LOWER BIG HOLE RIVER CORRIDOR ASSESSMENT

PHASE 1

Prepared For:

Big Hole Watershed Committee
PO Box 21
Divide, MT 59727

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Prepared By:

Confluence consulting, inc.
P.O. Box 1133 Bozeman, Montana 59771
voice (406) 585-9500 fax (406) 582-9142
website: www.confluenceinc.com

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1. INTRODUCTION

The Big Hole River has received recent attention for watershed issues that contribute to water quality impairments and reduced fisheries production. The Lower Big Hole River Corridor, defined as a five mile reach of the river between Pennington Bridge and the High Bridge, has been identified by the Big Hole Watershed Committee (BHWC) and Montana Fish, Wildlife and Parks (FWP) as a top priority for restoration activities due to private landowner interest in improving aquatic resources and a growing number of issues including overall lack of spawning habitat, high water temperatures, irrigation efficiency, water management, land use, and weed control.

In order to address these issues from a holistic perspective, the BHWC received a planning grant through the Montana Department of Natural Resources and Conservation (DNRC) to initiate a restoration plan for the lower corridor. The results of this restoration planning approach will help to ensure coordination among stakeholders, efficient use of funds, and maximum resource benefit.

Primary goals of this planning effort include:

1. Conducting a comprehensive review of existing data sources,
2. Identifying specific projects that address aquatic resource concerns, and
3. Developing a prioritization plan for ranking projects that address resource concerns in the lower Big Hole River Corridor.

This report provides results of the planning effort within Phase 1 of the corridor, defined as a reach beginning at the High Bridge near Twin Bridges, MT and extending approximately three miles upstream. This effort provides a starting point for restoration planning efforts in the lower watershed, and is meant to be an iterative process as additional data are collected, more projects are identified, and the extent of the corridor assessment continues upriver to the Pennington Bridge.

2. LOCATION

The Big Hole River is located in southwest Montana (Figure 1). A headwater tributary to the Jefferson River, the Big Hole River stems from the Continental Divide near the town of Jackson, Montana. It flows 153 miles before its confluence with the Beaverhead River near Twin Bridges. The Lower Big Hole Corridor Assessment starts at Pennington Bridge and extends downstream approximately 5 miles to the High Road Bridge at the Melrose-Twin Bridges County Road. Phase 1 is an assessment of the lower 3 miles of the corridor with the downstream extent at the High Road Bridge.

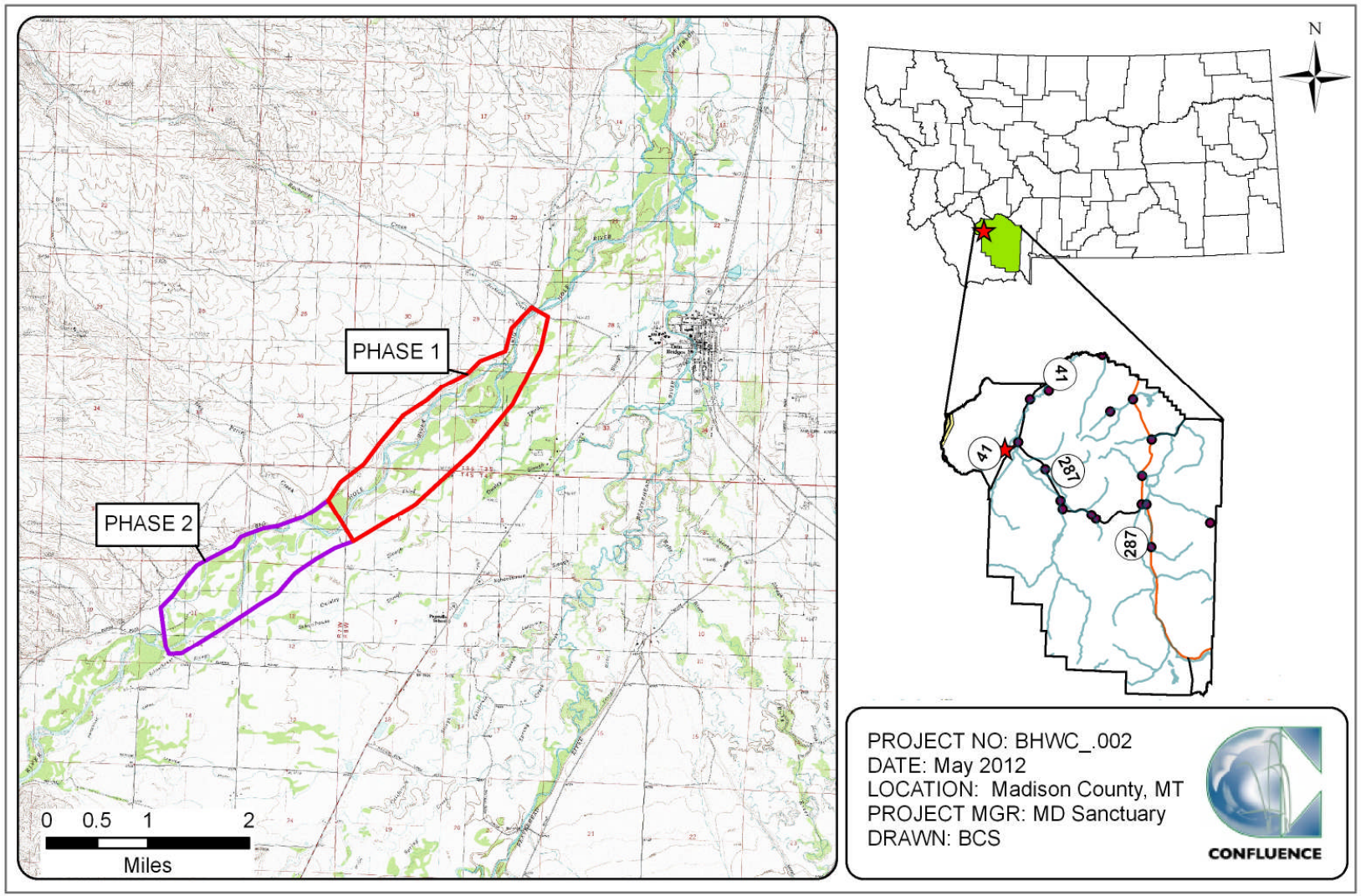

Figure 1. Lower Big Hole Corridor Phase 1 and 2 Location.

3. BACKGROUND

The Big Hole River flows through a large alluvial valley that contains many low order tributaries. While much of the river exhibits excellent aquatic and riparian habitat features, human influences along the Big Hole River are evident throughout the valley bottom where agriculture development, livestock production, and irrigation practices occur. Numerous diversion structures are present along the river and floodplain areas have been modified to improve agricultural operations and provide county road crossings. The combination of several factors including irrigation withdraws, loss of wetlands, and the development of side channels into ditches has led to a reduction in fisheries productivity and thermal impairments in lower segments of the Big Hole River.

The Big Hole River has been nationally known to fly fishermen since the 1880's, when it was published in *The Angler's Guide* and touted as a premier fishing destination for grayling and trout. Today the river continues to draw fishermen from around the world. However, dewatering and increasing water temperatures have become a major concern for fishermen and landowners. In 1988, the Big Hole River went dry for 35 consecutive days and the Melrose gauging station reported flows at approximately 50 cubic feet per second for two weeks (BHWC, 2012). In 1994, the river again hit critically low levels and was closed to fishing. The issues of dewatering, the resulting thermal increases, and the potential listing of Arctic grayling as an endangered species forged the path for formation of the Big Hole Watershed Committee.

