the floodplain has altered the morphology and function of Flint Creek in Reach Flint 4, resulting in accelerated bank erosion where the stream is adjusting to loss of meander width and stream length. In addition, the railroad bed isolates wetlands from natural flooding and thus decreases the system's long-term water storage capacity. The total length of railroad from Phillipsburg to the Clark Fork River is approximately 27 miles, approximately 7.5 miles of which is affecting channel dynamics of Flint Creek, primarily in Reach Flint 4.

Maps in Figures 17-19 below illustrate the degree to which the railroad grade confines the channel and reduces the active floodplain in subreaches of Flint 4. Subreach F-16, F-18, and F-19a are three subreaches with the most severe floodplain constriction. Flint Creek is eroding the railroad grade throughout the reach, but most severely in the more constricted subreaches, and in F17. Flint Creek has undermined the railroad in at least three sites, and the tracks are overhanging the stream. Stream meanders have been cut off from the original channel throughout the reach. Many of these meanders still provide intact wetland habitat and are at a similar elevation to the current channel. In some instances the distance between the current channel and the old meander is less than twenty feet, and re-connecting the meander likely would involve minimal construction. A complete geomorphic and hydrologic analysis is recommended prior to reconnecting meanders to determine the likely channel response and to fit the actions into a larger restoration approach.

Addressing floodplain constriction by the historic railroad grade is one of the most important restoration actions to improve habitat and natural process functioning on Flint Creek. Addressing the influence of the railroad grade also will be one of the most complex restoration efforts, as it will require a high level of outreach, coordination, and planning. It is unrealistic to assume that removal of the railroad bed can be initiated as one of the first- tier restoration actions, but starting the initial outreach and scoping to define alternatives is recommended as high priority.

