CORRIDOR PLAN

MANASTASH CREEK CORRIDOR HABITAT ENHANCEMENT AND FLOOD HAZARD REDUCTION PLAN

Prepared for
Kittitas County Conservation District

Prepared by
Herrera Environmental Consultants, Inc.
and
Watershed Science & Engineering, Inc.

WATERSHED
Science & Engineering

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Note:
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Landowners Committee

- The neighbors and stewards of Manastash Creek

Technical Committee

- Kittitas County Department of Public Works
- Washington State Department of Fish & Wildlife
- Washington State Department of Ecology
- National Marine Fisheries Service
- US Department of Fish & Wildlife
- U.S.D.A. Natural Resources Conservation Service
- Trout Unlimited - Washington Water Project
- Washington State Department of Natural Resources
- Yakama Nation

Project Funded By

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1. INTRODUCTION

The Kittitas County Conservation District (KCCD) is conducting a reach-scale assessment of Manastash Creek (also referred to herein as "the project") that seeks to identify opportunities to improve aquatic habitat and reduce flood hazards. Figure 1 shows the Manastash Creek watershed boundary and project study area.

This corridor plan documents the outcome of this effort. It consists of a focused strategy and a list of viable projects that can be cooperatively implemented to improve aquatic habitat and reduce the impacts of flooding and erosion along Manastash Creek.

The corridor plan is organized in two main sections: Project Opportunities and Plan Implementation. Descriptions of each of those sections are provided following the Introduction. Summaries of each of 21 project reaches are provided in Appendix A. A description of the scoring criteria used to evaluate project opportunities is provided in Appendix B. Appendix C includes details on the scoring of each project opportunity. Potential project funding sources are listed in Appendix D.

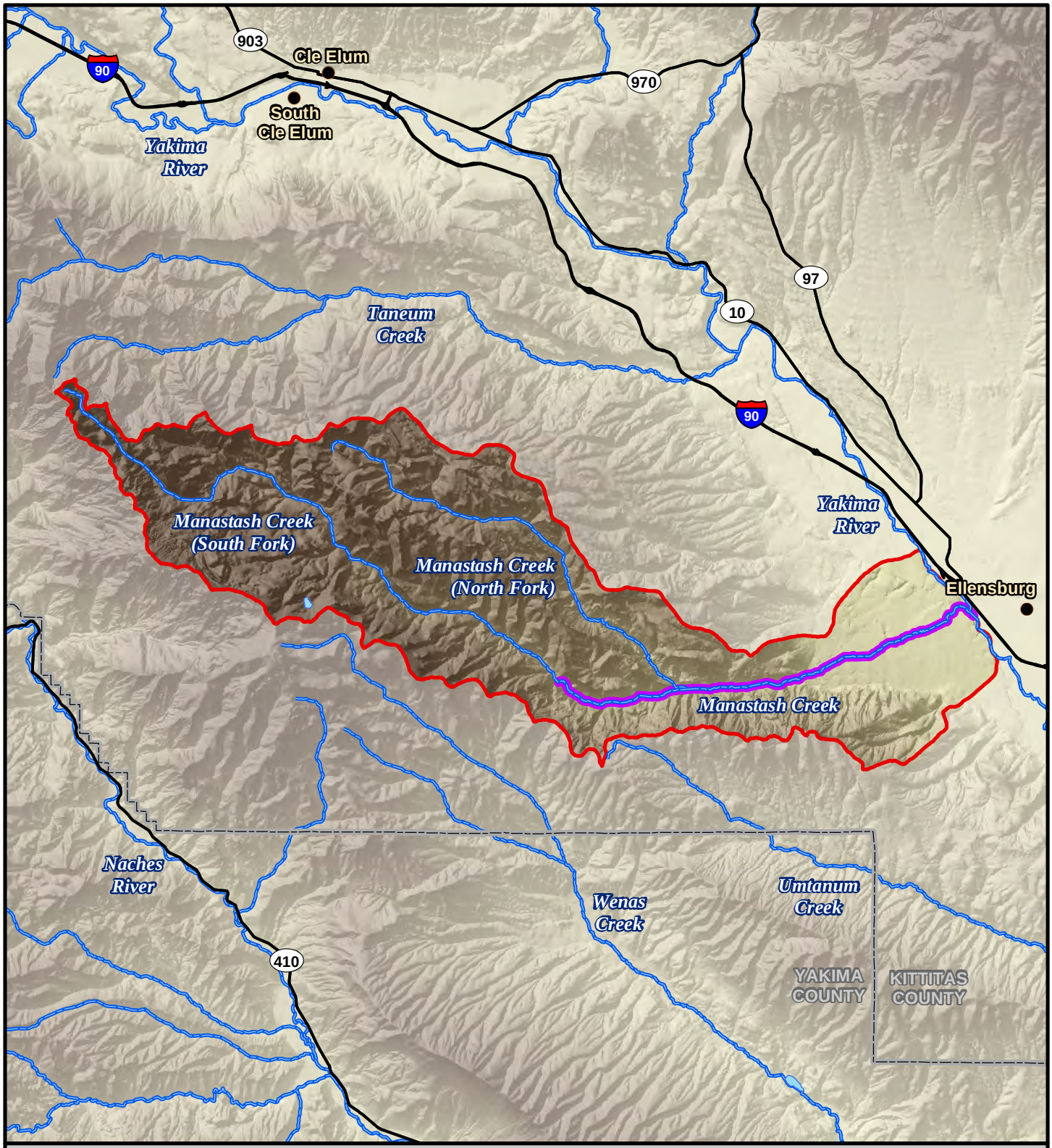
1.1. Objectives

The project objectives include the following:

- Identify factors within Manastash Creek that limit salmonid productivity
- Identify existing flood and erosion hazards in the Manastash Creek floodplain
- Identify opportunities to protect and restore dynamic fluvial and landscape processes that will sustain healthy salmonid populations and improve water quality
- Identify opportunities to reduce flood and erosion damage to private property and public infrastructure without affecting riparian or aquatic habitat
- Engage landowners, resource managers, and others in collaborative efforts that contribute to the success of restoration and flood protection efforts

1.2. Background

The project is being conducted because Manastash Creek has been designated as critical habitat for the Mid-Columbia Summer Steelhead, a species listed as threatened under the Endangered Species Act (ESA). Effective use of fish habitat in Manastash Creek is limited by excessive sedimentation, low stream flows during the summer and fall, and lack of fish access to upper portions of the system. In response to the ESA listing, the KCCD has been actively working with the local agricultural community to improve habitat conditions and to avoid or minimize potential impacts associated with agriculture practices along the lower 6 miles of the stream. Past activities have included installation of fish screens at irrigation diversions,



Legend

- City
- Highway
- County boundary
- River
- Project study area
- Watershed boundary

Figure 1. Manastash Creek watershed location map.

N

0 9,500 19,000 38,000

Feet

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K:\Projects\12-05295-000\Project\watershed_location_map.mxd (9/12/2012)

removal of fish passage barriers, and efforts to improve stream flow conditions. There remain three unscreened irrigation diversions, all of which are planned for decommissioning after the water rights are moved to the "Consolidated Diversion". One of those three diversions is a large fish passage barrier, which will be removed when the consolidation occurs.

The project is also being undertaken because flood and erosion damage continues to adversely affect private property and public infrastructure. For years, flood damage reduction activities have taken place in an *ad hoc* fashion, often with little regard for potential impacts on habitat. A comprehensive strategic plan is needed to implement projects that will reduce flood and erosion damage while preserving or enhancing aquatic habitat.

The project is being led by the KCCD in partnership with Kittitas County (County). Funding is provided by the State of Washington Salmon Recovery Funding Board (SRFB), the Washington State Conservation Commission, the Bureau of Reclamation's Yakima River Water Enhancement Program, and Kittitas County Public Works.

1.3. Existing Conditions

Existing habitat and flood/erosion hazard conditions were assessed in the previous phase of this project, and are documented in the *Watershed and Reach Scale Investigation of Existing Conditions* (Herrera and WSE 2012). Critical factors affecting both habitat quality and flood and erosion hazards were:

- Hydrology – lack of base flow in a portion of the system during the summer months
- Riparian and floodplain vegetation – lack of healthy vegetation in the streamside (riparian) zone

These related factors lead to many of the habitat deficiencies observed in lower Manastash Creek. In addition, lack of vegetation increases rates of bank erosion, channel movement, and sediment transport during extreme flood events.

1.3.1. Habitat Limiting Factors

Channel hydrology is a primary limiting factor to habitat formation, maintenance, overall habitat quality, and fish habitat use and accessibility. Diversion of water for irrigation has led to dry channel conditions from upstream of Cove Road to the West Side Irrigating Company canal spill during the summer and fall, and reduced stream flow downstream of the West Side Irrigating Company canal spill. In addition, the Reed diversion dam is a major barrier to upstream fish migration.

Irrigation diversion and return flows also affect water quality. Elevated water temperatures and turbid water occur downstream of the West Side Irrigating Company canal spill. Lack of riparian vegetation and, therefore, lack of shade throughout portions of the lower 6 miles of Manastash Creek also increases stream temperature.

Berms constructed in the vicinity of Serenity Lane and Cove Road and, to lesser degrees, elsewhere along Manastash Creek, confine stream flows to the channel and reduce floodplain

storage. This can exacerbate downstream flooding and negatively affect water quality and habitat. Channel confinement also affects sediment transport processes and leads to excessive deposition, which in turn leads to channel migration in certain reaches of the system. The channel is also confined at undersized crossings at Serenity Lane, Cove Road, KRD Lateral 13.8, KRD South Branch, and multiple crossings in Manastash Canyon.

Many reaches in the lower 6 miles of Manastash Creek have limited habitat complexity and low density of large woody debris (LWD) in the channel. Active floodplain processes provide flood storage and reduce velocity in the stream channel. Large wood in the stream channel moderates sediment transport, leads to gravel sorting that provides spawning habitat, and form and maintain pools for fish rearing. Reaches with intact riparian vegetation tend to have greater LWD density and habitat complexity.

1.3.2. Flood and Erosion Hazard Areas

In general, flood, erosion, and sedimentation hazards are present throughout the project area. This is due to the volume of sediment moving through the system, development within the floodplain, lack of riparian vegetation, confined channel reaches, and roadway crossings.

At the Yakima River confluence, flood hazards are significant. Extreme care must be exercised for any proposed development within this reach. The downstream half of the reach is dynamic; because Manastash Creek actively floods and deposits sediment in that area, the hazards are significant. The northern half of the Manastash Creek delta is partially protected by an earthen levee along the edge of the Yakima River, and it is the river that poses the greatest threat to that part of the delta, not Manastash Creek.

Between Serenity Lane and the Yakima River confluence, flood risk is generally confined to the narrow, entrenched floor of the reach. Fortunately, few structures have been built on the entrenched valley floor (i.e., the narrow, entrenched floodplain and channel zone); therefore, the potential for costly flood damage is low. Other infrastructure that could sustain damage include two county road bridges, an irrigation siphon crossing, and driveway road fill. Lateral erosion is of concern as there are several places where the stream is eroding the toe of the entrenched terrace wall. Structures currently do not appear at risk from such erosion. However, where structures are present in this reach, lateral erosion should be monitored.

Between Cove Road and Serenity Lane, flood hazards are highly dependent upon the capacity of the Cove Road Bridge. If the bridge remains open, then flood, erosion, and sedimentation risks along the main channel would be high. If the bridge clogs with sediment, flood risk would decrease within the main channel downstream where less water is flowing, but it would increase within the network of historical swales and irrigation ditches that would carry the water downstream. A major concern is the potential for increased erosion along the main channel where little to no vegetation covers the banks. Significant erosion would introduce large quantities of sediment to the stream. The material would deposit downstream where it would likely aggravate erosion and flooding. Efforts by KCCD and other partners to purchase water rights and increase water conservation should continue to restore year-round stream flows so healthy vegetation can be established along the stream banks.

Flood risk is high between Kittitas Reclamation District (KRD) South Branch Road and Cove Road. The extent of flooding will depend upon main channel capacity. If the channel fills with sediment or debris, flow would find its way downstream through the network of historical swales and irrigation ditches. Lateral erosion is likely to continue within the reach between the Cove Road Bridge and the Reed diversion, where there is little to no vegetation on the banks. As noted above, water conservation efforts should continue to re-establish year-round stream flows and bank vegetation. Sediment deposition is and will continue to be a concern, especially in the vicinity of the Cove Road Bridge. Avulsion potential is moderate because there are a number of significant distributary swales that connect to the channel along the reach.

Flood hazards are significant within Manastash Canyon, but most are confined to the active floodplain. Fortunately, most residences and structures are located outside of the active floodplain. Infrastructure most at risk are driveway bridges and Manastash Road where it is adjacent to the stream. Opportunities to reduce flood hazard risk within Manastash Canyon will need to be addressed on a site-by-site basis, as there appear to be few reach-scale opportunities for flood hazard reduction.

2. How to Use this Corridor Plan

If you are interested in potential projects in a specific part of Manastash Creek, identify the project reach/sheet in the Index Sheet figure in *Appendix A – Project Reach Summaries*. Then find the corresponding Project Reach Summary in Appendix A.

If you are interested in the highest priority actions recommended in the project area, or projects with the greatest potential benefits, see Table 1 (pages 16-17) and Table 2 (pages 18-20) in the *Project Opportunities* section of this plan. Then look to the Project Reach Summaries in Appendix A corresponding to the projects of interest.

If you are interested in more discussion of how the potential projects should be implemented, see the *Plan Implementation* section of this plan (page 21).

3. PROJECT OPPORTUNITIES

3.1. Description of Potential Projects

In the following subsections, potential projects developed to improve aquatic habitat and/or reduce flood and erosion hazards are described. These potential projects are organized by "project reaches," or channel lengths of Manastash Creek organized by groups of potential projects that could be implemented in coordination. Project reaches are identified in Figure 2. In general, potential projects are divided into three categories:

- **Landowner Engagement** – This effort involves communicating with landowners and developing guidelines and educational material for reducing flood and erosion hazards and protecting stream habitat.
- **Operational Projects** – These projects involve long-term operations and maintenance activities such as floodplain management policy revisions, sediment management plans, large wood management plans, and water management.
- **Capital Projects** – These projects involve construction or implementation of in-channel and floodplain measures, such as floodplain revegetation or stream bank stabilization.

Following is a description of each of the three project categories.

3.1.1. Landowner Engagement

Landowner engagement and education should be an ongoing effort in the Manastash Creek watershed. As a part of the development of this plan, a committee of interested landowners was engaged to provide information and input about conditions and problems in the Manastash Creek system. This effort should continue with a dual focus:

- Learn from the landowners about conditions, hazards, and concerns related to Manastash Creek
- Provide information and education on the natural processes, effects of human actions, and responsible stewardship

The landowner engagement effort should include the following elements:

- Periodic listening sessions to discuss current concerns and interests regarding Manastash Creek, and to provide updates on project implementation
- Site tours to observe projects that have been or are being installed
- Development of additional educational materials focused on specific issues (for instance, flood protection for homes, how to establish native vegetation)

KCCD would be an appropriate lead for the landowner engagement effort because KCCD has a good relationship with landowners in the Manastash Creek watershed.

3.1.2. Operational Projects

Operational projects are recommended actions that include policy development or the creation of long-term management programs. Specific operational projects recommended for Manastash Creek include:

- FEMA flood hazard maps update
- Sediment management
- Water conservation and in-stream flow restoration
- Monitoring

3.1.2.1. Flood Map Update

FEMA flood maps should be updated to accurately reflect high hazard zones in the Manastash Creek floodplain throughout the project area, and to prevent development within them. The County, through the Kittitas County Flood Control Zone District (KCFCZD), is currently pursuing this effort.

3.1.2.2. Sediment Management

Areas of chronic sediment deposition should be investigated to determine the effect of periodic removal of sediment from the system. These locations would need to be associated with areas of chronic flooding of both private property and public infrastructure. A plan should be developed that identifies locations, methods, and volumes of sediment removal, and that identifies required permits from natural resource agencies and others. Development and implementation of a sediment management plan should be pursued by the County through the KCFCZD because of its primary function of flood hazard reduction.

3.1.2.3. Water Conservation and Flow Restoration

KCCD is working with individual water right holders, Trout Unlimited- Washington Water Project, Washington Department of Ecology, the Bureau of Reclamation, and KRD on an ongoing flow restoration effort in Manastash Creek. Projects completed to date include on-farm conversions from rill irrigation to sprinkler irrigation, and purchase of water rights from willing sellers. As of this writing, more than 15 cubic feet per second has been entered into the Washington State Trust Water Rights program. Additional ongoing actions include conversions from earthen delivery ditches to pressurized pipelines, more on-farm conversions from rill to sprinklers, and continuing negotiations with willing sellers. See Appendix E for the instream flow potential project descriptions.

3.1.2.4. Monitoring

Monitoring of stream flow, fish presence, and water quality should be conducted over time to gauge the effectiveness of individual and cumulative actions. A stream flow telemetry system is currently planned for Manastash Creek at the Barnes, Keach Jensen, and MWDA diversion structures. Flow monitoring is ongoing of water diverted and creek flows at these locations. A permanent flow monitoring station is also planned for Manastash Creek near the Reed diversion.

Flow monitoring at a location downstream of the Reed diversion is recommended to get a long-term record of the effects of flow restoration. Reestablishing and/or continuing flow monitoring at the listed sites is recommended:

- Cove Road crossing
- KRD Lateral 13.8 crossing
- Serenity Lane crossing
- West Side Irrigating Company canal crossing

Water quality monitoring of temperature, turbidity, and nutrients is recommended in locations through the system to record changes in conditions throughout the seasons, as well as long-term trends. Monitoring locations should include at a minimum:

- **Upstream station** - upstream of the Keach Jensen and MWDA diversions
- **Intermediate station** - between the Reed diversion and the West Side Irrigating Company canal crossing
- **Downstream station** – downstream of the West Side Irrigating Company canal crossing

Funding for development of a monitoring plan and monitoring activities should be investigated through the Washington Department of Ecology's Water Quality Program.

Finally, water table monitoring within the seasonally dry portion of Manastash Creek (from the West Side Irrigating Company canal crossing to the Reed diversion) is recommended to evaluate the effects of instream flow restoration, and to determine when groundwater levels are restored enough to support healthy streamside vegetation. This monitoring can be implemented with the installation of monitoring wells adjacent to the stream and periodic measurement of water levels using an electronic sounder.

3.1.3. Capital Projects

Capital projects are described in the project reach summaries located in Appendix A. Each stand-alone reach summary includes a description of the reach, a review of habitat limitations and flood/erosion hazards, and recommendations for projects to address problems. In addition, each reach summary includes a figure (map) that shows where key features and potential projects are located.

3.2. Project Scores and Prioritization

Potential projects were evaluated to help with prioritization of implementation efforts. Potential projects were numerically scored based on five criteria:

- **Benefit [habitat improvement].** Score range: 0 (no benefit) to 5 (high benefit)
- **Benefit [flood and erosion hazard reduction].** Score range: 0 (no benefit) to 5 (high benefit)
- **Negative Impact**. Score range: -5 (substantial impact) to 0 (no impact)
- **Cost Effectiveness**. Score range: 0 (very expensive relative to benefits) to 5 (very low cost relative to benefits)
- **Uncertainty and Risks**. Score range: 0 (substantial uncertainty or risk of failure) to 5 (very little uncertainty or risk of failure)

Appendix B provides a detailed discussion of how scores were determined. In addition, notes regarding scoring for each of the potential projects are provided in Appendix C.

Projects are ranked in Table 1 based on overall score, incorporating all of the criteria listed above. Table 2 summarizes the highest scoring projects based only on total benefit score (Benefit [habitat] + Benefit [flood and erosion hazard reduction]).

As can be seen in Tables 1 and 2, projects with the highest overall score include in-stream flow augmentation, reach-scale revegetation, and barrier removal/crossing modifications. These project types generally score well for both habitat and flood and erosion hazard reduction benefit.

3.3. Project Reach Summaries

Detailed summaries of recommended projects are provided in Project Reach Summaries located in Appendix A. Below is a list of the project reaches with hyperlinks to the associated summary.

- Reach 1 – Confluence to Brown Road (RM 0 to RM 0.7)
- Reach 2 – Barnes to Brown Road (RM 0.7 to RM 1.52)
- Reach 3 – West Side Irrigating Company Crossing (RM 1.52 to RM 1.9)
- Reach 4 – Serenity Lane Reach (RM 1.9 to RM 2.6)
- Reach 5 – Abandoned Dam Reach (RM 2.6 to RM 3.3)
- Reach 6 – Anderson Diversion Reach (RM 3.3 to RM 3.85)
- Reach 7 – Cove Road Reach (RM 3.8 to RM 4.2)
- Reach 8 – Upstream Cove Road to Downstream Reed Diversion (RM 4.2 to RM 4.9)

- Reach 9 – Reed Diversion Reach (RM 4.9 to RM 5.2)
- Reach 10 – Natural Reach (RM 5.2 to RM 5.5)
- Reach 11 – KRD South Branch Road Reach (RM 5.5 to RM 5.7)
- Reach 12 – Keach-Jensen to Manastash Road Bridge (RM 5.7 to RM 6.2)
- Reach 13 – Manastash Bridge Confined Reach (RM 6.2 to RM 6.85)
- Reach 14 – Canyon 14 Reach (RM 6.85 to RM 8.9)
- Reach 15 – North Fork Confluence Reach (RM 8.9 to RM 9.5)
- Reach 16 – County Road Reach (RM 9.5 – RM 10.4)
- Reach 17 – Canyon 17 Reach (RM 10.4 to RM 11.1)
- Reach 18 – Lazy F Ranch (RM 11.1 to RM 11.4)
- Reach 19 – Canyon 19 Reach (RM 11.4 to RM 12.1)
- Reach 20 – Mitchell Road Reach (RM 12.1 to RM 12.5)
- Reach 21 – Canyon 21 Reach (RM 12.5 to RM 13.2)

3.4. Project Funding Sources

There are many sources of potential funding for habitat restoration and enhancement and for flood and erosion hazard reduction, including federal government agencies, State of Washington, local agencies and districts, and nonprofit organizations and foundations. Potential funding sources include:

- **Washington State Department of Fish and Wildlife (WDFW)** – Land acquisition, restoration, research, education, access, and artificial production projects
- **Washington State Salmon Recovery Funding Board (SRFB)** – Habitat restoration projects benefiting threatened and endangered salmon
- **Washington State Department of Natural Resources (WDNR)** - Land acquisition, restoration, research, education, access, and artificial production projects
- **Washington State Conservation Commission (WSCC)** – Riparian vegetation, water conservation, and irrigation efficiency projects
- **Washington Department of Ecology (Ecology)** - Water delivery and water quality projects, and water acquisition
- **US Fish and Wildlife Service (USFWS)** – Conservation, land acquisition, and habitat conservation projects

- **US Bureau of Reclamation (Reclamation)** – Yakima River Basin Water Enhancement Program - Water supply; improvement, protection, and enhancement of fish and wildlife resources; water quality projects. *Yakima River Basin Water Enhancement Project, Tributary Enhancement Program, Manastash Creek Investigation Report* (USBR 2013), *Kittitas Reclamation District Water Conservation Plan Irrigation Water Conservation Plan of System Improvements (*CH2MHILL 1999)

- **USDA Natural Resources Conservation Service (NRCS**) – Technical assistance, water conservation and irrigation efficiencies projects, riparian revegetation, conservation easements

- **National Oceanic and Atmospheric Administration (NOAA) Fisheries** – Technical assistance with removal of barriers and community-based restoration, NOAA American Rivers, RC National and Regional Partnership Grants, and the Open Rivers Initiative

- **Bonneville Power Administration (BPA)** – Critical habitat restoration including fish screening, barrier removal, habitat enhancement, and irrigation efficiency projects

- **National Fish and Wildlife Foundation (NFWF)** – Water acquisition and land conservation projects

- **American Sportfishing Association** – Habitat restoration projects

- **The Nature Conservancy (TNC)** – Conservation, community-based restoration

- **Trout Unlimited** – Watershed restoration projects and water acquisition

- **Kittitas County Conservation District** – Technical assistance, financial assistance to private landowners

- **Kittitas County Public Works** – Public infrastructure protection projects

- **Kittitas County Flood Control Zone District** – Flood reduction projects and programs

- **Federal Emergency Management Agency(FEMA)** – Hazard Mitigation Assistance

- **Great Northern Landscape Conservation Cooperative – Grant Program** – Program funds landscape related science and information that address one or more of the following themes: Habitat Connectivity, Aquatic Integrity, Data Integration, Climate, Partnerships, and Outreach and Education.

- **Title II – Special Projects on Federal Land** – Funds projects on BLM and US Forest Service land including, but not limited to road, trail, and infrastructure maintenance or obliteration; soil productivity improvement; improvements in forest ecosystem health; watershed restoration and maintenance; restoration, maintenance and improvement of wildlife and fish habitat; control of noxious and exotic weeds; and re-establishment of native species.

- **Washington State – Family Forest Fish Passage Program (FFFPP)** - The Family Forest Fish Passage Program provides funding to small forest landowners to repair or remove

fish passage barriers. This is probably a long shot and would only relate to small forest landowners (likely above this reach), but RCO is working hard to spend $5 million on the Family Forest Fish Passage Program.

- **Endangered Species Tax Deduction** - Farmers and ranchers implementing conservation actions that contribute to the recovery of threatened and endangered species may now be eligible for a tax deduction. The 2008 Farm Bill established a tax deduction for expenditures paid or incurred for the purpose of achieving site-specific management actions recommended in recovery plans for species listed as threatened or endangered under the Endangered Species Act (ESA).

Appendix D provides more information about the purpose, amount, and applicability of each funding sources listed above.

Table 1. Project Opportunities in Manastash Creek Ordered by Total Project Score.			
Project #	**River Mile**	**Project Type**	**Total Score (0 – 20)**
General-1	1.75 - 4.95	Stream flow augmentation	17
6-2	3.3 - 3.8	Reach-scale revegetation	17
8-1	4.2 - 4.9	Levee modification; Bank protection; Reach-scale revegetation	17
7-1	4.05	**Cove Road** - Flood protection; Bridge replacement; Other infrastructure modifications; Channel restoration; In-stream habitat enhancement; Reach-scale revegetation	16
4-3	2.3 - 2.6	**Serenity Lane** - Bridge replacement; channel restoration; In-stream habitat enhancement; Reach-scale revegetation	15
10-1	5.2 - 5.5	Conservation/Protection	15
15-1	9.3	**N.F. Manastash Crossing** - Bridge replacement; Other infrastructure modification; Sediment management	14
1-1	0 - 0.7	Conservation/Protection, In-stream habitat enhancement	14
9-1	4.9 - 5.2	**Reed Diversion** - Barrier removal; Channel restoration, In-stream habitat enhancement; Site-scale revegetation	14
5-1	2.6 - 3.3	Crossing assessment/removal; Floodplain connectivity; Reach-scale revegetation	13
11-1	5.5 - 5.7	**KRD South Branch Road** - Barrier removal; Levee modification/removal; Other infrastructure modifications; Floodplain connectivity; In-stream habitat enhancement; Reach-scale revegetation	13
14-1	7.0 - 8.1	Reach-scale revegetation	13
3-1	1.5 - 1.9	Floodplain/streambank revegetation; In-stream habitat enhancement	12
4-1	1.75 - 2.3	Bank protection; In-stream habitat enhancement; Reach-scale revegetation	12
16-1	9.85 - 10.2	Channel relocation; Floodplain connectivity; Reach-scale revegetation; Bank protection	12
3-3	1.75	**West Side Irrigating Company Canal** - Channel/floodplain restoration and enhancement	11
6-4	3.55	Channel restoration; Floodplain connectivity	11
16-2	10.2	Flood protection; Bank protection	11
1-3	0.65 - 0.7	Flood-prone property buyout; Floodplain restoration; Site-scale revegetation	11

Table 1 (continued). Project Opportunities in Manastash Creek Ordered by Total Project Score.			
Project #	**River Mile**	**Project Type**	**Total Score (0 – 20)**
2-3	0.9 - 1.6	In-stream habitat enhancement	11
18-1	11.1 - 11.4	**Lazy F** - Bridge replacements; Flood protection; Floodplain connectivity	11
8-2	4.2 - 4.9	In-stream habitat enhancement	11
14-2	6.9	Floodplain connectivity	11
5-2	3.1	**Abandoned Dam** - Barrier assessment/removal; Channel restoration; Floodplain connectivity	10
6-3	3.5	**Anderson Diversion** - Barrier removal; Site-scale revegetation	10
10-2	5.47	**Hatfield Diversion** - Barrier removal	10
3-2	1.5 - 1.9	Floodplain reconnection	10
17-1	10.3 - 10.7	In-stream habitat enhancement; Bank protection; Reach-scale revegetation	10
12-1	5.7 - 5.8	Flood protection	10
12-2	5.8 - 6.2	Flood protection; Site-scale revegetation	10
20-2	12.2	Roadside embankment reinforcement and habitat enhancement	10
2-2	0.9 - 1.6	Floodplain connectivity	9
6-1	3.3 - 3.8	In-stream habitat enhancement	9
13-1	6.3 - 6.4	Infrastructure modification	9
3-4	1.75	Water quality improvement	8
13-2	6.2 - 6.4	Infrastructure modification; Channel realignment	8
General-2	6.6 - 9.0	Bridge assessment; Bank protection; In-stream habitat enhancement; Flood protection	8
2-1	0.7	**Brown Road** - Bridge replacement	7
2-4	1.6	**Barnes Road** - Bridge replacement	7
2-5	1.6	In-stream habitat enhancement	7
1-2	0 - 0.4	Site-scale revegetation	7
4-2	1.75 - 2.3	Floodplain connectivity	7
20-1	12.3 - 12.5	Flood protection; Sediment management; Bank protection	6

Table 2. Project Opportunities in Manastash Creek Ordered by Combined Benefit Score (Habitat Benefit + Flood Hazard Reduction Benefit).

Project #	River Mile	Project Type	Ecological Benefit (0-5)	Flood Hazard Reduction Benefit (0-5)	Combined Benefit Score (0-10)
General-1	1.75 - 4.95	Stream flow augmentation	5	5	**10**
7-1	4.05	**Cove Road** - Flood protection; Bridge replacement; Other infrastructure modifications; Channel restoration; In-stream habitat enhancement; Reach-scale revegetation	5	5	**10**
4-3	2.3 - 2.6	**Serenity Lane** - Bridge replacement; Channel restoration; In-stream habitat enhancement; Reach-scale revegetation	5	5	**10**
8-1	4.2 - 4.9	Levee modification; Bank protection; Reach-scale revegetation	5	4	**9**
9-1	4.9 - 5.2	**Reed Diversion** - Barrier removal; Channel restoration; In-stream habitat enhancement; Site-scale revegetation	5	4	**9**
11-1	5.5 - 5.7	**KRD South Branch Road** - Barrier removal; Levee modification/removal; Other infrastructure modifications; Floodplain connectivity; In-stream habitat enhancement; Reach-scale revegetation	4	5	**9**
13-2	6.2 - 6.4	Infrastructure modification; Channel realignment	4	5	**9**
15-1	9.3	Bridge replacement; Other infrastructure modification; Sediment management	3	5	**8**
5-1	2.6 - 3.3	Crossing assessment/removal; Floodplain connectivity; Reach-scale revegetation	3	5	**8**
10-1	5.2 - 5.5	Conservation/Protection	5	3	**8**
12-2	5.8 - 6.2	Flood protection; Site-scale revegetation	3	5	**8**
16-1	9.85 - 10.2	Channel relocation; Floodplain connectivity; Reach-scale revegetation; Bank protection	4	4	**8**
16-2	10.2	Flood protection; Bank protection	3	4	**7**
1-1	0 - 0.7	Conservation/Protection; In-stream habitat enhancement	4	3	**7**
1-3	0.65 - 0.7	Flood-prone property buyout; Floodplain restoration; Site-scale revegetation	3	4	**7**

Table 2 (continued). Project Opportunities in Manastash Creek Ordered by Combined Benefit Score (Habitat Benefit + Flood Hazard Reduction Benefit).					
Project #	**River Mile**	**Project Type**	**Ecological Benefit (0-5)**	**Flood Hazard Reduction Benefit (0-5)**	**Combined Benefit Score (0-10)**
4-1	1.75 - 2.3	Bank protection; In-stream habitat enhancement; Reach-scale revegetation	3	4	**7**
6-2	3.3 - 3.8	Reach-scale revegetation	3	4	**7**
8-2	4.2 - 4.9	In-stream habitat enhancement	4	3	**7**
12-1	5.7 - 5.8	Flood protection	2	5	**7**
6-3	3.5	**Anderson Diversion** - Barrier removal; Site scale revegetation	3	3	**6**
6-4	3.55	Channel restoration; Floodplain connectivity	3	3	**6**
2-3	0.9 - 1.6	In-stream habitat enhancement	3	3	**6**
3-2	1.5 - 1.9	Floodplain reconnection	4	2	**6**
18-1	11.1 - 11.4	**Lazy F** - Bridge replacements; Flood protection; Floodplain connectivity	2	4	**6**
General-2	6.6 - 9.0	Bridge assessment; Bank protection; In-stream habitat enhancement; Flood protection	2	4	**6**
14-1	7.0 - 8.1	Reach-scale revegetation	3	3	**6**
2-1	0.7	**Brown Road** - Bridge replacement	3	2	**5**
2-4	1.6	**Barnes Road** - Bridge replacement	3	2	**5**
17-1	10.3 - 10.7	In-stream habitat enhancement; Bank protection; Reach-scale revegetation	3	2	**5**
20-1	12.3 - 12.5	Flood protection; Sediment management; Bank protection	1	4	**5**
6-1	3.3 - 3.8	In-stream habitat enhancement	4	1	**5**
14-2	6.9	Floodplain connectivity	2	3	**5**
20-2	12.2	Roadside embankment reinforcement and habitat enhancement	1	4	**5**
3-3	1.75	**West Side Irrigating Company Canal** - Channel/floodplain restoration and enhancement	3	1	**4**
3-4	1.75	Water quality improvement	4	0	**4**

Table 2 (continued). Project Opportunities in Manastash Creek Ordered by Combined Benefit Score (Habitat Benefit + Flood Hazard Reduction Benefit).					
Project #	**River Mile**	**Project Type**	**Ecological Benefit (0-5)**	**Flood Hazard Reduction Benefit (0-5)**	**Combined Benefit Score (0-10)**
5-2	3.1	**Abandoned Dam** - Barrier assessment/removal; Channel restoration; Floodplain connectivity	3	1	**4**
2-2	0.9 - 1.6	Floodplain connectivity	3	1	**4**
3-1	1.5 - 1.9	Floodplain/streambank revegetation; In-stream habitat enhancement	3	1	**4**
4-2	1.75 - 2.3	Floodplain connectivity	3	1	**4**
13-1	6.3 - 6.4	Infrastructure modification	1	3	**4**
10-2	5.47	**Hatfield Diversion** - Barrier removal	3	0	**3**
2-5	1.6	In-stream habitat enhancement	2	0	**2**
1-2	0 - 0.4	Site-scale revegetation	1	1	**2**

4. PLAN IMPLEMENTATION

4.1. Implementation Strategy

Improving habitat and reducing flood and erosion hazards in Manastash Creek will involve a combination of immediate and long-term actions. Some actions can be implemented right away. However, there are key actions that need to be completed before effectively improving conditions in the lower 6 miles of the system. Projects identified in this plan should be implemented in the following sequence:

- **Continuous/Ongoing Actions** – These actions can be started (or continued if already started) right away, and should continue through the long term.
- **Phase 1 Actions (Immediate)** – These actions are of high priority and should be taken first. Some of these actions must be completed before other actions can be effectively implemented.
- **Phase 2 Actions** – These are actions that should be implemented, but they may need to wait until key immediate actions are completed or because higher priority actions take precedence.