In 1995, the BHWC was established to address the resource and community concerns in the Big Hole watershed. Local, state, and federal agencies participate as technical advisors and the BHWC works closely with other conservation organizations as well as local, state, and federal agencies on watershed restoration and management plans. Since the establishment of the BHWC, over 60 articles have been written documenting the ecosystem of the Big Hole Watershed. BHWC also hosts and sponsors projects throughout the Big Hole corridor. These projects have included irrigation infrastructure replacement and enhancement on the Big Hole Cooperative Ditch, water monitoring on the lower Wise River, and a wetlands and watershed restoration project in conjunction with the Montana Department of Water Quality (DEQ) and Montana Wetlands Legacy Project. The BHWC is currently developing a basin-wide restoration plan that prioritizes projects to address water quality, habitat and thermal impairments to the Big Hole River. The results of this report provide a starting point for restoration efforts within the Lower Corridor Assessment Area and will complement the restoration plan for the watershed.

4. EXISTING CONDITIONS

Several previous studies have been conducted to document existing conditions and potential causes for watershed impairments along the Big Hole River. Data sources reviewed as part of the Lower Corridor Assessment document thermal conditions (Lohr 1996; Flynn 2008), irrigation infrastructure (PBS&J 2008), bank erosion, road and bridge impairments, fishing access sites, wetlands (DEQ, 2012), and water rights (DNRC databases). The following section summarizes existing conditions pertaining to Phase 1 of the Lower Big Hole Corridor.

Water Retention and Wetlands

Wetlands throughout the Lower Big Hole Corridor are abundant. Wetland types are primarily riparian wetlands, with smaller areas of riverine and depressional wetlands. However, agriculture and irrigation networks throughout the valley have diverted and rerouted water from these areas, limiting their ability to filter sediment and nutrients. Aerial photographs show numerous meander scars and low lying areas that hold potential for restoration and enhancement. Figure 2 shows wetlands that currently exist in the Lower Big Hole Corridor as identified by the National Wetlands Inventory.

The Montana Department of Environmental Quality (DEQ) is in the process of developing an interactive mapping program that allows users to explore how wetlands may help address water quality issues within the watershed. This mapping program contains information from the National Wetlands Inventory and provisional data from the Montana Natural Heritage program. This program identifies target areas for enhancement and restoration of wetlands and riparian areas throughout the watershed (DEQ 2012). Key areas identified as having the greatest potential impacts to temperature and sediment retention are primarily in depressional and riverine wetlands. This program helps to identify areas for prospective restoration and has the potential to drive wetland enhancement and restoration efforts in the Lower Big Hole Corridor.

Water Temperature

Montana's water quality standard for temperature specifies a maximum allowable increase above the "naturally occurring" temperature in order to protect the existing thermal regime for fish and aquatic life. Water temperatures have been identified as a major concern in the Lower Big Hole Watershed (Lohr 1996; DEQ 1999; Gammons et al. 2001; Flynn 2008; PBS&J 2008). Human influences in the watershed have reduced stream cover and increased stream width, thus decreasing the ability of the stream channel to adjust to temperature fluctuations from solar heating. Irrigation withdrawals throughout the Lower Big Hole Corridor are substantial and can lead to increased temperatures due to decreased flows in the mainstem river. Water temperature issues arise from channel dewatering, irrigation returns and lack of shading throughout the river corridor. The corridor has been identified as an area of concern for chronic dewatering, with irrigation being cited as the greatest threat (Lohr 1996, BHWC 2012).

Water temperatures have been documented for the lower section of the Big Hole watershed in the Middle and Lower Big Hole Planning Area TMDL and Water Quality Improvement Plan (DEQ 1999). In summer 2011 temperature data was collected and monitored by MT FWP at the Smith Ditch slough outlet and the headwaters of Owsley Slough. More data will be collected during the summer of 2012 in the Smith Ditch and areas of Owsley Slough (Jim Olsen, personal communication).

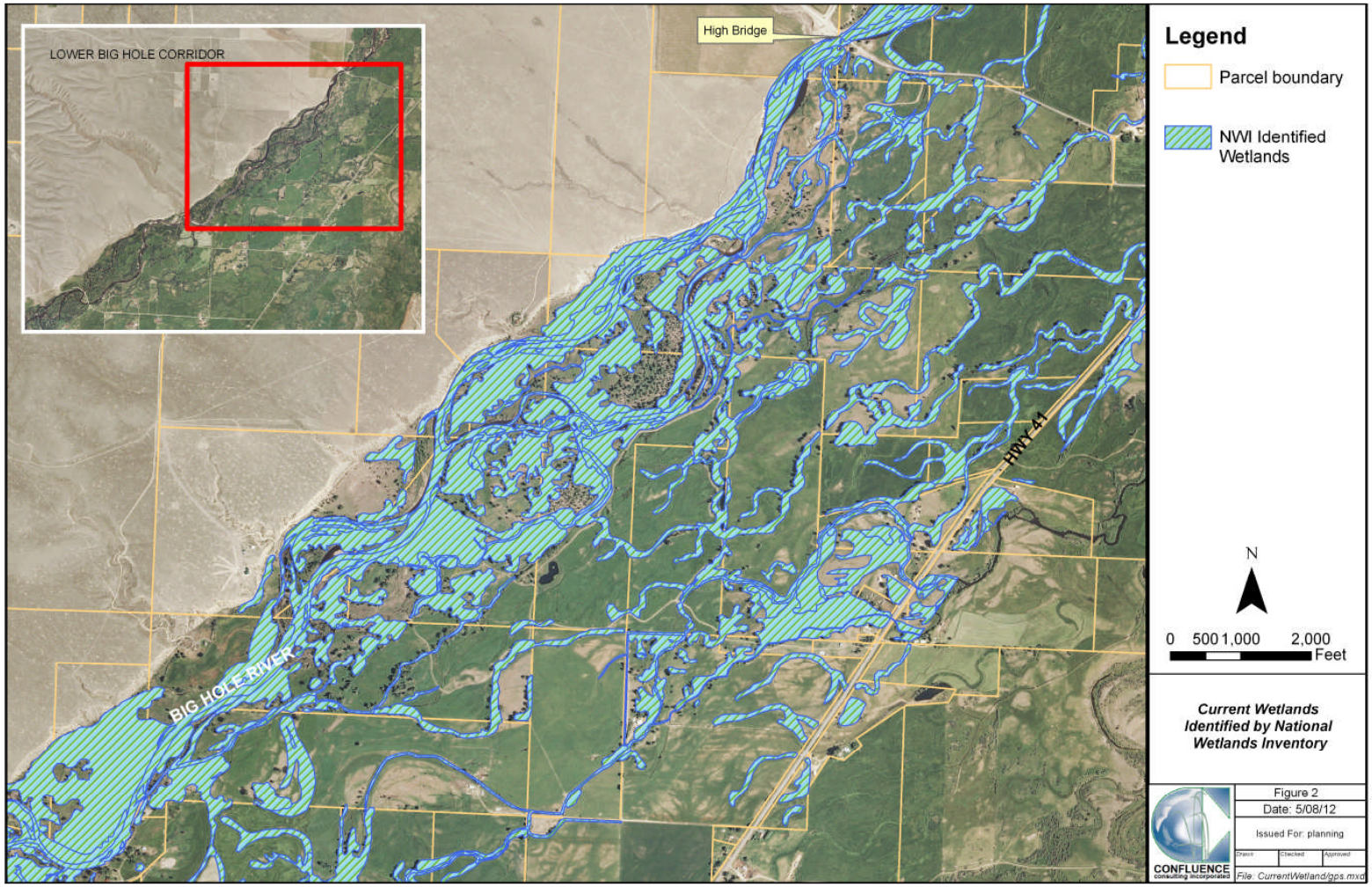

Figure 2. Current wetlands identified by National Wetlands Inventory.