Figure 17. Railroad constriction of stream between F12 – F15

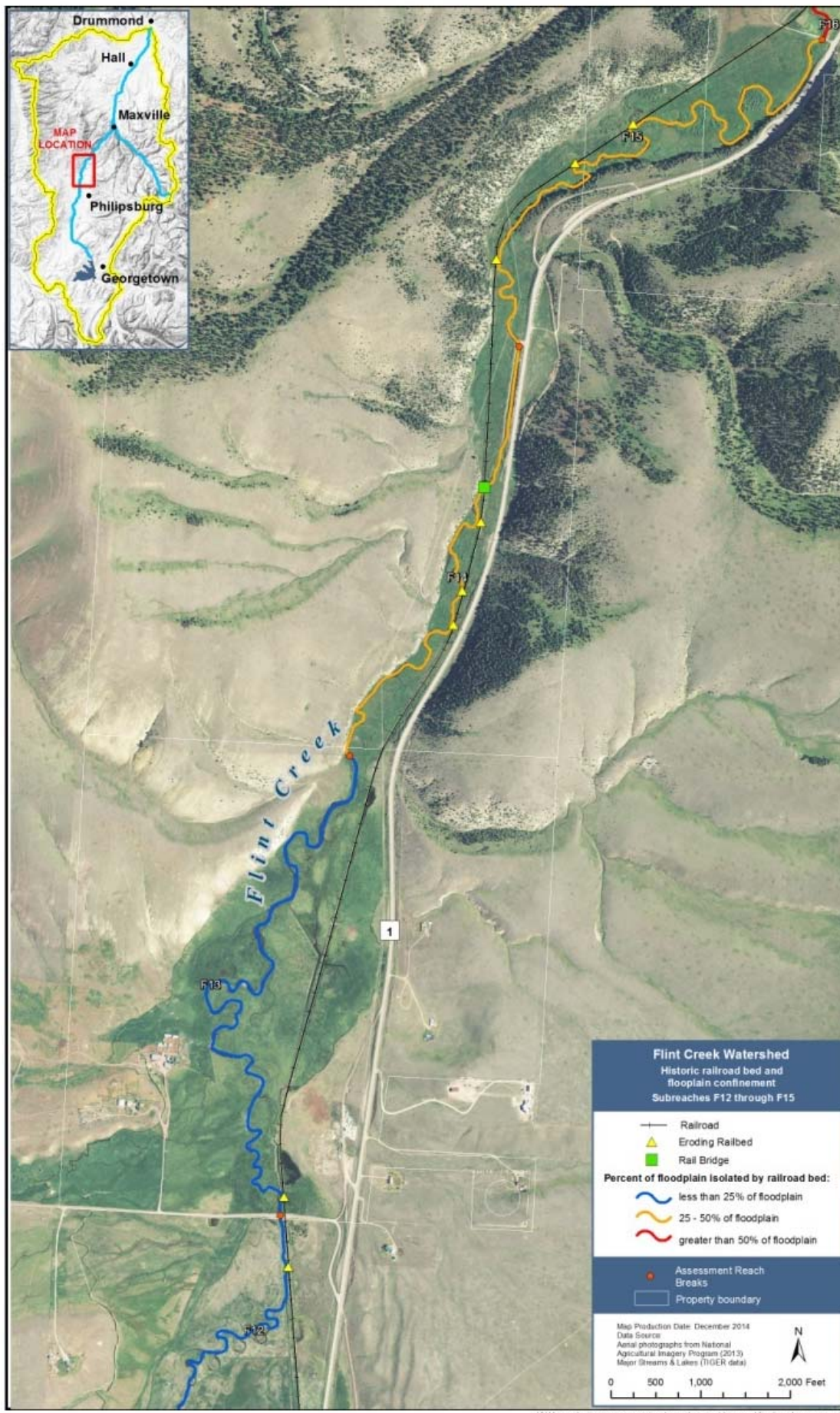


Figure 18. Railroad constriction of stream between F16 – F17

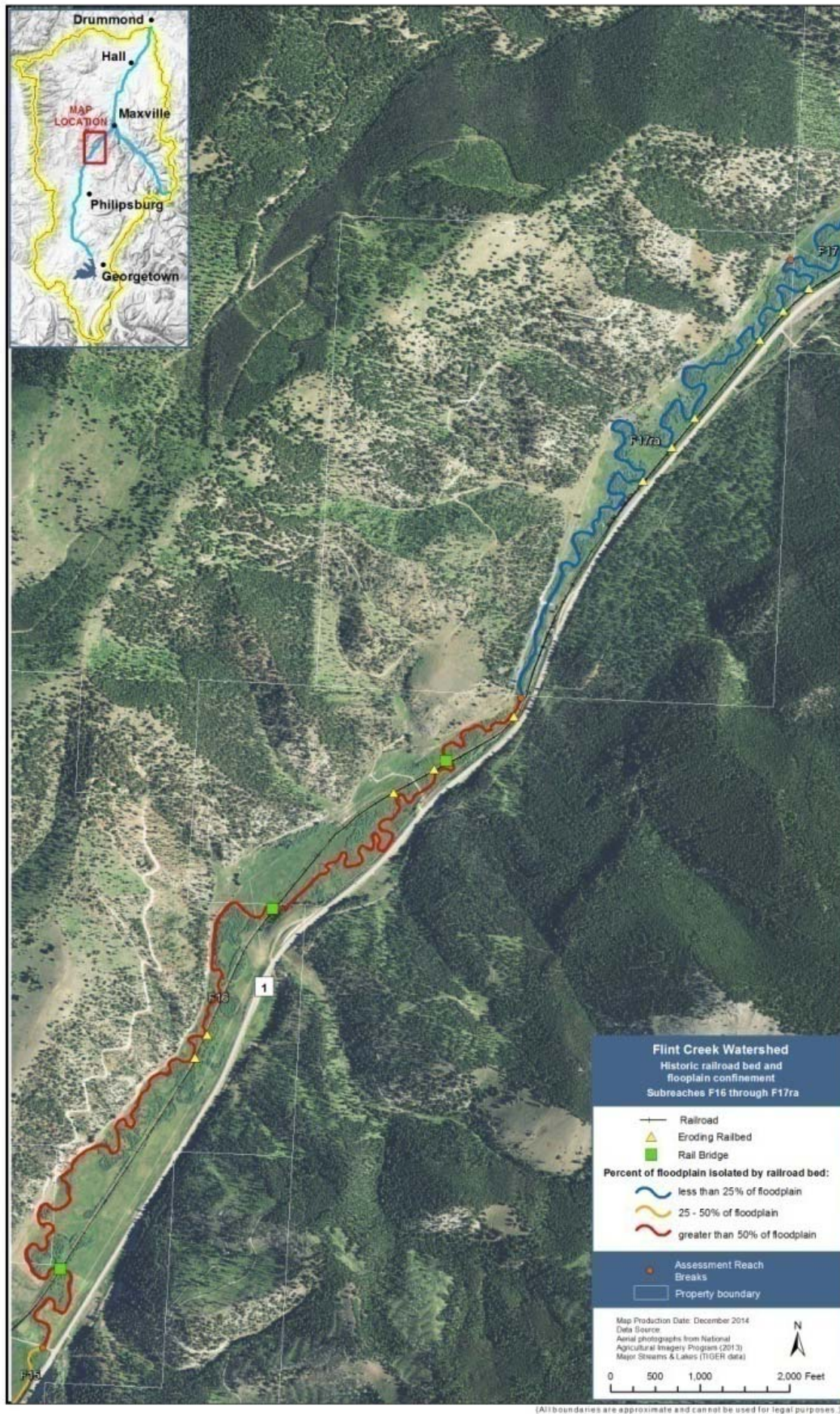


Figure 19. Railroad constriction of stream between F17 – F19



5.0 DISCUSSION AND RESTORATION RECOMMENDATIONS

This section examines subreach priority rankings at the reach and subreach scale. Grouped into reaches, the entire stream system can be evaluated based on similar land uses, morphology and associated stream impairments. The types of restoration projects recommended in this study also tended to be grouped by reach.

Reaches Flint 6 and Flint 4 stand out as areas with numerous high and moderate priority subreaches, while Flint 3 has a larger percentage of Moderate priority than High priority subreaches, due mostly to the decreased priority of this area for fish habitat concerns.

In Table 16 below, the number of reaches in each priority ranking is shown with a brief description of project types for each reach.

Table 16. Summary of Prioritization Rankings by Reach				
Reach ID	# High Priority Subreaches	# Moderate Priority Subreaches	# Low Priority Subreaches	General High Priority Project Type
Flint 1	0	0	3	No High Priority Projects
Flint 2	0	1	2	No High Priority Projects
Flint 3	3	9	3	Grazing management techniques to reduce pressure on streambanks and vegetation; riparian fencing and plant protection; regeneration of native vegetation; irrigation improvements; fish passage and entrainment improvements
Flint 4	4	4	2	Improve floodplain and wetland connectivity, water storage across historic railroad bed; some grazing management; riparian revegetation and plant protection in small, select areas
Flint 5	0	1	5	No High Priority Projects
Flint 6	9	7	0	Grazing management techniques to reduce pressure on streambanks and vegetation, particularly in downstream subreaches; mitigation of berming activities in lower subreach; riparian fencing and plant protection; regeneration of native vegetation; irrigation improvements; fish passage and entrainment improvements
Boulder 1	0	0	4	No High Priority Projects
Boulder 2	2	0	4	Streambank stabilization on long stretch of stream; riparian vegetation establishment; high flow mitigation and water holding improvement
Boulder 3	0	0	4	No High Priority Projects

Figures 20 and 21 below show priority rankings for all of Flint Creek and Boulder Creek respectively.