Actions in each of these categories are summarized in the following subsections.

4.1.1. Continuous/Ongoing Actions

Landowner engagement activities should continue as described in the *Project Opportunities* section of this plan.

In addition, unique opportunities to implement projects should be identified as they arise. An example would be implementing a streambank revegetation project when an infrastructure replacement project is occurring.

4.1.2. Phase 1 Actions (Immediate)

Restoration of year-round flow to the lower 6 miles of Manastash Creek is a primary action that will allow for effective revegetation and other habitat improvement projects in this area. For this reason, efforts to conserve irrigation water both on-farm and in delivery ditches, and purchase water rights from willing sellers should continue as described in Appendix E. As flows increase, this area will be dry for shorter periods of time each year, improving the chance of success for revegetation projects within the lower 6 miles of the creek.

Removal of the last known fish passage barrier on Manastash Creek, the Reed diversion dam (Project 9-1), will greatly increase habitat access for steelhead and other fish species.

Removal of the barrier will also open up opportunities to receive salmon recovery grant funds for projects upstream of the diversion.

High priority flood and erosion hazard reduction/habitat improvement projects should also be implemented right away. These projects include reducing hazards at the Cove Road crossing (Project 7-1), improving the Serenity Lane crossing (Project 4-4), replacing the crossing of North Fork Manastash Creek at Manastash Road (Project 15-1), moving the channel away from Manastash Road at RM 10 in Manastash Canyon (Project 16-1), and property buyout at Brown Road (Project 1-3).

High priority habitat improvement projects that are not limited by seasonal dry conditions between the Reed diversion and the West Side spill should be implemented right away. These projects and those mentioned above are listed in Table 3.

Table 3. Phase 1 (Immediate) Projects.

Project #	River Mile	Project Type
1-1	0 - 0.7	Conservation/Protection, In-stream habitat enhancement
1-3	0.65 - 0.7	Flood-prone property buyout; Floodplain restoration, Site-scale revegetation
2-2	0.9 – 1.6	Floodplain connectivity
2-3	0.9 – 1.6	In-stream habitat enhancement
3-1	1.5 – 1.9	Floodplain/streambank revegetation; In-stream habitat enhancement
3-2	1.5 – 1.9	Floodplain reconnection
General-1	1.75 – 4.95	Stream flow augmentation
4-3	2.3 – 2.6	Bridge replacement; Channel restoration; In-stream habitat enhancement; Reach-scale revegetation
7-1	4.05	Flood protection; Bridge replacement; Other infrastructure modifications; Channel restoration; In-stream habitat enhancement; Reach-scale revegetation
9-1	4.9 – 5.2	Barrier removal; Channel restoration, In-stream habitat enhancement, Site-scale revegetation
10-1	5.2 – 5.5	Conservation/Protection
12-2	5.8 – 6.2	Flood protection; Site-scale revegetation
15-1	9.3	Bridge replacement; Other infrastructure modification; Sediment management
16-1	9.85 – 10.2	Channel relocation; Floodplain connectivity; Reach-scale revegetation; Bank protection
16-2	10.2	Flood protection; Bank protection

4.1.3. Phase 2 Actions

Reach-scale restoration of native riparian vegetation in the reaches of Manastash Creek between the Reed diversion and the West Side Irrigating Company canal spill (Project Reaches 4 through 8) should pursued as soon as instream flows have increased enough to raise the water table and support healthy plants. Projects of this nature include 5-1, 6-2, and 8-1.

In addition, projects that were not identified as a Phase 1 (Immediate) action (see Table 3) should be considered once the higher priority projects have been considered or completed.

4.2. Implementation

When a project has been identified for implementation, the first steps will involve identifying a lead entity (if not already decided) and potential funding sources. The project summaries included in Appendix C of this plan provide recommendations for potential lead entities to implement the work and funding sources to consider.

4.3. Adaptive Management

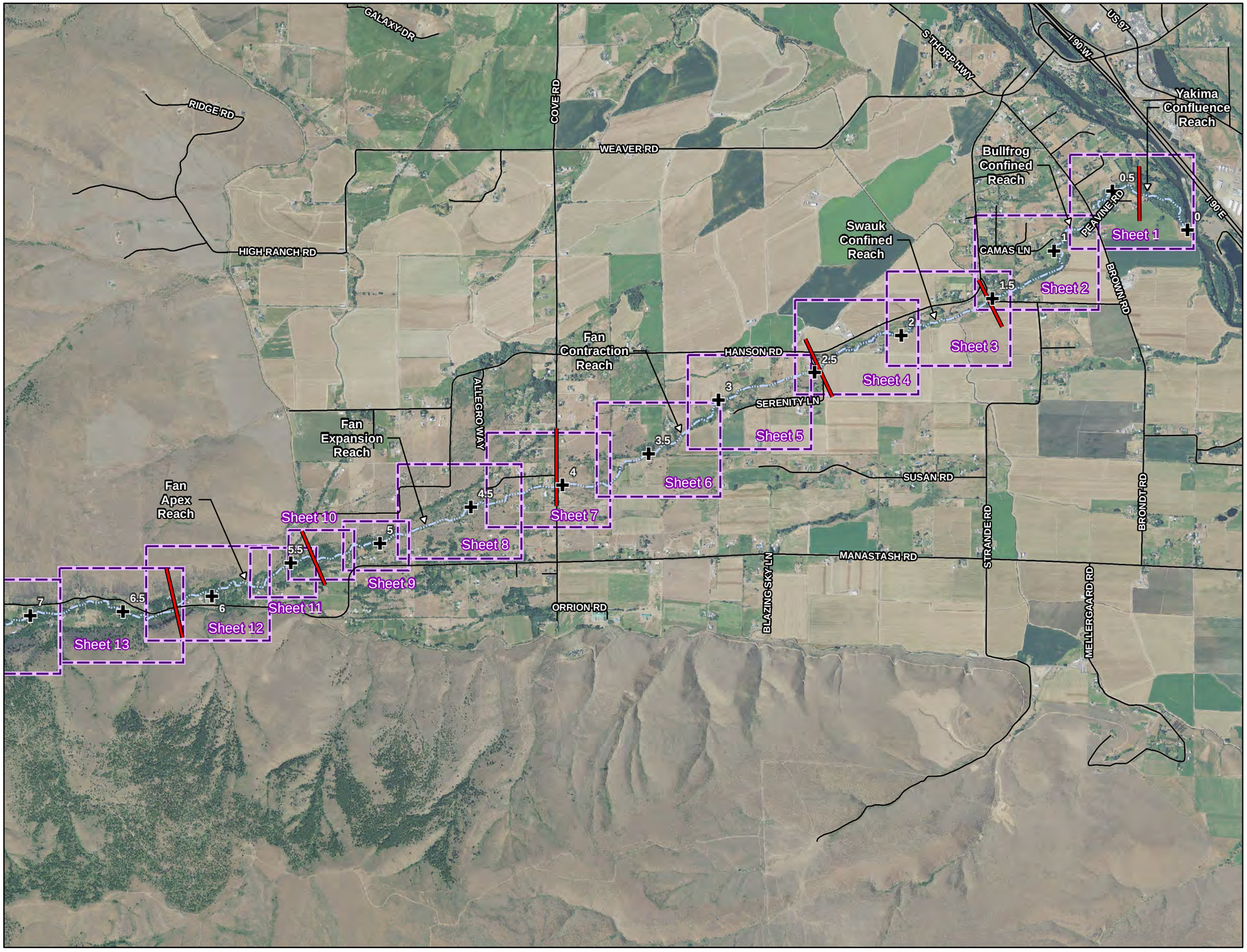
It should be understood that the potential projects described in this plan, and the scoring and prioritization of those projects, are current as of the plan's publication date. Additional project opportunities may be identified, and conditions may change that lead to a shift in priorities.

5. REFERENCES

Herrera and WSE. 2012. "Watershed and Reach Scale Investigation of Existing Conditions." Prepared for Kittitas County Conservation District by Herrera Environmental Consultants, Inc., Portland, Oregon, and Watershed Science & Engineering, Inc. November 13, 2012.

APPENDIX A

Project Reach Summaries



Index Map (Sheet 1 of 2)

Legend

- Half river mile
- Reach break
- Manastash Creek
- Road
- Reach Print Boundary

N

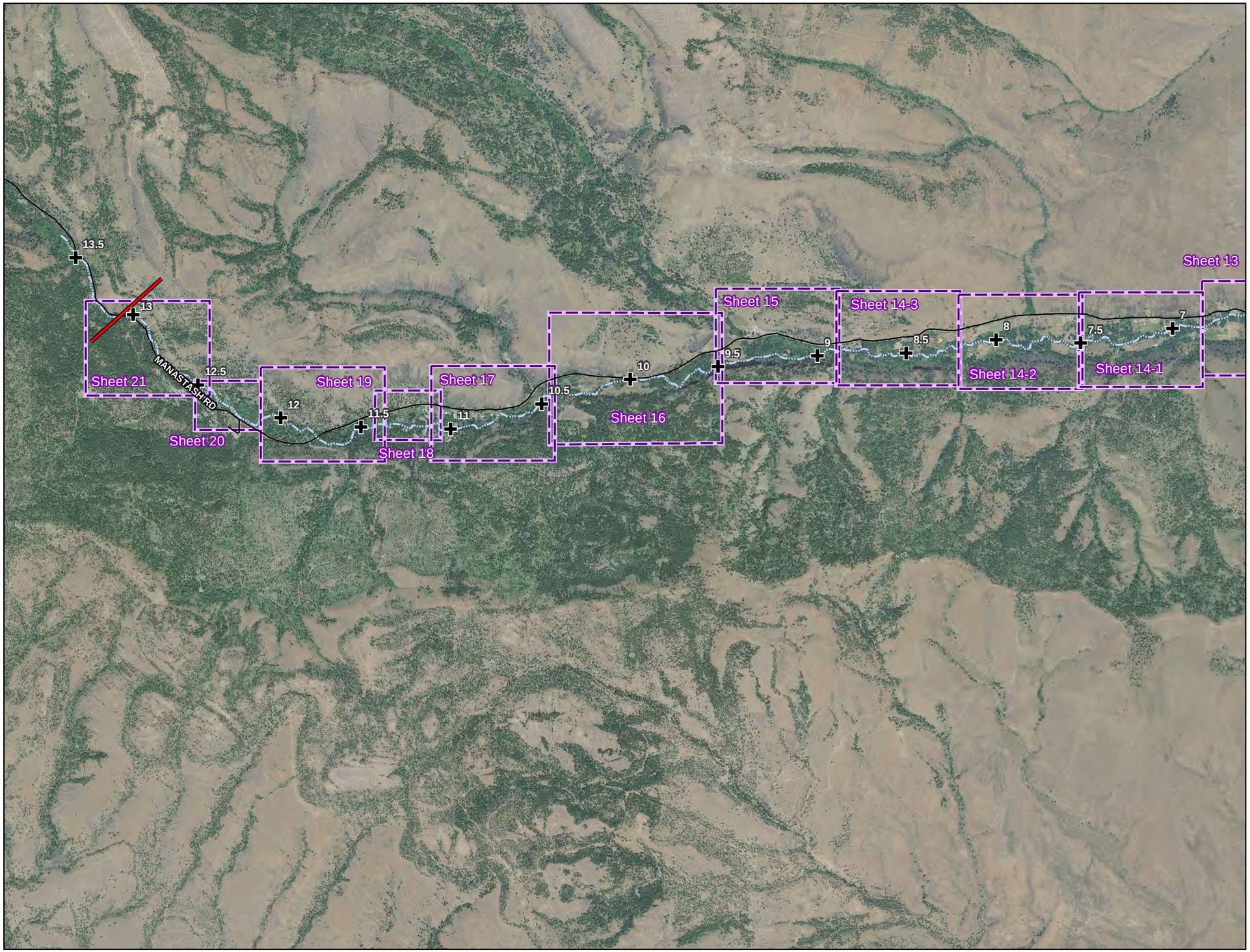
0 1,250 2,500 5,000

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography: USDA (2011)

Produced By: GIS
Project: K:\Projects\12-05295-000\Project\index_figure.mxd (4/10/2013)



Index Map (Sheet 2 of 2)

Legend

- Half river mile
- Reach break
- Manastash Creek
- Road
- Reach Print Boundary

N

0 1,250 2,500 5,000

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography: USDA (2011)

Produced By: GIS
Project: K:\Projects\12-05295-000\Project\index_figure.mxd (4/10/2013)

Manastash Creek Project Reach Summary

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

PROJECT REACH 1. Confluence to Brown Road (RM 0.0 to RM 0.7)

PRIORITY: High

PROJECT REACH DESCRIPTION

Sub-reach 1 begins at the Yakima River and extends upstream 0.7 mile to Brown Road (see Sheet 1). Between RM 0.0 and 0.3 the stream flows down a large alluvial delta that it has created on the south floodplain of the Yakima River. At RM 0.3 the stream enters a deeply incised narrow valley carved into a Yakima River/glacial outwash terrace.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Flood hazards are high on the floor of the valley and on the active portion of the delta.
2. The valley wall beneath the home on parcel 955517 is eroding.
3. The residence on parcel 178233 is on the floor of the valley and is susceptible to repeated flooding.

Habitat Limitations:

1. Juvenile fish rearing and refuge habitat.
2. A flood protection berm surrounds the structure on Parcel 178233 which cuts off a portion of the historical floodplain.
3. Fill left from an abandoned road crossing constricts the channel.
4. Reduced base flow and increased temperature, turbidity, and nutrients during low flow caused by irrigation withdrawals and return flows.

RECOMMENDED ACTIONS

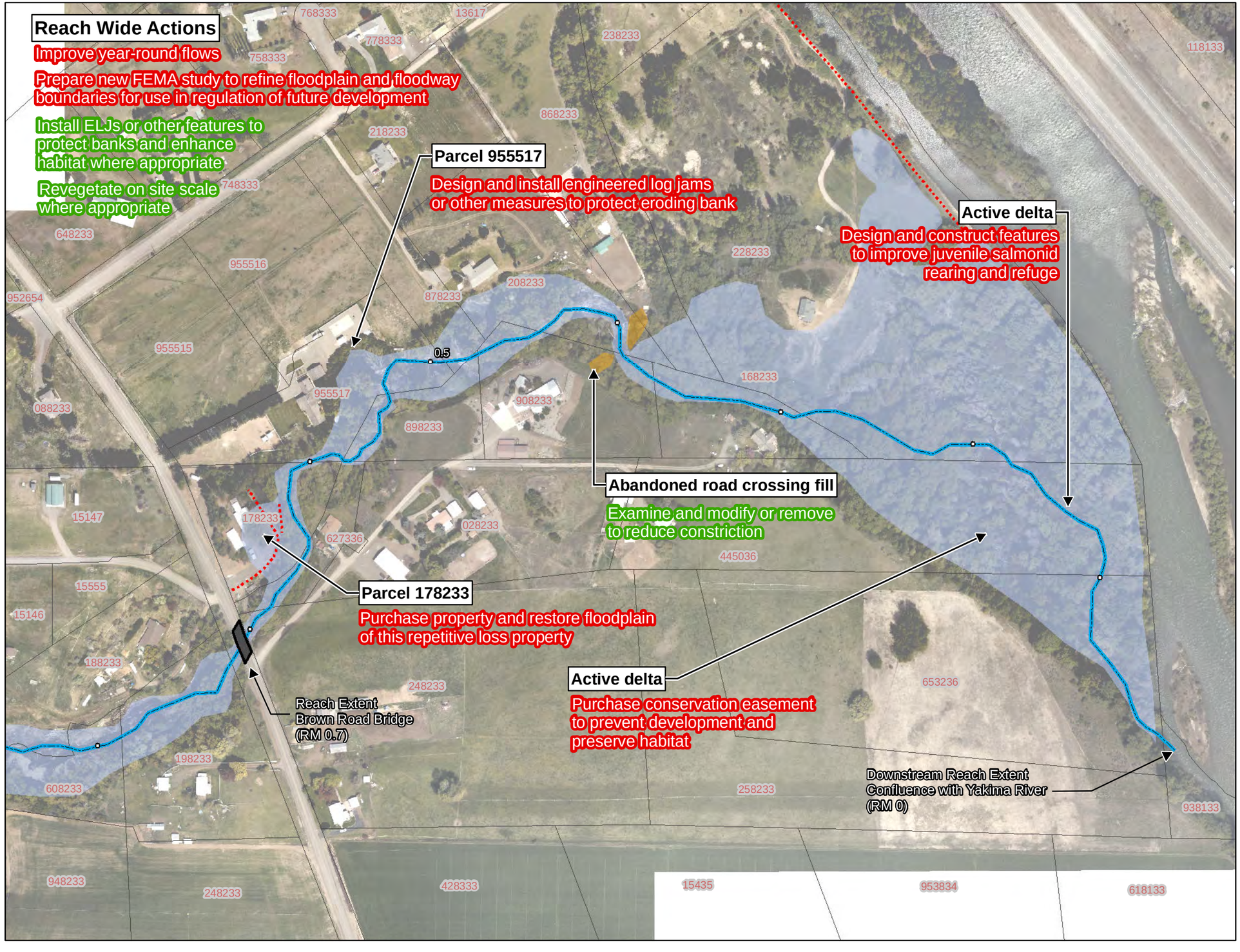
Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
	Active delta	Propose conservation easement to prevent development. (Note: this would also be a significant habitat benefit.)
	Parcel 178233	Purchase property and remove structures.
Erosion	Parcel 955517	Construct engineered log jam (ELJ) (or other) to protect eroding bank.
	General -- bank protection	Where appropriate, construct ELJs or revegetate to increase bank stability, especially adjacent to floodplain structures.
Habitat	Delta	Restore portions of the delta to improve juvenile salmonid rearing and refuge
	Parcel 178233	Purchase property, remove structures, and restore active floodplain.
	Abandoned road crossing	Modify or remove fill
	General – stable LWD	Install anchored LWD or ELJs in appropriate locations to provide improved refuge habitat for Yakima River salmonids

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into three distinct projects. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
1-1	Procure/establish a conservation easement to ensure the protection of mature floodplain forest bottomlands at the dynamic confluence of Manastash Creek and the Yakima River. Enact development restrictions in high-hazard areas. Modify or remove abandoned road crossing fill. Install multi-log habitat structures where appropriate in the downstream portion of this reach (RM 0.0 - 0.5). Improve habitat, accumulate naturally recruited pieces of LWD, and potentially aggrade the stream bed to improve overall floodplain connectivity in the reach.	14/20	Kittitas County Public Works KCCD	SRFB NRCS YRBWEP USFWS
1-2	Site-specific revegetation at Parcel 228233. Work will require collaboration with and approval from the landowner.	7/20	KCCD	SRFB WSCC
1-3	Seek property buyout for Parcel 178233. Perform minor excavation creating small floodplain benches and/or removing existing push-up levees to enhance floodplain inundation and reduce hydraulic severity. Revegetate site.	11/20	KCFZD KCCD	KCFZD FEMA SRFB



SHEET 1

Project Reach 1:
Confluence to Brown Road
(RM 0 to RM 0.7)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Abandoned Road Crossing Fill
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 1 to 8.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

PROJECT REACH: 2. Barnes to Brown Road (RM 0.7 to 1.52)

PRIORITY: Low

PROJECT REACH DESCRIPTION

Sub-reach 2 begins at Brown Road and extends 0.8 mile upstream to Barnes Road (see Sheet 2). The reach includes the bridges of both roads. The stream is confined to the floor of a deeply incised narrow valley carved into a Yakima River/glacial outwash terrace. There are no homes or other inhabitable structures located on the floor of the valley within the reach.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Flood hazards are high on the floor of the valley.
2. Lateral erosion is attacking the wall of the valley in several places. Most sites affect farm or riparian areas; however, there is at least one location where the erosion may pose a threat to a home or structures (near RM 1.0; the structures are located on parcel 628233).

Habitat Limitations:

1. Lack of habitat structure including stable in-stream wood.
2. With isolated exceptions, stream bank and floodplain vegetation is adequate.
3. Both the Brown Road and Barnes Road crossings constrict the natural floodplain and negatively affect stream morphology. The impact caused by Brown Road is minor, while the impact of Barnes Road is greater because the bridge is quite narrow.
4. Immediately downstream from Barnes Road, the stream flows along the face of a concrete wall that is part of the Barnes Road irrigation diversion structure. Velocities along the base of the wall are swift.
5. Reduced base flow and increased temperature, turbidity, and nutrients occur during low flow due to irrigation withdrawals and return flows.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

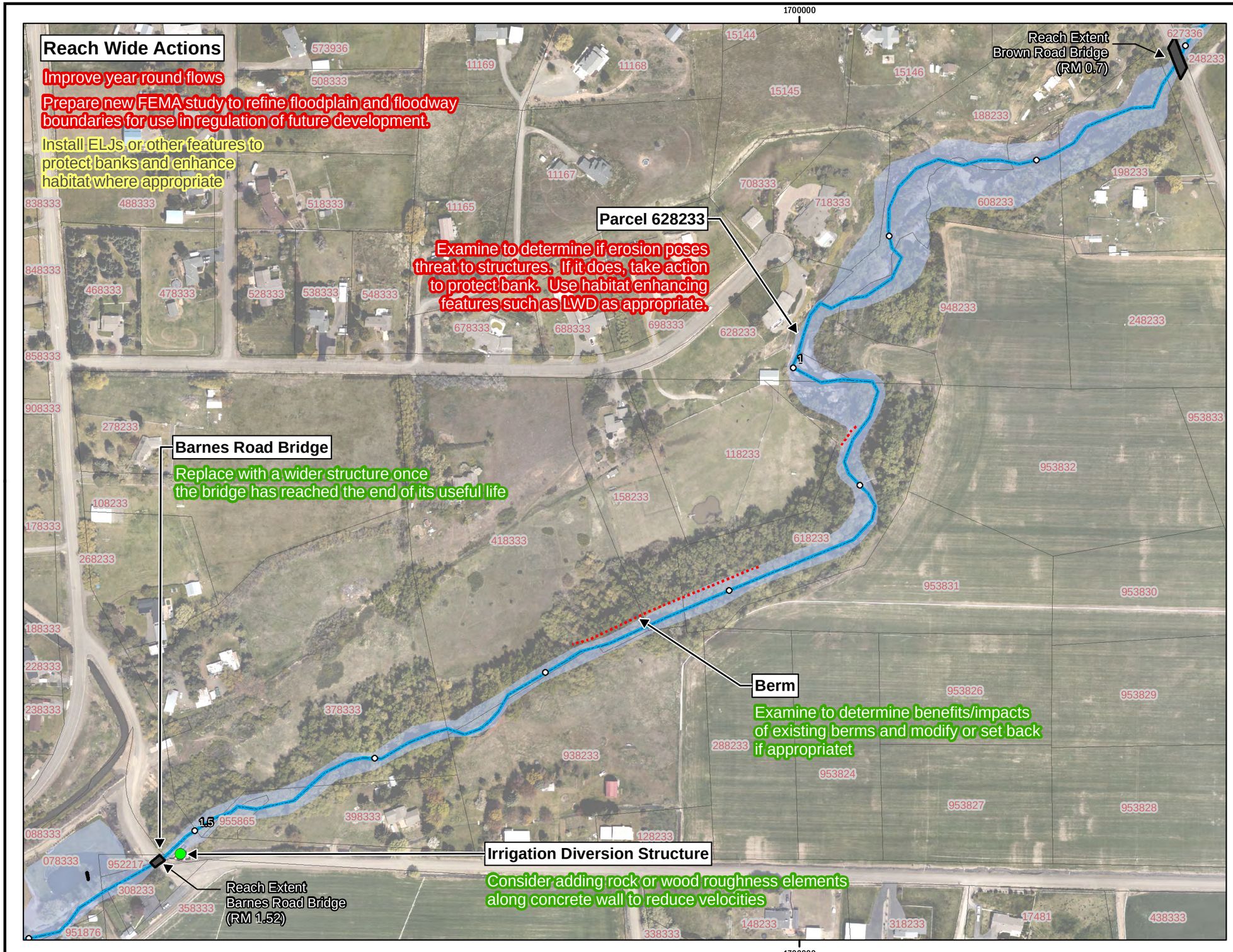
	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas. In this reach, this would amount to keeping homes from being built on the floor of the valley.
Erosion	Parcel 628233	Examine erosion to determine if it poses a threat to the structures that are located near the edge of the valley wall.
	General – bank protection	Where appropriate, construct ELJs or revegetate to increase bank stability, especially adjacent to floodplain structures.
Habitat	General – habitat structure	Install anchored LWD or boulder vanes in appropriate locations.
	General – vegetation	Plant vegetation along banks and floodplain where it is lacking.

	Reduced base flow	Acquire instream flow via voluntary acquisition and water conservation projects.
	Brown Road crossing	When the existing bridge reaches the end of its useful life, consider replacing with a wider crossing.
	Barnes Road crossing	When the existing bridge reaches the end of its useful life, consider replacing with a wider crossing.
	Berms	Examine existing berms to determine if they can be removed to improve floodplain and side channel connectivity.
	Wall of irrigation diversion	Examine to determine if features could be installed to roughen channel along base of wall to reduce swift velocities.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into five distinct projects in addition to a general flow restoration effort that applies to much of the lower project area. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP SRFB NFWF BPA Ecology WSCC NRCS
2-1	The Brown Road Bridge is structurally sound and is not scheduled for replacement. When it is, conduct detailed hydraulic and geomorphic evaluation to determine the best replacement design to balance costs and habitat.	7/20	Kittitas County Public Works	KCFZD SRFB YRBWEP
2-2	Examine existing berms along the left bank to determine if they can be removed to improve floodplain connectivity and access to remnant side channels without reducing flood protection.	9/20	KCCD	SRFB USFW NRCS
2-3	Install instream habitat / erosion protection structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	11/20	KCFZD KCCD	FEMA SRFB USFW YRBWEP
2-4	Replace the Barnes Road Bridge with hydraulically and geomorphically appropriate crossing.	7/20	Kittitas County Public Works	KCFZD SRFB YRBWEP
2-5	Consider adding rock or wood roughness elements along concrete wall to reduce velocities.	7/20	KCCD	SRFB



SHEET 2

Project Reach 2:
Brown Road to Barnes Road
(RM 0.7 to RM 1.52)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 1 to 8.mxd (6/7/2013)

Manastash Creek
DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 3 – West Side Irrigating Company Crossing Reach (RM 1.52 to 1.9)
PRIORITY: High

SUB-REACH DESCRIPTION
Sub-reach 3 begins just above Barnes Road and extends upstream 0.3 mile beyond the West Side Irrigating Company siphon crossing (see Sheet 3). Between Barnes Road and the siphon the channel is straight and the left (north) bank is lined with a single row of large-diameter cottonwood trees. This reach of the channel was straightened in the 1940s or 1950s. Due to the straight planform, the channel is generally a continuous riffle or glide with few pools or resting areas for fish. The irrigation siphon and its protective scour apron create a rise in the longitudinal bed profile. Upstream, the channel is attempting to reestablish meanders and the outside banks of the bends are actively eroding.

EXISTING HAZARDS AND LIMITATIONS
Flood and Erosion Hazards:

1. The primary hazard within this reach is the risk that scour and erosion pose to the West Side Irrigating Company's siphon. The top of the siphon has been exposed by past floods. Temporary countermeasures were recently installed to protect the siphon.
2. Upstream from the siphon the banks are actively eroding in several locations; however, the erosion does not pose a threat to structures.

Habitat Limitations:

1. There are virtually no pools or woody debris within the straight reach between Barnes Road and the siphon.
2. Stream channel is confined and disconnected from floodplain
3. A significant portion of the right (south) bank between Barnes Road and the siphon is covered with broken concrete rubble.
4. There is little shade vegetation along the right (south) bank of the stream, and there is a single row of mature cottonwoods on the left (north) bank.
5. Reduced base flow and increased temperature, turbidity, and nutrients occur during low flow and are caused by irrigation withdrawals and return flows.

RECOMMENDED ACTIONS
Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
Erosion	West Side siphon	The West Side Irrigating Company is in the process of designing a replacement crossing for the siphon. The West Side hopes to replace it with an elevated bridge structure. Construction is tentatively planned for summer 2014.

		As part of the replacement, the stream channel and return flow ditch will need to be reconfigured to accommodate the new crossing, which will provide an opportunity to improve channel geomorphic characteristics while reducing scour and erosion potential.
	General – bank erosion	Where appropriate, construct ELJs or revegetate to increase bank stability. However, do not prevent natural channel migration if it does not pose a threat to structures or other facilities.
Habitat	Straight channel	Conduct investigation to determine how to restore or, at a minimum, improve geomorphic characteristics and habitat complexity within the straight reach (i.e. increase pools).
	Concrete rubble	Remove concrete rubble from right (south) bank and replace with vegetation.
	Vegetation	Increase bank and floodplain vegetation to create adequate shade and a reasonable riparian buffer.
	Reduced base flow	Acquire instream flow via voluntary acquisition and water conservation projects.
	Irrigation return flows	Investigate methods to reduce water temperature impacts caused by irrigation return flows (e.g. infiltration).
	General – habitat structure	Install anchored LWD or ELJs in appropriate locations.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into four distinct projects in addition to a general flow restoration effort that applies to much of the lower project area. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP SRFB NFWF BPA Ecology WSCC NRCS
3-1	Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is aesthetically acceptable to property owners. Develop and implement plans to add roughness and complexity to existing bank armoring treatments to improve habitat.	12/20	KCCD	SRFB WSCC USFW NRCS

3-2	Reconnect floodplain habitat on both banks.	10/20	KCCD	SRFB USFW YRBWEP
3-3	Restore channel and floodplain habitat at West Side Irrigating Company siphon crossing location when replaced/repaired.	11/20	West Side Irrigating Company/ KCCD USBR	SRFB YRBWEP USFW
3-4	Conduct study to determine the feasibility/effectiveness of an infiltration or other facility to treat warm, silt-laden return flows before they re-enter Manastash Creek.	8/20	KCCD	SRFB YRBWEP

Reach Wide Actions

Restore year round flows

Prepare new FEMA study to refine floodplain boundaries for use in regulation of future development

Revegetate channel banks once year-round flows are re-established

Install anchored LWD, ELJs or boulder vanes in secure and appropriate locations

Downstream of Siphon

Remove concrete rubble from south bank and revegetate. Investigate methods to reduce water temperature impacts from irrigation return flow

Reach Extent (RM 1.9)

Reach Extent Barnes Road Bridge (RM 1.52)

Straight channel

Conduct investigation to determine how to restore or improve geomorphic characteristics and habitat complexity

Westside Siphon

Siphon to be replaced with elevated crossing
Reconfigure channel and return flow ditch to improve channel geomorphic characteristics while reducing scour and erosion

SHEET 3

Project Reach 3:
Westside Irrigation Crossing
(RM 1.52 to RM 1.9)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 1 to 8.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 4. Serenity Lane Reach (RM 1.9 to 2.6)

PRIORITY: High

SUB-REACH DESCRIPTION

Sub-Reach 4 includes approximately 0.8 mile of Manastash Creek, beginning upstream from the West Side Irrigation Company siphon and extending to just beyond the private Serenity Lane bridge (see Sheet 4). This reach is dry during portions of the irrigation season due to irrigation withdrawals upstream at the Reed diversion.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Scour has partially undermined the footings of the Serenity Lane bridge.
2. Stream banks eroded both upstream and downstream from the bridge during the May 2011 flood. The erosion exposed a residential power line upstream. Erosion upstream from bridge was influenced by significant sediment deposition.
3. Sediment and woody debris deposited on the left floodplain near RM 2.3 downstream from Serenity Lane during May 2011 flood.
4. Flooding during the May 2011 event on the left floodplain (RM 1.9 to 2.4) was partially due to overland flow that was redirected toward the creek by Hanson Road.
5. A driveway bridge near RM 2.1 constricts the floodplain. It sustained scour and erosion damage during the May 2011 flood.