Irrigation Infrastructure

The Phase 1 reach of the lower corridor contains three mainstem diversions and are referred to in this report by the names assigned to them in the 2008 Lower Big Hole Irrigation Infrastructure Inventory and Prioritization Report (PBS&J 2008). This report prioritized necessary headgate improvements due to two factors including 1) headgate and diversion dam factors, and 2) cumulative impact factors. All three diversion structures within the Lower Corridor were rated as "very high" priority for replacement due to headgate construction, condition, and landowner interest.

The Orphan Ditch is located along a relatively straight section of river along the right river bank (Appendix B, Photo 1). The Irrigation Infrastructure Report indicated diversion dam factors of design, construction, maintenance, and the influence on natural channel processes at this headgate were ranked high (PBS&J 2008). All cumulative impact factors (individual diversions per mile, claimed points of diversion per mile, ditch length to reach length ratio, percent of reach with streambank alterations, and streamflow gain/loss analysis) evaluated at the Orphan Ditch ranked high in the prioritization scheme outlined in the Irrigation Infrastructure Report.

The Logan-Smith Ditch is located in the right channel on an outside bend at the right river bank. The headgate is comprised of a wooden pin and plank structure with two openings and is difficult to operate. The Irrigation Infrastructure Report found headgate and diversion dam factors of design, construction, maintenance, and potential for increased stream flows of this headgate were cause for replacement (PBS&J 2008). The landowners are supportive of replacing this irrigation structure if a new, cost effective structure will reduce fish losses to the ditch. All cumulative impact factors (individual diversions per mile, claimed points of diversion per mile, ditch length to reach length ratio, percent of reach with streambank alterations, and streamflow gain/loss analysis) evaluated at the Logan-Smith Ditch ranked high in the prioritization scheme outlined in the Irrigation Infrastructure Report.

The Lott-Harvey Ditch is located in the right channel upstream of a large floodplain berm on the right river bank. This headgate is comprised of a wooden pin and plank diversion structure with two openings. The headgate and ditch are parallel to stream flow. The Irrigation Infrastructure Report cited headgate and diversion dam factors of design, construction, influence on natural channel processes, and potential for increased stream flows as reasons for headgate replacement. The landowners are supportive of installing a new, cost effective irrigation structure if fish losses to the ditch are reduced. All cumulative impact factors (individual diversions per mile, claimed points of diversion per mile, ditch length to reach length ratio, percent of reach with streambank alterations, and streamflow gain/loss analysis) evaluated at the Lott-Harvey Ditch ranked high in the prioritization scheme outlined in the Irrigation Infrastructure Report (PBSJ 2008).

Streambank Erosion

The majority of the Lower Big Hole River is intact and exhibits erosion commensurate with a natural river. However, a large amount of sediment is contributed to the river by a steep bluff on the left bank that runs from the High Bridge to approximately one-half mile upstream. The right bank has been subject to manipulation for crop irrigation and livestock water purposes by irrigation headgate structures. Approximately 1.79 of the 5 miles in the lower corridor are stabilized or confined by large rock and cobble levees and riprap, which prevents the river from accessing its floodplain and decreases wetland and

riparian function adjacent to the river (PBS&J 2008). There was minor evidence of livestock use throughout the corridor and fences are relatively limited in this area.

County Roads and Bridges

In 2011, high runoff caused major flooding and threatened High Bridge. Emergency measures were taken to maintain the integrity of the bridge, including placing large boulders on the west bank in an attempt to stabilize the western bridge abutment. Prior to placing this rock, major erosion occurred along the high terrace just upstream of the bridge, creating a gravel bar along the left side of the river channel just below the bridge. This new bar feature is cause for concern, as it routes water away from a large side channel that provides water to an irrigation diversion. Furthermore, landowners and county officials are concerned with the current channel configuration, as it no longer flows perpendicular to the bridge abutments and potentially destabilizes the structural integrity of the bridge.

RESTORATION PROJECT DESCRIPTIONS

Restoration projects in the Lower Big Hole Corridor were identified by meeting with landowners, observing DEQ aquatic resources maps and National Wetland Inventory maps, and reviewing aerial photographs, data sources, and reports. The projects discussed in this section were chosen based on their potential ability to address one or more of six target areas (water retention and wetlands, water temperature, improving spawning habitat, irrigation infrastructure, streambank erosion, and county roads and bridges) and overall benefits to the watershed. Projects have been classified into major categories including irrigation improvements, fisheries habitat enhancements, wetland enhancements, bridge stability, and bank erosion/deposition.

Irrigation Improvements

Project 1. Smith Ditch (Orphan Home) Headgate

The Orphan Ditch is located on a relatively straight section of the river on the right river bank. The initial point of diversion is a bermed side channel that extends into the river. The headgate is located approximately 600 feet downstream in the diversion side channel. High water and flooding in 2011 redistributed rock and woody materials creating a large instream rock bar and debris jam that prevents adequate flows from entering the side channel. Emergency modifications were done in 2011 to modify the main channel in order to sustain flows to this diversion. A floodplain berm along the diversion channel extends downstream of the headgate. At the headgate, a small gravel berm was built to divert water toward the headgate, which sits parallel to flows. The headgate is comprised of wooden boards with a metal structure constructed form an old boiler pipe (Appendix B, Photos 1 and 2). This diversion section has a cobble stream bed and there is a Parshall flume in the ditch

This project would involve removal and replacement of the current headgate structure and installment of a fish passage structure (Appendix A, Map 1). The headgate is comprised of wooden boards with a metal structure constructed from an old boiler pipe. The landowners are interested in replacing this irrigation structure. The primary benefits of replacing this irrigation headgate include potential increased stream flows in the Big Hole River, decreased maintenance costs, and fish passage.

Suggested Monitoring Strategies:
Monitor flows in the Big Hole River and Smith ditch
Document fish passage through headgate

Permitting Needs:
No permitting is necessary for irrigation system improvements

Estimated Costs:

Project #	Action	Quantity	Unit	Unit Price	Cost
1	Replace headgate structure *	1	EA	$ 6,600	$ 6,600
	Install fish ladder **	1	EA	$ 7,200	$ 7,200
				Subtotal	**$ 13,800**

* price generated from 2012 NRCS EQIP cost list, small structure installation

** price generated from 2012 NRCS EQIP cost list, fish passage structure

Project 2. Orphan Home Diversion and upper Smith Ditch Channel Alteration
The existing diversion at the head of the Smith Ditch is problematic and requires constant maintenance. This project includes installing a new diversion and headgate structure at the upstream end of the ditch system (Appendix A, Map 2; Appendix B, Photo 3). Replacing this structure will help to control the quantity of water entering the Smith Ditch system. This ditch has a stock water right which allows for year round water diversion. Careful management of year round flows would be beneficial for fisheries enhancement in this area and provide additional habitat for wintering fish.

Changing the location of the current headgate structure and rebuilding the upper segment of the ditch would decrease diversion maintenance costs and potentially increase stream habitat within the ditch system. If constructed properly, this diversion would allow for controlled flows in the ditch to maximize fishery potential while minimizing the possibility of erosion or channel instability. Alteration of the Smith Ditch channel and headgate would remove or greatly decrease maintenance costs of the existing diversion structure.

Suggested Monitoring Strategies:
Establishment of photo points throughout the area,
Document fisheries use in the upper ditch segment
Monitor winter flows through Smith Ditch system

Permitting Needs:
Madison County CD 310 permit
U.S. Army Corps of Engineers 404 permit
Madison County Floodplain permit

Estimated Costs:

Project #	Action	Quantity	Unit	Unit Price	Cost
2	Install new diversion structure *	1	EA	$ 10,000	$ 10,000
	Install fish ladder **	1	EA	$ 7,200	$ 7,200
	Costruct new ditch alignment ***	1,100	FT	$ 10	$ 11,000
				Subtotal	**$28,200**

* price generated from 2012 NRCS EQIP cost list, medium sized structure for water control

** price generated from 2012 NRCS EQIP cost list, fish passage structure

*** price generated from typical excavation costs for ditch and spoils placement in uplands

Project 3. Logan-Smith Headgate
The Logan-Smith Ditch is located in the right channel of the Big Hole River, on an outside bend at the right river bank. This side channel appears to hold less than half of the total flow of the Big Hole River during the irrigation season. A gravel berm extends into the channel to a riffle, which deflects flow toward the headgate. The headgate is comprised of a wooden pin and plank structure with two openings and is difficult to operate. There is no Parshall flume in this ditch.