Figure 20. Project Priority Rankings for Flint and Boulder Creeks



Flint Creek Reach 1

Stream flow in this reach is almost entirely dependent on power plant operation. The channel in this reach is dry or nearly so over most of its length in most years, whenever the power plant downstream of the reach is operational. According to a power plant employee, Flint Creek flowed from 1989 to 2013, when the power plant was not in operation after a blow-out in 1989; during this period stream flow likely delivered excess sand and gravel from highway maintenance and hill slope erosion to the lower reaches of Flint Creek, but sediment delivery is expected to be lower now that the power plant is in operation and the channel is basically dry above the plant. The channel in sections of reach Flint-1 contained water during the time of the assessment but was obviously dewatered. Fish habitat scores are low but fish potential here is limited due to proximity to dam and topographic/infrastructure constraints.

Potential Conditions in this reach are unlikely to change without significant changes to major infrastructure and power generation in the valley. While some subreaches were impaired, prioritization of restoration projects here were scored as Low due to the minimal positive gain for fisheries in this upper extent of the watershed.

Flint Creek Reach 2

Restoration of this reach is assigned a low priority due to the low potential habitat value of this subreach, the water-released influence of the dam and the decreased priority of this area of the stream for fish populations. Projects could include some bank stabilization and riparian planting, noxious weed control, and diversion improvements.

Flint Creek Reach 3

This upper reach of Flint Creek is of lower priority in regards to improving fish habitat conditions in the watershed, due in part to the dam-controlled influence of surface flows as well as the distance from the main stem of the Clark Fork. Subreaches scoring At Risk for riparian habitat tended not to be ranked as high a priority as subreaches with similar conditions in the lower Drummond valley reaches of Flint Creek for these reasons. However, there is much potential to improve conditions in the Phillipsburg valley overall, and increased moisture in this part of the drainage could improve riparian restoration potential.

Potential conditions in this reach depend in large part on land owner willingness to integrate restoration approaches to their land management. Primary opportunities foreseen in this reach relate to changing streamside bank vegetation composition away from grasses and toward woody species, accomplished through fencing weed matting, planting, and adjusting grazing rotations to decrease pressure on streamside areas and improve natural regeneration of native species.

Improvement of irrigation practices and diversions could improve fish entrainment, and the few passage issues noted in previous studies.

Flint Creek Reach 4

A restoration priority for Reach Flint-4 would be to reconnect the floodplain and historic meanders that were cut off by construction of the railroad bed. Restoration of this reach will be limited without removing the railroad bed from the lower and wetter areas of the floodplain, where it cuts off meanders and disrupts wetlands and water flow. Other restoration priorities include stabilizing some high eroding banks, increasing riparian shrub cover along streambanks, and increasing aquatic habitat complexity.

Efforts toward addressing railroad grade confinement should be completed in phases, starting with a feasibility study and outreach effort, which would identify alternatives for partially or completely removing the railroad bed material and reconnecting historic meanders and natural floodplain functions. The feasibility analysis might include the option of converting the railroad bed, or portions thereof, to a trail, which has been promoted by some parties in the past. A feasibility analysis including trail development as an option would need to determine which portions of the railroad bed could be incorporated into a trail system without detrimental impact to stream or floodplain function, along with other costs and benefits of increased public access.

Flint Creek Reach 5

Restoration in this reach was generally scored as lower priority than potential projects downstream and upstream. Benefits of riparian habitat improvements here would be modest in comparison with improved habitat conditions downstream in Reach 6 and improved sediment capture and floodplain connectivity upstream in Reach 4. There is, of course, potential for improvements in habitat conditions and outreach should be conducted to, at minimum, conserve and maintain existing conditions throughout this reach.

Flint Creek Reach 6

Subreaches in Flint Creek Reach 6 were prioritized slightly higher than those of reaches further upstream due to the importance of a healthy connection between the Clark Fork River and lower reaches of Flint Creek for fish habitat and passage issues as well as for water quantity considerations. Potential conditions throughout this reach are the continued viability of agricultural activities but within a management scheme that prioritizes stable, well-vegetated riparian habitat conditions throughout the reach to improve canopy cover to maintain lower water temperatures and improve in-stream habitat conditions for trout species of concern.

In a 2013 Stakeholder Interest and Prioritization Exercise conducted by the Granite Headwaters Watershed Group, streambank erosion was ranked by landowners in the drainage as the second highest priority, just below metals contamination. Best management practices agreed upon by participants at the meeting included:

- Managing livestock
- Fencing riparian areas
- Constructing hardened water gaps
- Managing vegetation
- Building livestock exclosures
- Planting willows and other shrubs
- Prohibiting development in floodplains

(Granite Headwaters, 2014)

These practices are also highlighted by the NRDP as restoration prioritization actions, so there is a positive point of departure from which conversations can begin.

Limiting factors to implementing habitat restoration activities in this reach will likely include resistance to changing management practices and the loss of hay land or grazing land to expanded riparian buffer zones. Outreach and education with landowners should be an automatic part of any restoration efforts in the valley.

Issues involving irrigation infrastructure and practices for fish and water quantity are being addressed by NRDP and are outside the scope of this study. Low flow conditions was cited as the fourth most important priority for landowners in the study cited above.

Interestingly, fish entrainment and fish passage were not cited by any landowners among their priorities for the watershed.

Boulder Creek Reach 1

This stream is known to be an important refuge for Bull trout and West Slope Cutthroat trout. Primary impacts to this reach are historic mining activity. Restoration activities for old mine sites are beyond the scope of this report but information as to riparian habitat impacts from these sites is noted in subreach descriptions.

Boulder Creek Reach 2

The two ownerships showing stream impacts and decreased habitat conditions are the only locations where restoration activities are assigned a high priority throughout Boulder Creek. The subreaches in question, located in low gradient valleys, are sediment sources to the remainder of the system downstream but, with restoration, could become sediment sinks. More detail of the proposed restoration activities is provided in the subreach descriptions for subreaches B04 and B05.

Boulder Creek Reach 3

This reach runs entirely through the town of Maxville and under Highway 1. While the channel is constricted through town and likely straightened, potential for restoration in this reach are limited due to urban infrastructure.