Habitat Limitations:

1. Reduced base flow leads to dry channel conditions during summer months.
2. Straightening of the channel downstream from the Serenity Lane bridge has altered the natural movement and deposition of sediment, which has in-turn altered in-channel gravel habitat features.
3. Berms limit flooding and, therefore, floodplain connectivity and fish refuge. They also affect sediment transport because they increase or concentrate flow energy.
4. In general, this reach is incised; this has reduced floodplain connectivity.
5. Buffer vegetation is lacking along the stream in specific locations.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Serenity Lane bridge	• Install temporary scour countermeasures to protect the foundations until a replacement bridge can be designed and installed. • Replace bridge with a longer, secure structure.
	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
Erosion	Bank erosion at or near Serenity Lane bridge	• Install temporary measures to prevent erosion from outflanking of existing bridge. • Modify right (south) bank upstream from bridge to remove in-channel spoil pile berm and protect power line. • When new bridge is installed, modify and protect banks as needed.
	Driveway bridge	Seek to increase size of waterway to reduce velocities and install erosion protection as needed.
	General	Construct ELJs or revegetate to increase bank stability where appropriate.
Habitat	Stream flow	Restore year-round stream flows.
	Straightened channel downstream from Serenity Lane	Restore channel complexity.
	Berms	Evaluate impact, modify or set back if appropriate.
	Bank vegetation	Revegetate banks and floodplain where adequate buffers do not exist or are narrow.
	Habitat structure	Install anchored LWD or boulder vanes in key locations to provide bank stability and habitat enhancement

DISCUSSION OF RECOMMENDED ACTIONS

Note: Landowner engagement and input will be critical for success.

Flood/Erosion

1. **Serenity Lane bridge** – The Serenity Lane bridge has a major impact on channel form and function because it is too narrow. This causes sediment to deposit upstream which aggravates lateral bank erosion; flow is "throttled" through the bridge, which scours the streambed and causes the downstream banks to erode. The abutment foundations have been partially undermined; therefore, the bridge is scour-critical and interim countermeasures should be installed to protect the structure until a replacement crossing can be installed.
2. **Floodplain regulations –** FEMA maps should be updated or produced to establish a defensible floodplain and floodway for Manastash Creek (RM 0 to 12.5). These maps then should be used to prevent or limit development in high flood hazard areas.
3. **Bank erosion –** The exposed power line should be protected or moved. The existing protection on right (south) bank immediately upstream should be extended upstream to reduce the potential for the stream to erode the bank and outflank the bridge. When a

replacement bridge is installed, the banks of the channel upstream and downstream will need to be modified to accommodate a new bridge.

4. **Driveway bridge** – The driveway bridge at RM 2.1 constricts the channel and was damaged during the May 2011 flood. This, along with numerous other driveway bridges along Manastash Creek, should eventually be modified or replaced to minimize their impact on channel processes and to reduce the likelihood that they will be damaged during floods. We are not suggesting that every landowner replace their driveway bridge, only that individually and collectively these bridges have a significant impact on the channel. Over the long term, it would be best if there was a plan to help landowners replace their bridges with longer and higher structures as the existing bridges reach the end of their useful lives.

Habitat

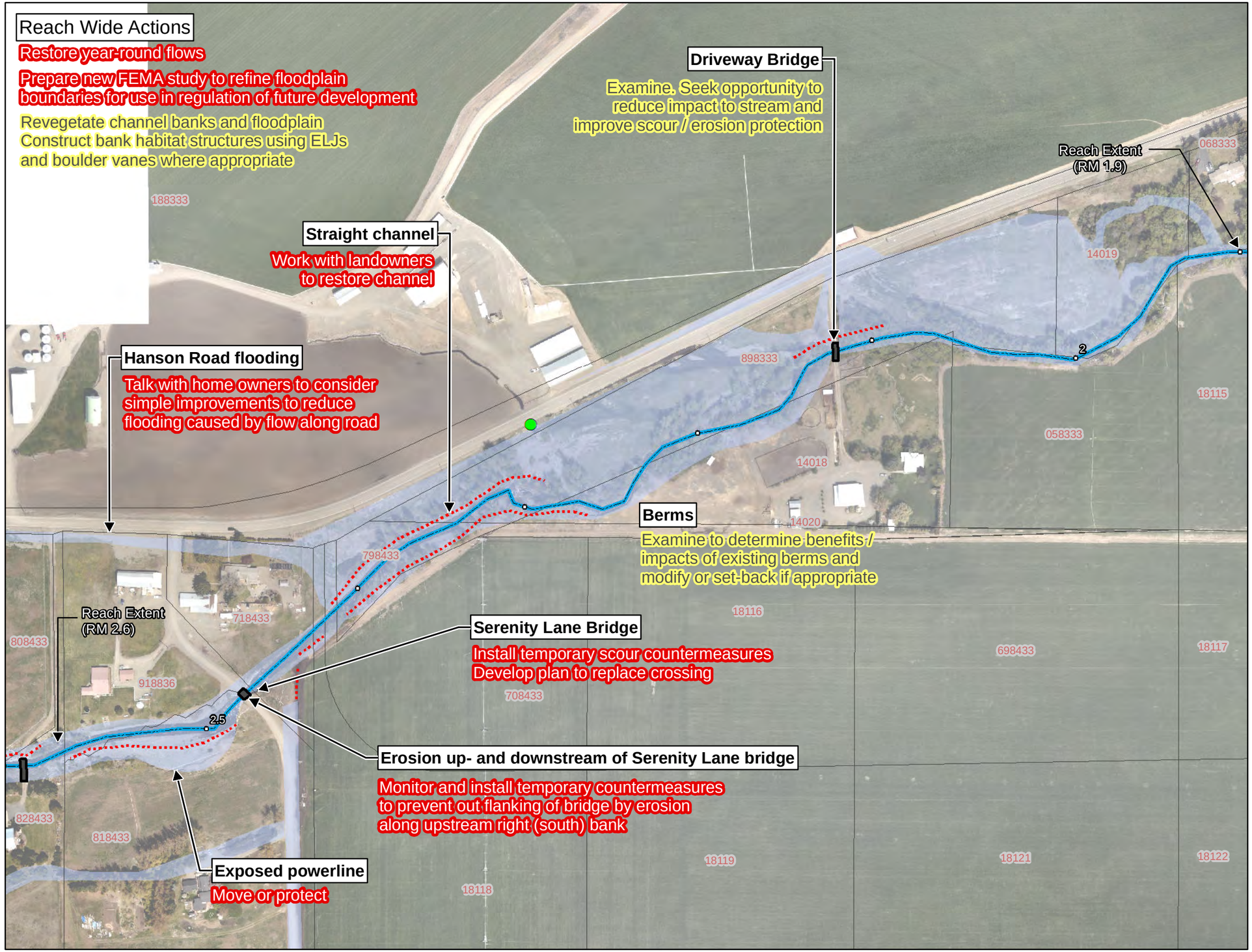
5. **Stream flow** – Restore year-round flows to Manastash Creek in the "Dry Reach" which begins at the Reed Diversion (RM 4.9) and extends downstream to the Westside Irrigation Diversion (RM 1.7).
6. **Straightened channel** – Consider restoring the straightened channel immediately downstream from Serenity Lane. This may include removing or setting the existing earthen berms back from the channel and restoring floodplain connectivity through benching. The potential benefits or impacts to hydraulics and sediment transport will need to be carefully considered before any significant channel modifications are made.
7. **Berms** –- There are numerous independent spoil pile berms that border the channel along this reach. Each should be examined to determine its function, whether it adversely impacts stream morphology, and if it should be modified or set back from the channel.
8. **Bank and floodplain vegetation** – Vegetation buffers are important for both bank stability and habitat. Vegetation should be planted where there is no vegetation or where the buffers are too narrow.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into four distinct projects in addition to a general flow restoration effort that applies to much of the lower project area. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP NFWF BPA Ecology WSCC NRCS
4-1	Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding into confined valley walls/high banks and to simultaneously	12/20	KCCD	SRFB YRBWEP USFW

	improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.			
4-2	Remove or set back berms along reach where risk of erosion and flooding is not increased.	7/20	KCCD	SRFB YRBWEP USFW
4-3	Channel and floodplain restoration/ revegetation downstream of Serenity Lane Bridge.	13/20	KCCD	SRFB YRBWEP USFW WSCC NRCS
4-4	Replace the Serenity Lane bridge with a hydraulically and geomorphically appropriate structure. Reconstruct channel to reduce flood/erosion problems and improve habitat. Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and to simultaneously improve habitat conditions. Bank protection measures should strive for short-term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Large-scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is aesthetically acceptable to property owners.	15/20	KCFCZD KCCD	SRFB YRBWEP USFW



SHEET 4

Project Reach 4:
Serenity Lane
(RM 1.9 to RM 2.6)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

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Feet

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Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 1 to 8.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 5. Abandoned Dam Reach (RM 2.6 to 3.3)

PRIORITY: Medium

SUB-REACH DESCRIPTION

Sub-reach 5 begins at the first driveway bridge upstream from Serenity Lane and continues 0.6 mile upstream (see Sheet 5). The reach contains an old, now abandoned, concrete irrigation diversion dam. The center portion of the dam was removed during the May 2011 flood. The reach downstream from the dam is deeply incised, likely due in part to the retention of sediment upstream of the dam.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Due in part to the channel incision downstream from the abandoned dam, flooding is not a major problem along the reach. There are several swales or channels on both the floodplain to the north and south that transport water during major floods. Homes located within the Serenity Lane development on the south floodplain were affected by flows during the May 2011 flood.
2. There are several areas where the banks are eroding, but none appear to threaten homes or structures.

Habitat Limitations:

1. Reduced base flow leads to dry channel conditions during summer months.
2. The reach downstream from the abandoned dam is deeply incised, which has reduced floodplain and side channel connectivity.
3. The incised reach also appears to have been straightened at some time in the past. This may have contributed to the incision.
4. There is a relatively long spoil pile berm along the left (north) bank downstream from the abandoned dam. This berm may also have contributed to channel incision by increasing flow intensity within the channel.
5. The first driveway bridge upstream from Serenity Lane appears to be large and high and, therefore, likely has little impact on the channel. The second driveway bridge upstream is narrower and likely constricts the channel.
6. Healthy vegetation is lacking in areas along stream banks and within the floodplain buffer.
7. Stable in-stream wood and spawning-sized substrate are lacking.

RECOMMENDED ACTIONS

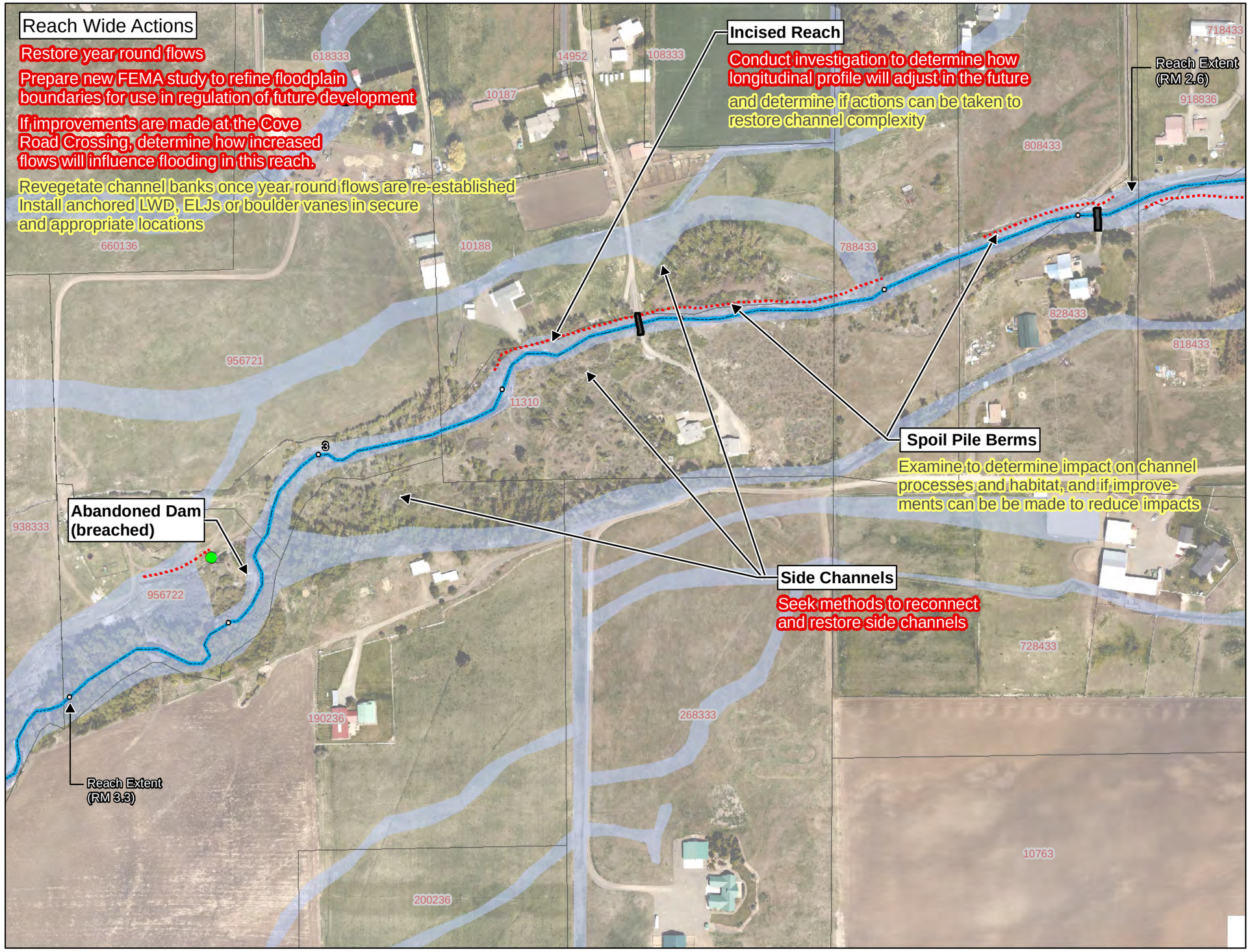
Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
	Incised reach downstream from abandoned dam	Conduct investigation to determine how the longitudinal stream profile will adjust in the future. If it will aggrade, the frequency and severity of flooding will increase on the adjacent floodplain.
	Entire reach – response to Cove Road changes	If improvements are eventually made at the Cove Road crossing upstream, and if these increase flows downstream, determine how the increased flows will influence flooding within the abandoned dam reach.
Erosion	General – bank erosion	Where appropriate, construct ELJs or revegetate to increase bank stability. However, do not prevent natural channel migration if it does not pose a threat to structures or other facilities.
Habitat	Side channel connectivity	Seek methods to reconnect and restore side channels. Do this in conjunction with the investigation recommended above that seeks to predict long-term adjustments of the longitudinal stream bed profile.
	Stream flow	Restore year-round stream flows.
	Spoil pile berms	Examine existing spoil pile berms to determine their impact on channel processes and, therefore, habitat. Determine if improvements or modifications can be made to reduce their impact (e.g., can they be set back from the edge of the channel?).
	Straightened reach downstream from abandoned dam	As part of the investigation recommended above, determine the impact that channel straightening has had on natural geomorphic processes. Determine if actions can be taken to restore channel complexity.
	Driveway bridge	Typical of most existing driveway bridges along Manastash Creek, examine bridges to determine if improvements can be made to reduce impacts on the channel.
	Vegetation	Increase bank and floodplain vegetation in areas where buffers are thin or do not exist.
	General – habitat structure	Install anchored LWD or boulder vanes in appropriate locations.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into two distinct projects in addition to a general flow restoration effort that applies to much of the lower project area. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP NFWF BPA Ecology WSCC NRCS
5-1	Assessment of driveway bridge improvements and possible berm modifications. Determine if actions can be taken to improve crossing security and flood protection while enhancing stream function. Remove or breach left bank berm to open access to forested floodplain areas. May need to build setback berm; further study is required. Large-scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is aesthetically acceptable to property owners.	13/20	KCCD KCFCZD	SRFB YRPWEP USFW WSCC NRCS
5-2	Assess future channel profile adjustments downstream of removed diversion dam. Determine how will this affect flooding, erosion, and habitat. Determine need for removing abandoned diversion dam structure to restore stream function and improve fish passage. Reconnect historic side channels in the vegetated right bank floodplain.	10/20	KCCD	SRFB YRBWEP USFW



SHEET 5

Project Reach 5:
Abandoned Dam
(RM 2.6 to RM 3.3)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

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Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 1 to 8.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 6. Anderson Diversion Reach (RM 3.3 to 3.85)

PRIORITY: Medium

SUB-REACH DESCRIPTION

Sub-Reach 6 centers on the Anderson Diversion and KRD 13.8 lateral crossing, and extends from approximately RM 3.3 to RM 3.85 (see Sheet 6). This reach is dry during portions of the irrigation season due to irrigation withdrawals upstream.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Flooding within floodplain swales.
2. Erosion of channel banks at multiple locations due in-part to lack of healthy vegetation.
3. Erosion at the Anderson diversion and KRD 13.8 lateral bridge.

Habitat Limitations:

1. Reduced base flow leads to dry channel conditions during summer months.
2. Lack of safe fish passage due to an unscreened irrigation diversion.
3. Lack of healthy vegetation along stream banks and floodplain buffer.
4. Channel incision has reduced frequency of floodplain connectivity.
5. Lack of stable in-stream wood and spawning-sized substrate.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Floodplain	• Monitor and take action if needed to protect buildings or infrastructure. Treat on a case-by-case approach. • Consider the impact that possible future changes to the Cove Road crossing may have on flooding along reach.
	Channel profile	Inspect channel and conduct evaluation to determine how the longitudinal profile will adjust in the future in response to the recent demolition of the abandoned dam and possible future changes to the Cove Road crossing. Profile adjustments could affect flooding, bank erosion, and habitat.
Erosion	Anderson diversion & KRD 13.8 lateral bridge	Inspect to determine if improvements should be made to reduce scour/erosion problems and improve habitat. Consider replacing existing bridge crossing with longer structure.
Habitat	Bank vegetation	Once year-round flows are re-established, revegetate banks and floodplain as needed to create appropriate buffer.
	Stream flow	Restore year-round stream flows.
	Existing berms	Inspect to determine their function and whether they should be set back from the stream or modified.

	Habitat structure	Install anchored LWD or boulder vanes in secure and appropriate locations.
	Fish passage	Decommission diversion structure in order to remove an unscreened irrigation diversion and a partial barrier to fish passage (during irrigation season)

DISCUSSION OF RECOMMENDED ACTIONS

Flood/Erosion

1. **Flooding** – Flooding has not been a major problem in this reach; however, increased flooding could eventually occur if actions are taken at Cove Road (upstream) that increase the amount of water passing under the bridge. This issue must be addressed when improvements for Cove Road are considered.
2. **Channel Profile** – The elevation of the channel profile may change in the future now that the abandoned dam has been partially demolished and actions may eventually be taken at the Cove Road crossing. If the elevation of the profile increases, flooding may become more frequent.
3. **KRD 13.8 Lateral Bridge** –— Examine the site to determine if actions should be taken to minimize future flood and erosion damage to the existing bridge and to improve natural stream function. The Kittitas Reclamation District may be considering replacing the crossing. The bridge should be replaced with a crossing that minimizes impacts to the channel, and the channel restored .
4. **Channel Bank Erosion** – Due to upstream withdrawals, this reach does not contain water during the summer irrigation season. As a result, the existing vegetation is generally in poor health, the root network has been weakened, and, therefore, the banks are susceptible to erosion. Healthy bank vegetation is critical to long -term bank stability and reduced sediment transport/deposition downstream.

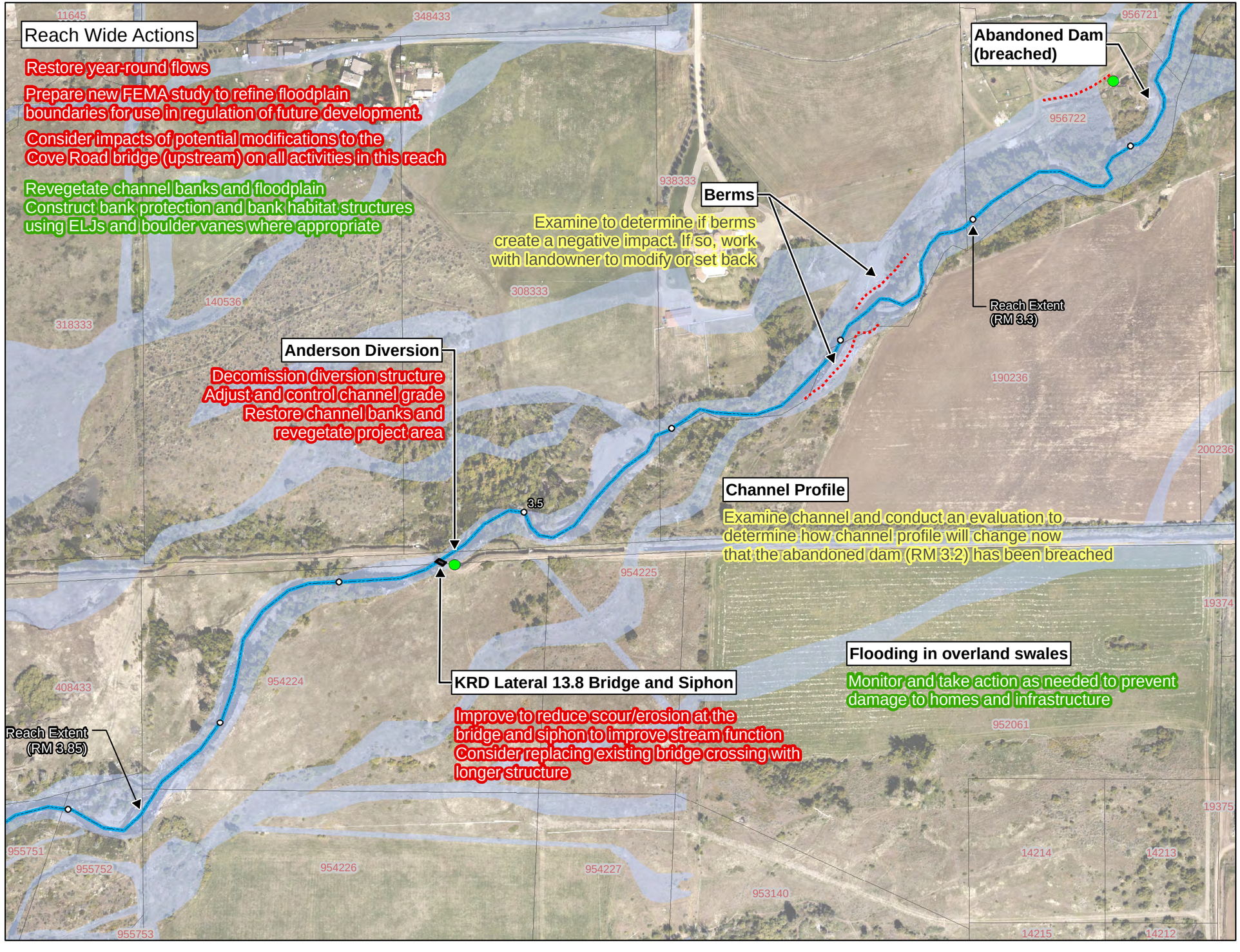
Habitat

1. **Stream Flow** – Restore year-round flows to Manastash Creek in the "Dry Reach," which begins at the Reed Diversion (RM 4.9) and extends downstream to the Westside Irrigation Diversion (RM 1.7).
2. **Bank Vegetation** – In addition to No. 4 above, healthy buffer vegetation will improve habitat by increasing shade and the quantity/quality of wood that interacts with the stream.
3. **Existing Berms** – Two spoil pile berms are located along either side of the stream near the downstream end of the reach (RM 3.25). We recommend examining these to determine if they are having an adverse impact on stream function. If they are, work with the landowners to determine if they can be modified or set back to reduce the impact.
4. **Habitat Structure –** Installing secure LWD or boulder vanes at key locations along the creek margins to provide habitat and bank stabilization while vegetation is given a chance to establish.
5. **Anderson Diversion–** The individual water right holders at the diversion are considering decommissioning the diversion after moving their point of diversion to another location as part of the long standing Manastash Creek Restoration Project. If this occurs, the channel and streambank should be restored at the site of diversion.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into four distinct projects in addition to a general flow restoration effort that applies to much of the lower project area. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP NFWF BPA Ecology WSCC NRCS
6-1	Install stable stream bank habitat structures	9/20	KCCD	SRFB YRBWEP USFW
6-2	Revegetation of stream banks and riparian zone where needed	17/20	KCCD	SRFB WSCC NRCS
6-3	Decommission diversion structure; adjust and control channel grade; restore stream banks and revegetate project area	10/20	KCCD	SRFB YRBWEP USFW WSCC NRCS
6-4	Widen KRD 13.8 lateral bridge crossing and restore bank/floodplain	11/20	KRD/USBR KCCD	SRFB YRPWEP USFW



SHEET 6

Project Reach 6:
Anderson Diversion
(RM 3.3 to RM 3.85)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 1 to 8.mxd (6/7/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 7. Cove Road Reach (RM 3.85 to 4.2)

PRIORITY: High

SUB-REACH DESCRIPTION

Manastash Creek sub-reach 7 includes the area directly affected by facilities and maintenance activities in the vicinity of Cove Road (see Sheet 7). During the May 2011 flood, a large portion of the flow escaped the channel at Cove Road and flowed down the floodplain via numerous historical swales. Most of this overland flow was eventually intercepted by Hanson Road and returned to Manastash Creek downstream of Serenity Lane.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Channel capacity is reduced during floods because large quantities of sediment deposit within the reach.
2. Cove, Cedar Cove, and Hanson Roads, along with numerous gravel driveways, are overtopped by the overland flows. This damages the roads and driveways.
3. The water that overtops the roads and driveways poses a threat to public safety.
4. The home immediately upstream and north of Cove Road (parcel 435133) sits in a low-lying area of the floodplain and is highly susceptible to flooding. It was severely damaged during the May 2011 flood. The three other properties that border the bridge (parcels 11052, 408433, and 955748) also flood, but few structures are affected.
5. Numerous fields and several structures located in or near floodplain historical swales flood.
6. The reach is bordered by spoil pile berms, several of which are very old and of unknown integrity.
7. Bank and floodplain erosion along the left (north) bank parcels upstream and downstream of the bridge.

Habitat Limitations:

1. Reduced base flow leads to dry channel conditions during summer months.
2. Natural channel characteristics have been disturbed within the reach due to repeated channel excavation and the construction of spoil pile berms.
3. Existing spoil pile berms reduce floodplain connectivity and opportunities for fish refuge.
4. Sufficient buffer vegetation is lacking along significant portions of the reach.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Cove Road bridge	Conduct detailed hydraulic and sediment transport investigation to determine if the bridge should be replaced with a wider/higher crossing.
	Channel sediment	Use the investigation above to determine if sediment management activities should be conducted, and develop a maintenance plan that will maximize flood protection and improve habitat.
	Properties downstream from the sub-reach located near the stream	Use the investigation above to determine if proposed changes in the vicinity of Cove Road will increase flow rates downstream from the reach. If they will, determine if this is likely to cause flood/erosion/and sediment problems and recommend actions to minimize impacts. (Note: this issue will need to be considered in the design of the Serenity Lane replacement bridge.)
	Properties downstream from Cove Road located near floodplain swales	Use the investigation above to estimate reduction in overland flow and the reduction in flood damages to roads and property.
	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
	Home on parcel 435133	Seek grant to elevate or buy out home.
	Parcels 11052, 408433, and 955748 (parcels that border Cove Road bridge)	Use the investigation above to make sure proposed improvements will not adversely affect or, better, will reduce flooding on these properties.
	Berms	1. Examine berms along right (south) bank upstream from Cove Road. These are quite old and the level of protection they provide is unknown. Determine the potential consequences should they fail. 2. Determine if berms downstream from Cove Road can be removed or setback without increasing sediment deposition within the stream channel.
Erosion	Bank erosion along parcels 435133 and 408433	Examine existing conditions and recommend countermeasures.
	Banks leading to and from bridge	If bridge is replaced, make sure stream banks leading to and from the bridge are appropriately configured and protected.
Habitat	Channel sediment	Develop a long-term plan to manage sediment. Seek to minimize impacts on channel.
	Stream flow	Restore year-round stream flows.
	Berms	Evaluate impact, modify or set back if appropriate.
	Bank vegetation	Revegetate banks and floodplain where adequate buffers do not exist or are too narrow. This may have to wait until year-round flows are returned to the stream.
	Habitat structures	Install anchored LWD or boulder vanes in key locations where appropriate.

DISCUSSION OF RECOMMENDED ACTIONS

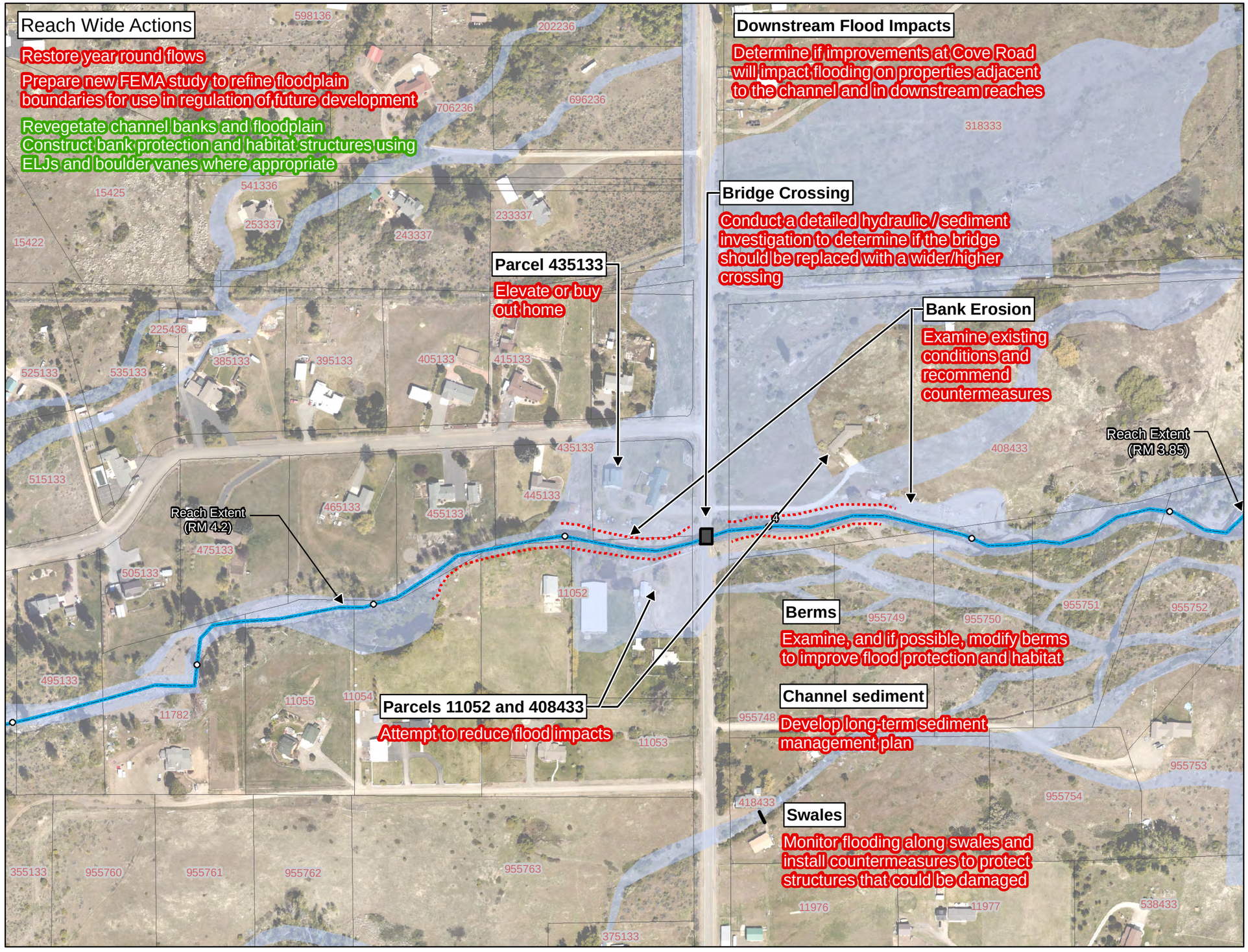
Cove Road Bridge, Sediment, Overland Flow, Berm, etc. – This reach of the channel fills with sediment during floods, greatly reducing the capacity of the channel and bridge waterway. In response, flood water leaves the channel, crosses Cove and Cedar Cove Roads and finds its way downstream via numerous historical floodplain swales. This flow can cause significant damage as it inundates and erodes properties, roads, and driveways. A comprehensive investigation is needed to find a long-term solution that reduces flooding in the vicinity of Cove Road and improves habitat.