This project would involve the removal and replacement of the existing Logan-Smith headgate and installment of a fish passage structure (Appendix A, Map 1; Appendix B, Photos 8 through 10). The landowners are interested in replacing this irrigation structure if a replacement structure is cost effective and will reduce fish losses to the ditch system. The primary benefit of replacing this headgate is increasing stream flows in the Big Hole River by allowing additional control of irrigation withdraws at this headgate.

Suggested Monitoring Strategies:
Monitor flows entering the Logan Smith headgate

Permitting Needs:
Madison County CD 310 permit
Madison County Floodplain permit

Estimated Costs:

Project #	Action	Quantity	Unit	Unit Price	Cost
3	replace headgate structure *	1	EA	$ 10,000	$10,000
				Subtotal	**$10,000**

* price generated from 2012 NRCS EQIP cost list, medium sized structure for water control

Project 4. Lott-Harvey Headgate
The Lott-Harvey Ditch is located in the right channel of the Big Hole River, upstream of a large floodplain berm on the right river bank. The initial diversion is comprised of boulders that create a peninsula with a small barb and cobbles that extend into the stream channel, creating a secondary channel. This channel extends to a wooden pin and plank diversion structure with two openings. The headgate and ditch are parallel to stream flow. There is no Parshall flume in this ditch.

This project would involve the removal and replacement of the existing Lott-Harvey Headgate (Appendix A, Map 1; Appendix B, Photos 11 and 12). This headgate is a simple pin and plank structure that is in poor condition and difficult to use. The landowners are interested in replacing this irrigation structure if a replacement structure is cost effective and will reduce fish losses to the ditch system.

The primary benefit of replacing this headgate is increasing stream flows in the Big Hole River by allowing additional control of irrigation withdraws at this headgate. It is unknown how much water is expected to stay in the river if the headgate is replaced.

Suggested Monitoring Strategy:
Monitor flows entering the Lott Harvey headgate.

Permitting Needs:
Madison County CD 310 permit
Madison County Floodplain permit

Estimated Costs:

Project #	Action	Quantity	Unit	Unit Price	Cost
4	replace headgate structure *	1	EA	$ 10,000	$10,000
	install fish passage structure **	1	EA	$ 7,200	$7,200
				Subtotal	**$17,200**

* price generated from 2012 NRCS EQIP cost list, medium sized structure for water control

** price generated from 2012 NRCS EQIP cost list, fish passage structure

Fisheries Habitat Enhancements

Project 5. Smith Ditch Fisheries Enhancement

Limitations to fisheries in the main stem Big Hole River may be addressed by improving habitat, thermal refuge, and spawning areas on smaller side channels and irrigation systems that exist within the channel migration zone of the river. Careful management to prevent entrainment and allow passage through diversions enables fisheries benefits within irrigation systems. The Smith Ditch provides an excellent opportunity to improve fisheries in the lower corridor by providing habitat opportunities for fish to reside and spawn in a channel that has shade, cover, and good pool complexity. Improving fisheries production in this system will ultimately aid main stem fish populations by providing a source of recruitment, thermal refuge, and forage.

Although its primary function is to convey irrigation water to diversion structures and agricultural fields, the Smith Ditch system provides an opportunity to improve the lower Big Hole River fishery. Channel narrowing and pool enhancement along two channels of the ditch system would help to decrease stream temperatures while encouraging spawning and rearing (Appendix A, Map 3, Appendix B, Photos 4 and 5). The ditch has a year-round stock water right and has spring influences, allowing the potential for year-round flows. Minimum winter flows are currently unknown and should be investigated to determine if they are sufficient to produce a sustainable winter fishery. Flooding in this area is common and consistent during spring runoff; however the system remains isolated from the mainstem river during base flows. Habitat enhancement opportunities include modifying channel dimensions to provide optimal pools, spawning riffles, and enhancing riparian cover.

The Smith Ditch empties into a large oxbow of the Big Hole River. This oxbow is much wider than the Smith Ditch outlet, and likely heats water between the terminus of the ditch system and the mainstem river. Construction of an alternative alignment from the outlet of the ditch to the river would reduce thermal heating and improve connectivity between the river and ditch system (Appendix A, Map 4; Appendix B, Photos 6 and 7). This new channel section would be designed to include varying depths and instream habitats to support varying life stages of fish populations.

The primary benefits of this project include increased spawning habitat, improved fish habitat for various life stages, enhanced riparian zone, sustained stream flows, shading, and a reduction of thermally charged water to the Big Hole River.

Suggested Monitoring Strategies:
Establishment of pre- and post-project photo points
Establish stream cross sections to monitor habitat variability
Establish vegetation transects to monitor shade and cover
Monitor water temperature in Smith Ditch system
Conduct red surveys in Smith Ditch system

Permitting Needs:
Madison County CD 310 permit
U.S. Army Corps of Engineers 404 permit
Madison County Floodplain permit

Estimated Costs:

Project #	Action	Quantity	Unit	Unit Price	Cost
5	Habitat Enhancement in exisiting channels*	12,300	FT	$ 7	$79,950
	Create new channel to bypass oxbow*	2,850	FT	$ 75	$213,750
	Fish ladders**	3	EA	$ 7,200	$21,600
				Subtotal	**$392,100**

Project costs include restoring run/pool/riffle habitat, project oversight, design, permitting, and project management.

* price generated from typical costs for habitat enhancement in medium channels (5-25 cfs)

** price generated from 2012 NRCS EQIP cost list, fish passage structure

Project 6. Lott-Harvey and Logan-Smith Ditch Side Channel Fishery

This project includes combining the Lott-Harvey, Logan Smith, and Owsley Slough ditch as far upstream as possible to maximize the length of a new stream channel designed to provide spawning, rearing, and adult trout habitat (Appendix A, Map 5). Flow from the Logan-Smith diversion may be conveyed to the new stream through an existing ditch/channel. This ditch originates on adjacent property, so any modifications will require coordination with the landowner.

Flow from the Harvey-Lott diversion may be conveyed initially in an existing ditch but will then require construction of a relatively short new channel segment to tie in to the new fishery stream. An alternative to replacement of this ditch is complete removal with subsequent transfer of water rights upstream to the Logan-Smith diversion. A detailed investigation of water rights transfers would need to be undertaken to do this transfer.

Flow from the Big Hole Ditch/Owsley Slough ditch may also be conveyed through an existing channel, but this channel will need to be enlarged to accommodate the full water right. In addition, the diversion and headgate will need to be replaced with larger, fully functional structures. Finally, an existing dam and outlet structure along the proposed channel alignment from the Big Hole Ditch/Owsley Slough to the new stream channel will need to be replaced or removed. It will be important to carefully manage demands on water in Owsley Slough as not to jeopardize fishery resources in lower segments of the Owsley system.

Flow in the new stream will be controlled, so the stream will behave more like a spring creek than a freestone system. Groundwater interception is anticipated during excavation of the new channel, especially where pool habitat is created. This will increase the influence of groundwater, helping to cool the stream in summer and warm it in winter. Controlled flow will allow us to create complex habitat to maximize fishery potential while minimizing the possibility of erosion or channel instability.