Table 17 provides further detail for the 18 high priority subreaches found in this study.

Table 17. High Priority Subreach Summary				
Stream	Subreach ID	Limiting Factors	General High Priority Project Type	Landowner Comments
Boulder Creek	B04	Stream is in new channel cut through a meadow in 2011. Minimal riparian vegetation. Bridge constriction of stream and decreased floodplain connectivity downstream of pond.	Riparian planting throughout meadow with weed matting; some bioengineered bank structures; hydrologic assessment of bridge crossing and mitigation of channel constriction if necessary; Engineer pond hydrology to allow overflow into side channels and wetlands downstream	Seemed very favorable to project to stabilize new stream channel. Interest in fish habitat and wetlands; Does not want to put stream back in old channel; Neighbors own and operate heavy machinery
	B05	Vegetation removal on river right streambank leading to increased erosion rates	Enhance access to floodplain and side channels to decrease stream energy near home; revegetate streambanks on river right; install bioengineering structures to stabilize banks	Very interested in restoration opportunities- particularly to avoid risk to property at sharp bend in channel; Neighbors own and operate heavy machinery
Flint Creek	F07	Competition from grass and weeds along streambank; channel incised; channel and flow altered by irrigation weir	Riparian shrub planting and temporary or long-term riparian fencing; Bio-engineered structures to improve channel stability and habitat; Upgrade current weir to improve fish passage and weir function	Seemed open to conservation on the land; small parcel between remote assessed subreaches; outreach to up/downstream owner to expand scope of work
	F08	Channel incised; stream flows through pasture used for livestock grazing and is not fenced; high eroding banks present in upper reach; one patch of reed canary grass observed near house.	Remove car bodies; Install bioengineered bank stabilization riparian planting; Re-activate old meander bends (mid-reach) and side channels; Work with landowner and lessee to revise riparian grazing management; Weed control	Landowner was surprised by grazing impact and is enthusiastic about restoration.
	F12	Competition from pasture grasses and browse limit shrub regeneration;	Restore native riparian shrubs to reduce bank erosion; Temporary fencing of the stream belt width to increase existing shrub density where browse is limiting factor; Plant riparian shrubs where grass competition is heavy; Remove railroad grade from downstream end	No landowner comments regarding restoration; wants to see recommendations.
	F14	Railroad grade; browse on shrubs and competition from pasture grass	Restore meanders and floodplain connectivity where channel confined by RR grade; riparian planting, bioengineering for bank protection; weed control	Open to discuss potential restoration projects*

Table 17. High Priority Subreach Summary				
Stream	Subreach ID	Limiting Factors	General High Priority Project Type	Landowner Comments
	F15	Railroad grade; browse on shrubs and competition from pasture grass	Restore meanders and floodplain connectivity where channel confined by RR grade; riparian planting, bioengineering for bank protection and aquatic habitat; weed control	Open to discuss potential restoration projects*
	F16	Railroad grade constriction of floodplain; browse on shrubs and competition from pasture grass	Restore meanders and floodplain connectivity where channel confined by RR grade; riparian planting, bioengineering for bank protection; weed control; Restore wetlands on tributaries to reach	No landowner comments from downstream landowner; upstream landowner open to discuss projects*
	F18	Railroad grade constriction of floodplain limits capacity of subreach to slow and store water and capture sediment during high flow events; railroad bed undercut by stream in at least one location; several small areas of banks lacking woody vegetation; weed incursion along railroad grade	Connect stream to active floodplain by removing railroad grade entirely or in specific locations; Weed control along railroad grade and floodplain; Enhance existing conservation land use practices; Plant bare banks where needed	Upstream landowner very conservation and wildlife-oriented, open to potential for restoration; no contact with downstream landowner at location of undercut railroad grade
	F25	Channel is over-widened and has limited aquatic habitat and energy-trapping features. Infrastructure for irrigation and the hwy limit channel restoration potential. Dewatering from irrigation reduces stream energy. Browse by livestock and wildlife has reduced riparian shrub diversity and cover.	Riparian shrub protection, or review grazing mgt to allow recovery; Install LWD/ bioengineered structure to improve aquatic habitat; Redesign diversion to improve fish passage	Expressed interest in potential off-site water project
	F28	Grazing influence is heavy on this subreach, but easily managed and restoration should be straightforward. The riparian community is in decline, and habitat value will decrease further with no action.	Enhance grazing management already begun. Temporary riparian fencing to allow recovery; riparian shrub planting and weed control to improve riparian community; hardened approach/water gap if necessary; Brush fascines to stabilize low banks;	Landowner seems interested in restoration. Stock was removed from stream years ago and off-site water installed. Expressed pride in efforts to date and interest in expanding on it. Interested in planting cottonwoods.
	F31	Heavy grazing influence; lack of riparian vegetation in areas;	Grazing management or riparian fencing; fencing of cottonwood and willow stands to promote natural recolonization; Grazing management including off-site water, to decrease duration on riparian areas; Fish screens	Expressed interest in restoration, specifically an off-site water project in upper section of property where cattle come down from steeps and into the stream*