Note: Landowner engagement and input will be critical for success.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented as a single project on that scale if possible. The table below summarizes this project. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP NFWF BPA Ecology WSCC NRCS
7-1	Develop comprehensive solution to manage sediment, minimize flooding, and restore channel and floodplain health. Flood protection for Cove Road residents: berms, structure elevation, buyouts, etc. Replace or modify Cove Road bridge with hydraulically and geomorphically appropriate crossing. Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and simultaneously improve habitat conditions. Bank protection measures should strive for short-term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Large-scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is aesthetically acceptable to property owners.	16/20	Kittitas County Public Works KCCD	KCFCZD SRFB YRBWEP USFW WSCC NRCS



SHEET 7

Project Reach 7:
Cove Road Crossing
(RM 3.85 to RM 4.2)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500
Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
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Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 8. Upstream Cove Road to Downstream Reed Diversion Reach (RM 4.2 to 4.9)

PRIORITY RANK: Medium

SUB-REACH DESCRIPTION

Sub-Reach 8 is the 0.7-mile-long section of Manastash Creek that lies between the Cove Road and Reed Diversion reaches (see Sheet 8). The reach is characterized by a relatively straight channel that flows through coarse porous stream and glacial alluvium. In its natural state, it appears that trees thrived on the banks of the stream but did not cover the floodplain. Floodplain vegetation was and continues to be mostly drought–tolerant, sagebrush-type species. For more than 40 years, the reach typically has not carried flow during the late summer irrigation season due to withdrawals upstream at several diversions. In response, many of the trees on the stream banks have either died or are in poor health. This has left the banks vulnerable to erosion because tree roots help bind the bank material together and the trees themselves create roughness, which reduces velocities along the bank. During the May 2011 flood, significant lateral erosion occurred within the reach, and the eroded material was the primary source of sediment that deposited within the Cove Road Reach downstream.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. The channel is quite large and has significant capacity; therefore, flooding is not a major concern on the adjacent floodplain.
2. Erosion of channel banks is a significant issue; fortunately, most (but not all) homes and structures are set back from the edge of the channel.

Habitat Limitations:

1. Reduced base flow, which leads to dry channel conditions during summer months.
2. Lack of healthy vegetation along the banks of the stream.
3. Lack of stable in-stream wood and spawning-sized substrate.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Floodplain	Determine if flooding will increase on the floodplain if future channel improvements are made upstream (e.g., removal of Reed Diversion dam). If they will, take action to mitigate impacts.
	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
Erosion	Channel banks (general)	Once year-round flows are returned to the stream, reestablish healthy vegetation buffer along all banks. Where needed to protect facilities or structures, construct ELJs or other appropriate countermeasures.
	Parcel 485133 and 355133	Bank erosion has progressed to the point that it is beginning to become a concern for the homes on these parcels. Use ELJs or other appropriate countermeasures to prevent additional lateral migration of the channel toward homes.
	Sediment (general)	Consider methods to manage sediment within the reach so that less is transported downstream to Cove Road.
Habitat	Stream flow	Restore year-round stream flows.
	Bank and floodplain vegetation	Vegetate channel banks and, to the extent possible, the floodplain next to the stream once year-round flows are reestablished.
	Habitat structure	Install anchored LWD or boulder vanes in secure and appropriate locations

DISCUSSION OF RECOMMENDED ACTIONS

Flood/Erosion

1. **Flooding** – The channel through this reach is quite large; therefore, flooding on the adjacent floodplain is not a significant concern. If actions are taken upstream that would direct more flow into this reach during floods, the potential flood and erosion impacts will need to be evaluated and actions may be necessary to protect homes and property that border the channel. Specifically, this issue will need to be considered when the Reed Diversion dam is removed. The dam has caused the channel upstream from it to fill with sediment, which has reduced the channel's ability to convey flow downstream to this subreach. If capacity is restored to the reach upstream from the dam, more flow will be conveyed downstream to this sub-reach.
2. **Channel Bank Erosion and Sediment** – It is very important to reestablish a healthy vegetation buffer on the banks of the channel within this reach. This will help limit lateral channel movement and, more importantly, will reduce the amount of sediment that is conveyed to and deposited at Cove Road. As part of the Cove Road sediment management plan, actions should be considered in this sub-reach that would further reduce the amount of sediment delivered to Cove Road during a major flood. For example, it may be possible to force sediment to deposit in this reach by flattening the profile by meandering the channel.

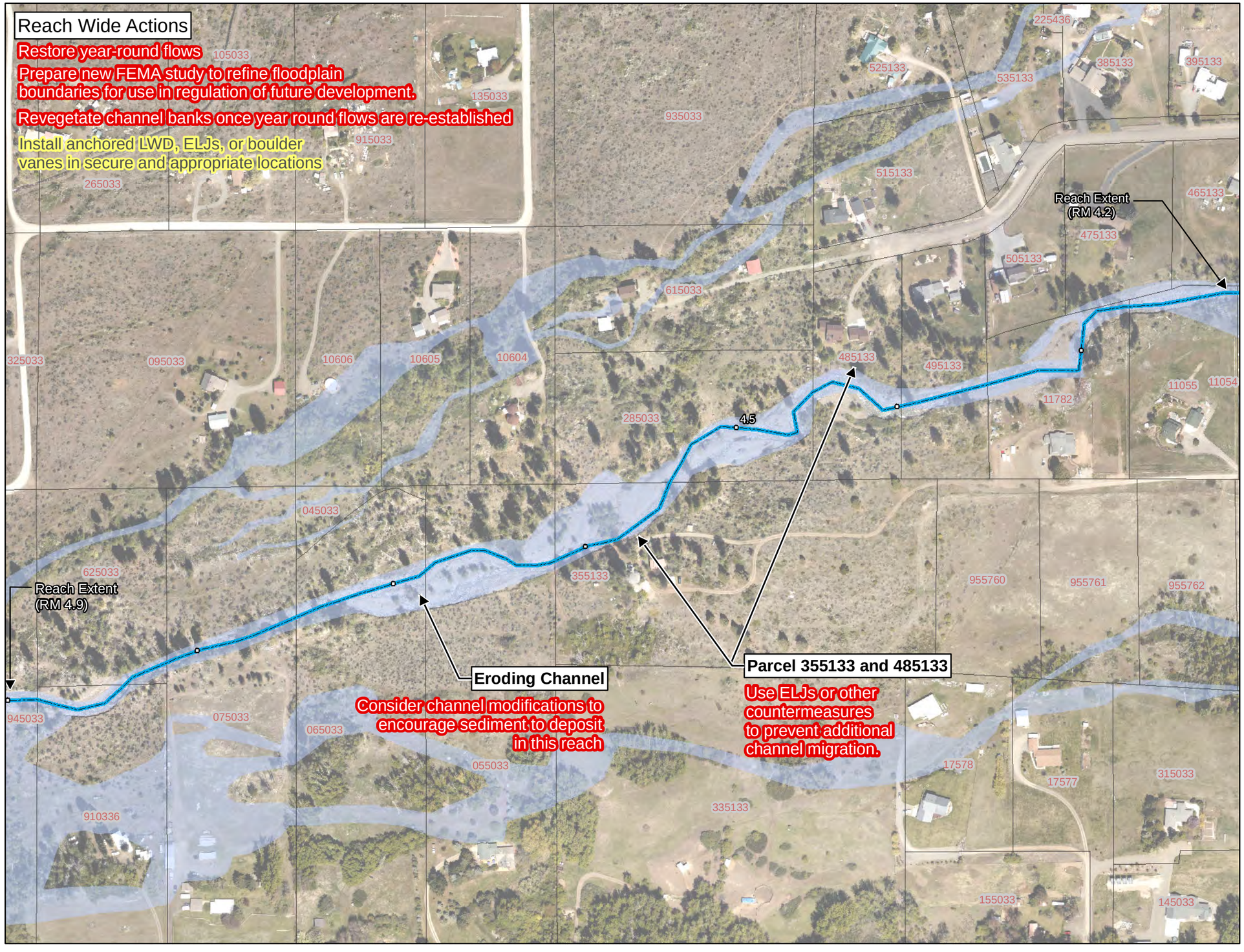
Habitat

1. **Bank Vegetation** – Healthy buffer vegetation will improve habitat by increasing shade and the quantity/quality of wood that interacts with the stream. . It is unlikely that a vegetation buffer can be established on the floodplain because the ground is sosoils are quite porous and, therefore, ground water levels are likely well below the surface. . Historical aerial photographs of the reach indicate that there was not a significant natural floodplain vegetation buffer.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into two distinct projects. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP NFWF BPA Ecology WSCC NRCS
8-1	Evaluate benefit / impact of existing berm along right bank and modify to improve flood protection and habitat if needed. Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and to simultaneously improve habitat conditions. Bank protection measures should strive for short-term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Large-scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is aesthetically acceptable to property owners.	17/20	KCCD KCFZD	SRFB YRWEP USFW WSCC NRCS
8-2	Install instream habitat structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	11/20	KCCD	SRFB YRWEP USFW



SHEET 8

Project Reach 8:
US Cove Road to DS Reed Diversion
(RM 4.2 to RM 4.9)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500
Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 1 to 8.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 9. Reed Diversion Reach (RM 4.9 to 5.2)

PRIORITY: Medium

SUB-REACH DESCRIPTION

Sub-Reach 9 centers on the Reed Diversion dam and includes a 0.1-mile-long incised reach downstream and a 0.2-mile-long aggraded reach upstream (see Sheet 9). The reach downstream is deeply incised because the dam cutoff the natural supply of coarse sediment. The reach upstream has aggraded or filled with sediment because coarse sediment has been retained by the dam.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Flooding is a significant concern on both the left (north) and right (south) floodplains upstream from the Reed Diversion dam.
2. Lateral erosion of the channel banks is not a significant issue along this reach.
3. Channel incision downstream from the dam has been significant and changes will occur once the dam is removed.

Habitat Limitations:

1. Reduced base flow leads to dry channel conditions during summer months.
2. Lack of safe fish passage due to unscreened diversion and fish passage barrier at Reed Diversion.
3. Bank vegetation is generally healthy along this reach.
4. Channel incision downstream from the Reed Diversion Dam has reduced connectivity to the floodplain.
5. Spoil pile berms line the channel upstream from the Reed Diversion Dam. These reduce floodplain connectivity.
6. Stable in-stream wood and spawning-sized substrate are lacking.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood and Erosion	General	As part of the Reed Diversion removal plan, conduct an evaluation to determine how the longitudinal profile will adjust in response to the removal of the dam. Profile adjustments will affect flooding, bank erosion, and habitat. Engineer a solution to control profile adjustments so that habitat will be maximized and flood/erosion will be minimized.
	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
Habitat	Bank vegetation	Once year-round flows are reestablished, revegetate channel banks.
	Stream flow	Restore year-round stream flows.
	Fish passage	Consolidated this point of diversion to the "Consolidated Diversion" and decommission diversion structure in order to remove an unscreened irrigation diversion and a barrier to upstream fish passage
	Floodplain connectivity	As part of the Reed Diversion Dam removal plan, carefully consider how the profile will adjust once the dam is removed to determine how floodplain function and connectivity may benefit or be impacted.
	Existing spoil pile berms	Inspect to determine their function and whether they can be removed or setback from the stream or modified.
	Habitat structures	Install anchored LWD or boulder vanes in secure and appropriate locations

DISCUSSION OF RECOMMENDED ACTIONS

Flooding – Because sediment has filled the 0.2-mile reach upstream from the Reed Dam, the channel has very little capacity to contain flood flows. During large floods water overtops both banks, with the most significant flooding along the right (south) bank. The water that leaves the channel floods a large area of the floodplain, then finds its way into a historical swale that transports the flow downstream. This flow does not rejoin the mainstem until it reaches the abandoned dam and Serenity Lane areas. Flows in this swale damaged a number of structures and driveways during the May 2011 flood. Flows that leave the channel along the left (north) bank, generally flood areas adjacent to the Reed Diversion ditch. It is our understanding that these flows did not cause significant damage to homes or structures, but did damage driveways during the May 2011 flood. Ultimately the flows are intercepted by Hanson Road where, in May 2011, they joined other overflows and together caused significant erosion damage to the road.

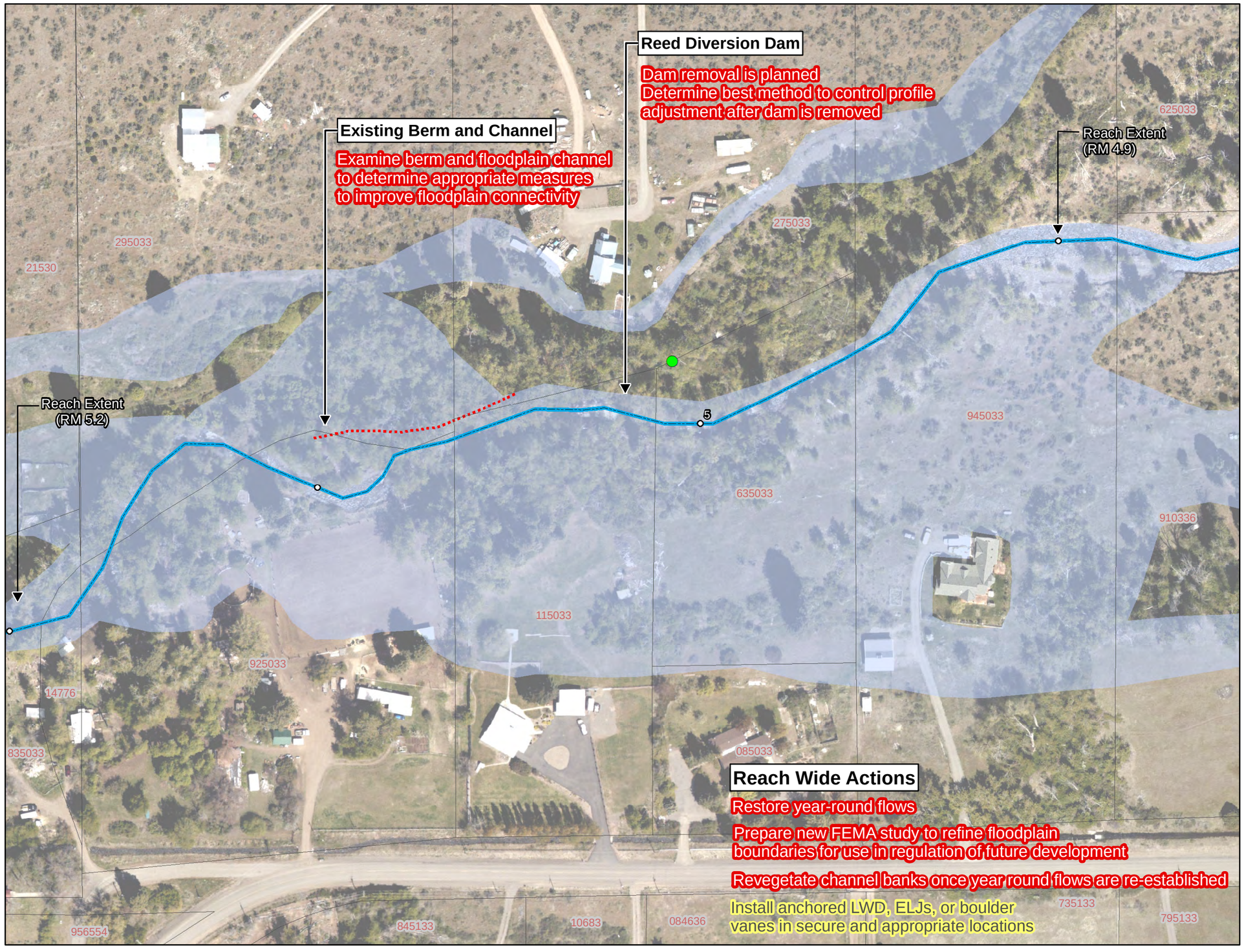
Channel Profile and Flooding – Changes to the channel profile will have to be carefully evaluated and considered as part of the Reed Diversion dam removal project. Once the dam is removed, the channel profile will adjust. It may not be in the best interest from either a flood or habitat perspective to allow uncontrolled adjustments because deep incision would progress upstream and would severely damage existing high quality habitat, floodplain connectivity, and channel stability. However, a controlled profile adjustment may improve both habitat and reduce flooding.

Allowing the upstream channel to degrade one or two feet to reestablish pre-dam natural bed levels should be considered.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented as a single project on that scale if possible. The table below summarizes this project. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General-1	Instream flow restoration	17/20	KCCD USBR Trout Unlimited	YRBWEP NFWF BPA Ecology WSCC NRCS
9-1	Restore safe fish passage for all life stages at the Reed Diversion by consolidating the point of diversion for the water rights to the "Consolidated Diversion" and removing structure. Predict channel response to dam removal; take action needed to prevent adverse impacts on flooding and habitat. Install series of grade control weirs to prevent significant upstream channel incision once dam is removed and restore stream banks. Revegetate banks and cleared areas upstream of the Reed Diversion. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is aesthetically acceptable to property owners.	14/20	KCCD	SRFB YRBWEP USFW WSCC NRCS



SHEET 9

Project Reach 9:
Reed Diversion Reach
(RM 4.9 to RM 5.2)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- 1 River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 60 120 240

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (6/7/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 10. Natural Reach (RM 5.2 to 5.5)

PRIORITY: High

SUB-REACH DESCRIPTION

Sub-Reach 10 is a 0.3-mile reach that appears to be in very good condition. It has excellent habitat and few significant flooding problems (see Sheet 10).

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. There may be flood and erosion hazards associated with a private driveway bridge in the reach.
2. Flood waters flow through swales in the Manastash floodplain in this reach, but no significant hazards to structures or infrastructure are known.

Habitat Limitations:

1. Lack of safe fish passage due to an unscreened irrigation diversion.

RECOMMENDED ACTIONS

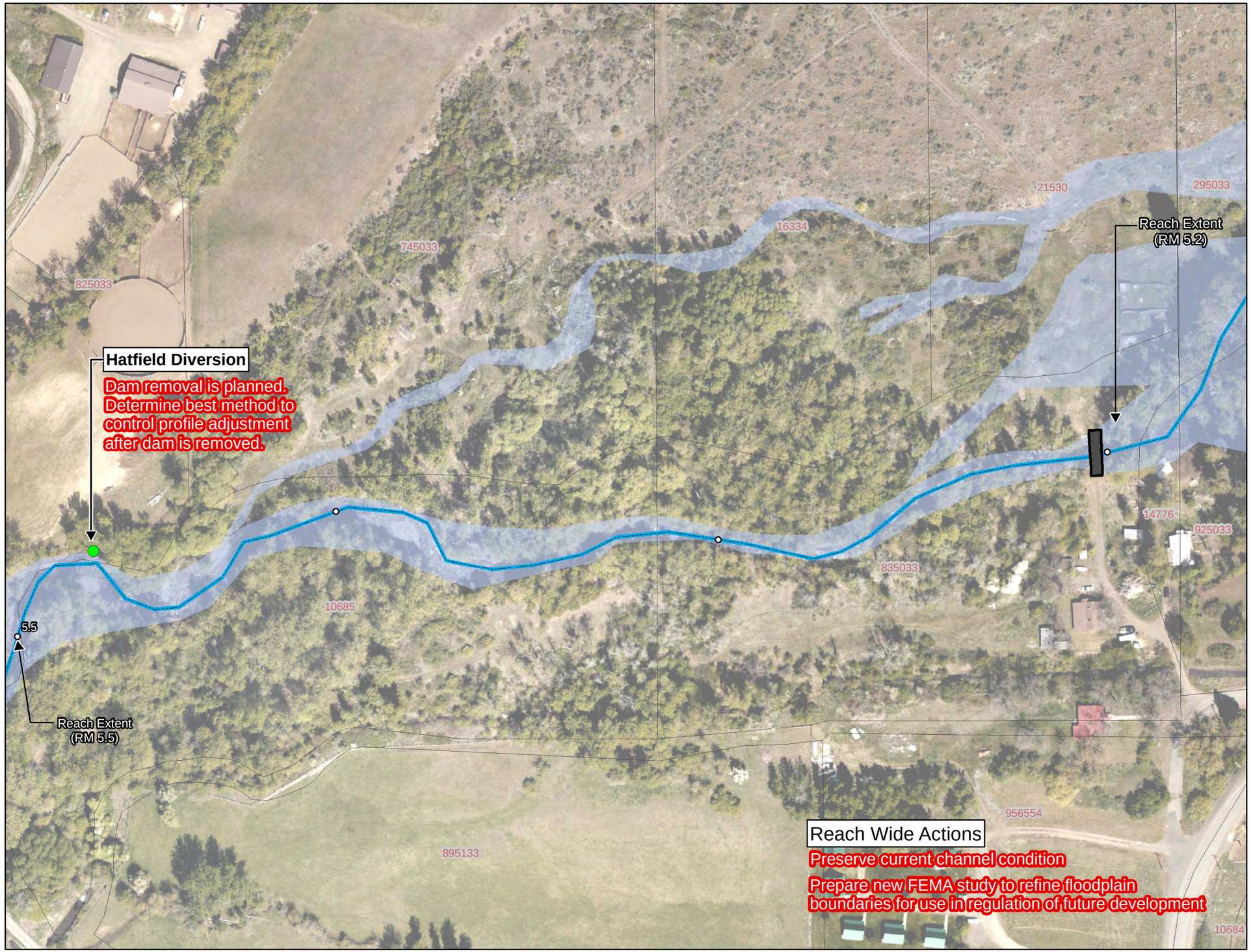
Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood, Erosion and Habitat	Entire reach	Preserve in current condition. If necessary for preservation, consider purchasing a conservation easement from landowners.
	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
	Private bridge	Investigate potential flood and erosion hazards
	Hatfield diversion	Remove once diversion consolidation actions are complete.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
10-1	Protect quality habitat from future impacts. Pursue conservation easements to preserve existing high quality habitat. Decommission Hatfield diversion once Consolidated pipeline is operational.	15/20	KCCD KCFCZD	SRFB YRBWEP USFW
10-2	Decommission Hatfield Diversion – install fish screen or blockage as necessary to prevent fish loss down Hatfield Ditch	10/20	KCCD	SRFB YRBWEP USFW



SHEET 10

Project Reach 10:
Natural Reach
(RM 5.2 to RM 5.5)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 62.5 125 250

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (6/7/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 11. KRD South Branch Road Reach (RM 5.5 to 5.7)

PRIORITY: High

SUB-REACH DESCRIPTION

Sub-Reach 11 is a 0.2-mile-long reach that includes the KRD South Branch Road crossing, a KRD operational spill and siphon, and a significant levee (see Sheet 11).

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. The KRD South Branch Road bridge is narrow and should be enlarged.
2. The levee upstream from the KRD South Branch Road overtops during large floods.
3. The KRD South Branch Road is damaged from water overtopping during flood events.
4. Concrete apron over siphon is damaged from scour.

Habitat Limitations:

1. The KRD South Branch Road bridge is narrow and includes a concrete apron on the channel floor.
2. The leveed reach upstream of the bridge was scoured clean during the May 2011 flood. The channel floor degraded 12 to 18 inches during the flood. As a result it has no significant channel complexity (i.e. pools, riffles, woody debris, etc.) and, therefore, habitat conditions are poor.
3. The vegetation buffer along the right (south) bank upstream from the bridge is thin due to the presence of the levee and the adjacent pasture.
4. Irrigation water discharged into the stream at KRD spill can elevate stream water temperature in the hot summer months.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood and Erosion	KRD South Branch Road bridge	Replace KRD South Branch Road bridge with longer structure to improve conveyance. Modify road to accommodate new bridge.
	Levee	Consider setting the existing levee back from the stream to increase channel conveyance. Do this in conjunction with replacement of the KRD bridge.
	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
Habitat	KRD South Branch Road bridge	Remove concrete apron when a new crossing is installed, and provide alternative pipeline protection.
	Levee	Set back the levee to reduce channel velocities so that the stream bed will not scour during floods.
	Habitat structure	If the levee is set back, restore channel complexity by installing

		anchored LWD or boulder vanes in secure and appropriate locations.
	Vegetation	Increase vegetation on the right (south) bank. If the levee is set back, plant the floodplain bench between the stream and levee.
	Irrigation return flows	Investigate methods to reduce water temperature impacts caused by irrigation return flows (e.g. infiltration).

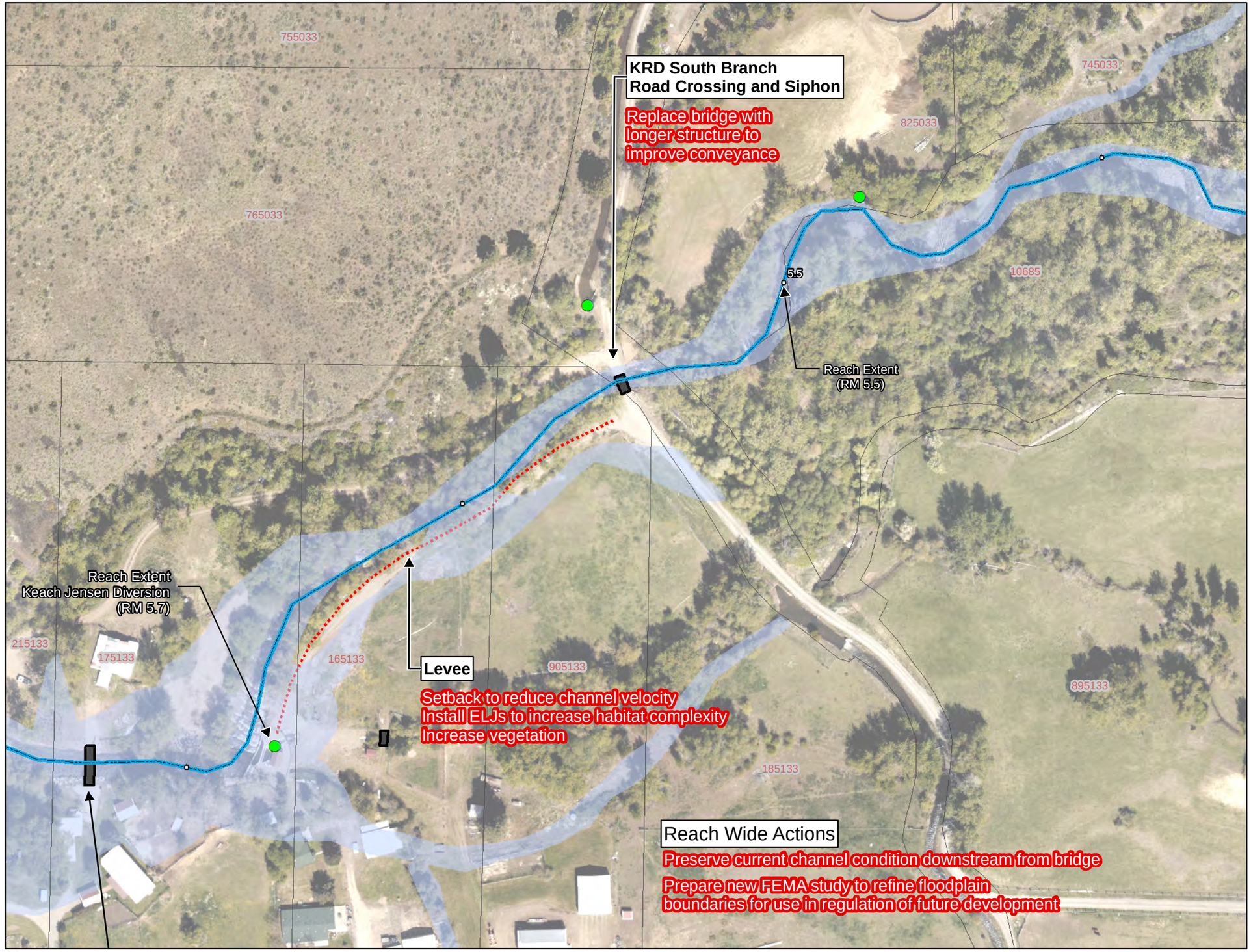
DISCUSSION OF RECOMMENDED ACTIONS

KRD Bridge and Levee – The KRD South Branch Road bridge is too narrow, and the levee immediately upstream is too close to the stream. Combined, these cause velocities to increase significantly during floods, causing the bed to scour. The levee overtops during major floods, which allows water to flow across the floodplain and over the KRD gravel road. We recommend working with the KRD and the landowners to seek a comprehensive solution that would reduce flooding and improve habitat. Key components would include a new bridge and setting the existing levee back from the stream.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented as a single project on that scale if possible. The table below summarizes this project. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
11-1	Replace or Modify KRD South Branch Road crossing with a longer bridge (larger waterway) and armor road shoulder. Remove concrete apron at siphon and provide alternative pipeline protection. Assess impact of KRD spill. Remove or set back levee/access road on right bank to improve flood storage and enhance floodplain connectivity. Revegetate streambank and pasture areas on right bank if levees are set back. Install bank habitat structures where appropriate to replace current bank armoring and to simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	9/20	KRD USBR KCCD	YRBWEP SRFB USFW WSCC NRCS



SHEET 11

Project Reach 11:
KRD South Branch Road Reach
(RM 5.5 to RM 5.7)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 62.5 125 250

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Hazard Reduction

SUB-REACH: 12. Keach-Jensen to Manastash Road Bridge (RM 5.7 to 6.2)

PRIORITY: High

SUB-REACH DESCRIPTION

Sub-Reach 12 begins at the Keach-Jenson Diversion and extends upstream 0.5 mile to the Manastash Road Bridge (see Sheet 12). This reach is highly prone to flooding, sediment deposition, and lateral channel movement.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. The majority of the valley floor in this sub-reach was inundated during the May 2011 flood, and several homes were flooded.
2. Lateral channel movement and local bank erosion are concerns for all parcels. All experienced some form of erosion during the May 2011 flood.
3. Sediment deposition is and will continue to be a significant issue, particularly on the three or four most upstream parcels. Sediment deposition initiated most of the lateral erosion that occurred during the May 2011 flood. Sediment deposits in this reach because: 1) the channel slope flattens approximately 20 percent, and the valley expands as the stream leaves the narrow confines of the upstream reach; and 2) the reach upstream from the bridge is narrow and, therefore, sediment tends to be transported through it rather than deposited.

Habitat Limitations:

1. Due to the natural sediment deposition characteristics within this reach, there are numerous historic channel scars and wetlands, several of which have been affected by human activities such as grading, site development, and pond excavation.
2. A healthy stream bank vegetation buffer is absent in places.
3. Channel is confined at Manastash Road crossing and by revetments and spoil pile berms in reach.
4. LWD and spawning-sized substrate are lacking.

SUMMARY OF RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Floodplain development regulations	Refine FEMA floodplain and floodway boundaries to establish new defensible maps. Use these maps to regulate future development and structure improvements.
	Existing homes within floodway	Elevate homes if allowed under County Code; move homes out of floodway if possible; purchase existing homes when owners are ready to move, then remove structures and convert to conservation land.
	Keach Jensen and MWDA	Monitor effectiveness of modification made to protect facilities.

	diversions	
Erosion	All properties	Stabilize banks as needed to protect existing structures and high value land. Use methods that minimize impacts on habitat. Long term, seek to purchase properties and allow the stream to migrate freely. Highest priority parcels are those that are likely to see significant sediment deposition (three or four upstream parcels).
	Private bridge and revetment on parcel 175133	Monitor condition of existing revetment and bridge.
Habitat	Wetlands on parcels 235133, 055133, and 17936	Over the long term, seek to purchase properties then restore wetlands and floodplains in a manner that allows natural hydraulic and fluvial process to maintain function.
	MWD diversion	Monitor effectiveness of modifications made to reduce sediment deposition problem in the diversion intake.
	Bank vegetation	Revegetate banks where buffers do not exist or are narrow.
	Habitat structure	Install anchored LWD or boulder vanes in key locations.