The primary benefits of this project include creation of high quality fish habitat, enhanced wetland and riparian areas, improved irrigation infrastructures, reactivation of floodplain zone, and a source of cool water to the Big Hole River. The existing water rights on the Lott-Harvey and Logan-Smith ditches do not allow diverting river water outside of the irrigation season, which limits the potential for establishing a high quality fishery in this new channel. A feasibility study of this project is recommended to determine the potential for revising the water right periods of use to allow for diverting water in the winter and leaving water in the main stem river during the summer. The results of this water right investigation will greatly assist in determining the feasibility of producing a high quality side channel fishery resource.

Suggested Monitoring Strategies:
Establish photo documentation locations.
Vegetation transects and stream cross sections
Monitor stream temperatures in new channel
Monitor spawning redds in new channel

Permitting Needs:
Madison County CD 310 permit
U.S. Army Corps of Engineers 404 permit
Madison County Floodplain permit

Estimated Costs:

Project #	Action	Quantity	Units	Unit Price	Cost
6	reactive historic channel/swale*	30,000	FT	$ 24	$ 720,000
	replace headgate(s)**	3	EA	$ 10,000	$ 30,000
	install pond outlet structure***	1	EA	$ 1,000	$ 1,000
	fortify culvert under county road w/riprap****	1	LS	$ 1,500	$ 1,500
				Subtotal	**$ 752,500**

Project includes project oversight, design, permitting, and project management

* cost generated from typical enhancement projects in channels 25-50 cfs

** price generated from 2012 NRCS EQIP cost list, medium sized structure for water control

*** price generated for purchase and installation of AgriDrain device or equivalent

**** price generated from 2012 NRCS EQIP cost list, CMP culverts

Wetland Enhancement

Project 7. Upper Smith Ditch Wetland Improvement

Currently, a historic meander scar of the Big Hole River accumulates irrigation return water and drains through a culvert directly into the Smith Ditch approximately 1600 feet downstream of the Orphan Ditch headgate (Appendix A, Map 6). The Smith Ditch returns to the Big Hole River; therefore efforts to reduce temperatures in the Smith Ditch system will ultimately improve conditions in the mainstem channel. Thermal loading to the Smith Ditch system could be addressed by plugging the outlet pipe at the downstream end of the meander scar.

If the culvert is plugged, the containment of water and improvement of wetland function in this area will serve many beneficial purposes. The wetland will help decrease nutrients and herbicides from entering the irrigation ditch and subsequently the Big Hole River. The wetland will also act as a sediment trap, by slowing water and allowing for sediment to settle to the bottom. Thermal issues will be addressed in this location by increasing vegetation cover and allowing heated surface waters to infiltrate through the soil profile and into groundwater.

Suggested Monitoring Strategies:
Perform Montana Wetland Assessment Methodology (MWAM) to determine wetland function at this site.

Before and after photographs at established monitoring points to show evidence of wetland development.
Monitor Smith Ditch temperatures

Permitting Needs:
U.S. Army Corps 404 permit for potential fill in wetlands
Madison County Floodplain Permit for construction within a FEMA mapped floodplain

Estimated Costs:

Project #	Action	Quantity	Unit	Unit Price	Cost
7	Plug stream outlet*	1	LS	$1,000	$1,000
				Subtotal	$1,000

* costs include excavation and reseeding for plug

Bridge Stability

Project 8. High Bridge
Flooding in 2011 caused emergency bank stabilization action at the High Bridge to prevent destabilization of the bridge abutments. Emergency efforts included placing riprap along the west bank of the river and shaping a rock point to direct water away from the western bridge abutment. This project includes revising western bank line upstream of the bridge to prevent the river from being directed away from a side channel on the west side of the river just north of the bridge. (Appendix A, Map 7). The primary benefit of this project includes creating a more stable configuration at the High Bridge reducing the potential of deactivating the side channel to the north of the bridge.

Suggested Monitoring Strategies
Before and after photographs

Permitting Needs:
Madison County CD 310 permit
U.S. Army Corps of Engineers 404 permit
Madison County Floodplain permit

Estimated Costs:
The Hamilton Ranch and Madison County are currently developing a plan to address this project. Details of this plan are currently unknown; therefore estimated costs are not provided at this time.

Bank Erosion and Deposition

Project 9. Big Hole River Levee Removal and Side Channel Reactivation
The removal of a 2,000-foot levee would allow the river to flow through a series of side channels deactivated by the presence of the levee (Appendix A, Map 8; Appendix B, Photo 14). Reactivation of these side channel braids would allow the river to connect to its natural floodplain, promote wetland and riparian vegetation, increase fish and wildlife habitat, and more appropriately align the river channel with the High Bridge. This project would allow the river to spread across a wider floodplain and reduce the river's scouring against the high bluff to the west. This bluff is a source of fine sediment deposition in the vicinity of the bridge; therefore reducing this source will reduce maintenance needs at the bridge and headgates immediately downstream of the bridge.

Primary benefits associated with this project include a more appropriately aligned channel to the High Bridge abutments; increased stream, wetland, and riparian habitats; and renewal and enhancement of the floodplain. Allowing the Big Hole River to capture the abandoned side channels may require regrading the floodplain where a former gravel pit has been excavated. The Lott-Harvey ditch will be jeopardized by one of the potential river channels (see Project 5 for potential revisions to Lott-Harvey Ditch).
Suggested Monitoring Strategies:
Montana Wetland Assessment Methodology to monitor wetland function in areas that develop as a result of floodplain reactivation
NRCS Riparian Assessment Method (RAM)
Human input

Permitting Needs:
Madison County CD 310 permit
U.S. Army Corps of Engineers 404 permit
Madison County Floodplain permit
DEQ 318 permit for temporary turbidity

Estimated Costs:

Project #	Action	Quantity	Unit	Unit Price	Cost
10	Remove levee and riprap*	2000	FT	$ 87	$174,000
				Subtotal	$ 174,000

* Includes: material removal and short haul, native riparian revegetation, grading of spoil area, revegetate spoils with grasses, project oversight, design, permitting, and project management.

5. DISCUSSION

Project Prioritization

The BHWC determines restoration priorities on an annual basis and is in the midst of developing a comprehensive watershed restoration plan. The framework for project prioritization will help the BHWC to determine which projects should take precedence over others within the Lower Big Hole Corridor and throughout the watershed. To simplify the prioritization process, three main prioritization categories were identified for consideration and evaluation, including landowner interest, feasibility of resource benefits, and satisfying established watershed goals.

Landowner Interest

Landowner interest and support is a key component for project implementation and success. The Lower Big Hole Corridor project was a direct response to landowner interest in improving and conserving aquatic habitat and addressing water quality and quantity issues from Pennington Bridge to High Bridge. In the Phase 1 section of the corridor, nine potential projects were identified on three main properties.

Cost/Benefit Analysis

The nine projects described above have a wide range of costs and ecosystem benefits. It is important to evaluate each of these projects based on the ecosystem benefits they provide and the feasibility of obtaining funding for project implementation. Conducting a cost benefit analysis of each project is a helpful way to assist in prioritizing a multitude of restoration projects. In addition to conducting a cost/benefit analysis, the identification of available funding sources to help in the implementation of these projects will help offset landowner costs and could help to increase influence participation in enhancement and restoration projects in the corridor.

Satisfaction of Prioritized Watershed Goals

Setting specific goals and objectives is an important component of any watershed restoration effort. The BHWC has established goals to address water quality and habitat issues within the watershed; these goals should be reviewed with respect to each restoration project to determine whether the project helps meet one or more restoration goals. Projects that help to meet the goals outlined in the watershed plan should be given higher priority than those that do not.

Difficulties and Limitations

Primary difficulties and limitations to water resource projects in the Lower Big Hole Corridor include water rights. Smaller projects, such as headgate removal, would not require changes in water right. However, both of the side channel habitat enhancement projects proposed in this report require winter flows to maximize benefits to the fishery, and may require adjustments to the period of use allowed by the water right. Revising water rights can be challenging and time consuming, and typically requires expertise in water right law.