Table 17. High Priority Subreach Summary				
Stream	Subreach ID	Limiting Factors	General High Priority Project Type	Landowner Comments
	<i>F32ra-2</i>	Grazing appears to limit quality of riparian habitat; likely high grass component to riparian vegetation	Offsite water by corrals; Riparian fencing and planting (particularly river right); Grazing management	No contact made with landowner
	F32	Decadent woody shrub community; grazing and grass competition limit woody riparian vegetation	Examine water use efficiency; Riparian fencing and weed matting; Bank stabilization with woody plantings and weed matting	Ownership may be changing for this subreach- see WRC landowner contact notes
	<i>F33ra-1</i>	Lack of riparian vegetation on river right; abundance of grasses mixed in with some shrubs limits regeneration potential;	Riparian planting and plant protection; Bank stabilization on active bank erosion	Upstream landowner on river right has many reservations, specifically with fish-related work; river left owners appear to be out-of-state
	<i>F33ra-2</i>	Less than 65% of right bank with adequate riparian vegetation; access to floodplain may be constricted by agricultural activities	Riparian planting and expansion of buffer zone; grazing management	No contact with river left landowner. River right landowner same as for F33ra-1 (see above)
	<i>F33ra-3</i>	Streamside vegetation is limited; channel may be entrenched and disconnected from floodplain in places; riparian fencing collapsing into stream	Riparian planting and buffer expansion; Enhance floodplain connectivity where constricted; Mitigate entrainment risk at diversions	No contact with landowner; downstream landowner (F33) leases property for grazing
	F33	Lack of riparian vegetation and heavy grazing influence leading to grass and weed-dominated banks with frequent high-bank erosion; earth work and berms constrict floodplain access in places; confluence with CFR wide and shallow	Improve grazing management including off-site water, hardened crossings; riparian planting and fencing over large area; fencing around cottonwood stands to allow regeneration; Work with landowner to install overflow channels, allow for larger floodplain and energy dissipation; close attention to geomorphology at confluence	Owner mentioned channel fluctuations and his earth work to contain the channel; likely open to conversation about restoration opportunities; owner's son skeptical of fish projects

* Indicates same landowner for all or most of subreach

6.0 REFERENCES

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8.0 APPENDIX 2: SUBREACH HABITAT SUMMARY DATA

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F01ra	10/15/2014	A. Chadwick, A. Stanley	forest, highway, & dam spillway	CC3	A	4.4%	1.2	1.2	10	8.3	gravel, cobble, boulders	6	5	2	6	0	na	na	na	na	2	21	44	48%	na	na	3	10	30%
F01	7/1/2014	A. Chadwick, A. Stanley	forest & highway	CC3	A3-B4	2.9%	1.3	1.2	11	9.2	gravel, cobble, boulders	8	5	2	6	0	1	0	8	4	4	38	60	63%	7	5	0	27	44%
F02ra	10/15/2014	A. Chadwick, A. Stanley	forest & highway	CC3 XX1	A	15.8%	1.1	na	na	na	boulders	8	8	4	4	0	na	na	6	na	2	32	42	76%	na	3	0	7	43%
F02	7/1/2014	A. Chadwick, A. Stanley & TMDL	recreation, campground, power plant	CC2	B4	2.1%	1.2	1.8	20	11.1	large gravel	6	3	2	6	0	2	0	8	2	6	35	60	58%	7	7	3	30	57%
F03ra-1	10/15/2014	A. Chadwick, A. Stanley	recreation, possible light grazing	SR4	B4c	1.6%	1.1	1.3	15	11.5	large gravel	8	3	4	6	0	na	0	8	na	6	35	53	66%	Na	5	3	20	40%
F03ra-2	10/15/2014	A. Chadwick, A. Stanley	grazing, w/riparian area fenced	SR4	B4c	1.3%	1.1	1.3	15	11.5	large gravel	8	5	4	6	2	na	0	8	na	6	39	53	74%	na	7	3	20	50%

Flint Creek and Boulder Creek Riparian Habitat Assessment

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F03	7/1/2014	A. Chadwick, A. Stanley	forest service meadow, no grazing	SR4	C4	1.2%	1.4	1.3	19	14.6	large gravel	8	5	4	6	0	0	0	8	4	6	41	60	68%	10	7	7	30	80%
F04ra	10/15/2014	A. Chadwick, A. Stanley & TMDL	grazing	SR4	C4	1.3%	1.4	1.3	20	15.4	large gravel	8	5	4	6	4	na	na	8	na	8	43	50	86%	na	7	7	20	70%
F04	7/1/2014	A. Chadwick, A. Stanley	light grazing, historic heavy grazing	SR4	C4	0.7%	1.4	1.3	20	15.4	large gravel	6	5	4	6	0	0	0	8	3	6	38	60	63%	7	7	7	30	70%
F05	7/1/2014	A. Chadwick, A. Stanley	historic grazing, irrigation, diversions	SR4	C4	1.3%	1.1	1.4	22	15.7	gravel	8	5	4	6	4	1	1	8	4	8	49	60	82%	10	10	7	30	90%
F06	7/2/2014	A. Chadwick, A. Stanley	grazing	BB4	C4	0.9%	1.2	1.4	18	12.9	gravel, w/ fines	6	3	4	6	0	1	0	4	1	2	27	60	45%	7	7	3	30	57%
F07ra	10/15/2014	A. Chadwick, A. Stanley & TMDL	grazing	BB4	C4	1.1%	1.2	1.4	22	15.7	gravel	8	3	4	4	0	na	0	4	na	4	27	53	51%	na	7	3	20	50%
F07	7/2/2014	A. Chadwick, A. Stanley	heavy grazing, gravel pit nearby	BB2	C4	0.8%	1.5	1.3	15	11.5	gravel	6	5	4	4	0	0	0	6	4	4	33	60	55%	7	7	3	30	57%