DISCUSSION OF RECOMMENDED ACTIONS

1. **Floodplain Development Regulations** – Kittitas County is a member of the National Flood Insurance Program (NFIP) and, as such, its citizens are allowed to purchase federally backed flood insurance. As a member of the NFIP, the County must uphold specific floodplain development regulations mandated by FEMA. One rule is that residences cannot be built within a designated FEMA floodway. In addition, non-residential structures cannot be built within a floodway unless it can be demonstrated that the structure will have no impact on base flood elevations (BFE), which is the level of the 100-year flood. Existing structures that were present before the FEMA floodway was mapped can remain, but they cannot be modified unless it is shown that the proposed changes will not cause BFEs to rise. If a structure is substantially damaged (by flood, fire, landslide, etc.), it cannot be rebuilt within the designated floodway. Since nearly all of the homes within this reach are located within the mapped floodway, and because new LiDAR topographic data are available, we recommend updating the floodplain and floodway boundaries to ensure that they are correct and defensible. Refining the FEMA map would require a hydraulic investigation, which would include the development of a simple hydraulic computer model of the reach.
2. **Existing Homes within Floodway** – For resident safety, preventing potential catastrophic monetary loss, and long-term habitat health, it is our recommendation that a long-term strategy be developed to remove structures from the floodway. The highest priority properties are those where significant sediment tends to deposit (Parcels 035133, 235133, 055133 and 17936). It is our understanding that steps have been taken by the County to determine if grant funds can be obtained to purchase parcel 035133, which is currently for sale. We are NOT suggesting that residents be forced to move. Rather, alternatives should be presented and discussed with the property owners; the alternatives may include property purchase at such a time as they are ready to move.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into two distinct projects. The table below summarizes these projects. Details regarding project scores can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
12-1	Consider measures to reduce flooding at Keach Jensen and MWDA diversion facilities; improvement of crossings and riprap embankments; install measures to discourage sedimentation at diversion inlets.	10/20	KCCD	SRFB YRBWEP
12-2	Elevate or buy out homes. Property owners in this area report regular and significant problems with flooding, sedimentation, and ice jams. Consider purchasing the property at a fair price and restoring the area. Associated building/structure removal and floodplain restoration should be included. Revegetation of banks, floodplain areas, and cleared areas throughout the reach, especially on right bank along residential properties. Work with landowners throughout the reach to develop a re-vegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.	10/20	Kittitas County Public Works KCCD	KCFCZD SRFB FEMA YRBWEP USFW WSCC NRCS

Reach Wide Actions

Prepare new FEMA study to refine floodplain boundaries for use in regulation of future development

Revegetate channel banks and floodplain where appropriate
Construct bank protection and habitat structures using ELJs and boulder vanes

MWDA Diversion

Develop solution to sediment deposition at diversion inlet

MWDA and Keach Jensen Diversion

Determine if countermeasures should be installed to reduce flood damage risk

Existing FEMA Floodway

High quality wetland area

Long term, seek to restore wetland

Reach Extent
Keach Jensen
Diversion
(RM 5.7)

Private Bridge

Monitor conditions of bridge and existing revetment

Spoil Pile Berms

Evaluate benefit/impact and work with landowners to modify

Reach Extent
Manastash Road Bridge
(RM 6.2)

Parcels 035133, 235133, 055133 and 17936

Flood proof homes if allowed under County code
Eventually purchase pacels when landowners are ready to move, then remove structures and convert to conservation land

Limit of FEMA Floodway. Downstream area (in red) is approximate flood zone No FEMA Floodway exists for this area

675033 755033 765033 025133 255133 075133 085133 245133 028136 035133 235133 055133 17936 225133 215133 175133 165133 875133 6

SHEET 12

Project Reach 12:
Keach Jensen to Manastash Rd Bridge
(RM 5.7 to RM 6.2)

DRAFT

Legend

- Diversion
- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)

FEMA Flood Zone

- Floodplain A and AE
- Floodway

River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 9 to 21.mxd (4/9/2013)

Manastash Creek
DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 13. Manastash Bridge Confined Reach (RM 6.2 to 6.85)
PRIORITY: Low

SUB-REACH DESCRIPTION
Sub-Reach 13 begins at the Manastash Road bridge near the mouth of the canyon and extends 0.4 mile upstream (see Sheet 13). Within the downstream 0.2 mile, the channel is confined to a narrow corridor by the county road. Within the upstream 0.2 mile, the canyon widens and neither the county road nor canyon walls constrict the channel.

EXISTING HAZARDS AND LIMITATIONS
Flood and Erosion Hazards:

1. Flooding is generally not a major problem within this reach, with the exception of parcel 645133. The home on this parcel was not flooded in May 2011, but was flooded in 1996, and remains a risk of future flood damage.
2. Erosion is a significant concern. The channel is eroding the bank along the county road in three locations. The existing riprap revetments at these sites are too steep and likely will be damaged or fail during future floods.
3. Logs with root wads project from the rock revetment that protects the county road at the downstream erosion site. The logs project too far into the channel and are likely to catch debris and create log jams. This could worsen flooding and erosion.

Habitat Limitations:

1. The lower 0.2 mile of the channel is artificially confined to a narrow "chute" by the county road. There is little to no habitat complexity within this reach.

RECOMMENDED ACTIONS
Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
	Home on parcel 645133	Determine best method to flood-proof the structure.
Erosion	Three erosion sites along county road	• At the two upstream sites, reconstruct the rock revetments on a flatter slope and add a buried toe key. • At the downstream site, there is no obvious cost-effective solution due to limited room. The greatest benefit would be to set the road back from the stream channel, but this is not a reasonable alternative at this time.
	LWD along county road revetment downstream site	Cut off the logs. If mitigation is required, replace with LWD at or near the two erosion sites upstream.
Habitat	0.2 mile confined reach	The only meaningful solution to improve habitat within this reach would be to move the county road away from the stream. This is not a practical solution at this time.

DISCUSSION OF RECOMMENDED ACTIONS

Homes – Within the downstream 0.2 mile of the reach, four homes are located on parcels north of the road. These parcels would flood if it were not for the county road. The road is elevated on fill, which prevents water from flooding the properties (with the exception of the home immediately downstream from the bridge). Near the upstream end of this confined reach, the road is elevated only about one foot above the floodplain, so it is possible that water could overtop the road at this location and flow through all four of these properties during a major flood. It is unknown if this occurred during the May 2011 flood. Within the upstream 0.2 mile, one developed parcel may experience flooding during major events.

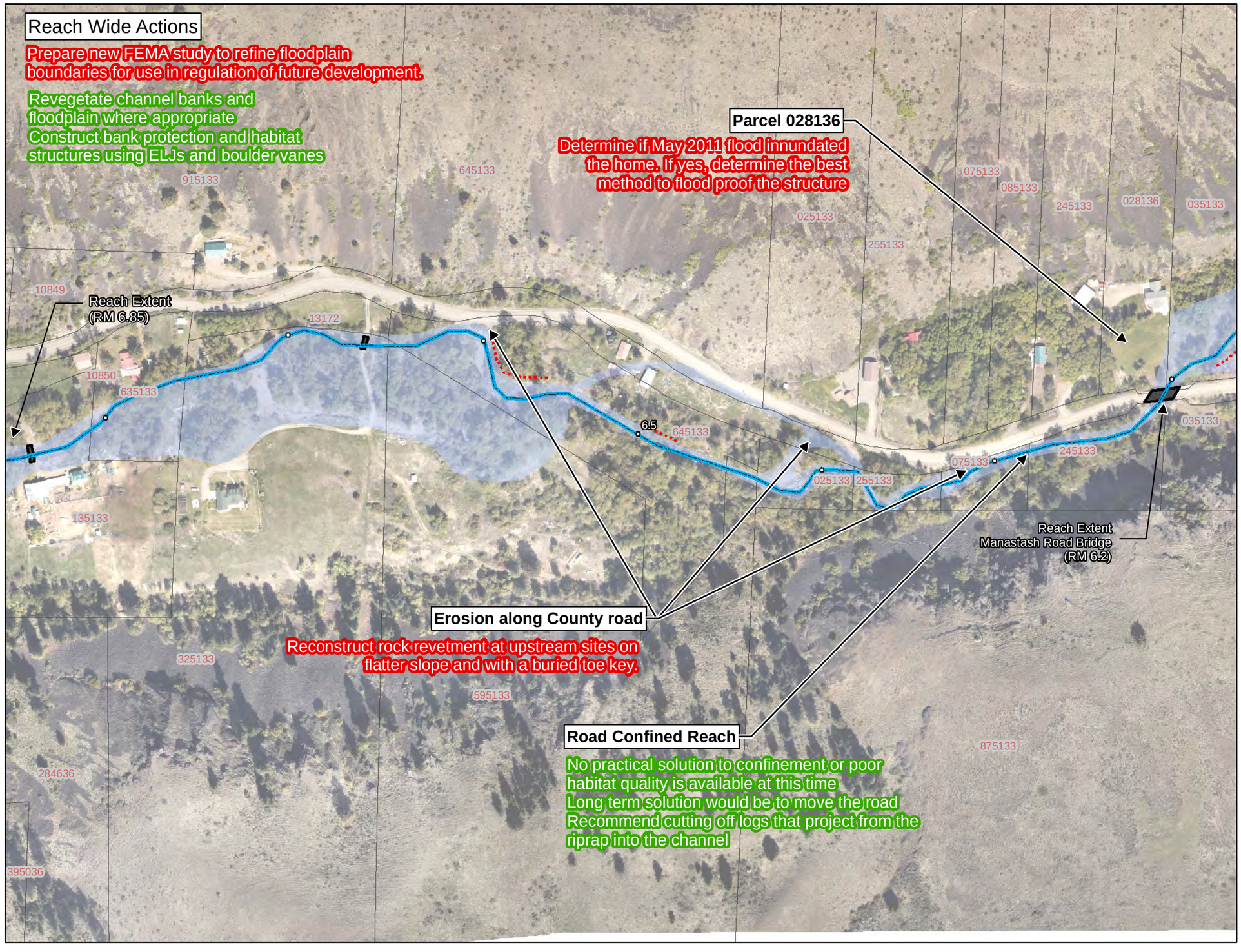
Three Erosion Sites – At all three sites, the rock revetments are too steep and do not appear to contain an adequate rock toe. It is likely that all three revetments will be damaged during future large floods. The County should work with WDFW to reconstruct the revetments at the two upstream sites because these sites have adequate room to place the revetments on a flatter slope and to construct an adequate toe key. Not much can be done at the downstream site because the road is so close to the stream. The best solution would be to move the road away from the stream, but this is an unrealistic alternative at this time for it would require purchase of the parcels to the north and major capital investment to physically move the road.

LWD Embedded in Rock Revetment – Several logs with root wads extend into the channel from the riprap revetment that protects the county road within the confined reach at RM 6.3. These logs were installed as part of the recent revetment project. The logs present a serious hazard for they extend too far into the channel and will catch debris. This could aggravate flooding and poses a serious threat to the stability of the revetment. The logs should be cut off and, if mitigation is necessary, securely anchored logs should be installed at a different and more appropriate location. The reach needs complexity; however, until the road can be moved away from the channel, wood should not be installed within this reach unless it can be done a manner that does not pose a hazard or risk.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. The table below summarizes these projects. Details regarding project scores can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and to simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-Proof, Elevate, or Protect Homes.	8/20	KCFCZD	FEMA SRFB USFWS
13-1	Modify existing bank protection LWD to prevent debris collection to ensure road protection.	9/20	Kittitas County Public Works	KCFZD



SHEET 13

Project Reach 13: Manastash Bridge Confined Reach (RM 6.2 to RM 6.85)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches 9 to 21.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACHES: 14 – Typical Canyon Reach

PRIORITY: Low

SUB-REACH DESCRIPTION

Sub-reach 14 is located within the Manastash Canyon (see Sheet 14). Detailed inspections were not conducted along this reach, so site-specific flood/erosion hazards and habitat limitations have not been identified. However, general issues are present and are identified below.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Lowland floodplain areas near the stream are prone to flooding. Buildings that occupy these areas will be inundated during large floods. Fortunately, most, but not all, homes have been built on slightly elevated land.
2. Driveway bridges are typically just long enough to span the active channel and the abutments are immediately adjacent to the stream. This constricts the channel, which results in increased velocities and scour of the streambed, which can cause the abutments to fail. Also, many of the bridges will capture debris because they are either too low or the waterway is too narrow. A debris jam can push a bridge deck off its abutments and constrict the channel, deflecting flow into an abutment or onto the floodplain.
3. Sediment deposition is a major concern in certain areas. It can reduce channel capacity and therefore increase flooding, increase bank erosion, or cover low floodplain areas with coarse material.

Habitat Limitations:

1. Vegetation buffers are thin or do not exist in some areas.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the low lying high hazard areas near the channel.
	Buildings in low floodplain areas	Treat case-by-case. Consider methods to flood-proof, elevate, or move structures if there is significant damage potential.
	Bridges and driveways	• Develop a simple document that will help landowners understand why bridges should be longer and higher. The document should include design examples and a step-by-step guide to the permit process. • Approach fills that elevate a driveway to a bridge should be as short as possible to minimize blockage of the floodplain. • Driveways that cross the floodplain should remain low to avoid blocking floodplain flow paths.

		• Remove remaining abutments from abandoned crossings.
	Woody debris	The canyon reach is not wood debris limited. Therefore, monitor wood debris accumulations and, if they pose a significant threat to a bridge or structure, the landowner should work with WDFW to reduce the threat. Options may include: replacing a bridge if it is a chronic debris catcher, cutting the wood into smaller pieces and letting it pass downstream, or removing the wood.
Erosion and Sediment	Local bank erosion	Develop simple guidelines that clearly describe the steps required to protect an eroding bank. This document should include design examples and a step-by-step guide to the permit process.
	Sediment deposition	Conduct an investigation to understand sediment transport and deposition processes within the canyon. Use this information to determine if actions can be taken to minimize sediment deposition in areas where it will cause significant damage to developed lands.
Habitat	Vegetation	Plant vegetation on the channel banks and floodplain where little to no buffer exists.

IMPLEMENTATION

The general actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions are grouped into a single general project. The table below summarizes this project. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-Proof, Elevate, or Protect Home.	8/20	KCFCZD KCCD	KCFCZD FEMA SRFB YRBWEP
14-1	Revegetate streambanks and floodplain to improve shading and reduce excessive floodplain sediment deposition.	13/20	KCCD	SRFB
14-2	Remove remaining abutments from abandoned bridge crossing	11/20	KCFCZD	KCFCZD

SHEET 14-1
Project Reach 14:
Canyon 14 (1 of 3 Figures)
(RM 6.85 to RM 8.9)

DRAFT

Driveway Bridges

Develop simple document to help owners understand why bridges should be longer and higher, including design examples and step-by step permiting.
Keep bridge approach fills short and driveway fill low to minimize floodpain blockage.

Wood Debris

Monitor wood accumulations. If they pose a risk to structures landowners should work with WDFW to reduce threat.
Options may include replacing bridges that catch debris, cutting wood to let is pass, or debris removal.

Reach Extent (RM 6.85)

Floodplain

Remove abandoned bridge abutments

Upstream Reach Extent Not Pictured (RM 8.9)

Erosion and Sediment

Develop simple document to help landownsers understand what they need to do to install bank protection. Include design examples and step-by-step permitting process.
Conduct investigation of sediment transport and deposition within the canyon and detemine if actions can be taken to minimize deposition in developed areas

Flood Protection

Prepare new FEMA study to refine floodplain and floodway boundaries for use in regulation of future development.

Consider methods to flood proof, elevate, or move structures with significant flood damage potential.

Habitat

Plant vegetation on channel banks and floodplain where little to no buffer exists

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

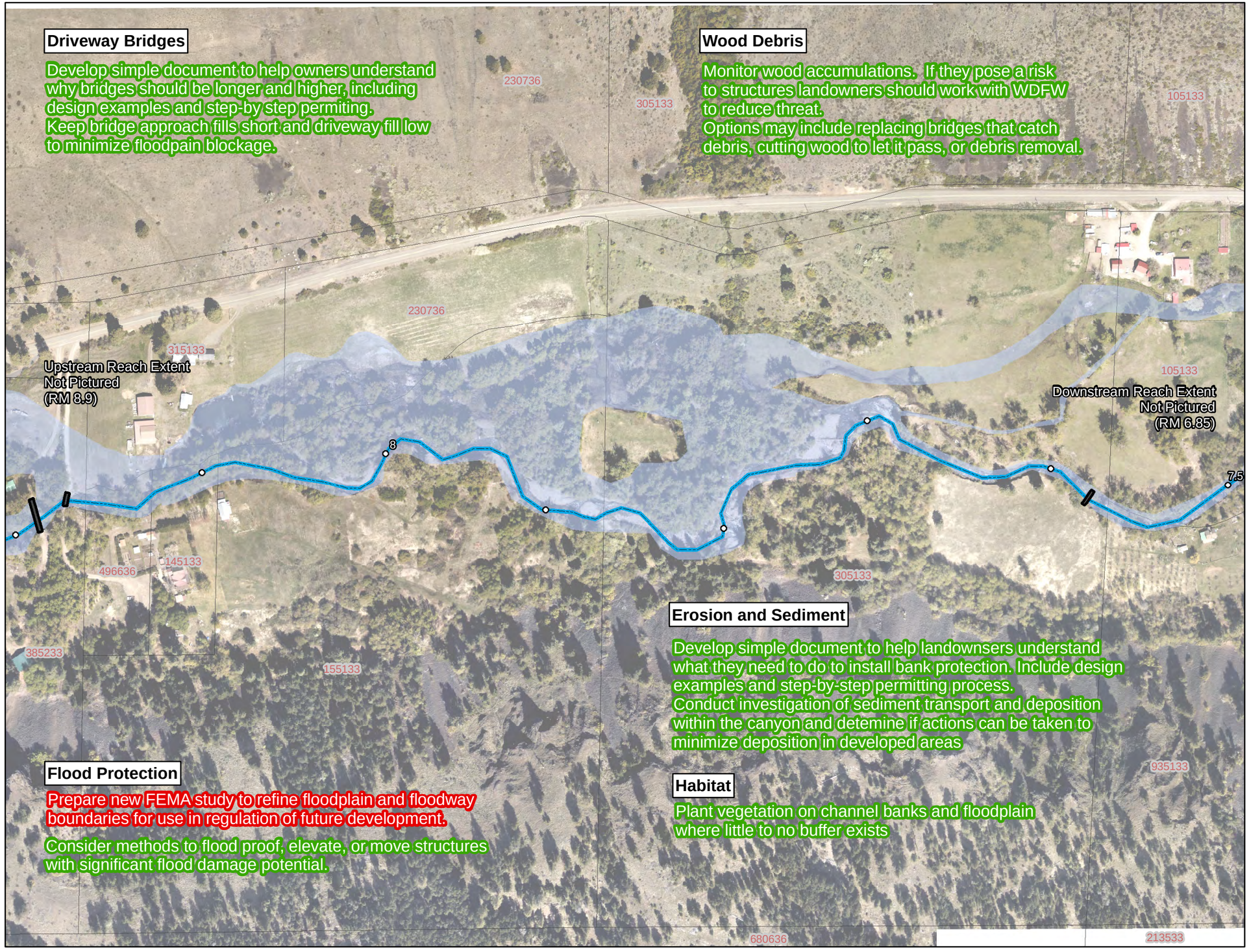
N

0 125 250 500
Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (6/7/2013)



SHEET 14-2

Project Reach 14:
Canyon 14 (2 of 3 Figures)
(RM 6.85 to RM 8.9)

DRAFT

Legend

- Bridges
- Manastash Creek
- Approx. Limits of May 2011 Flood
- Berm
- Tax Parcels (see note)
- Tenth Mile Marker
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches Canyon.mxd (6/7/2013)

Driveway Bridges

Develop simple document to help owners understand why bridges should be longer and higher, including design examples and step-by step permiting.
Keep bridge approach fills short and driveway fill low to minimize floodpain blockage.

Wood Debris

Monitor wood accumulations. If they pose a risk to structures landowners should work with WDFW to reduce threat.
Options may include replacing bridges that catch debris, cutting wood to let it pass, or debris removal.

Erosion and Sediment

Develop simple document to help landownsers understand what they need to do to install bank protection. Include design examples and step-by-step permitting process.
Conduct investigation of sediment transport and deposition within the canyon and detemine if actions can be taken to minimize deposition in developed areas

Reach Extent (RM 8.9)

Downstream Reach Extent Not Pictured (RM 6.85)

395233
465233
230736
335233
230736
435233
10945
8.5
355233
405233
365233
385233
455233
375233

Flood Protection

Prepare new FEMA study to refine floodplain and floodway boundaries for use in regulation of future development.

Consider methods to flood proof, elevate, or move structures with significant flood damage potential.

Habitat

Plant vegetation on channel banks and floodplain where little to no buffer exists

SHEET 14-3
Project Reach 14:
Canyon 14 (3 of 3 Figures)
(RM 6.85 to RM 8.9)

DRAFT

Legend

- Bridges
- Manastash Creek
- Approx. Limits of May 2011 Flood
- Berm
- Tax Parcels (see note)
- Tenth Mile Marker
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500
Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches Canyon.mxd (6/7/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 15. North Fork Manastash Creek Confluence (RM 8.9 to 9.5)

PRIORITY: Medium

SUB-REACH DESCRIPTION

Sub-Reach 15 includes the mainstem Manastash Creek and the North Fork of Manatash Creek from its confluence to approximately 350 feet upstream from the Manastash Road crossing (see Sheet 15). This reach of the stream flows down an alluvial fan that the North Fork has created on the floodplain of the main stem.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. The county road and the parcel upstream/north of the road were severely damaged during the May 2011 flood at the N.F. Manastash Creek crossing.
2. Earthen flood reduction berms parallel both banks of the channel downstream from the road at the N.F. Manastash Creek crossing and the left (east) bank upstream.

Habitat Limitations:

1. The N.F. Manastash Creek reach at the Manastash Road crossing bordered by berms is essentially a swift chute that has no significant channel complexity (i.e. pools, riffles, woody debris, etc.) and therefore, habitat conditions are poor.
2. The berms are located at the edge of the channel and cut off the natural connection to the historical floodplain.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Crossing	Replace existing culvert crossing with a larger culvert or bridge.
	Berms	Construct floodplain bench to reduce confinement (see cautionary notes below).
Erosion	Berm upstream	The upstream berm is critical to protecting the parcel to the east and the county road.
Habitat	Berms	• Determine if the downstream berms are needed and remove or set back if possible (see cautionary notes below). • Setback the upstream berm to the extent possible without having to remove the cottonwood trees that cover the adjacent floodplain.

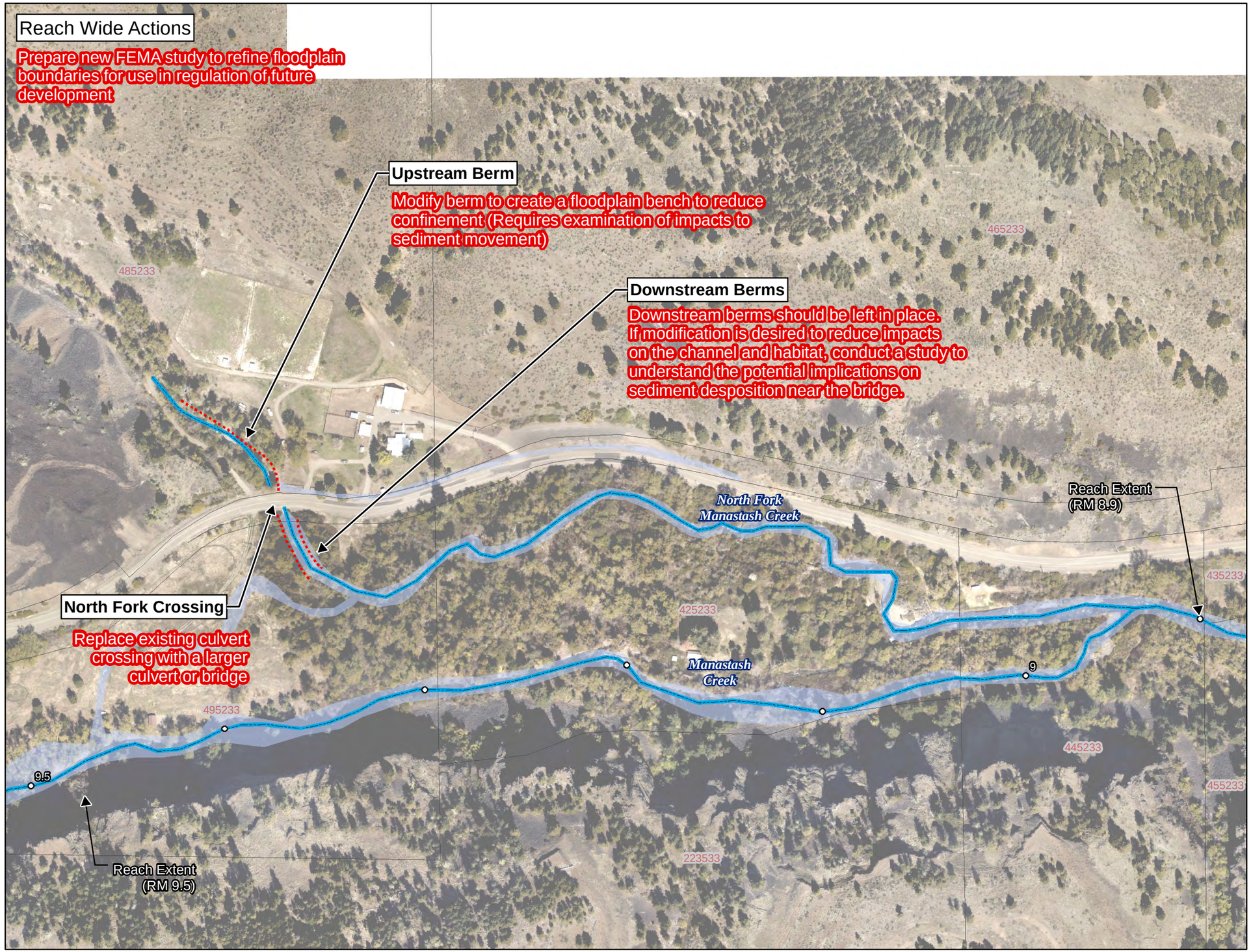
DISCUSSION OF RECOMMENDED ACTIONS

Berms – The upstream berm will be modified as part of the crossing replacement, but the downstream berms will not, other than to refine how they tie in to the new bridge waterway. If there is sufficient concern over the berms and their effect on channel processes, a detailed hydraulic and sediment investigation will need to be conducted. Due to the confinement provided by the berms, the reach is a very efficient conveyor of sediment. Removing or setting the berms back from the channel may cause sediment to deposit in the vicinity of the bridge, which could create the need to conduct sediment management activities in the vicinity of the road to keep the bridge waterway open. This should be avoided.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. The table below summarizes these projects. Details regarding project scores can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and to simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-Proof, Elevate, or Protect Homes.	8/20	KCCD KCFZD	SRFB KCFZD FEMA YRBWEP
15-1	Replace Manastash Road crossing over North Fork Manastash Creek; armor ditch and embankment; remove existing berms; develop sediment management plan.	14/20	Kittitas County Public Works	KCFZD SRBF YRBWEP



SHEET 15

Project Reach 15:
North Fork Confluence Reach
(RM 8.9 to RM 9.5)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (6/7/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 16. County Road Reach (RM 9.5 to 10.3)

PRIORITY: High

SUB-REACH DESCRIPTION

Sub-reach 16 includes approximately 0.4 mile of Manastash Creek near RM 10 (see Sheet 16). The reach passes through two private parcels and land owned by WDFW. Approximately one-half of the reach was straightened many years ago to maximize productive crop/range land and to accommodate the county road.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Flooding of home/ranch buildings and lateral erosion that threatens a historic working barn.
2. Flooding of the County road and recurring damage to the revetment that protects the road.
3. Possible partial obstruction to the down-valley movement of water on the floodplain by an old, slightly elevated, driveway fill that crosses the floodplain on WDFW property.
4. Constriction of the channel and possible erosion risk at two driveway bridges.

Habitat Limitations:

1. The channel is confined to a straight reach along the county road, and is bounded by riprap protection along the road on the left (north) bank and a berm on the right bank that limits flooding of range land to the south.
2. The straightening of the channel has affected sediment movement and, therefore, has negatively affected natural in-channel geomorphic features such as riffles, pools, etc.
3. Lack of buffer vegetation along the stream in specific locations.
4. Small bridges cross Manastash Creek at many locations within Manastash Canyon, confining the channel and disconnecting the creek from the floodplain.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards and habitat limitations are:

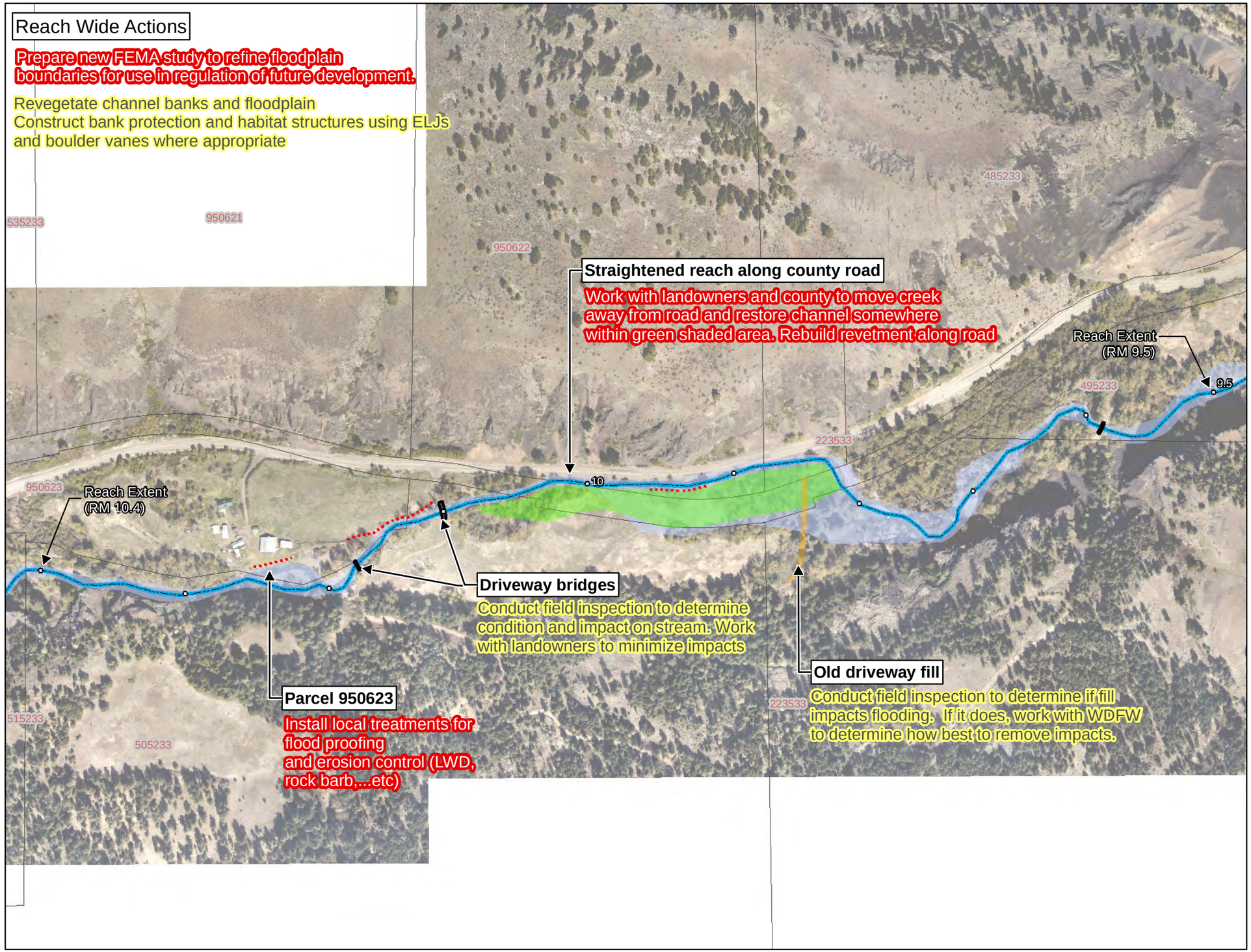
	Specific Features or Sites	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
	Parcel 950623	Investigate and implement appropriate methods to limit flood inundation damage to home and ranch buildings.
	County road	Eliminate confinement by removing berm along right (south) bank and relocate channel to forested area.
	Old driveway road fill	Determine if it affects flooding. If it does, consider alternatives to minimize impact.
Erosion	County road	Relocate stream away from road and reconstruct rock revetment on a flatter slope so that it is more secure.
	Parcel 950623	Install bank protection features to prevent additional migration toward buildings. Use methods that include LWD.
	Driveway bridges	Inspect bridges to determine their impact on the stream and the condition of the abutments. If bridge abutments have been damaged, work with landowners to repair/protect. Long term, seek to improve or replace crossings to minimize their impact on stream processes.
Habitat	Straightened reach	Move channel away from county road into forested floodplain to the south. Restore natural geomorphic characteristics.
	Bridges	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes.
	Bank vegetation	Revegetate banks where buffers do not exist or are narrow.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions were grouped into two distinct projects. The table below summarizes these projects. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and to simultaneously improve habitat conditions. Perform hydraulic modeling and	8/20	KCFZD KCCD	SRFB KCFZD FEMA YRBWEP

	geomorphic analysis to ensure that structures do not increase flood risk. Flood-Proof, Elevate, or Protect Homes.			
16-1	Currently, the Manastash Creek channel runs parallel and immediately adjacent to Manastash Creek Road. Erosion and flooding issues are common here. Relocate the creek channel into the vegetated floodplain, away from county road. Remove old access road fill in floodplain to improve floodplain function. Revegetate floodplain areas and cleared areas throughout the reach. Once mature vegetation becomes reestablished, the stream channel may be relocated into the vegetated area, away from Manastash Creek Road. Reconstruct existing rock armor along county road to improve reliability as a short-term resolution to erosion and flooding issues. Once stream is moved, place rock on flatter slope.	12/20	KCFZD KCCD	SRFB KCFZD YRPWEP USFW WSCC NRCS
16-2	Flood-Proof, Elevate, or Protect Home. Purchasing the property in the floodplain and removing associated buildings and structures would allow for a full restoration and revegetation of the floodplain in this area and would eliminate flood issues for the landowner. If property purchase is not feasible, address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	11/20	Kittitas County Public Works	KCFZD FEMA SRFB YRBWEP



SHEET 16

Project Reach 16:
County Road
(RM 9.5 to RM 10.4)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Abandoned Road Crossing Fill
- Widened Creek Corridor
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 175 350 700

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACHES: 17 – Typical Canyon Reach

PRIORITY: Low

SUB-REACH DESCRIPTION

Sub-reach 17 is located within the Manastash Canyon (see Sheet 17). Detailed inspections were not conducted along this reach, so site-specific flood/erosion hazards and habitat limitations have not been identified. However, general issues are present and are identified below.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Lowland floodplain areas near the stream are prone to flooding. Buildings that occupy these areas will be inundated during large floods. Fortunately, most, but not all, homes have been built on slightly elevated land.
2. Driveway bridges are typically just long enough to span the active channel and the abutments are immediately adjacent to the stream. This constricts the channel, which results in increased velocities and scour of the streambed, which can cause the abutments to fail. Also, many of the bridges will capture debris because they are either too low or the waterway is too narrow. A debris jam can push a bridge deck off its abutments and constrict the channel, deflecting flow into an abutment or onto the floodplain.
3. Sediment deposition is a major concern in certain areas. It can reduce channel capacity and therefore increase flooding, increase bank erosion, or cover low floodplain areas with coarse material.

