CARTERSVILLE IRRIGATION DAM FISH PASSAGE ALTERNATIVE ANALYSIS AND ENVIRONMENTAL ASSESSMENT

October 26, 2010

Submitted to:

Montana Fish Wildlife and Parks

Submitted by:

DOWL HKM

With:

WHPacific

CONFLUENCE consulting incorporated

KOZMO

Applied Geomorphology, Inc.

Bob Bramblett, PhD

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The U.S. Army Corps of Engineers (USACE) will provide permits for this project and may be the source of funds for construction. USACE "Procedures for Implementing NEPA" (33 CFR 230) states the following:

> "A FONSI shall be prepared for a proposed action, not categorically excluded, for which an EIS will not be prepared. The FONSI will be a brief summary document as noted in 40 CFR 1508.13. In the case of feasibility, continuing authority, or special planning reports and certain planning/engineering reports, the draft FONSI and EA should be included with the draft report and circulated for a minimum 30-day review to concerned agencies, organizations and the interested public (40 CFR 1501.4(e)(2)."

Finding of No Significant Impact
Cartersville Irrigation Dam Fish Passage
Forsyth, Montana

The Department of Montana Fish, Wildlife, & Parks (FWP), in cooperation with the United States Army Corps of Engineers (USACE), Omaha District; Montana Department of Environmental Quality (DEQ); and Montana Department of Natural Resources and Conservation (DNRC), is planning to modify the Cartersville irrigation dam to allow proper passage of fish, specifically, the shovelnose sturgeon.

A report titled "Draft Cartersville Irrigation Dam Fish Passage Alternative Analysis and Environmental Assessment", dated April 2010, was prepared for FWP by DOWL HKM.

The Corps' Regulations Implementing NEPA (33 CFR 230), paragraph 21 states, "A District Commander may adopt another agency's EA/FONSI."

State agencies may also adopt an EA completed by co-lead or complete further documentation as they see fit to comply with the Montana Environmental Policy Act (MEPA) process.

Initial alternatives were developed for this project as part of a 2-day meeting in February 2009. The participants generated 60 ideas for various alternatives. The Cartersville Irrigation District supported the rock ramp alternative, with several options, and the controlled notch (inflatable bladder) alternative. The rock ramp alternative consists primarily of a rock ramp in the north channel of the Yellowstone River below the diversion dam, a berm from the south abutment of the diversion dam to the south edge of the north channel (north side of island) to control the split of river flows to the north and south channel, and bank protection/apron downstream of the rock ramp. The controlled notch (inflatable bladder) alternative consists of installing an inflatable bladder across the entire Yellowstone River at the location of the existing diversion dam. The rock ramp alternative with a constant slope of 0.5% was selected as the proposed action for meeting the goals/objectives of the project.

The proposed action would improve fish passage in the vicinity of the Cartersville Irrigation Dam. Additionally, a migration barrier would be removed and connectivity to upstream habitat would be improved for fish and other aquatic animals; as a result, there may be more food available for fish-dependent species. Angling opportunities may also be improved. The no-action alternative would not modify the existing dam.

The proposed work would affect waters of the United States regulated by Section 404 of the Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act; therefore a Section 404/10 Department of the Army (DA) permit and a Montana State Water Quality Certification Permit (Section 401) would be needed for the project.

Compliance with the following additional laws, regulations, and policies was evaluated as part of the EA:

- The Farmland Protection Policy Act of 1995;
- Fish and Wildlife Coordination Act of 1958;
- Migratory Bird Treaty Act and Executive Order 13186;
- National Historic Preservation Act of 1966;
- Rivers and Harbors Appropriation Act of 1899;
- Executive Order 13112 (Invasive Species);
- Executive Order 11988 (Floodplain Management);
- Executive Order 11990 (Protection of Wetlands);
- Executive Order 13007 (Indian Sacred Sites);
- Executive Order 12898 (Environmental Justice);
- State Water Rights;
- Stream Protection Act;
- Short Term Water Quality Standards for Turbidity (318);
- Montana Land-Use License of Easement on Navigable Waters;
- Stormwater Discharge General Permits; and
- Section 401 Water Quality Certification.

FWP will coordinate with the responsible agencies to obtain all necessary permits and approvals, and ensure compliance with these laws, regulations, and policies during design and construction.