Flint Creek and Boulder Creek Riparian Habitat Assessment

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F08ra	10/15/2014	A. Chadwick, A. Stanley	pasture, hay	BB2	E4	0.8%	1.5	1.3	12	9.2	gravel	8	5	4	4	0	na	0	6	na	4	31	53	58%	na	7	3	20	50%
F08	7/7/2014	A. Chadwick, A. Stanley	grazing	SR4	C4-E4	0.4%	1.7	1.8	23	12.8	silt, sand, gravel	8	3	4	4	0	1	0	0	1	4	25	60	42%	7	5	0	30	40%
F09ra	10/15/2014	A. Chadwick, A. Stanley	pasture, grazing		E4	0.4%	2.0	1.8	25	13.9	gravel	8	3	4	6	0	na	0	6	na	4	31	53	58%	na	7	3	20	50%
F09	7/7/2014	A. Chadwick, A. Stanley	grazing	SR4	E4	0.3%	1.9	1.8	23	12.8	gravel	8	3	4	6	0	2	0	6	2	6	37	60	62%	7	7	3	30	57%
F10ra	10/15/2014	A. Chadwick, A. Stanley	pasture, grazing		E4-C4	0.7%	1.6	1.8	24	13.3	gravel	8	5	4	4	0	na	0	0	na	4	25	53	47%	na	7	3	20	50%
F10	11/4/2014	Pedro Marques, A. Chadwick	grazing, city lagoon adjacent	SR4	E4	0.6%	2.2	1.8	32	17.8	gravel w fines	8	5	4	4	2	2	0	4	1	6	36	58	62%	7	7	7	30	70%
F11	8/7/2014	P. Marques, A. Switalski	pasture	GR2	C4c	0.6%	1.6	1.8	32	17.8	gravel	8	5	4	4	4	2	1	4	1	8	41	60	68%	7	7	3	30	57%

Flint Creek and Boulder Creek Riparian Habitat Assessment

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F12	7/8/2014	A. Chadwick, A. Stanley	grazing	GR2	E4	0.3%	1.7	2	22	11.0	gravel	8	5	2	2	0	2	0	2	2	4	27	60	45%	10	7	3	30	67%
F13	8/16/2014	P. Marques, A. Switalski	grazing, hay	GR2	C4	0.1%	1.8	1.8	30	16.7	gravel	8	5	4	0	6	3	2	0	n/a	8	36	56	64%	3	7	3	30	43%
F14	7/3/2014	A. Chadwick, A. Stanley	historic grazing, old rail bed	GR2	C4	0.7%	1.2	2	30	15.0	gravel, sand	8	3	4	4	2	1	0	0	1	2	25	60	42%	7	5	0	30	40%
F15	7/2/2014	A. Chadwick, A. Stanley & TMDL	recreation, grazing, railway	SR4	C4	0.1%	1.8	2	30	15.0	gravel	8	3	4	4	2	0	0	0	2	4	27	60	45%	7	5	3	30	50%
F16	7/3/2014	A. Chadwick	grazing	SR4	E4	0.5%	1.7	2.5	28	11.2	gravel, sand	8	3	4	6	4	1	0	8	2	6	42	60	70%	7	7	7	30	70%
F17ra	11/1/2014	P. Marques	grazing, natural	SR4	E4	0.1%	1.8	1.8	30	16.7	gravel	8	5	4	4	0	na	0	8	na	6	35	53	66%	na	7	7	20	70%
F17	7/5/2014	P. Marques, A. Switalski	hay, natural	SR4	E4/5	0.5%	2.0	2	23	11.5	gravel, sand	8	5	4	6	2	2	0	8	2	6	43	60	72%	3	7	7	30	57%

Flint Creek and Boulder Creek Riparian Habitat Assessment

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F18ra	11/1/2014	P. Marques	grazing, natural	SR4	C4	0.2%	1.5	2	25	12.5	gravel	8	5	4	4	2	na	0	8	na	6	37	53	70%	na	7	7	20	70%
F18	7/3/2014	P. Marques, A. Switalski	habitat, recreation	SR4	C4	0.2%	1.5	2	25	12.5	gravel, cobble	8	5	4	6	6	2	3	8	2	6	50	60	83%	3	5	3	30	37%
F19ra	11/1/2014	P. Marques	residential, natural	SR4	C4	1.1%	1.4	2	30	15.0	gravel, cobble	8	5	4	4	2	na	0	8	na	6	37	53	70%	na	7	3	20	50%
F19	7/3/2014	P. Marques, A. Switalski & TMDL	forest, old mine site	BB2	B3c	1.8%	1.1	1.8	30	16.7	cobble, boulder	8	8	4	6	6	2	2	8	3	6	53	60	88%	7	7	7	30	70%
F20	7/9/2014	P. Marques, A. Switalski	residential	BB2	B3c	2.0%	1.0	1.8	35	19.4	cobble, boulder	8	8	6	6	6	2	3	8	4	8	59	60	98%	7	10	7	30	80%
F21	7/9/2014	P. Marques, A. Switalski	residential	BB2	B3c	2.0%	1.1	2	35	17.5	cobble, boulder	8	8	6	6	4	2	3	6	3	6	52	60	87%	10	7	7	30	80%
F22ra	RA	A. Chadwick, A. Stanley	grazing	BB2	B3	1.7%	1.1	2	32	16.0	cobble, boulder	8	8	6	6	4	na	2	6	na	8	48	53	91%	na	7	7	20	70%

Flint Creek and Boulder Creek Riparian Habitat Assessment

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F22	7/8/2014	A. Chadwick, A. Stanley & TMDL	grazing	SR4	B3	1.9%	1.2	2.5	35	14.0	cobble, boulder	8	8	6	6	4	2	1	8	3	8	54	60	90%	10	10	7	30	90%
F23	7/8/2014	A. Chadwick, A. Stanley	grazing	SR4	C3	1.2%	1.1	2.5	35	14.0	cobble, boulder	8	3	4	6	1	1	0	2	1	6	32	60	53%	7	7	3	30	57%
F24	7/8/2014	A. Chadwick, A. Stanley & TMDL	hay meadow, grazing	SR4	B3	0.5%	1.2	2.5	35	14.0	gravel, cobble, boulder	8	5	4	6	2	1	0	8	2	6	42	60	70%	7	10	3	30	67%
F25	7/8/2014	A. Chadwick, A. Stanley	grazing	SR4	C3b	2.1%	1.0	2	40	20.0	gravel, cobble, boulder	8	3	4	6	0	1	0	6	1	4	33	60	55%	7	7	3	30	57%
F26ra	RA	A. Chadwick, A. Stanley	grazing	BB2	C3	0.8%	1.1	2	35	17.5	cobble	8	3	4	6	0	na	0	6	na	6	33	53	62%	na	7	3	20	50%
F26	8/7/2014	P. Marques, A. Switalski	agriculture	BB2	C4c	0.8%	1.2	1.8	30	16.7	gravel, cobble	8	5	4	6	0	1	0	6	2	6	38	60	63%	7	7	7	30	70%
F27	6/30/2014	Pedro Marques, A. Chadwick & TMDL	grazing	SR4	C4c	0.8%	1.2	1.8	28	15.6	gravel	8	5	4	6	0	0	0	6	2	6	37	60	62%	7	7	7	30	70%