Habitat Limitations:

1. Vegetation buffers are thin or do not exist in areas where pastures extend right to the edge of the channel.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

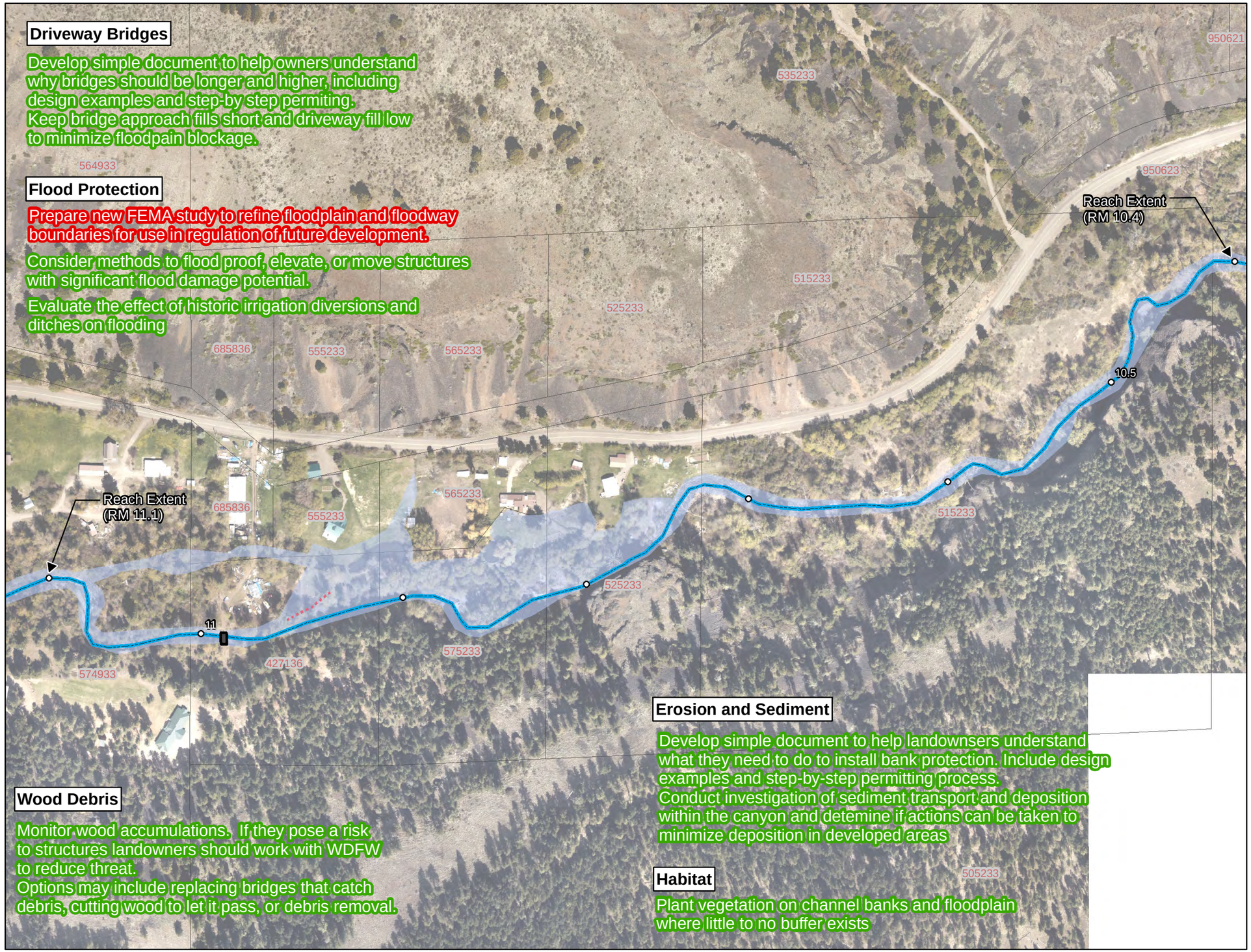
	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the low lying high hazard areas near the channel.
	Buildings in low floodplain areas	Treat case-by-case. Consider methods to flood-proof, elevate, or move structures if there is significant damage potential.
	Bridges and driveways	• Develop a simple document that will help landowners understand why bridges should be longer and higher. The document should include design examples and a step-by-step guide to the permit process. • Approach fills that elevate a driveway to a bridge should be as short as possible to minimize blockage of the floodplain. • Driveways that cross the floodplain should remain low to

		avoid blocking floodplain flow paths.
	Woody debris	The canyon reach is not wood debris limited. Therefore, monitor wood debris accumulations and, if they pose a significant threat to a bridge or structure, the landowner should work with WDFW to reduce the threat. Options may include: replacing a bridge if it is a chronic debris catcher, cutting the wood into smaller pieces and letting it pass downstream, or removing the wood.
Erosion and Sediment	Local bank erosion	Develop simple guidelines that clearly describe the steps required to protect an eroding bank. This document should include design examples and a step-by-step guide to the permit process.
	Sediment deposition	Conduct an investigation to understand sediment transport and deposition processes within the canyon. Use this information to determine if actions can be taken to minimize sediment deposition in areas where it will cause significant damage to developed lands.
Habitat	Vegetation	Plant vegetation on the channel banks and floodplain where little to no buffer exists.

IMPLEMENTATION

The general actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions are grouped into a single general project. The table below summarizes this project. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-Proof, elevate, or protect homes.	8/20	KCFZD KCCD	SRFB KCFZD FEMA YRBWEP



SHEET 17

Project Reach 17:
Canyon 17
(RM 10.4 to RM 11.1)

DRAFT

Legend

- Bridges
- Manastash Creek
- Approx. Limits of May 2011 Flood
- Berm
- Tax Parcels (see note)
- Tenth Mile Marker
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches Canyon.mxd (6/10/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 18. Lazy F Reach (RM 11.1 to 11.4)

PRIORITY: Medium

SUB-REACH DESCRIPTION

Sub-Reach 18 includes 0.3 mile of Manastash Creek where it passes through the Lazy F Camp and Retreat Center (see Sheet 18).

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Flood water flows through a large pond located upstream of the main camp area. This water inundates one of the main camp buildings.
2. Local bank erosion has occurred in several places, but it currently does not threaten facilities.

Habitat Limitations:

3. Habitat is generally in good condition. There are numerous side channels upstream from the main camp. Examine connections to the main channel and improve if necessary.
4. The Retreat Center's main bridge over Manastash Creek is narrow, and both it and the stream would benefit if it was longer. This is a common condition seen at nearly every driveway bridge that crosses the creek within the canyon.
5. Small bridges cross Manastash Creek at many locations within Manastash Canyon, confining the channel and disconnecting the creek from the floodplain.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood	Main camp building	Construct berm along the upstream side of building to divert flow around structure.
	Upstream pond	Examine ponds and side channel that flow into them to determine if there is anything that should be done to minimize the amount of water that passes through the pond during floods.
	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas.
Erosion	Various locations	Monitor and take appropriate action if erosion begins to threaten center facilities.
Habitat	Side channel	Inspect to determine if connections to the main channel can be improved without aggravating flooding.
	Bridges	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes
	Main bridge	Replace with a longer and higher structure once it reaches the end of its useful life.

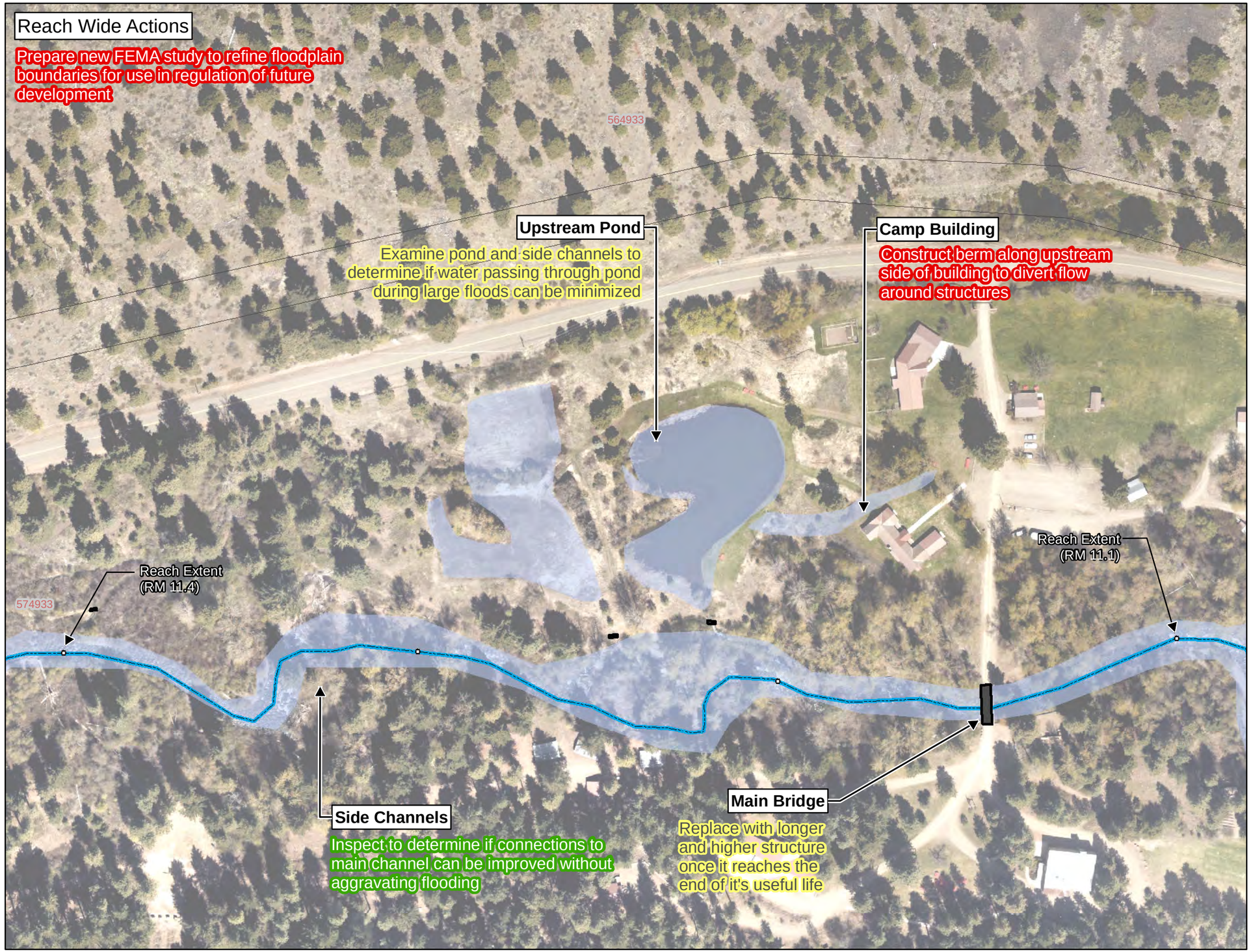
DISCUSSION OF RECOMMENDED ACTIONS

Camp Buildings and Pond – According to the property managers, during large floods water from the stream flows through the large pond that is located just upstream from the main camp area. This water spills out of the pond and inundates one of the main camp buildings. We recommend a detailed site inspection to examine the situation and to determine the best course of action to reduce or prevent damage to the building. One logical solution would be to construct a low landscaped berm along the upstream side of the structure to divert the flow around the building and return it to the stream.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. The table below summarizes these actions. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and to simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-proof, elevate, or protect homes.	8/20	KCFCZD KCCD	SRFB KCFCZD FEMA YRPWEP
18-1	Replace or modify undersized private bridge crossings throughout the area to improve fluvial processes. Evaluate and determine solution to flooding problem through pond. Investigate potential to reconnect right bank floodplain/side channels without increasing flood risk to adjacent structures.	11/20	KCCD KCFCZD	SRFB YRPWEP USFW



SHEET 18

Project Reach 18:
Lazy F
(RM 11.1 to RM 11.4)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 62.5 125 250

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (4/9/2013)

Manastash Creek
DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACHES: 19 – Typical Canyon Reach
PRIORITY: Low

SUB-REACH DESCRIPTION
Sub-reach 19 is located within the Manastash Canyon (see Sheet 19). Detailed inspections were not conducted along this reach, so site-specific flood/erosion hazards and habitat limitations have not been identified. However, general issues are present and are identified below.

EXISTING HAZARDS AND LIMITATIONS
Flood and Erosion Hazards:

1. Lowland floodplain areas near the stream are prone to flooding. Buildings that occupy these areas will be inundated during large floods. Fortunately, most, but not all, homes have been built on slightly elevated land.
2. Driveway bridges are typically just long enough to span the active channel and the abutments are immediately adjacent to the stream. This constricts the channel, which results in increased velocities and scour of the streambed, which can cause the abutments to fail. Also, many of the bridges will capture debris because they are either too low or the waterway is too narrow. A debris jam can push a bridge deck off its abutments and constrict the channel, deflecting flow into an abutment or onto the floodplain.
3. Sediment deposition is a major concern in certain areas. It can reduce channel capacity and therefore increase flooding, increase bank erosion, or cover low floodplain areas with coarse material.

Habitat Limitations:

1. Vegetation buffers are thin or do not exist in areas where pastures extend right to the edge of the channel.

RECOMMENDED ACTIONS
Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the low lying high hazard areas near the channel.
	Buildings in low floodplain areas	Treat case-by-case. Consider methods to flood-proof, elevate, or move structures if there is significant damage potential.
	Bridges and driveways	• Develop a simple document that will help landowners understand why bridges should be longer and higher. The document should include design examples and a step-by-step guide to the permit process. • Approach fills that elevate a driveway to a bridge should be as short as possible to minimize blockage of the floodplain. • Driveways that cross the floodplain should remain low to

		avoid blocking floodplain flow paths.
	Woody debris	The canyon reach is not wood debris limited. Therefore, monitor wood debris accumulations and, if they pose a significant threat to a bridge or structure, the landowner should work with WDFW to reduce the threat. Options may include: replacing a bridge if it is a chronic debris catcher, cutting the wood into smaller pieces and letting it pass downstream, or removing the wood.
Erosion and Sediment	Local bank erosion	Develop simple guidelines that clearly describe the steps required to protect an eroding bank. This document should include design examples and a step-by-step guide to the permit process.
	Sediment deposition	Conduct an investigation to understand sediment transport and deposition processes within the canyon. Use this information to determine if actions can be taken to minimize sediment deposition in areas where it will cause significant damage to developed lands.
Habitat	Vegetation	Plant vegetation on the channel banks and floodplain where little to no buffer exists.

IMPLEMENTATION

The general actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions are grouped into a single general project. The table below summarizes this project. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-proof, elevate, or protect homes.	8/20	KCFCZD KCCD	SRFB KCFCZD FEMA YRBWEP

Driveway Bridges

Develop simple document to help owners understand why bridges should be longer and higher, including design examples and step-by step permiting.
Keep bridge approach fills short and driveway fill low to minimize floodpain blockage.

Erosion and Sediment

Develop simple document to help landownsers understand what they need to do to install bank protection. Include design examples and step-by-step permitting process.
Conduct investigation of sediment transport and deposition within the canyon and detemine if actions can be taken to minimize deposition in developed areas

Wood Debris

Monitor wood accumulations. If they pose a risk to structures landowners should work with WDFW to reduce threat.
Options may include replacing bridges that catch debris, cutting wood to let it pass, or debris removal.

564933

Reach Extent (RM 12.1)

12

Reach Extent (RM 11.4)

11.5

574933

449136

584933

Flood Protection

Prepare new FEMA study to refine floodplain and floodway boundaries for use in regulation of future development.

Consider methods to flood proof, elevate, or move structures with significant flood damage potential.

Habitat

Plant vegetation on channel banks and floodplain where little to no buffer exists

SHEET 19

Project Reach 19:
Canyon 19
(RM 11.4 to RM 12.1)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches Canyon.mxd (4/9/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACH: 20. Mitchell Road Reach (RM 12.1 to 12.5)

PRIORITY: Medium

SUB-REACH DESCRIPTION

Sub-Reach 20 includes 0.2 mile of Manastash Creek where it passes through a developed area just upstream from Mitchell Road (see Sheet 20). Several cabins have been built on the floodplain and two driveway bridges cross the stream. The canyon is narrow and several cabins are built close to the stream.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Flood, erosion, and sediment problems will continue to be a challenge for the property owners along this highly dynamic narrow reach.
2. Manastash Road embankment is threatened by erosion from Manastash Creek.

Habitat Limitations:

3. The stream has been highly impacted by the development that has occurred within this reach.
4. Small bridges cross Manastash Creek at many locations within Manastash Canyon, confining the channel and disconnecting the creek from the floodplain.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

	Specific Features or Sites	Potential Actions
Flood , Erosion and Habitat	General	It will be very difficult to achieve both flood /erosion protection and maintain healthy stream processes and habitat within this reach. We recommend a detailed site inspection to examine conditions to determine what, if anything, can be done to reduce flooding and erosion without harming habitat.
	Floodplain Regulations	Update FEMA floodplain and floodway maps to regulate development in the high flood hazard areas. This is particularly important in this very narrow and high hazard portion of the canyon.
	Erosion	Protect/reinforce the Manastash Road embankment
Habitat	Bridges	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes.

DISCUSSION OF RECOMMENDED ACTIONS

This is a highly dynamic reach of Manastash Creek that is confined to a narrow portion of the canyon. Due to the location of the cabins and driveway bridges, the stream generally must stay fixed in its current location or it will threaten the structures. Because of the high energy, it will be a perpetual challenge to prevent lateral erosion. There is no obvious solution that would protect

the developed parcels from lateral erosion and allow the stream the freedom to create and sustain healthy habitat. The floor of the canyon is too confined and narrow. A detailed investigation should be conducted to examine the site and its issues. Based upon the outcome, the landowners, agency representatives, and technical experts should try to agree to a long-term strategy for the reach that strives to achieve maximize flood/erosion protection and habitat health.

IMPLEMENTATION

The actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. The table below summarizes these actions. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-proof, elevate, or protect homes.	8/20	KCFCZD KCCD	SRFB KCFCZD FEMA YRBWEP
20-1	Flood-proof, elevate, or protect homes. Purchase property to eliminate flooding issues and allow for restoration of floodplain processes. Assess sediment deposition problems. If infeasible, address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and to simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	6/20	KCFCZD KCCD	SRFB KCFCZD FEMA YRBWEP
20-2	Reinforce roadway embankment and enhance habitat using large rock and wood structures.	10/20	KCFCZD Kittitas County Public Works	Kittitas County Public Works

SHEET 20

Project Reach 20:
Mitchell Road Reach
(RM 12.1 to RM 12.5)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 62.5 125 250

Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReachs 9 to 21.mxd (6/10/2013)

Manastash Creek

DRAFT Recommended Actions for Habitat Enhancement & Flood Reduction

SUB-REACHES: 21 – Typical Canyon Reach

PRIORITY: Low

SUB-REACH DESCRIPTION

Sub-reach 21 is located within the Manastash Canyon (see Sheet 21). Detailed inspections were not conducted along this reach, so site-specific flood/erosion hazards and habitat limitations have not been identified. However, general issues are present and are identified below.

EXISTING HAZARDS AND LIMITATIONS

Flood and Erosion Hazards:

1. Lowland floodplain areas near the stream are prone to flooding. Buildings that occupy these areas will be inundated during large floods. Fortunately, most, but not all, homes have been built on slightly elevated land.
2. Driveway bridges are typically just long enough to span the active channel and the abutments are immediately adjacent to the stream. This constricts the channel, which results in increased velocities and scour of the streambed, which can cause the abutments to fail. Also, many of the bridges will capture debris because they are either too low or the waterway is too narrow. A debris jam can push a bridge deck off its abutments and constrict the channel, deflecting flow into an abutment or onto the floodplain.
3. Sediment deposition is a major concern in certain areas. It can reduce channel capacity and therefore increase flooding, increase bank erosion, or cover low floodplain areas with coarse material.

Habitat Limitations:

1. Vegetation buffers are thin or do not exist in areas where pastures extend right to the edge of the channel.

RECOMMENDED ACTIONS

Recommended actions to address flood and erosion hazards, and habitat limitations are:

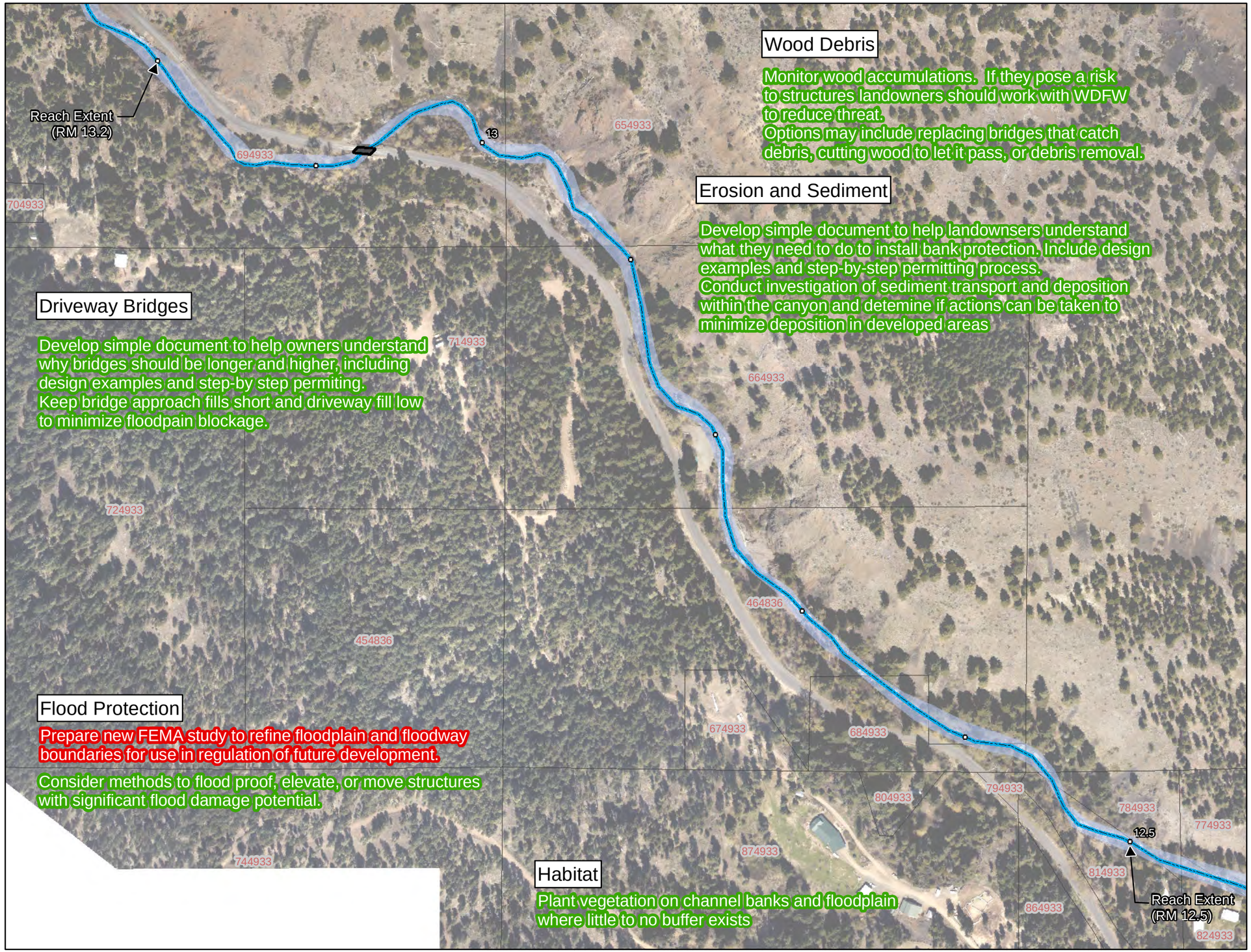
	Specific Site or Item	Potential Actions
Flood	Floodplain regulations	Update FEMA floodplain and floodway maps to regulate development in the low lying high hazard areas near the channel.
	Buildings in low floodplain areas	Treat case-by-case. Consider methods to flood-proof, elevate, or move structures if there is significant damage potential.
	Bridges and driveways	• Develop a simple document that will help landowners understand why bridges should be longer and higher. The document should include design examples and a step-by-step guide to the permit process. • Approach fills that elevate a driveway to a bridge should be as short as possible to minimize blockage of the floodplain. • Driveways that cross the floodplain should remain low to

		avoid blocking floodplain flow paths.
	Woody debris	The canyon reach is not wood debris limited. Therefore, monitor wood debris accumulations and, if they pose a significant threat to a bridge or structure, the landowner should work with WDFW to reduce the threat. Options may include: replacing a bridge if it is a chronic debris catcher, cutting the wood into smaller pieces and letting it pass downstream, or removing the wood.
Erosion and Sediment	Local bank erosion	Develop simple guidelines that clearly describe the steps required to protect an eroding bank. This document should include design examples and a step-by-step guide to the permit process.
	Sediment deposition	Conduct an investigation to understand sediment transport and deposition processes within the canyon. Use this information to determine if actions can be taken to minimize sediment deposition in areas where it will cause significant damage to developed lands.
Habitat	Vegetation	Plant vegetation on the channel banks and floodplain where little to no buffer exists.

IMPLEMENTATION

The general actions recommended above should be considered together on the sub-reach scale and implemented on that scale if possible. For purposes of evaluation and prioritization, the actions are grouped into a single general project. The table below summarizes this project. Details regarding project score can be found in Appendices B and C of this plan.

Project #	Description	Project Score	Potential Lead Entity	Potential Funding Source(s)
General -2	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infrastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-proof, elevate, or protect homes.	8/20	KCFZD KCCD	SRFB KCFZD FEMA YRBWEP



SHEET 21

Project Reach 21:
Canyon 21
(RM 12.5 to RM 13.2)

DRAFT

Legend

- Manastash Creek
- Bridges
- Approx. Limits of May 2011 Flood
- Berm
- Tenth Mile Marker
- Tax Parcels (see note)
- River Mile

Priority

- High
- Medium
- Low

Note:
Tax parcel boundaries are from theKittitas County GIS layer. Although georeferencing appears to be poor in many areas, the boundaries are included for general reference.

N

0 125 250 500
Feet

HERRERA WATERSHED SCIENCE & ENGINEERING

Aerial Photography:
Bergman Photographic Services, Inc. (May 7, 2012)

Produced By: GIS
Project: K:\Projects\12-05295-000\FromWSE\Figures\SubReaches Canyon.mxd (4/9/2013)

APPENDIX B

Project Scoring Criteria

Manastash Creek
Habitat and Flood Hazard Reduction Improvement Opportunities

Opportunity Screening and Evaluation Criteria

General Screening - Action Feasibility

Landowner Approval/Endorsement	yes/no
Unacceptable impact to human activities	yes/no
Unacceptable flood hazard impacts	yes/no
Unacceptable environmental impacts	yes/no
Cost Prohibitive	yes/no

If any of the above screening criteria fail, project is not advanced to evaluation below. These screening criteria should be checked again when a project is being advanced to design and implementation,

Evaluation Criteria for Specific Actions

Benefits

Ecological 0 - 5 High score = high level of benefit

Measure of ecological lift provided by the project - primarily fish habitat and access improvement.