6. REFERENCES

Big Hole Watershed Committee. 2012. Accessed April 23, 2012 at: www.bhwc.org.

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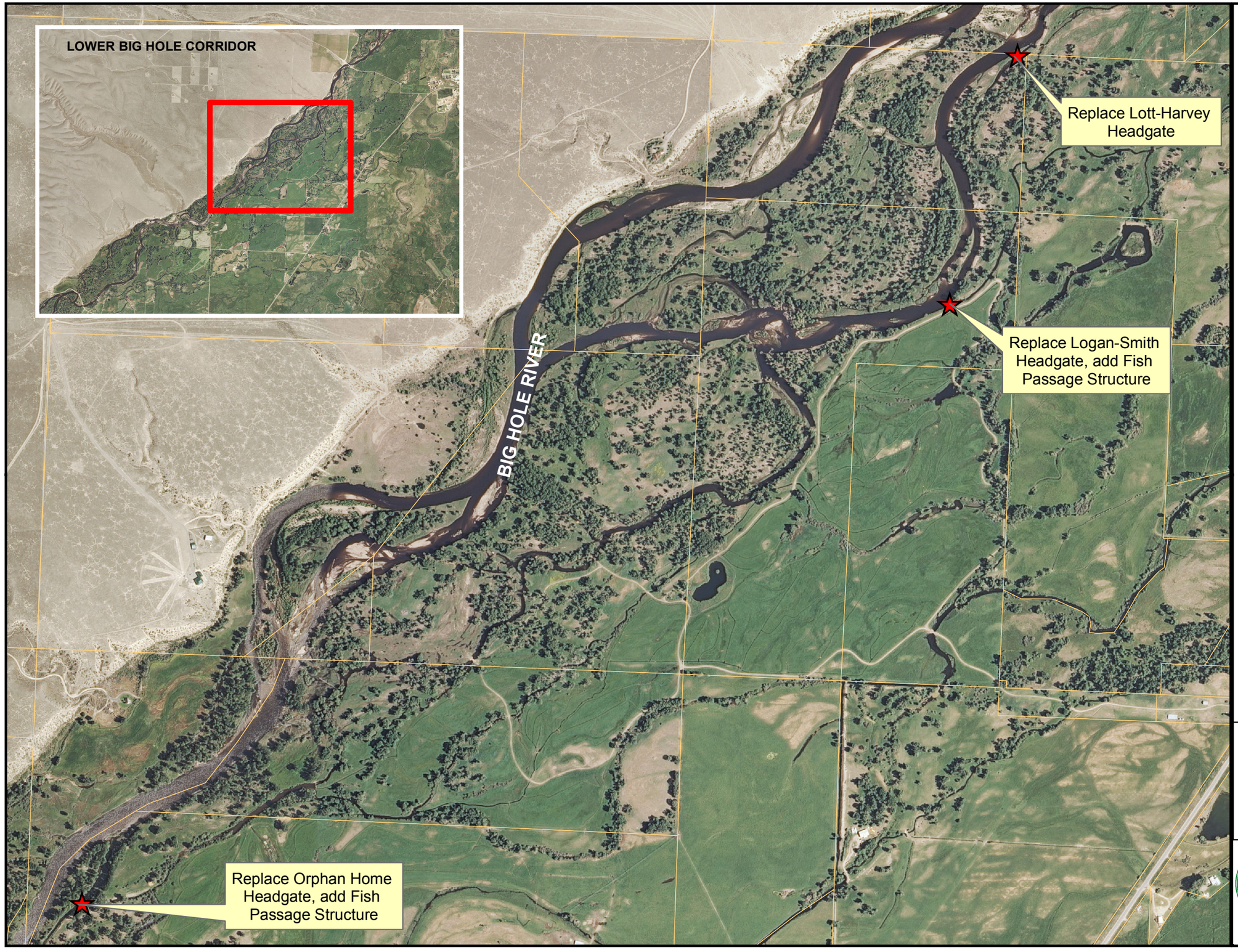
APPENDIX A

Maps and Figures

Lower Big Hole Corridor Assessment Project
Twin Bridges, Montana



Legend

- Headgates
- Parcel Boundaries

N

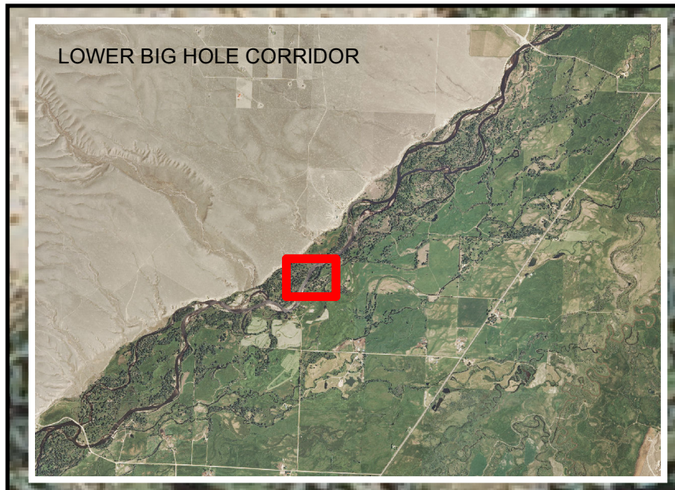
0 375 750 1,500 Feet

MAP 1

Lower Big Hole Corridor Irrigation Infrastructure Replacement

CONFLUENCE consulting incorporated

Map 1 of 8	
Date: 5/08/12	
Issued For: planning	
Drawn	Checked / Approved
File: headgates.mxd	