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Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F28	6/30/2014	Pedro Marques, A. Chadwick	grazing	SR2	C4c	0.8%	1.1	1.8	28	15.6	gravel, cobble	8	3	4	6	0	0	0	4	0	6	31	60	52%	7	7	3	30	57%
F29	8/16/2014	P. Marques, A. Switalski	agriculture	SR4	C4c	0.8%	1.2	1.8	35	19.4	gravel	8	5	4	6	4	2	1	8	3	6	47	60	78%	7	7	7	30	70%
F30ra	11/1/2014	P. Marques	Agriculture	SR4	C3c	0.6%	1.6	1.5	25	16.7	cobble	8	5	6	6	2	na	0	8	na	6	41	53	77%	na	na	na	na	na
F30	7/10/2014	P. Marques, A. Switalski	agriculture	SR4	C3	1.0%	1.1	1.8	35	19.4	cobble	8	5	4	6	2	2	0	6	3	6	42	60	70%	7	7	3	30	57%
F31	7/10/2014	P. Marques, A. Switalski	agriculture ranching	SR4	C4c	0.6%	1.4	1.8	35	19.4	gravel, cobble	8	3	4	6	0	2	0	4	1	4	32	60	53%	7	7	3	30	57%
F32ra-1	11/1/2014	P. Marques	Agriculture natural	SR4	C4c	0.3%	1.5	1.8	32	17.8	gravel	8	8	6	6	4	na	1	8	na	8	49	53	92%	na	na	na	na	na
F32ra-2	11/1/2014	P. Marques	Agriculture	SR4	C4c	0.6%	2.0	1.8	32	17.8	gravel	8	5	4	4	2	na	0	6	na	6	35	53	66%	na	na	na	na	na

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
F32	7/11/2014	P. Marques, A. Switalski	agriculture	SR4	C4c	0.6%	1.6	1.2	32	26.7	gravel	8	3	2	6	0	2	0	4	1	4	30	60	50%	7	7	3	30	57%
F33ra-1	11/1/2014	P. Marques	Agriculture	SR4	C4c	0.4%	1.6	1.2	32	26.7	gravel	8	3	4	4	2	na	0	8	na	6	35	53	66%	na	na	na	na	na
F33ra-2	11/1/2014	P. Marques	Grazing	SR4	C4c	0.4%	1.3	1.2	30	25.0	gravel	8	3	4	4	0	na	0	6	na	6	31	53	58%	na	na	na	na	na
F33ra-3	10/15/2014	P. Marques & TMDL	Hay	BB2	C4c	0.7%	1.1	1.7	51	30.0	large gravel, small cobble	6	3	4	6	0	Na	0	4	Na	4	27	53	51%	na	5	3	20	40%
F33	7/10-11/14	P. Marques, A. Switalski	Agriculture	BB2	C4c	0.4%	1.6	1.2	40	33.3	gravel	8	0	2	6	0	2	0	4	0	4	26	60	43%	7	7	3	30	57%

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Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
B01ra	11/1/2014	P. Marques	Forest	CC2	A2	7.8%	1.3	1.5	15	10	cobble, boulder	8	8	6	6	6	na	3	8	na	8	53	53	100%	10	10	10	30	100%
B01	6/30/2014	P. Marques, A. Stanley, A. Chadwick, A. Switalski	Public forest, resource extraction	CC2	A2	5.9%	1.1	1.5	15	10.0	cobble, boulder	8	8	6	6	6	2	3	8	4	8	59	60	98%	10	10	7	30	90%
B02ra	11/1/2014	P. Marques	Public forest	CC2	A2	4.4%	1.2	1.5	15	10	cobble, boulder	8	8	6	6	6	na	3	8	na	8	53	53	100%	10	10	10	30	100%
B02	7/1/2014	P. Marques, A. Switalski & TMDL	Public forest	CC2	B2a	4.7%	1.2	1.5	18	12.0	cobble, boulder	8	8	6	6	6	3	3	8	4	6	58	60	97%	10	10	7	30	90%
B03	7/2/2014	P. Marques, A. Switalski	Public forest	CC2	B3	2.9%	1.1	1.5	20	13.3	cobble	8	5	6	6	6	2	3	8	4	6	54	60	90%	10	10	10	30	100%
B04ra	11/1/2014	P. Marques	residential	CC2	B3c	1.5%	1.1	1.5	20	13.3	cobble	8	5	6	6	6	na	3	8	na	8	50	53	94%	10	na	na	10	100%
B04	7/1/2014	P. Marques, A. Switalski	residential	SR4	B3c	1.6%	1.1	1.5	20	13.3	cobble	6	5	4	6	2	2	1	8	2	6	42	60	70%	7	7	7	30	70%