Considerations:

Existing condition (identified limiting factor) and degree of improvement
Restore Processes (High) vs Enhancement (Low)
Addresses High-Priority Habitat Needs or Priority Reaches
Duration of Benefits - Long-Term (High) vs Short-Term (Low)
Geographic Extent of Benefits - Sub-reach Scale (High) vs Site Scale (Low)

Flood Hazard 0 - 5 High score = high level of benefit

Measure of flood/erosion hazard reduction provided by the project

Considerations:

Existing level of hazard and degree of improvement
Reduce or Control Damage Potential (Flooding, Scour, Erosion)
Duration of Benefits - Long-Term (High) vs Short-Term (Low)
Geographic Extent of Benefits - Multiple (High) vs Single Beneficiaries (Low)

Impact

-5 - 0 High score = low/no impact

Measure of negative impacts to site caused by the project

Considerations:

Flood Hazard Impacts
Ecological Impacts
Physical Impacts to Property or Human Use/Activity
Irrigation System/Water Supply Impacts
Construction Impacts - Clearing, Grading (High) vs. Low Impact (Low)

Cost Effectiveness

0 - 5 High score = low relative cost

Qualitative measure of project cost relative to benefits to be gained

Considerations:

Design, Analysis, and Permitting Cost
Land Acquisition or Easement Cost
Construction Cost - Cost relative to geographic extent
Maintenance Needs/Long-Term Cost

Risk and Uncertainty

0 - 5 High score = low level of risk/uncertainty

Meaure of potential risk of project failure

Considerations:

Permittability - Straightforward permitting (High), challenging permit requirements (Low)
Community and Landowner Acceptance
Time to Implementation
Certainty of Project Success (Success = gaining all anticipated benefits)

Evaluation Score = Sum of 5 Scores Above; Compared Amongst Project Opportunities to Prioritize

APPENDIX C

Project Opportunities

Manastash Creek Project Opportunities
Preliminary Evaluation

Project #	Subreach	RM	Description	Ecological Benefit	Flood Hazard Reduction Benefit	**Combined Benefit Score**	Negative Impact	Cost Effectiveness	Risk and Uncertainty	**Total Score**
				0-5	0-5	**0-10**	-5 - 0	0-5	0-5	**0-20**
1-1	1 - Yakima River Confluence to Brown Road	0 - 0.7	Procure/establish a conservation easement to ensure the protection of mature floodplain forest bottomlands at the dynamic confluence of Manastash Creek and the Yakima River. Modify or remove abandoned road crossing fill Install multi log habitat structures where appropriate in the downstream portion of this reach (0.0 - 0.5). Improve habitat, accumulate naturally recruited pieces of LWD, and potentially aggrade the stream bed to improve overall floodplain connectivity in the reach.	4	3	**7**	0	4	3	**14**
1-2	1 - Yakima River Confluence to Brown Road	0 - 0.4	Site specific revegetation along cleared portion of left bank floodplain where a new home was recently constructed. Work will require collaboration with and approval from the landowner.	1	1	**2**	0	3	2	**7**
1-3	1 - Yakima River Confluence to Brown Road	0.65 - 0.7	Seek property buyout for the property on the left bank immediately downstream of Brown Road if repetitive flooding an property loss is expected. Perform minor excavation creating small floodplain benches and/or removing existing push up levees to enhance floodplain inundation and reduce hydraulic severity. Revegetate site.	3	4	**7**	-1	1	4	**11**
2-1	2 - Brown Road to Barnes Road	0.7	The **Brown Road Crossing** is structurally sound and is not scheduled for replacement. When it is, conducted detailed hydraulic and geomorphic evaluation to determine the best replacement design to balance costs and habitat.	3	2	**5**	-1	1	2	**7**
2-2	2 - Brown Road to Barnes Road	0.9 - 1.52	Remove existing berms along the left bank to improve floodplain connectivity and access to remnant side channels.	3	1	**4**	0	3	2	**9**
2-3	2 - Brown Road to Barnes Road	0.9 - 1.52	Install instream habitat / erosion protection structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	3	3	**6**	0	3	2	**11**
2-4	2 - Brown Road to Barnes Road	1.52	Replace the **Barnes Road crossing** with hydraulically and geomorphically appropriate crossing.	3	2	**5**	-1	1	2	**7**
2-5	2 - Brown Road to Barnes Road	1.52	Consider adding rock or wood roughness elements along concrete wall to reduce velocities	2	0	**2**	0	2	3	**7**
3-1	3 - Westside Irrigation Crossing	1.52 - 1.9	Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically. Develop and implement plans to add roughness and complexity to existing bank armoring treatments to improve habitat. Project will likely require a landowner education component to gain their acceptance.	3	1	**4**	0	4	4	**12**
3-2	3 - Westside Irrigation Crossing	1.52 - 1.9	Reclaim/enhance floodplain habitat on both banks	4	2	**6**	-1	3	2	**10**
3-3	3 - Westside Irrigation Crossing	1.75	Restore channel and floodplain habitat at siphon crossing location when replaced/repaired	3	1	**4**	0	3	4	**11**
3-4	3 - Westside Irrigation Crossing	1.75	Develop infiltration facility or other facility to treat warm, silt laden return flows before they reenter Manastash Creek	4	0	**4**	-1	3	2	**8**

General-1	Westside Siphon to Reed Diversion	1.75 - 4.95	Acquire instream flow via voluntary acquisition and water conservation projects	5	5	**10**	0	4	3	**17**
4-1	4 - Serenity Lane	1.9 - 2.3	Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding into confined valley walls/high banks and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Large scale revegetation of banks, spot treating as needed throughout the area. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to proprty owners aesthetically.	3	4	**7**	0	3	2	**12**
4-2	4 - Serenity Lane	1.9 - 2.3	Remove berms along reach.	3	1	**4**	-1	3	1	**7**
4-3	4 - Serenity Lane	2.3 - 2.6	Replace the **Serenity Lane Bridge** crossing with a hydraulically and geomorphically appropriate structure. Reconstruct channel to reduce flood/erosion problems and improve habitat. Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and simultaneously improve habitat conditions. Bank protection measures should strive for short term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.	5	5	**10**	-1	3	3	**15**
5-1	Serenity Lane to Abandoned Dam	2.6 - 3.3	Assessment of driveway bridge improvements and possible berm modifications. Determine if actions can be taken to improve crossing security and flood protection while enhancing stream function. Remove or breach left bank berm to open access to forested floodplain areas. May need to build setback berm -- further study required. Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to proprty owners aesthetically.	3	5	**8**	-1	3	3	**13**
5-2	Abandoned Dam	3.1	Assess future channel profile adjustments downstream of removed diversion dam. Determine how will this affect flooding, erosion, and habitat. Determine need for removing abandoned diversion dam structure to restore stream function and improve fish passage. Reconnect historic side channels in the vegetated right bank floodplain. Requires additional study.	3	1	**4**	0	3	3	**10**
6-1	6 - Anderson Diversion	3.3 - 3.8	Install instream LWD habitat structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	4	1	**5**	0	3	1	**9**

6-2	6 - Anderson Diversion	3.3 - 3.8	Revegetation of cleared streambanks, riparian areas, floodplain forest;	3	4	**7**	0	5	5	**17**
6-3	6 - Anderson Diversion	3.5	Decommission diversion structure; adjust and control channel grade; restore streambanks and revegetate project area	3	3	**6**	-1	2	3	**10**
6-4	6 - Anderson Diversion	3.55	Widen channel crossing and restore bank/floodplain	3	3	**6**	-1	2	4	**11**
7-1	7 - Cove Road Crossing	4.05	Develop comprehensive solution to manage sediment, miminize flooding, and restore channel and floodplain health. Flood Protection for Cove Road Residents -- berms, structure elevation, buyouts, etc. Replace or Modify **Cove Road Bridge** with hydraulically and geomorphically appropriate crossing. Road Shoulders and Ditch Armoring along Cove Road. Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and simultaneously improve habitat conditions. Bank protection measures should strive for short term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.	5	5	**10**	-1	3	4	**16**
8-1	8 - U.S. of Cove Road to D.S. of Reed Diversion	4.2 - 4.9	Evaluate benefit / impact of existing berm along right bank and modify to improve flood protection and habitat if needed. Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and simultaneously improve habitat conditions. Bank protection measures should strive for short term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.	5	4	**9**	0	4	4	**17**
8-2	8 - U.S. of Cove Road to D.S. of Reed Diversion	4.2 - 4.9	Install instream LWD habitat structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	4	3	**7**	-1	2	3	**11**

9-1	9 - Reed Diversion	4.9 - 5.2	Restore upstream fish passage for all life history stages at the **Reed Diversion** by removing structure. Predict channel response to dam removal -- take action needed to prevent adverse impacts to flooding and habitat Install series of grade control weirs to prevent significant upstream channel incision once dam is removed and restore streambanks Enhance habitat within the Reed Ditch and ensure that fish stranding does not occur following the irrigation season Revegetation of banks and cleared areas upstream of the Reed Diversion. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.	5	4	**9**	-1	3	3	**14**
10-1	10 - Reed Diversion to KRD South Branch Road	5.2 - 5.5	Protect quality habitat from future impact. Pursue conservation easements to preserve existing high quality habitat.	5	3	**8**	0	4	3	**15**
10-2	10 - Reed Diversion to KRD South Branch Road	5.47	Remove remainder of **Hatfield Diversion**. Install necessary fish barrier to prevent fish loss down the abandoned Hatfield Ditch.	3	0	**3**	0	2	5	**10**
11-1	11 - KRD South Branch Road Crossing	5.5 - 5.7	Replace or Modify **KRD South Branch Road** Crossing with a longer bridge (larger waterway) Assess impact of MDWA spill KRD South Branch Road Shoulder Armoring Remove or set back levee/access road on right bank to improve flood storage and enhance FP connectivity. Revegetate streambank and pasture areas on right bank if levees are set back. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	4	5	**9**	-1	2	3	**13**
12-1	12 - Keach-Jensen to Manastash Road Bridge	5.7 - 5.8	Consider measures to reduce flooding at Keach Jenson and MWDA diversion facilities; improvement of crossings and riprap embankments; install measures to discourage sedimentation at diversion inlets	2	5	**7**	-1	2	2	**10**

12-2	12 - Keach-Jensen to Manastash Road Bridge	5.8 - 6.2	Flood protection may include sediment management plan, channel realignment, floodplain reconnection, bank protection structures. Flood-Proof, Elevate or Protect Homes. Property owners in this area report regular and significant problems with flooding, sedimentation, and ice jams. This is not unexpected due to the location at the apex of the fan. Consider purchasing the property at a fair price and restoring the area. Associated building/structure removal and floodplain restoration should be included. Revegetation of banks, floodplain areas, and cleared areas throughout the reach, especially on right bank along residential properties. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.	3	5	**8**	-1	2	1	**10**
13-1	13 - Manastash Bridge Confined Reach	6.3 - 6.4	Modify existing bank protection LWD to prevent debris collection to ensure road protection.	1	3	**4**	-1	3	3	**9**
13-2	13 - Manastash Bridge Confined Reach	6.2 - 6.4	Realign County road; channel realignment to reduce confinement and threat to road.	4	5	**9**	-2	0	1	**8**
General-2	Canyon - 13, 14, 15, 16, 17, 18	6.6 - 9.0	Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes. Address localized bank erosion that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Flood-Proof, Elevate or Protect Home. local flood protection	2	4	**6**	-1	2	1	**8**
14-1	14 - Canyon	7.0 - 8.1	Revegetation of floodplain areas, and cleared areas throughout the reach. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.	3	3	**6**	0	4	3	**13**
15-1	15 - North Fork Manastash Creek	9.3	Replace **Manastash Road** crossing over N.F. Manastash Creek; armor ditch and embankment; remove existing berms; develop sediment management plan for N.F. Manastash Creek.	3	5	**8**	-1	3	4	**14**
16-1	16 - County Road	9.85 - 10.2	Currently, the Manastash Creek channel runs parallel and immediately adjacent to Manastash Creek Road. Erosion and flooding issues are common here. Relocate the creek channel into the vegetated floodplain, away from county road An abandoned logging road crosses the floodplain at this location. Remove old access road fill in floodplain to improve FP function. Revegetation of floodplain areas, and cleared areas throughout the reach. Once mature vegetation becomes reestablished, the stream channel may be relocated into the vegetated area, away from Manastash Creek Road. Reconstruct existing rock armor along County Road to improve reliability as a short term resolution to erosion and flooding issues. Once stream is moved, place rock on flatter slope.	4	4	**8**	-1	2	3	**12**

16-2	16 - County Road	10.2	Flood-Proof, Elevate or Protect Home Purchasing the property in the floodplain and removing associated buildings and structures would allow for a full restoration and revegetation of the floodplain in this area and eliminate flood issues for the landowner. If property purchase is not feasible, address localized bank erosion that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	3	4	**7**	-1	2	3	**11**
17-1	17 - Canyon	10.3 - 10.7	Install instream LWD habitat structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Address localized bank erosion along left bank that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk. Revegetate bank areas and cleared areas throughout the reach.	3	2	**5**	0	3	2	**10**
18-1	18 - Canyon (Lazy-F)	11.1 - 11.4	Replace or modify undersized private bridge crossings throughout the area to improve fluvial processes. Evaluate and determine solution to flooding problem through pond. Investigate potential to reconnect right bank floodplain/side channels without increasing flood risk to adjacent structures.	2	4	**6**	-1	3	3	**11**
20-1	20 - Canyon	12.3 - 12.5	Flood-Proof, Elevate or Protect Home Assess Sediment deposition problems Purchase property to eliminate flooding issues and allow for restoration of floodplain processes. If infeasible, address localized bank erosion that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.	1	4	**5**	-1	1	1	**6**

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 1-1

Location: ***RM*** 0 - 0.7 ***Subreach*** YC/BC

Project Type Conservation/Protection; habitat enhancement

Description:

Procure/establish a conservation easement to ensure the protection of mature floodplain forest bottomlands at the dynamic confluence of Manastash Creek and the Yakima River.

Enstate development restrictions in high-hazard areas.

Install multi log habitat structures where appropriate in the downstream portion of this reach (0.0 - 0.5). Improve habitat, accumulate naturally recruited pieces of LWD, and potentially aggrade the stream bed to improve overall floodplain connectivity in the reach.

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***14***

Ecological Benefit (0 to 5) 4

Notes: Addresses wq limiting factor by protecting good quality riparian zone. Creation and enhancement of physical habitat for rearing and refuge. Benefits both Manastash Creek fish species as well as Yakima River stocks. If implemented without LWD habitat structures, benefit score would be reduced to 3

Flood/Erosion Hazard Reduction Benefit (0 to 5) 3

Notes: Protection of healthy vegetation will prevent future hazards associated with site development.

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 4

Notes: Protection of existing habitat expected to be cost-effective. Habitat structures are a more cost intensive element of the project

Certainty of Project Success (0 to 5) 3

Notes: Uncertainty due to landowner willingness

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 1-2

Location: ***RM*** 0 - 0.4 ***Subreach*** YC

Project Type Site-scale revegetation

Description:

Site specific revegetation along cleared portion of left bank floodplain where a new home was recently constructed. Work will require collaboration with and approval from the landowner.

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***7***

Ecological Benefit (0 to 5) 1

Notes: Site-scale project - moderate improvement to identified limiting factor

Flood/Erosion Hazard Reduction Benefit (0 to 5) 1

Notes: Site-scale project - moderate benefit for flood hazard reduction

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 3

Notes: Relatively low cost for low benefit

Certainty of Project Success (0 to 5) 2

Notes: Uncertainty due to landowner willingness

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 1-3

Location: ***RM*** 0.65 - 0.7 ***Subreach*** BC

Project Type Flood-prone property buyout; floodplain restoration; site-scale revegetation

Description:

Seek property buyout for the property on the left bank immediately downstream of Brown Road if repetitive flooding an property loss is expected. Perform minor excavation creating small floodplain benches and/or removing existing push up levees to enhance floodplain inundation and reduce hydraulic severity. Revegetate site.

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***11***

Ecological Benefit (0 to 5) 3

Notes: Restoration of floodplain function - limiting factor for reach - substantial benefit at site scale

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes: Site-scale project, but substantial benefit at flooding problem location

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 1

Notes: Demolition and floodplain restoration is relatively expensive for site-scale project

Certainty of Project Success (0 to 5) 4

Notes: Project is in planning/design

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 2-1

Location: ***RM*** 0.7 ***Subreach*** BC

Project Type Bridge replacement - wider span

Description:

The Brown Road Crossing is structurally sound and is not scheduled for replacement. When it is, conducted detailed hydraulic and geomorphic evaluation to determine the best replacement design to balance costs and habitat.

Dependence on other actions or projects: While not dependent, project 1-3 benefits would be increased were this project implemented.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** 7

Ecological Benefit (0 to 5)	3

Notes: Restoration of floodplain function - limiting factor for reach

Flood/Erosion Hazard Reduction Benefit (0 to 5)	2

Notes: Site scale benefit - this has not been identified as a high priority flood hazard

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5)	1

Notes: Structure replacement is expensive relative to benefit

Certainty of Project Success (0 to 5)	2

Notes: Not currently scheduled to be replaced for structural reasons

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 2-2

Location: ***RM*** 0.9 - 1.52 ***Subreach*** BC

Project Type Floodplain connectivity

Description:

Remove existing berms along the left bank to improve floodplain connectivity and access to remnant side channels.

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***9***

Ecological Benefit (0 to 5)	3

Notes: Floodplain connection on site scale - limiting factor for habitat

Flood/Erosion Hazard Reduction Benefit (0 to 5)	1

Notes: Site scale - moderate benefit

Negative Impact (-5 to 0)	0

Notes: None expected

Cost Effectiveness (0 to 5)	3

Notes: Relatively low cost for low/moderate benefit

Certainty of Project Success (0 to 5)	2

Notes: Uncertainty due to landowner willingness

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 2-3

Location: ***RM*** 0.9 - 1.52 ***Subreach*** BC

Project Type Habitat enhancement

Description:

Install instream LWD habitat / erosion protection structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***11***

Ecological Benefit (0 to 5)	3

Notes: Moderate habitat benefit on subreach scale

Flood/Erosion Hazard Reduction Benefit (0 to 5)	3

Notes: Erosion protection at toe of terrace banks provides moderate benefit

Negative Impact (-5 to 0)	0

Notes: None expected

Cost Effectiveness (0 to 5)	3

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5)	2

Notes: Uncertainty due to landowner willingness

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 2-4

Location: ***RM*** 1.52 ***Subreach*** BC

Project Type Bridge replacement

Description:

Replace the Barnes Road crossing with hydraulically and geomorphically appropriate crossing

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***7***

Ecological Benefit (0 to 5) 3

Notes: Currently a constriction on channel width - moderate benefit at the site scale

Flood/Erosion Hazard Reduction Benefit (0 to 5) 2

Notes: Not a high flood/erosion hazard location, but flow improvements would provide a benefit

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 1

Notes: Structural replacement is expensive relative to benefits

Certainty of Project Success (0 to 5) 2

Notes: Not scheduled to be replaced for structural reasons

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 2-5

Location: ***RM*** 1.52 ***Subreach*** BC

Project Type In-stream habitat enhancement

Description:

Add rock or wood roughness elements along concrete wall to reduce velocities

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***7***

Ecological Benefit (0 to 5) 2

Notes: Reduction in velocity would provide minor benefit

Flood/Erosion Hazard Reduction Benefit (0 to 5) 0

Notes: None

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 2

Notes: Low cost for minor benefit

Certainty of Project Success (0 to 5) 3

Notes: Degree of benefit uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 3-1

Location: ***RM*** 1.52 - 1.9 ***Subreach*** SC

Project Type Floodplain/streambank revegetation; in-stream habitat enhancement

Description:

Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.

Develop and implement plans to add roughness and complexity to existing bank armoring treatments to improve habitat. Project will likely require a landowner education component to gain their acceptance

Dependence on other actions or projects: None.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***12***

Ecological Benefit (0 to 5) 3

Notes: Moderate reach-scale benefit to reach limiting factor - floodplain reconnection would be needed to increase benefit score

Flood/Erosion Hazard Reduction Benefit (0 to 5) 1

Notes: Minor benefit - not an identified flooding/erosion problem area

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 4

Notes: Low cost for moderate benefit

Certainty of Project Success (0 to 5) 4

Notes: Need to work with landowners to get buy-in

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 3-2

Location: ***RM*** 1.52 - 1.9 ***Subreach*** SC

Project Type Floodplain reconnection

Description:

Reclaim/enhance floodplain habitat on both banks between the West Side Canal siphon and Barnes Road.

Dependence on other actions or projects: Revegetation per Project 3-1 would need to also be implemented.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation — ***Total Score*** ***10***

Ecological Benefit (0 to 5)	4

Notes: Floodplain connection limiting factor on subreach scale

Flood/Erosion Hazard Reduction Benefit (0 to 5)	2

Notes: Increased floodplain storage

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5)	3

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5)	2

Notes: Property owner willingness uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 3-3

Location: ***RM*** 1.75 ***Subreach*** SC

Project Type Channel/floodplain restoration and enhancement

Description:

Restore channel and floodplain habitat at siphon crossing location when replaced/repaired.

Dependence on other actions or projects: Replacement of Westside Siphon.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***11***

Ecological Benefit (0 to 5) 3

Notes: Site scale, but will benefit currently degraded site

Flood/Erosion Hazard Reduction Benefit (0 to 5) 1

Notes: Minor benefit to erosion hazards

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 3

Notes: Moderate cost for moderate benefits

Certainty of Project Success (0 to 5) 4

Notes: Crossing replacement is planned

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 3-4

Location: ***RM*** 1.75 ***Subreach*** SC

Project Type Water quality improvement

Description:

Develop infiltration facility or other facility to treat warm, silt laden return flows before they reenter Manastash Creek.

Dependence on other actions or projects: Replacement of Westside Siphon.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***8***

Ecological Benefit (0 to 5) 4

Notes: Has potential for high benefit, but will be dependent on capacity of the system

Flood/Erosion Hazard Reduction Benefit (0 to 5) 0

Notes: None

Negative Impact (-5 to 0) -1

Notes: Facility would be constructed in floodplain

Cost Effectiveness (0 to 5) 3

Notes:

Certainty of Project Success (0 to 5) 2

Notes: Needs study to determine feasibility

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID General-1

Location: ***RM*** 1.75-4.95 ***Subreach*** SC, FC, FE

Project Type Stream flow augmentation

Description:

Acquire instream flow via voluntary acquisition and water conservation projects

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***17***

Ecological Benefit (0 to 5) 5

Notes: Addresses the most important habitat limiting factor in the lower Manastash Creek system

Flood/Erosion Hazard Reduction Benefit (0 to 5) 5

Notes: Addresses a critical flood and erosion hazard issue in the lower Manastash Creek system

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 4

Notes: Conservation measures and water rights acquisition - moderate cost expected for very high benefits

Certainty of Project Success (0 to 5) 3

Notes: Uncertainties exist for individual conservation and acquisition efforts, but uncertainty of overall effort is relatively low

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 4-1

Location: ***RM*** 1.9-2.3 ***Subreach*** SC

Project Type Bank protection; In-stream habitat enhancement; Reach-scale revegetation

Description:

Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding into confined valley walls/high banks and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Large scale revegetation of banks, spot treating as needed throughout the area. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to proprty owners aesthetically.

Dependence on other actions or projects: Success of revegetation depends upon re-establishment of year round flows.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***12***

Ecological Benefit (0 to 5) 3

Notes: Moderate benefit on the reach scale; structures provide moderate benefit on a site scale

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes: Erosion protection at the site scale

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 3

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5) 2

Notes: Landowner willingness uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 4.2

Location: ***RM*** 1.9-2.3 ***Subreach*** SC

Project Type Floodplain connectivity

Description:

Remove berms along reach.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***7***

Ecological Benefit (0 to 5)	3

Notes: Moderate benefit at a reach scale

Flood/Erosion Hazard Reduction Benefit (0 to 5)	1

Notes: Not a flood hazard area

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5)	3

Notes:

Certainty of Project Success (0 to 5)	1

Notes: Berms may serve a protection function - need to investigate with landowners

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID	4-3		
Location:	***RM*** 2.3-2.6	***Subreach***	SC, FC
Project Type	Bridge replacement; channel restoration; In-stream habitat enhancement; Reach-scale revegetation		

Description:

Replace the Serenity Lane Bridge crossing with a hydraulically and geomorphically appropriate structure. Reconstruct channel to reduce flood/erosion problems and improve habitat.

Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and simultaneously improve habitat conditions. Bank protection measures should strive for short term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to proprty owners aesthetically.

Dependence on other actions or projects: Success of revegetation depends upon reestablishment of year round flows.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***15***

Ecological Benefit (0 to 5) 5

Notes: Addresses critical limting factor in reach - high benefit on reach-scale. Existing condition is poor.

Flood/Erosion Hazard Reduction Benefit (0 to 5) 5

Notes: This project addresses a critical erosion/flood hazard area. Existing bridge is in danger of failing due to scour.

Negative Impact (-5 to 0) -1

Notes: Short-term impacts during construction

Cost Effectiveness (0 to 5) 3

Notes: Bridge replacement is a high cost item, but benefits are very high

Certainty of Project Success (0 to 5) 3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 5-1

Location: ***RM*** 2.6-3.3 ***Subreach*** FC

Project Type Crossing assessment/removal; Floodplain connectivity; Reach-scale revegetation

Description:

Assessment of driveway bridge improvements and possible berm modifications. Determine if actions can be taken to improve crossing security and flood protection while enhancing stream function.

Remove or breach left bank berm to open access to forested floodplain areas. May need to build setback berm -- further study required.

Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to proprty owners aesthetically.

Dependence on other actions or projects: Success of revegetation depends upon reestablishment of year round flows.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***13***

Ecological Benefit (0 to 5)	3

Notes: Addresses channel confinement, floodplain coinnection, and riparian vegetation - all limiting factors in the reach. Existing habitat condition is fair

Flood/Erosion Hazard Reduction Benefit (0 to 5)	5

Notes: Addresses important flooding hazard area

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5)	3

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5)	3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 5-2

Location: ***RM*** 3.1 ***Subreach*** FC

Project Type Barrier assessment/removal; Channel restoration; Floodplain connectivity

Description:

Assess future channel profile adjustments downstream of removed diversion dam. Determine how will this affect flooding, erosion, and habitat.

Determine need for removing abandoned diversion dam structure to restore stream function and improve fish passage.

Reconnect historic side channels in the vegetated right bank floodplain.

Requires additional study.

Dependence on other actions or projects: Success of restoration depends upon reestablishment of year round flows.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***10***

Ecological Benefit (0 to 5) 3

Notes: Side channel connection could provide moderate site-scale habitat benefit

Flood/Erosion Hazard Reduction Benefit (0 to 5) 1

Notes: Not a high priority flooding/erosion hazard area, but project could prevent future channel incision

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 3

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5) 3

Notes: Requires study to determine extent of channel work needed

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 6-1

Location: ***RM*** 3.3-3.85 ***Subreach*** FC

Project Type In-stream habitat enhancement

Description:

Install instream LWD habitat structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Dependence on other actions or projects: Success of restoration depends upon reestablishment of year round flows.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***9***

Ecological Benefit (0 to 5) 4

Notes: Reach-scale habitat improvements. Addresses identified limiting factor - in-channel habitat quality. If rock structures are implemented instead of LWD, benefit score would be less (2).

Flood/Erosion Hazard Reduction Benefit (0 to 5) 1

Notes: Not a high-priority flood or erosion hazard area.

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 3

Notes: Moderate/high cost for similar benefits

Certainty of Project Success (0 to 5) 1

Notes: Landowner willingness is unknown

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 6-2

Location: ***RM*** 3.3-3.85 ***Subreach*** FC

Project Type Reach-scale revegetation

Description:

Revegetation of cleared streambanks, riparian areas, floodplain forest where appropriate.

Dependence on other actions or projects: Success of revegetation depends upon reestablishment of year round flows.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***17***

Ecological Benefit (0 to 5)	3

Notes: Moderate reach-scale benefit to habitat limiting factor (vegetation). Existing conditions is moderate

Flood/Erosion Hazard Reduction Benefit (0 to 5)	4

Notes:

Negative Impact (-5 to 0)	0

Notes: None expected

Cost Effectiveness (0 to 5)	5

Notes: Relatively low cost for moderate benefit

Certainty of Project Success (0 to 5)	5

Notes: Little uncertainty related to revegetation assuming flow restoration and adequate plant establishment.

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 6-3

Location: ***RM*** 3.65 ***Subreach*** FC

Project Type Barrier removal; Site scale revegetation

Description:

Decommission diversion structure; adjust and control channel grade; restore streambanks and revegetate project area

Dependence on other actions or projects: Requires consolidation of diversion locations

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***10***

Ecological Benefit (0 to 5) 3

Notes: Moderate benefit at site-scale - addresses channel constriction

Flood/Erosion Hazard Reduction Benefit (0 to 5) 3

Notes: Moderate benefit at site-scale - addresses channel constriction

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 2

Notes: Grade control may be relatively expensive for site-scale benefits

Certainty of Project Success (0 to 5) 3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 6-4

Location: ***RM*** 3.65 ***Subreach*** FC

Project Type Channel restoration; Floodplain connectivity

Description:

Widen KRD bridge and canal channel crossing and restore bank/floodplain

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***11***

Ecological Benefit (0 to 5)	3

Notes: Moderate benefit at site-scale - addresses channel constriction

Flood/Erosion Hazard Reduction Benefit (0 to 5)	3

Notes: Moderate benefit at site-scale - addresses channel constriction

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5)	2

Notes: Expensive relative to moderate benefit

Certainty of Project Success (0 to 5)	4

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID	7-1		
Location:	***RM*** 4.05	***Subreach***	FC, FE
Project Type	Flood protection; Bridge replacement; Other infrastructure modifications; Channel restoration; In-stream habitat enhancement; Reach-scale revegetation		

Description:

Develop comprehensive solution to manage sediment, miminize flooding, and restore channel and floodplain health. Flood Protection for Cove Road Residents -- berms, structure elevation, buyouts, etc.
Replace or Modify Cove Road Bridge with hydraulically and geomorphically appropriate crossing.
Road Shoulders and Ditch Armoring along Cove Road.
Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and simultaneously improve habitat conditions. Bank protection measures should strive for short term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.
Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.

Dependence on other actions or projects: x

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***16***

Ecological Benefit (0 to 5) 5

Notes: Addresses critical habitat limiting factors (in-channel habitat structure, vegetation). Existing condition is very poor

Flood/Erosion Hazard Reduction Benefit (0 to 5) 5

Notes: High priority flood hazard area affecting public infrastructure and multiple landowners.

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 3

Notes: High cost for high benefit

Certainty of Project Success (0 to 5) 4

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 8-1

Location: ***RM*** 4.2-4.9 ***Subreach*** FE

Project Type Levee modification; Bank protection; Reach-scale revegetation

Description:

Evaluate benefit / impact of existing berm along right bank and modify to improve flood protection and habitat if needed.

Install bank habitat structures where appropriate to reduce property loss where Manastash Creek is eroding banks and simultaneously improve habitat conditions. Bank protection measures should strive for short term stability until appropriate bank and floodplain vegetation can be reestablished. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Large scale revegetation of banks and cleared areas. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.

Dependence on other actions or projects: Success of revegetation depends upon reestablishment of year round flows.

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***17***

Ecological Benefit (0 to 5) 5

Notes: Existing condition is very poor. Reach-scale revegetation addresses habitat limiting factor.

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes: High priority flooding and erosion hazard area

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 4

Notes: Moderate costs for high benefits

Certainty of Project Success (0 to 5) 4

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 8-2

Location: ***RM*** 4.2-4.9 ***Subreach*** FE

Project Type In-stream habitat enhancement

Description:

Install instream LWD habitat structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Dependence on other actions or projects: Project must be implemented with reach-scale revegetation (Project 8-1)

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***11***

Ecological Benefit (0 to 5) 4

Notes: Addresses habitat limiting factor (in-stream habitat structure) at the reach scale. Existing condition is poor. If rock is used to create habitat structures, benefit will be less (2).

Flood/Erosion Hazard Reduction Benefit (0 to 5) 3

Notes: High-priority flooding and erosion hazard area.

Negative Impact (-5 to 0) -1

Notes: None expected

Cost Effectiveness (0 to 5) 2

Notes: Moderate cost for high benefit

Certainty of Project Success (0 to 5) 3

Notes: Landowner willingness is unknown

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 9-1

Location: ***RM*** 4.9-5.2 ***Subreach*** FE

Project Type Barrier removal; Channel restoration, In-stream habitat enhancement, Site-scale revegetation

Description:

Restore upstream fish passage for all life history stages at the Reed Diversion by removing structure.
Predict channel response to dam removal -- take action needed to prevent adverse impacts to flooding and habitat.
Install series of grade control weirs to prevent significant upstream channel incision once dam is removed and restore streambanks.
Enhance habitat within the Reed Ditch and ensure that fish stranding does not occur following the irrigation season.
Revegetation of banks and cleared areas upstream of the Reed Diversion. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.

Dependence on other actions or projects: Requires consolidation of irrigation diversion locations

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***14***

Ecological Benefit (0 to 5) 5

Notes: Restoring fish access to upper watershed is a critical benefit to fish habitat

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes: Can reduce out-of-channel flooding problems

Negative Impact (-5 to 0) -1

Notes: Short term construction impacts

Cost Effectiveness (0 to 5) 3

Notes: High cost for high benefit

Certainty of Project Success (0 to 5) 3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 10-1

Location: ***RM*** 5.2-5.5 ***Subreach*** FE

Project Type Conservation/Protection

Description:

Protect quality habitat from future impact. Pursue conservation easements to preserve existing high quality habitat.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***15***

Ecological Benefit (0 to 5)	5

Notes: Protection against future development/impact

Flood/Erosion Hazard Reduction Benefit (0 to 5)	3

Notes: Protection against future flood hazards

Negative Impact (-5 to 0)	0

Notes: None expected

Cost Effectiveness (0 to 5)	4

Notes: Relatively low cost for high benefit

Certainty of Project Success (0 to 5)	3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 10-2

Location: ***RM*** 5.2-5.5 ***Subreach*** FE

Project Type Barrier removal

Description:

Remove remainder of Hatfield Diversion. Install necessary fish barrier to prevent fish loss down the abandoned Hatfield Ditch.

Dependence on other actions or projects: Requires consolidation of diversion locations

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***10***

Ecological Benefit (0 to 5) 3

Notes: Moderate benefit - reduction of fish loss to irrigation system

Flood/Erosion Hazard Reduction Benefit (0 to 5) 0

Notes: None

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 2

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5) 5

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID	11-1		
Location:	***RM*** 5.5-5.7	***Subreach***	FE
Project Type	Levee modification/removal; Other infrastructure modifications; Floodplain connectivity; In-stream habitat enhancement; Reach-scale revegetation		

Description:

Replace or Modify KRD South Branch Road Crossing with a longer bridge (larger waterway).
Assess impact of MDWA spill.
KRD South Branch Road Shoulder Armoring.
Remove or set back levee/access road on right bank to improve flood storage and enhance FP connectivity.
Revegetate streambank and pasture areas on right bank if levees are set back.
Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Dependence on other actions or projects: x

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***13***

Ecological Benefit (0 to 5) 4

Notes: Addresses habitat limiting factors (channel constriction, floodplain connection)

Flood/Erosion Hazard Reduction Benefit (0 to 5) 5

Notes: Erosion hazard location at crossing

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 2

Notes: High cost for moderate/high benefits

Certainty of Project Success (0 to 5) 3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 12-1

Location: ***RM*** 5.7-5.8 ***Subreach*** FA

Project Type Flood protection

Description:

Consider measures to reduce flooding at Keach Jenson and MWDA diversion facilities; improvement of crossings and riprap embankments; install measures to discourage sedimentation at diversion inlets.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation — ***Total Score*** ***10***

Ecological Benefit (0 to 5)	2

Notes: Minor/moderate benefits to in-channel habitat quality

Flood/Erosion Hazard Reduction Benefit (0 to 5)	5

Notes: High hazard location

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5)	2

Notes:

Certainty of Project Success (0 to 5)	2

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 12-2

Location: ***RM*** 5.8-6.2 ***Subreach*** FA

Project Type Flood protection; Site-scale revegetation

Description:

Flood protection may include sediment management plan, channel realignment, floodplain reconnection, bank protection structures.

Flood-Proof, Elevate or Protect Homes. Property owners in this area report regular and significant problems with flooding, sedimentation, and ice jams. This is not unexpected due to the location at the apex of the fan. Consider purchasing the property at a fair price and restoring the area. Associated building/structure removal and floodplain restoration should be included.

Revegetation of banks, floodplain areas, and cleared areas throughout the reach, especially on right bank along residential properties. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.

Dependence on other actions or projects: x

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***10***

Ecological Benefit (0 to 5)	3

Notes: Potential to restore processes in the reach

Flood/Erosion Hazard Reduction Benefit (0 to 5)	5

Notes: High hazard location

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impact

Cost Effectiveness (0 to 5)	2

Notes:

Certainty of Project Success (0 to 5)	1

Notes: Specific measures and landowner willingness are uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 13-1

Location: ***RM*** 6.3-6.4 ***Subreach*** CY

Project Type Infrastructure modification

Description:

Modify existing bank protection LWD to prevent debris collection to ensure road protection.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***9***

Ecological Benefit (0 to 5)	1

Notes: Minor improvement to in-channel habitat

Flood/Erosion Hazard Reduction Benefit (0 to 5)	3

Notes: Addresses erosion/flood hazard

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5)	3

Notes: Low cost for low/moderate benefit

Certainty of Project Success (0 to 5)	3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 13-2

Location: ***RM*** 6.2-6.4 ***Subreach*** CY

Project Type Infrastructure modification; Channel realignment

Description:

Realign County road; channel realignment to reduce confinement and threat to road.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	X

Notes:

Project Evaluation ***Total Score*** ***8***

Ecological Benefit (0 to 5) 4

Notes: Improves channel confinement, improves in-channel habitat and floodplain connection

Flood/Erosion Hazard Reduction Benefit (0 to 5) 5

Notes: High hazard area

Negative Impact (-5 to 0) -2

Notes: Substantial short term construction impacts

Cost Effectiveness (0 to 5) 0

Notes: Very high cost for high benefit

Certainty of Project Success (0 to 5) 1

Notes: Feasibility is uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID General-2

Location: ***RM*** 6.6-9.0 ***Subreach*** CY

Project Type Bridge assessment; Bank protection; In-stream habitat enhancement; Flood protection

Description:

Evaluate potential to modify or remove driveway and private road bridges throughout the reach to improve flood/erosion protection and fluvial stream processes.