BIG HOLE RIVER

Existing Headgate Location

Build new Ditch Channel, Enhance Riparian Vegetation

New Headgate Location

Legend

- Headgates
- Current Ditch Alignment
- New Ditch Alignment

N

0 75 150 300 Feet

MAP 2

Smith Ditch/Orphan Home Channel Alteration

CONFLUENCE consulting incorporated

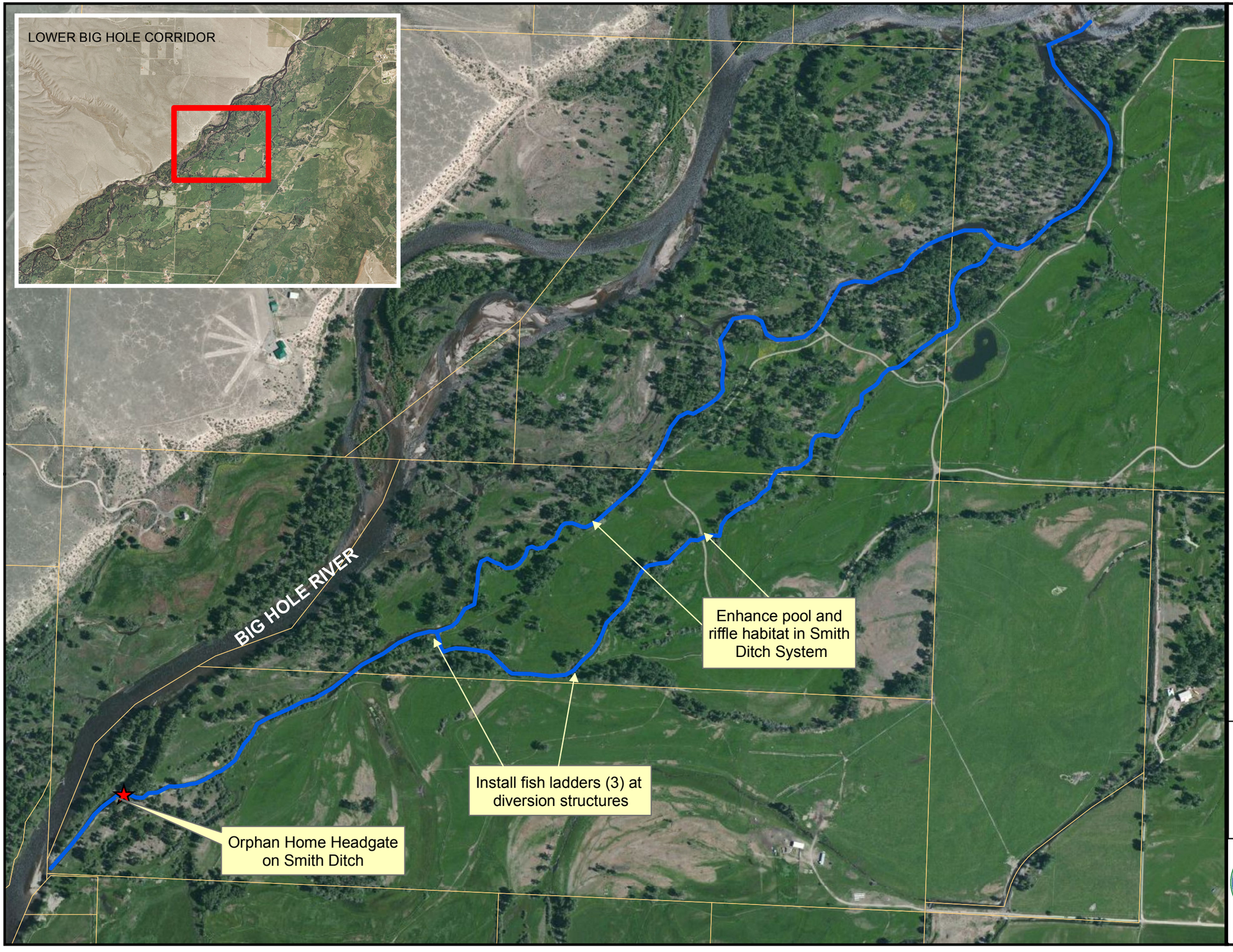
MAP 2 of 8

Date: 5/08/12

Issued For: planning

Drawn	Checked	Approved

File: SmithDitch/gps.mxd



Legend

- Smith Ditch Headgate
- Smith Ditch System
- Parcel boundary

N

0 250 500 1,000 Feet

MAP 3

Fisheries Enhancement on Smith Ditch System

CONFLUENCE consulting incorporated

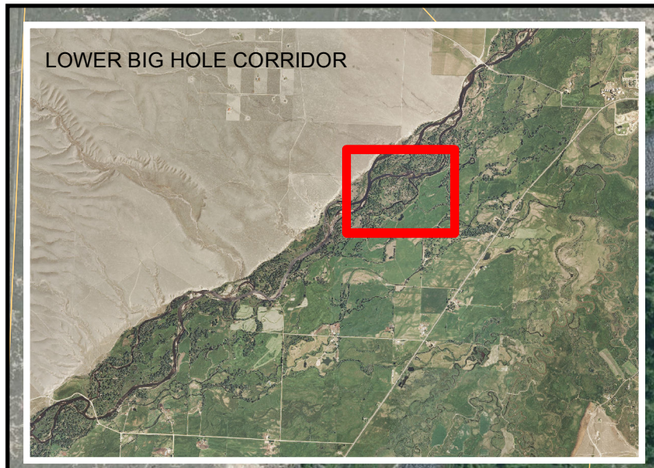
MAP 3 of 8

Date: 5/08/12

Issued For: planning

Drawn	Checked	Approved

File: SmithEnhance/gps.mxd



BIG HOLE RIVER

Create new channel to bypass oxbow

Existing Oxbow

Legend

- Smith Ditch System
- Proposed channel realignment
- Parcel boundary

N

0 200 400 800 Feet

MAP 4

Smith Ditch Channel Bypass

CONFLUENCE consulting incorporated

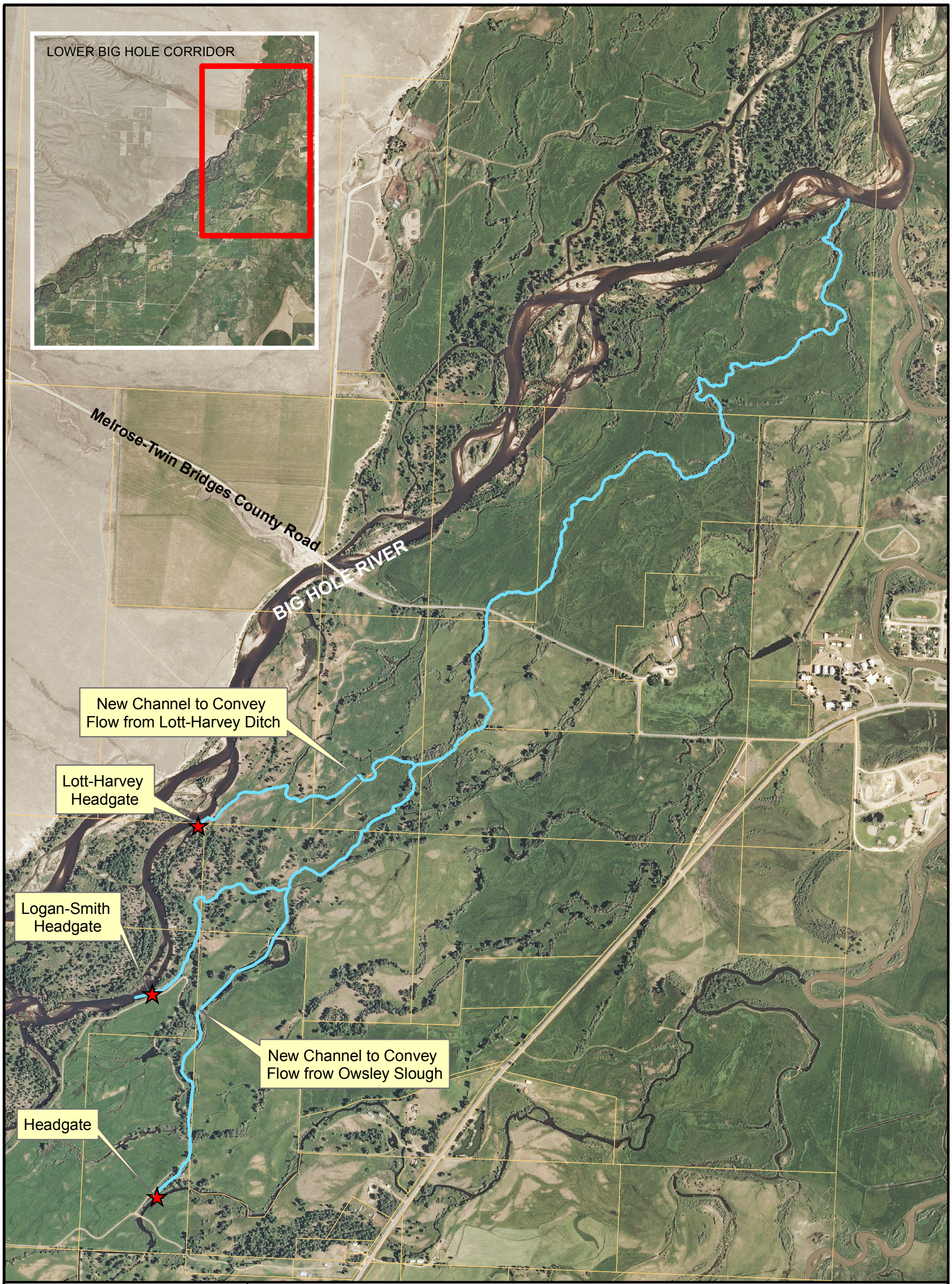
MAP 4 of 8

Date: 5/08/12

Issued For: planning

Drawn	Checked	Approved

File: LegacyOxbow/gps.mxd



MAP 5

Lott-Harvey and Logan-Smith Side Channel Fishery

CONFLUENCE consulting incorporated

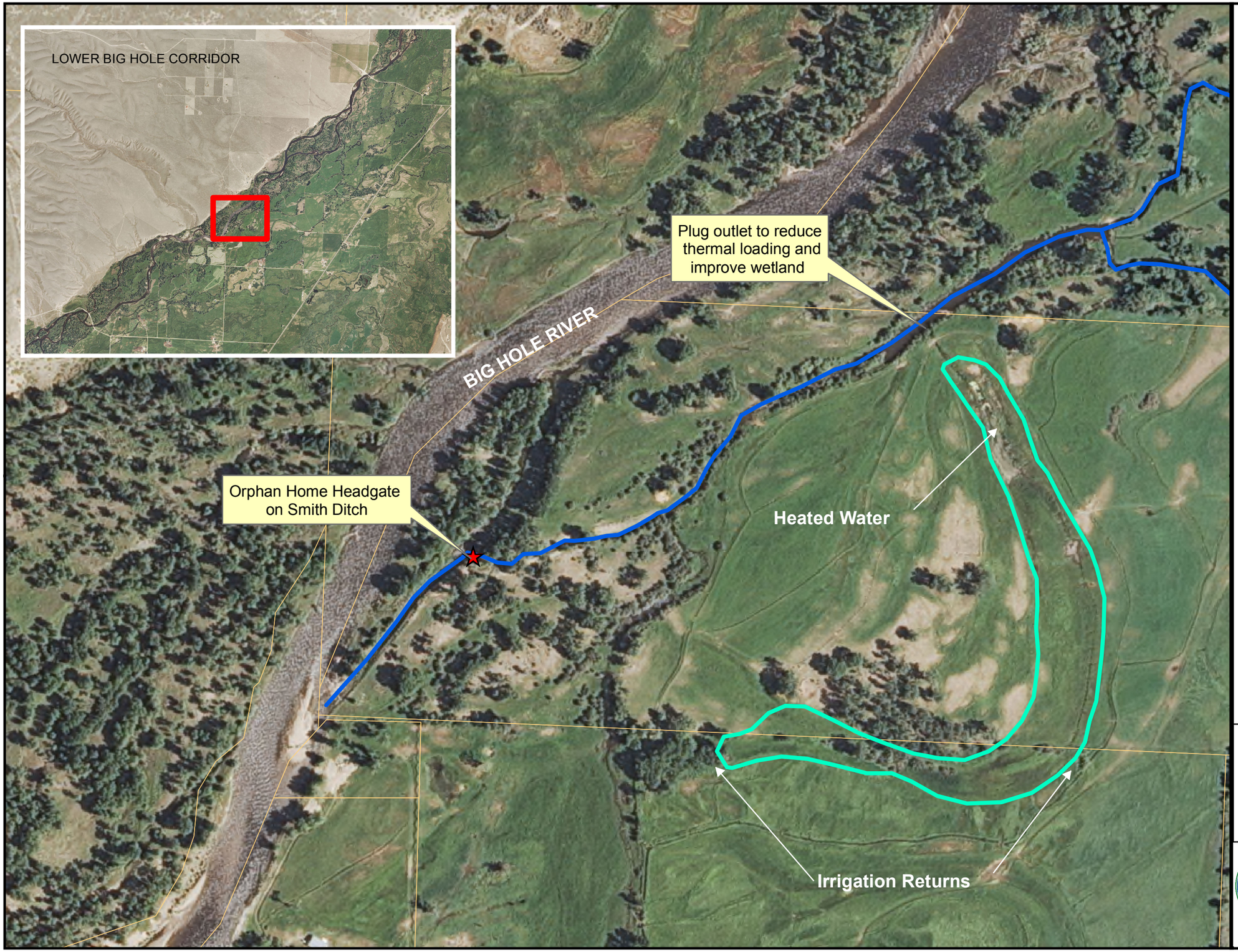
MAP 5 of 8			
Date: 5/08/12			
Issued For: planning			
Drawn	*Checked*	*Approved*	
File: BHSpringCrk/gps.mxd			

Legend

- Headgates
- Side Channel Fishery
- Parcel Boundaries

N

0 0.25 0.5 1 Miles



Legend

- Orphan Headgate
- Smith Ditch
- Wetland Improvement
- Parcel boundary

N

0 125 250 500 Feet

MAP 6

Wetland Enhancement

CONFLUENCE consulting incorporated

MAP 6 of 8

Date: 5/08/12

Issued For: planning

Drawn	Checked	Approved

File: JJCWetland/gps.mxd

Melrose-Twin Bridges County Road

BIG HOLE SIDE CHANNEL