Beneficial Impacts, Adverse Impacts, Cumulative Effects, and Proposed Mitigation

The beneficial impacts, adverse impacts, cumulative effects, and proposed mitigation related to the proposed action are summarized below.

<u>Ecological Resources</u>

- Hydrology
    - No changes to hydrology are anticipated as a result of the proposed action.

- Geomorphology
    - Beneficial impacts
        - The steep drop created by the current dam would be removed and extended over a longer channel distance, improving conditions for overall connectivity and fish passage.
        - Scour potential of the river bed downstream of the dam structure would be reduced.
    - Adverse impacts
        - Scour potential of the river bed and island downstream of the dam structure may be increased when the berm is overtopped.
    - Cumulative Effects
        - Total bank armor length would be increased by 2,100 linear feet, increasing the length of armored bank from 22% to 25% of the reach. This increase would be offset by the net benefit of the project to the Yellowstone River fishery.
    - Proposed mitigation
        - Bank armor would be designed to minimize the impact to fishing access.
- Federally-Listed Species and State Species of Special Concern
    - Beneficial impacts
        - Fish may concentrate at the toe of the dam, increasing food availability for bald eagles.
        - A potential migration barrier to spiny softshell turtles, blue sucker, sturgeon chub, paddlefish, and sauger would be removed.
    - Adverse impacts
        - Some great blue heron feeding habitat may be reduced.
    - Cumulative Effects
        - Fish passage would be improved as a result of the proposed action and modification of other dams on the Yellowstone River.
    - Proposed mitigation
        - No mitigation measures are proposed.
- Lands and Vegetation
    - Beneficial impacts
    - Adverse impacts
        - Natural bank vegetation may be displaced by bank armor; however, the existing vegetation is sparse, so the effect would be minimal.
        - Approximately 22 acres of waters of the US are estimated to be filled.

        - Approximately 1.45 acres wetlands are estimated to be lost. A wetland delineation would be completed during final design to confirm the wetland boundaries and impacts to wetlands and other waters of the US.
    - Cumulative Effects
        - The proposed rock ramp would add to the cumulative loss of wetlands in Montana.
    - Proposed mitigation
        - Placement of fill within the river channel is expected to be self mitigating as it will result in transforming slower moving, deep water riverine habitat to fast-moving, shallower water rapid habitat.
        - Mitigation for fill, if necessary, would be coordinated with the USACE, Montana Department of Environmental Quality, and other responsible agencies following final design of the rock ramp.
        - Mitigation wetlands would be constructed, in coordination with USACE, to offset the loss of wetlands resulting from this project.
- Aquatic Assemblages
    - Beneficial impacts
        - Fish passage would be improved for juvenile sauger, shovelnose sturgeon, endangered pallid sturgeon, and other species.
        - Previously unavailable spawning, rearing, and foraging areas upstream of the dam may become accessible for fish.
        - Genetic diversity and populations of fish may increase.
        - Recreational fishing opportunities may improve upstream of the dam.
    - Adverse impacts
        - Transport for unwanted or invasive fish would be improved.
        - Larval fish, macroinvertebrates, and freshwater mussels may be killed as a result of construction activities; the loss is expected to be short-term, localized, and minimal.
    - Cumulative Effects
        - Fish passage would be improved as a result of the proposed action and modification of other dams on the Yellowstone River.
    - Proposed mitigation
        - No mitigation measures are proposed.
- Recreation
    - Beneficial impacts
        - Recreational fishing opportunities may improve.

- Adverse impacts
    - Boat passage may be impacted in the vicinity of the existing boat ramp and island.
- Cumulative Effects
    - The Yellowstone River fishery would benefit as a result of the proposed action and modification of other dams on the Yellowstone River.
- Proposed mitigation
    - A new boat ramp may be constructed downstream of the existing state park on the south bank of the river, downstream of the dam.

Cultural Resources

- Beneficial impacts
    - The risk of dam failure would be minimized.
- Adverse impacts
    - Based on the potential disturbance to the diversion dam, the Montana State Historic Preservation Office (SHPO) believes that the project has the potential to impact cultural properties.
- Cumulative Effects
    - The Yellowstone River fishery would benefit as a result of the proposed action and modification of other dams on the Yellowstone River.
- Proposed mitigation
    - Future design and construction work would be coordinated with the State Historic Preservation Office to minimize effects to cultural resources.