Address localized bank erosion that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Flood-Proof, Elevate or Protect Home. Local flood protection.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***8***

Ecological Benefit (0 to 5) 2

Notes: Addresses identified limiting factors, but degree of improvement is likely low

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes:

Negative Impact (-5 to 0) -1

Notes:

Cost Effectiveness (0 to 5) 2

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5) 1

Notes: Landowner willingness is uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 14-1

Location: ***RM*** 7.0-8.1 ***Subreach*** CY

Project Type Reach-scale revegetation

Description:

Revegetation of floodplain areas, and cleared areas throughout the reach. Work with landowners throughout the reach to develop a revegetation strategy that benefits habitat in Manastash Creek and is acceptable to property owners aesthetically.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***13***

Ecological Benefit (0 to 5) 3

Notes: Habitat improvement at reach scale.

Flood/Erosion Hazard Reduction Benefit (0 to 5) 3

Notes: Addresses specific flooding/sedimentation issues.

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 4

Notes: Low cost for moderate benefit

Certainty of Project Success (0 to 5) 3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 14-2

Location: ***RM*** 6.9 ***Subreach*** CY

Project Type Floodplain reconnection

Description:

Remove reminaing bridge abutments at abandoned crossing

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***11***

Ecological Benefit (0 to 5)	2

Notes: Habitat improvement at site scale.

Flood/Erosion Hazard Reduction Benefit (0 to 5)	3

Notes: Removes constriction that could influence flooding and sediment transport.

Negative Impact (-5 to 0)	0

Notes: None expected

Cost Effectiveness (0 to 5)	3

Notes: Low cost for moderate benefit

Certainty of Project Success (0 to 5)	3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 15-1

Location: ***RM*** 9.3 ***Subreach*** CY

Project Type Bridge replacement; Other infrastructure modification; Sediment management

Description:

Replace Manastash Road crossing over N.F. Manastash Creek; armor ditch and embankment; remove existing berms; develop sediment management plan for N.F. Manastash Creek.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***14***

Ecological Benefit (0 to 5) 3

Notes: Habitat improvement up and downstream of the crossing

Flood/Erosion Hazard Reduction Benefit (0 to 5) 5

Notes: High priority flood hazard to public infrastructure

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 3

Notes: Expensive for high benefit

Certainty of Project Success (0 to 5) 4

Notes: Supported by County and landowners

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 16-1

Location: ***RM*** 9.85-10.2 ***Subreach*** CY

Project Type Channel relocation; Floodplain connectivity; Reach-scale revegetation; Bank protection

Description:

Currently, the Manastash Creek channel runs parallel and immediately adjacent to Manastash Creek Road. Erosion and flooding issues are common here. Relocate the creek channel into the vegetated floodplain, away from county road.

An abandoned logging road crosses the floodplain at this location. Remove old access road fill in floodplain to improve FP function.

Revegetation of floodplain areas, and cleared areas throughout the reach. Once mature vegetation becomes reestablished, the stream channel may be relocated into the vegetated area, away from Manastash Creek Road.

Reconstruct existing rock armor along County Road to improve reliability as a short term resolution to erosion and flooding issues. Once stream is moved, place rock on flatter slope.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***12***

Ecological Benefit (0 to 5) 4

Notes: High habitat lift - floodplain reconnection. Existing condition is poor.

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes: High priority location

Negative Impact (-5 to 0) -1

Notes: Short term construction impacts

Cost Effectiveness (0 to 5) 2

Notes: Expensive for high benefits

Certainty of Project Success (0 to 5) 3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 16-2

Location: ***RM*** 10.2 ***Subreach*** CY

Project Type Flood protection; Bank protection

Description:

Flood-Proof, Elevate or Protect Home.
Purchasing the property in the floodplain and removing associated buildings and structures would allow for a full restoration and revegetation of the floodplain in this area and eliminate flood issues for the landowner.
If property purchase is not feasible, address localized bank erosion that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***11***

Ecological Benefit (0 to 5) 3

Notes: bank habitat, floodplain reconnection - moderate benefit

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes: Addresses high hazard on private property

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 2

Notes: High cost for moderate benefits

Certainty of Project Success (0 to 5) 3

Notes: Landowner willingness uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 17-1

Location: ***RM*** 10.3-10.7 ***Subreach*** CY

Project Type In-stream habitat enhancement; Bank protection; Reach-scale revegetation

Description:

Install instream LWD habitat structures where appropriate. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Address localized bank erosion along left bank that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Revegetate bank areas and cleared areas throughout the reach.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***10***

Ecological Benefit (0 to 5) 3

Notes: In-channel habitat benefit - Existing condition is fair

Flood/Erosion Hazard Reduction Benefit (0 to 5) 2

Notes:

Negative Impact (-5 to 0) 0

Notes: None expected

Cost Effectiveness (0 to 5) 3

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5) 2

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 18-1

Location: ***RM*** 11.1-11.4 ***Subreach*** CY

Project Type Bridge replacements; Flood protection; Floodplain connectivity

Description:

Replace or modify undersized private bridge crossings throughout the area to improve fluvial processes.
Evaluate and determine solution to flooding problem through pond.
Investigate potential to reconnect right bank floodplain/side channels without increasing flood risk to adjacent structures.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation ***Total Score*** ***11***

Ecological Benefit (0 to 5)	2

Notes: Existing condition is good - moderate benefit for floodplain/side channel connection

Flood/Erosion Hazard Reduction Benefit (0 to 5)	4

Notes: Addresses existing hazard on provate property

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impact

Cost Effectiveness (0 to 5)	3

Notes: Moderate cost for moderate benefit

Certainty of Project Success (0 to 5)	3

Notes:

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 20-1

Location: ***RM*** 12.3-12.5 ***Subreach*** CY

Project Type Flood protection; Sediment management; Bank protection

Description:

Flood-Proof, Elevate or Protect Home.
Assess Sediment deposition problems.
Purchase property to eliminate flooding issues and allow for restoration of floodplain processes.
If infeasible, address localized bank erosion that is threatening infastructure on an as-needed basis. Install bank habitat structures where appropriate to replace current bank armoring and simultaneously improve habitat conditions. Perform hydraulic modeling and geomorphic analysis to ensure that structures do not increase flood risk.

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***6***

Ecological Benefit (0 to 5) 1

Notes: Little opportunities for habitat improvement

Flood/Erosion Hazard Reduction Benefit (0 to 5) 4

Notes: Existing flood hazard area

Negative Impact (-5 to 0) -1

Notes: Short-term construction impacts

Cost Effectiveness (0 to 5) 1

Notes: Measures likely to have high cost

Certainty of Project Success (0 to 5) 1

Notes: Landowner willingness is uncertain

Manastash Creek - Potential Project Evaluation Sheet

Project Information

Project ID 20-2

Location: ***RM*** 12.2 ***Subreach*** CY

Project Type Infrastructure Protection

Description:

Reinforce roadway embankment to protect from scour, enhance with large rock and large wood to enhance in-stream habitat

Dependence on other actions or projects: None

Project Feasibility Screening (X = not feasible)

Lack of landowner Approval/Endorsement	
Unacceptable impact to human activities	
Unacceptable flood hazard impacts	
Unacceptable environmental impacts	
Cost Prohibitive	

Notes:

Project Evaluation

Total Score ***10***

Ecological Benefit (0 to 5)	1

Notes: Minor enhancement opportunity on a site scale

Flood/Erosion Hazard Reduction Benefit (0 to 5)	4

Notes: Protect public roadway

Negative Impact (-5 to 0)	-1

Notes: Short-term construction impacts - in-stream construction

Cost Effectiveness (0 to 5)	3

Notes:

Certainty of Project Success (0 to 5)	3

Notes:

APPENDIX D

Project Funding Sources

Potential KCCD Grant Opportunities for Manastash Creek

Grant Name	Funding Agency	Amount	Eligible Applicants	Purpose	Opening date	Closing date	Link
WDFW ALEA Grant Program	WDFW, WDNR	Acquisition projects: $1 million Restoration or improvement projects: $500,000 Development projects: $500,000 Combination projects (acquisition and development or restoration): $1 million, of which not more than $500,000 may be for development or restoration costs.	Eligible applicants include individual citizens, non-profit organizations, schools (including universities), political subdivisions such as conservation districts and tribes. For-profit businesses, State, and federal agencies may not apply.	The ALEA Grant Program funds five major types of projects; however, others may be considered. Habitat projects include activities that restore and/or preserve fish and wildlife habitat. Research projects increase our knowledge of fish and wildlife species. Education projects communicate information or provide hands on experiences that will enhance public understanding of fish and wildlife and their habitat. Facility Development projects provide or enhance access to fish and wildlife related recreational opportunities. Artificial Production projects rear and release fish or wildlife for public recreation or to restore populations. All artificial production projects must be pre-approved by WDFW to be eligible to apply for an ALEA grant.	December 1	February 28	http://wdfw.wa.gov/grants/alea/
WDFW Cooperative Endangered Species Conservation Fund "Section 6"	USFWS	Large amounts (not many awarded - 2 grants were awarded in 2012 for ~$1mil and $3.7mil); minimum 25% non-federal cost share	Coordinate through WDFW for land acquisition proposal	Four grant programs are available through the CESCF. They include the "Traditional" Conservation Grants and the "Non-traditional" Habitat Conservation Plan Land Acquisition, Habitat Conservation Planning Assistance, and Recovery Land Acquisition Grants. Traditional Section 6 grants are awarded for State projects. KCCD acquisitions/projects may be applicable for Non-traditional grants. Non-traditional" Section 6 grants consist of three grant programs established in 2001 under the federal Cooperative Endangered Species Conservation Fund (CESCF). The three grant programs are: 1) Recovery Land Acquisition grants, 2) Habitat Conservation Plan Land Acquisition (HCP) grants, and 3) Habitat Conservation Planning Assistance grants. These grant programs are administered by the U.S. Fish and Wildlife Service (USFWS), and provide funding to states for species and habitat conservation actions on non-federal lands. A state must have a cooperative agreement with the USFWS under Section 6 of the Endangered Species Act to be eligible to receive funds under the CESCF. In Washington State, the non-traditional Section 6 grants are administered by the USFWS in conjunction with the state Departments of Fish and Wildlife (WDFW) and Natural Resources (DNR). Specific grant objectives are: Recovery Land Acquisition grants: provide funding for the permanent protection of lands that support approved recovery plans for listed species. HCP Land Acquisition grants: provide funding for the permanent protection of lands that complement conservation provided by an approved habitat conservation plan.	November	December	http://wdfw.wa.gov/grants/section6/non-traditional.html;
WDFW Washington Wildlife Recreation Program (WWRP) - habitat and riparian protection grants	WDFW	critical habitat category: $25k to $1mil (50% match required); riparian protection category $0 to $10k	Local agencies Special purpose districts, such as park and recreation districts, port districts, school districts State agencies Native American tribes Salmon recovery lead entities (riparian protection category only) Nonprofits (farmland preservation and riparian protection categories only)	The Washington Wildlife and Recreation Program provides funding for a broad range of land protection and outdoor recreation, including park acquisition and development, habitat conservation, farmland preservation, and construction of outdoor recreation facilities. The Washington Wildlife and Recreation Program was envisioned as a way for the state to accomplish two goals: Acquire valuable recreation and habitat lands before they were lost to other uses and develop recreation areas for a growing population. Grant applications are evaluated in 11 categories: Critical habitat , Farmland preservation , Local parks , Natural areas , Riparian protection, State lands development and renovation , State lands restoration and enhancement , State parks , Trails , Urban wildlife habitat , Water access Typical Projects: Protecting wildlife habitat Building regional athletic complexes Renovating community parks Developing regional trails Building waterfront parks Restoring state lands Protecting farmland	March (plans due)	May	
WDFW Salmon Recovery Funding Board (SRFB) grants	Pacific Coastal Salmon Recovery Fund through WDFW	$5k min, no max, except for design-only projects, which are limited to $200,000 (15% match required, see notes)	Local agencies State agencies Tribes Private landowners Nonprofits Conservation Districts Regional Fisheries Enhancement Groups	Salmon recovery grants are awarded by the Salmon Recovery Funding Board to protect and restore salmon habitat. The board funds projects that protect existing, high quality habitats for salmon, and that restore degraded habitat to increase overall habitat health and biological productivity. The board also awards grants for feasibility assessments to determine future projects and for other salmon releated activities. Projects may include the actual habitat used by salmon and the land and water that support ecosystem functions and processes important to salmon. The board believes that projects must be developed using science-based information and local citizen review. Projects must demonstrate, through an evaluation and monitoring process, the capacity to be implemented and sustained effectively to benefit fish. Applicants must submit their proposals to their local lead entity rather than directly to the Salmon Recovery Funding Board. The lead entity is responsible for assembling a ranked list of projects from its area and submitting them to the Salmon Recovery Funding Board for consideration.	preproposals Jan - April to Yakima Basin Fish and Wildlife Recovery Board (YBFWRB)	May to YBFWRB	http://www.rco.wa.gov/grants/schedules/salmon.shtml

Grant Name	Funding Agency	Amount	Eligible Applicants	Purpose	Opening date	Closing date	Link
USFWS National Fish Passage Program	USFWS	$15,000 - 80,000 (25% cost share requested - see notes)	Any private individual, State, Tribe, nonprofit organization, community group (such as a watershed team), land trust, corporation, individual entity, and some Federal entities	The National Fish Passage Program is a voluntary program to restore native fish and other aquatic species to self-sustaining levels by reconnecting habitat that has been fragmented by man-made barriers. Fish passage projects restore unimpeded flows and fish movement by removing barriers or providing ways for aquatic species to bypass them. Projects are prioritized based upon the benefits to species and the geographical area. Typical projects include barrier culvert removal or replacement with a fish passable culvert or bridge and re-opening oxbow and off channel habitats. Types of projects preferred for funding under the NFPP are those that: Show demonstrable ecological benefits for Federal trust species; exhibit permanence of fish passage benefits; make use of the most current scientific knowledge and proven technology; address objectives outlined in approved management plans.	rolling, but USFWS must fill out paperwork by Oct 19	rolling, but USFWS must fill out paperwork by Oct 19	http://www.fws.gov/wafwo/pdf/FY2013HaRPOProgramSummaryFinal.pdf
USFWS Partners for Fish and Wildlife	USFWS	up to $25,000 (50% cost share targeted - see notes)	Individual private landowners; tribes; businesses and corporations; non-governmental organizations and non-profit entities; counties, cities and soil/water conservation districts; schools	Landowners who wish to improve habitat on their property may request assistance from the Program at any time of the year. There is no application period. Landowners simply contact a local Partners Program representative in their area. The landowner works one-on-one with a local Partners biologist to design, fund and implement a project. A cooperative agreement is developed between the Service and the landowner for a minimum of ten years.	rolling	rolling, but USFWS must fill out paperwork by Oct 19	http://www.fws.gov/pacific/ecoservices/habcon/partners/HowitWorks.html
WDFW/USFWS Fisheries Restoration and Irrigation Management Act (FRIMA)	USFWS	varies (sponsor must identify 35% matching funds - see notes)	Any state agency, local group or private landowner can apply. Projects must include a local government or Tribal sponsor or co-applicant.	The FRIMA program provides financial and technical assistance to local partners to correct barriers to fish passage related to irrigation and water diversion projects and facilities. Projects must involve fish screens, fish ladders or related modifications to water diversions that are directly associated with passage improvements.	rolling	January	http://www.fws.gov/pacific/Fisheries/FRIMA/
USFWS Western Native Trout Initiative	USFWS, National Fish and Wildlife Foundation	WNTI typically allocates approximately $525,000 among 10 – 12 individual projects. (50% cost share targeted - see notes)	Eligible applicants include state and federal management agencies, non-governmental organizations (e.g. conservation groups, community associations, watershed councils, cooperatives, civic groups), municipalities, universities, schools, and local and tribal governments.	Projects considered for funding may include riparian or in-stream habitat restoration, barrier removal or construction, population or watershed assessments needed for prioritization and planning, evaluating stream flows or lake water levels, and community outreach and education. Watershed-based multiple projects can be submitted as one application, and may receive special consideration this funding year. WNTI funds projects that can be completed within 18-24 months of receipt of funding. In some cases WNTI will consider funding phases or components of larger, long-term projects, as long as funds can be expended, objectives met, and benefits realized within the requisite 24-month period.	rolling	October	http://westernnativetrout.org/
WaterSMART: Water and Energy Efiiciency Grants for 2012	U.S. Bureau of Reclamation	up to $1.5mil (total program funding $21mil) - requires cost share	State, Indian tribe, irrigation district, water district, or other organization with water or power delivery authority	For projects that seek to conserve and use water more efficiently, increase the use of renewable energy and improve energy efficiency, benefit endangered and threatened species, facilitate water markets, or carry out other activities to address climate-related impacts on water or prevent any water-related crisis or conflict. Through this FOA, Reclamation also makes funding available for water management improvements that complement other ongoing efforts to address water supply sustainability. For example, through the WaterSMART Basin Study Program, Reclamation is working with State and local partners, as well as other stakeholders, to comprehensively evaluate the ability to meet future water demands within a river basin. The Basin Studies allow Reclamation and its partners to evaluate potential impacts of climate change to water resources within a particular river basin, and to identify adaptation strategies to address those impacts. This FOA provides an opportunity for partners who have completed a Basin Study to apply for cost-shared funding to implement Basin Study adaptation strategies that meet the eligibility and other requirements of this FOA. In addition, funding is available through this FOA for water delivery system improvements that will enable farmers to make additional on-farm improvements in the future, including improvements that may be eligible for Natural Resources Conservation Service (NRCS) funding.Water conservation, use of water markets, and improved efficiency are crucial elements of any plan to address western United States water issues. With leveraged water and energy efficiency grants, an important step will be taken towards increasing conservation for a more efficient use of water in the West	10/30/2012	41291	http://www07.grants.gov/search/search.do;jsessionid=Qwt2QKPKPCTT8NhnY4n6JqQzlvKTzSmGqZQlKyzNQmCX24jk1XsD!-1109023279?oppId=205114&mode=VIEW
Columbia River Basin Grants	Department of Ecology	varies	Conservation districts, local governments, others	projects that will deliver permittable water to the Columbia River or one of its tributaries. Permittable water is water that is stored, retimed, or conserved through crop change, fallowing, capturing previously unused runoff, etc.	rolling	rolling	http://www.ecy.wa.gov/programs/wr/cwp/grantapp.html

Grant Name	Funding Agency	Amount	Eligible Applicants	Purpose	Opening date	Closing date	Link
Yakima River Basin Water Enhancement Project	Bureau of Reclamation	$13.7mil total available	Special district governments	This Funding Announcement is not a request for applications. This announcement is to provide public notice of the Bureau of Reclamation's intention to fund project activities, specifically the piping of multiple laterals, without full and open competition. The Bureau of Reclamation and the Sunnyside Division Board of Control(SDBOC) intend to enter into a grant agreement pursuant to the: Yavapai-Prescott Indian Tribe Water Settlement Act of 1994; P.L. 103-434, Section XII—Yakima River Basin Water Enhancement Project, Sec 1203 (a); (b) (3) and (4); (j) (3). SEC. 1203. YAKIMA RIVER BASIN WATER CONSERVATION PROGRAM. (a) ESTABLISHMENT- (1) The Secretary, in consultation with the State of Washington, the Yakama Indian Nation, Yakima River basin irrigators, and other interested parties, shall establish and administer a Yakima River Basin Water Conservation Program for the purpose of evaluating and implementing measures to improve the availability of water supplies for irrigation and the protection and enhancement of fish and wildlife resources, including wetlands, while improving the quality of water in the Yakima Basin. The anticipated length of the agreement is 5 years. Subsequent renewal or continuation modifications related to additional funds for any awards as of a result of this Notice of Intent may be entered into without future competition; however, they are conditioned upon successful project performance and availability of appropriated funds.	unknown	unknown	http://www.usbr.gov/pn/programs/yrbwep/phase1/index.html
FishAmerica Foundation Marine and Anadromous Sportfish Habitat Restoration Grants	American Sportfishing Association	$10k - $75k	Non-profit organizations such as local sporting clubs and conservation associations, educational institutions, and local and state governments may apply for funding. Non-profit organizations must provide proof of non-profit status (i.e. 501(c)(3) letter from the IRS). Local and state agencies, educational institutions and other government entities must provide their EIN number.	FishAmerica, in partnership with the NOAA Restoration Center, awards grants to local communities and government agencies to restore habitat for marine and anadromous fish species. Successful proposals have community-based restoration efforts with outreach to the local communities.	January	April	http://www.fishamerica.org/grants.html
NOAA Open Rivers Initiative	NOAA	typically $200k - $750k	Eligible applicants are institutions of higher education, non-profits, industry and commercial (for profit) organizations, organizations under the jurisdiction of foreign governments, international organizations, and state, local and Indian tribal governments whose projects have the potential to benefit	Through its Open Rivers Initiative, NOAA's Restoration Center provides technical expertise and financial assistance to remove dams and barriers and restore habitat for the many species that migrate between the ocean and the nation's freshwater rivers and streams. This initiative contributes to sustainability of U.S. fisheries, provides an economic boost for communities, and improves public safety.	last round was 2011	last round was 2011	http://www.habitat.noaa.gov/funding/ori.html
Washington State Centenial Clean Water Fund	Wa State Dept of Ecology	$60k and up	local governments and tribes	This program is funded by state dollars, provided primarily via the State Building Construction Account. The Centennial program provides grants for water quality infrastructure and nonpoint source pollution projects to improve and protect water quality. Eligible infrastructure projects are limited to wastewater treatment construction projects for financially distressed communities. Eligible nonpoint projects include stream restoration and buffers, on-site septic repair and replacement, education and outreach, and other eligible nonpoint activities	Fall	Fall	http://www.ecy.wa.gov/programs/wq/funding/FundingPrograms/Centennial/Cent.html
Commumity-based Restortaion Matching Grants Program	TNC and NOAA Fisheries	varies, but in 2012 was $25k to $85k; match required, see notes	Eligible applicants are institutions of higher education, non-profits, industry and commercial (for profit) organizations, organizations under the jurisdiction of foreign governments, international organizations, and state, local and Indian tribal governments whose projects have the potential to benefit NOAA trust resources	The objectives of TNC and NOAA's Community-based Restoration Program (CRP) are to bring together interested groups, public, private, tribal and non-profit organizations to implement habitat restoration projects to benefit NOAA trust resources (coastal and marine species and their habitats). This innovative program recognizes the significant role that partnerships can play in making habitat restoration happen within communities, and acknowledges that habitat restoration is often best implemented through technical and monetary support provided at a community level. We will consider any innovative restoration project nationwide that supports NOAA trust resources, and particularly those projects that have a multi-species benefit or emphasize Ecosystem-Based Management. A focal area of particular interest, though not exclusive or limiting, is native shellfish (bivalve) restoration projects. Projects throughout all USA states and territories are eligible to compete for these grants. Preference will be given to projects at priority sites identified through Marine Ecoregional Assessments and other TNC priority setting approaches at the state and territory level	n/a	April	For more information visit: http://www.habitat.noaa.gov/restoration/programs/crp.html and http://www.nature.org/ourinitiatives/habitats/oceanscoasts/howwework/habitat-restoration.xml)
Trout Unlimited - Home Rivers Initiative	Trout Unlimited	varies	varies	TU's signature grant program for watershed restoration	unknown	unknown	http://www.tu.org/conservation/watershed-restoration-home-rivers-initiative
Yakima Tributary Access and Habitat Program	BPA, SRFB, Department of Ecology	varies	Landowners	The Yakima Tributary Access & Habitat Program (YTAHP, "Y-Tap") was developed in 2001 to provide assistance to landowners in restoring critical salmon habitat by implementing projects that protect, restore, and enhance riparian and floodplain habitat currently or historically used by salmon. Program objectives are to screen irrigation diversions, remove manmade barriers (dams, culverts, etc), restore fish passage, and enhance stream habitat. The YTAHP program is made possible through a collaborative effort between the SCW RC&D Council, local conservation districts, and many other local, state, and federal entities. Projects are voluntary and are designed to serve the best interest of the landowner, salmon, and the community.	unknown	unknown	http://www.scwrcd.org/ytahp.html
National Fish and Wildlife Foundation - Keystone Grant in Fish Conservation	NFWF (The Foundation awards matching grants utilizing federal funds provided by annual Congressional appropriations and agreements with federal agencies including the U.S. Fish and Wildlife Service, Natural Resource Conservation	$1k - $200k plus; minimum 1:1 match for most grants	Federal, state, and local governments, educational institutions, and nonprofit organizations	The Freshwater Fish Keystone focuses on species and habitats species that occur in the U.S. or its territories and that have been identified as high priorities for the nation. Freshwater fish (anadromous and catadromous) and associated aquatic life such as mussels, crayfish, and other invertebrates are included in this Keystone. Our goal in the Freshwater Fish Keystone is to find the best conservation investments, fund the best solutions, and deliver measurable results for fish conservation. Under this mission statement we have selected Initiatives that focus on making a measurable impact on the status of specific species and their habitats. Individual Initiatives are focused under the three themes below that we believe are critical for conserving freshwater fish, aquatic organisms, and their habitats. Water Flows Climate Change and Adaptation Imperiled Fish: Apache Trout and Upper Klamath Basin	preproposals due 2 mo prior to proposal due date	January or August (6 mo cycle)	http://www.nfwf.org/AM/Template.cfm?Section=GrantPrograms

Grant Name	Funding Agency	Amount	Eligible Applicants	Purpose	Opening date	Closing date	Link
National Fish and Wildlife Foundation - Acres for America (Charter Grant)	NFWF (The Foundation awards matching grants utilizing federal funds provided by annual Congressional appropriations and agreements with federal agencies including the U.S. Fish and Wildlife Service, Natural Resource	Approximately $2.5 million will be available annually through 2014 for conservation investments; minimum 1:1 match required	Federal, state, and local governments, educational institutions, and nonprofit organizations	Acres for America is National Fish and Wildlife Foundation's premiere land conservation program, and was established to provide urgently needed funding for projects that conserve large, landscape-level areas that are important habitat for fish, wildlife, and plants through acquisition of interest in real property. Acres for America was launched in 2005 with Walmart Stores, Inc. (www.walmart.com) as the founding partner. Walmart's goal as a founding partner is to offset the footprint of their domestic facilities on at least an acre by acre basis through permanent conservation of important wildlife habitats. Applicants are strongly urged to contact the National Fish and Wildlife Foundation regional director in their area to discuss project ideas prior to submitting preproposals.	6/1/2012	June 1	http://www.nfwf.org/AM/Template.cfm?Section=Charter_Programs_List&Template=/TaggedPage/TaggedPageDisplay.cfm&TPLID=60&ContentID=24291
National Fish and Wildlife Foundation - Bring Back the Natives (Charter Grant)	NFWF program funded by U.S. Fish and Wildlife Service (USFWS), Bureau of Land Management (BLM), and U.S. Forest Service (USFS), Trout Unlimited	Grant awards generally range in size from $25,000 to $100,000 although grants greater than $100,000 will be considered. (Applicants must provide non-federal match of at least $2 for every $1 of grant funds requested. Eligible non-federal matching sources can include cash, in-kind donations, and/or volunteer labor.)	Federal, state, and local governments, educational institutions, and nonprofit organizations	Restore, protect, and enhance native populations of sensitive or listed fish species, especially on lands on or adjacent to federal agency lands. measureable conservation outcome for native fish species of special concern. Because the two leading factors in native fish species decline are habitat alteration and invasive species, projects that address either, or both, of these threats are of particular interest. Projects benefitting one or more of the following native fish species will be the priority for funding this year: Upper Colorado native fish (flannelmouth and bluehead suckers, roundtail chub, and Colorado cutthroat trout) Lahontan cutthroat trout Sierra Nevada native fishes Apache trout native brook trout and associated native aquatic species (Chesapeake and Upper Ohio River) Russian River (CA) Coho Klamath suckers, redband trout and Coho Southeast native bass River Herring Other native fish species identified in state, federal, and tribal fish and wildlife agency planning documents (such as the USFS or BLM Aquatic Sensitive Species Lists) and/or by recognized and candidate National Fish Habitat Board Fish Habitat Partnerships organized under the National Fish Habitat Action Plan Native fish identified in state Aquatic Invasive Species Management Plans as being at risk from invasive species	6/1/2012	June 1	http://www.nfwf.org/AM/Template.cfm?Section=Charter_Programs_List&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=24293

APPENDIX E

Instream Flow Projects

The Manastash Creek Restoration Project (the Project) has made great progress in the last four years on critical Project components including fish screening, passage barriers, and instream flow enhancement. Many opportunities remain to achieve even greater gains for instream flow and to improve salmon and steelhead habitat. To date, 15.8 cfs has been protected permanently for instream flow enhancement in Manastash Creek with Washington Department of Ecology's Trust Water Rights Program, including pending reports of examination by the Department of Ecology. Of that 15.8 cfs, 8.5 cfs has been purchased from willing water right holders through Trout Unlimited Washington Water Project's 2009 Manastash Creek Reverse Auction, and through individual water right acquisitions funded by Trout Unlimited, Department of Ecology, Bonneville Power Administration and the Columbia Basin Water Transactions Program. The remaining 7.3 cfs of protected instream flow enhancement water was gained through water conservation projects, primarily sprinkler conversions projects. The water conservation projects have been cost share agreements with Manastash Creek water right holders and the Kittitas County Conservation District (KCCD). Funding for the Project has been provided by the Bonneville Power Administration, Department of Ecology, Natural Resources Conservation Service's Agricultural Water Enhancement Program and Washington State Conservation Commission's Irrigation Efficiencies Program.

Further opportunities for instream flow, building on the incredible success to date, include additional water conservation projects and the purchasing of water rights to enhance instream flow. As current funders have made this initial success possible, acquiring additional funding sources is essential to the continued success of the Project.

Based on the 2012 Kittitas County Conservation District crop and irrigation survey, there are just over 3,300 acres in rill irrigation within the Manastash watershed. Rill irrigation is estimated to be 50% efficient. Within the last four years of the project, 587 acres have been converted from rill irrigation to center pivot or linear sprinkler systems, systems which are up to 85% efficient. Currently, KCCD's instream flow potential project list has several Manastash Creek water right holders interested in sprinkler conversion projects and piping 1 mile of an unlined irrigation ditch.

Many of the Manastash Creek water right holders have dual water rights with either the Kittitas Reclamation District (KRD) or Westside Irrigation Company. Working in coordination with the two irrigation entities will create additional water conservation opportunities. Currently, the KRD is planning the piping of lateral 13.8 as an early action item under the Yakima River Basin Water Enhancement Project Integrated Water Resource Management Plan (YRPWEP Integrated Plan), as outlined in the Yakima River Basin Water Enhancement Project, Tributary Enhancement Program, Manastash Creek Investigation Report (USBR 2013). The YRBWEP is a federally authorized program managed by the US Bureau of Reclamation to enhance fish and wildlife and improve irrigation reliability in the Yakima River basin. The Integrated Plan is a comprehensive approach to water resources and ecosystem restoration improvements in the entire Yakima River Basin prepared under YRBWEP. It is estimated that 3.5 cfs will be saved from piping lateral 13.8 which will be delivered into Manastash Creek to enhance instream flow during the irrigation season.

With the 13.8 lateral becoming a pressurized system, it creates the potential for additional water conservation projects with dual KRD and Creek water right holders. Such projects could include piping water right holder's KRD water, additional acquisition, and helping landowners move to more efficient irrigation methods, such as sprinkler conversion projects. These conservation projects may allow the

water right holders to become efficient enough to rely solely on KRD water, and trust their Creek water right for instream flow. It is estimated that there are 530 acres with dual KRD lateral 13.8 and Manastash Creek water rights.

The piping of additional KRD laterals and pursuing other KRD system improvements within the Manastash watershed will continue to create water conservation opportunities and the potential for additional instream flow enhancement in Manastash Creek, according to the Kittitas Reclamation District Water Conservation Plan Irrigation Water Conservation Plan of System Improvements (CH2MHILL 1999). Within the Manastash watershed, KRD has an estimated 11 additional miles of laterals that could be piped. For example, KRD 14.3 lateral is currently a 3.5 miles long open ditch. If the 14.3 lateral were piped, an estimated 400 acres of dual water rights could have the potential for water conservation projects.

As noted above, there are significant opportunities to further improve the instream flow of Manastash Creek, including pursuing options for acquiring stock water rights or converting winter surface stock water rights to groundwater wells. These kinds of projects could enhance flows during the non-irrigation season, an important component to fish restoration.