Flint Creek and Boulder Creek Riparian Habitat Assessment

Subreach ID	Date of Assessment	Observer	Primary Land Use	Plant Community	Rosgen Channel Type	Slope	Sinuosity	BFDepth (ft)	BFWidth (ft)	BFRatio (ft)	Channel Substrate	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total Score	Potential Score	NRCS Score	Fish Q1	Fish Q2	Fish Q3	Fish Habitat Potential	Fish Habitat Score
B05ra	11/1/2014	P. Marques	residential	SR4	B3c	1.6%	1.1	1.5	20	13.3	cobble	8	5	6	6	6	na	3	8	na	8	50	53	94%	10	na	na	10	100%
B05	11/4/2014	P. Marques, A. Chadwick	residential/ historic pasture	SR4	C3	1.1%	1.2	1.8	25	13.9	cobble	8	5	4	6	2	2	0	8	2	6	43	60	72%	7	7	7	30	70%
B06	7/1/2014	P. Marques, A. Switalski & TMDL	residential	CD1	B3/C3	2.0%	1.2	1.8	23	12.8	cobble	8	8	6	6	6	2	3	8	3	8	58	60	97%	10	10	10	30	100%
B07	7/2/2014	P. Marques, A. Switalski	residential	SR4	B3	1.9%	1.0	1.5	22	14.7	cobble	8	8	6	6	6	2	3	8	3	6	56	58	97%	10	7	7	30	80%
B07ra	11/1/2014	P. Marques	residential	CD1	B3/C3	1.5%	1.1	1.5	25	16.7	cobble	8	8	4	6	6	na	2	8	na	6	48	51	94%	10	na	na	10	100%
B08	7/3/2014	P. Marques, A. Switalski	residential	CD1	B3/C3	2.0%	1.1	1.5	25	16.7	cobble, boulder	8	8	6	6	6	2	3	8	3	8	58	60	97%	10	10	7	30	90%
B09	8/7/2014	P. Marques, A. Switalski	residential	CD1	B3	2.8%	1.1	1.5	25	16.7	cobble, boulder	8	8	6	6	6	2	3	8	4	6	57	60	95%	10	7	7	30	80%

9.0 APPENDIX 3: SUBREACH EROSION SUMMARY DATA

SubReach ID	Reach Length (ft)	Linear Bank Erosion (ft)	Total Bank Erosion (ft ²)	Percentage of Linear Bank Erosion (%)	Primary Erosion Source
F01ra	1486	NA	NA	NA	NA
F01	1752	304.5	9775	8.69	HS
F02ra	3701	NA	NA	NA	NA
F02	5682	364.5	1117.5	3.21	NBS
F03ra-1	2228	NA	NA	NA	NA
F03ra-2	388	NA	NA	NA	NA
F03	774	91	173	5.88	NBS
F04ra	2872	NA	NA	NA	NA
F04	1532	147	534.5	4.80	I
F05	1569	60	250	1.91	I
F06	6073	2863	5619	23.57	LS-P/LS-B
F07ra	5197	NA	NA	NA	NA
F07	1638	653	960	19.93	RI
F08ra	4025	NA	NA	NA	NA
F08	9561	3766	9309.5	19.70	LS-P/LS-B
F09ra	17987	NA	NA	NA	NA
F09	12820	3630	5480	14.16	LS-P/LS-B
F10ra	4317.6	NA	NA	NA	NA
F10	3017	435	601.5	7.21	CR
F11	2217	137	159	3.09	CR
F12	9258	1521	2029	8.21	CR/LS-P
F13	9150	1704	2433.5	9.31	CR/LS-P
F14	5947	1476	8840	12.41	RI
F15	8690	2663	5127.5	15.32	RI
F16	15002	4736	23906	15.78	HS/RI
F17ra	10632.1	NA	NA	NA	NA
F17	3528	773	860	10.95	CR
F18ra	2715.5	NA	NA	NA	NA
F18	9480	492	8037.5	2.59	NBS, RI
F19ra	2106.3	NA	NA	NA	NA
F19	6221	0	0	0.00	none
F20	3454	1.5	15	0.02	CR
F21	2292	80	40	1.75	CR
F22ra	1670.9	NA	NA	NA	NA
F22	3212	418	731.5	6.51	LS-P/LS-B
F23	5577	1449	4754.5	12.99	LS-P/LS-B
F24	3451	515	2384	7.46	RD/HS
F25	3045	1388	2319.5	22.80	LS-P/LS-B
F26ra	1613.8	NA	NA	NA	NA
F26	3168	950	875	15.00	CR
F27	2634	70	139	1.33	LS-P
F28	1020	298	511	14.61	LS-P/LS-B
F29	1945	422	884	10.85	CR/LS-B
F30ra	3385.8	NA	NA	NA	NA
F30	1628	159	114.5	4.88	CR
F31	14771	4663	9670	15.78	CR/LS-B
F32ra-1	4161.9	NA	NA	NA	NA
F32ra-2	5696.5	NA	NA	NA	NA
F32	5134	1679	3165.5	16.35	CR/LS-B
F33ra-1	5033.7	NA	NA	NA	NA
F33ra-2	3972.9	NA	NA	NA	NA
F33ra-3	2855.0	NA	NA	NA	NA
F33	14783	4906	12647	16.59	CR/LS-B

SubReach ID	Reach Length (ft)	Linear Bank Erosion (ft)	Total Bank Erosion (ft ²)	Percentage of Linear Bank Erosion (%)	Primary Erosion Source
B01ra	26762	NA	NA	NA	NA
B01	1215	245	775	10.08	RD
B02ra	2321	NA	NA	NA	NA
B02	10152	30	67.5	0.15	I
B03	6502	30.5	81	0.23	CR
B04ra	1871	NA	NA	NA	NA
B04	2979	771	1036	12.94	NC
B05ra	1330	NA	NA	NA	NA
B05	4952	846	1624	8.54	CR
B06	8155	317	669	1.94	NBS
B07	6034	196	496	1.62	HS
B07ra	1303	NA	NA	NA	NA
B08	779	59	81	3.79	CR
B09	2600	10	5	0.19	NBS

Code	Description	Code	Description
RD	Road Erosion	I	Geomorphic incision
BR	Bridge Erosion	NC	New channel has formed in area that lack riparian vegetation
CR	Cropland Encroachment: Lack of Riparian Veg	C	Corrals
LS-B	Livestock Browse: Lack of Riparian Veg	RE	Recreation Access
LS-P	Physical Livestock Erosion	RI	Riparian buffer removed, lack of veg
TP	Trampled by livestock, no real height of erosion	NBS	
HS	Hillside erosion, channel cutting into valley walls		