Revise bank line to reduce flow redirection toward east side of river

BIG HOLE RIVER

N

0 37.5 75 150 Feet

MAP 7

High Bridge Bank Modifications

CONFLUENCE consulting incorporated

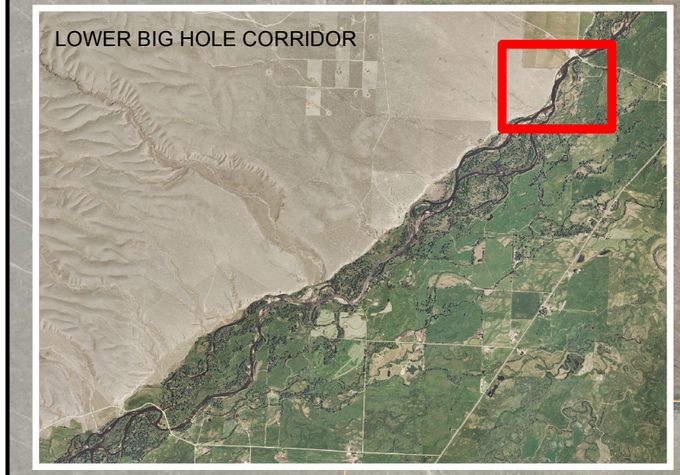
MAP 7 of 8

Date: 5/08/12

Issued For: planning

Drawn	Checked	Approved

File: HRBridge/gps.mxd



Melrose-Twin Bridges County Ro...

Sediment production from high bluff

River alignment more perpendicular to bridge abutments

Existing gravel pit

Sediment production from high bluff

BIG HOLE RIVER

Potential side channel activation

Remove riprap and levee

Legend

- Reactivated side channels
- Levee
- Parcel boundaries

N

0 175 350 700 Feet

MAP 8

Big Hole River Levee Removal and Side Channel Reactivation

CONFLUENCE consulting incorporated

MAP 8 of 8

Date: 5/08/12

Issued For:

Drawn	Checked	Approved

File: Sidechannel/gps.mxd

APPENDIX B

Lower Big Hole Corridor Site Photos

Lower Big Hole Corridor Assessment Project
Twin Bridges, Montana

Photo 1
Location: Orphan Home headgate looking downstream

Photo 2
Location: Orphan Home headgate looking upstream

Photo 3
Location: Big Hole River and Smith Ditch diversion channel

Photo 4
Location: Smith Ditch looking downstream

Photo 5
Location: Smith Ditch looking upstream

Photo 6
Location: Smith Ditch oxbow looking downstream

Photo 7
Location: Smith Ditch oxbow looking upstream

Photo 8
Location: Logan-Smith Headgate looking downstream

Photo 9
Location: Logan-Smith Headgate looking upstream

Photo 10
Location: Looking downstream Logan-Smith ditch

Photo 11
Location: Lott-Harvey Headgate looking upstream

Photo 12
Location: Lott-Harvey Headgate looking downstream

Photo 13
Location: East side of High Bridge

Photo 14
Location: Looking upstream at Big Hole River and proposed side channel.