Aesthetic Resources

- Beneficial impacts
    - The risk of dam failure would be minimized.
    - The rock ramp would provide aesthetic values similar to natural rapids.
    - The south channel of the Yellowstone River would stay in its current configuration.
- Adverse impacts
    - No adverse impacts are expected.
- Cumulative Effects
    - No cumulative effects are expected.
- Proposed mitigation
    - No mitigation measures are proposed.

Surface Water Quality

- Beneficial impacts
    - No beneficial impacts are anticipated.
- Adverse impacts
    - Turbidity and concentrations of other chemicals may increase temporarily in a localized area during construction.
- Cumulative Effects
    - The existing water quality impairment listing for the river upstream of the dam would be addressed by removing the warm water fish passage barrier.
- Proposed mitigation
    - Best Management Practices (BMPs) would be employed during construction to minimize adverse effects.
    - A sediment management plan would be prepared by the contractor and implemented during construction to monitor, control, and minimize turbidity.
    - Material handling, erosion control, and spill control protocols would also be developed and implemented during construction.
    - Disturbance to river bank vegetation during construction would be mitigated by revegetation with species native to the area.

Air Quality

- Beneficial impacts
    - No beneficial impacts are expected.
- Adverse impacts
    - Dust and exhaust fumes would increase temporarily, on a localized basis, during construction.
- Cumulative Effects
    - No cumulative effects are expected.
- Proposed mitigation
    - BMPs would be employed during construction to minimize dust and exhaust.

Conclusion

The proposed action has been and will continue to be fully coordinated with federal, state, tribal, and local agencies with jurisdiction over the biological, ecological, cultural, and hydrological resources of the project area. Based upon these factors and others discussed in detail in the Environmental Assessment, the planned action would not have a significant effect on the human environment. Therefore, an Environmental Impact Statement will not be prepared for the proposed Cartersville Irrigation Dam Fish Passage Project.

Agency Approval

Montana Department of Fish, Wildlife, & Parks

James E. Darling (ACTING CHIEF) 11/17/10

Name and Title Date

Finding of No Significant Impact
Cartersville Irrigation Dam Fish Passage
Forsyth, Montana

The Montana Department of Natural Resources and Conservation (DNRC) is a cooperating agency for the preparation of the Draft Cartersville Irrigation Dam Fish Passage Alternative Analysis and Environmental Assessment (EA).

On the basis of a thorough review of the analysis of environmental impacts as presented in the final EA, and implementation of all environmental commitments identified in the final EA, DNRC has determined that the proposed action would have no significant impact on the quality of the human environment of the study area. Therefore, an environmental impact statement (EIS) will not be prepared for this project.

Montana Department of Natural Resources and Conservation

DNRC Director — 11/5/10

Name and Title — Date

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LIST OF ABBREVIATIONS

%	-	percent
‘	-	foot (feet)
<	-	less than
ADCP	-	acoustic Doppler current profiler
BNSF	-	Burlington Northern Santa Fe
BRT	-	biological review team
CES	-	Cumulative Effects Study
cfs	-	cubic feet per second
DEQ	-	Department of Environmental Quality
FWCA	-	Fish and Wildlife Coordination Act
FWP	-	Department of Fish, Wildlife and Parks
EA	-	Environmental Assessment
ESA	-	Endangered Species Act
F	-	Fahrenheit
FL	-	fork length
FOB	-	Freight on Board
ft	-	feet
ft^2	-	feet squared, square feet
ft/s	-	feet per second
FWP	-	Fish, Wildlife and Parks
GIS	-	geographic information system
Jan	-	January
Jul	-	July
km/h	-	kilometers per hour
LERRD	-	Lands, easements, rights-of-way, relocations, and disposal areas
LiDAR	-	Light Detection and Ranging
M	-	meters
Mar	-	March
Max	-	maximum
MEPA	-	Montana Environmental Policy Act
MFISH	-	Montana Fisheries Information System
mg/l	-	Milligrams per liter
MNHP	-	Montana Natural Heritage Program
MRL	-	Montana Rail Link
MT	-	Montana
NEPA	-	National Environmental Policy Act
Nov	-	November
NRCS	-	Natural Resources and Conservation Service
NWI	-	National Wetland Inventory
O&M	-	Operation and Maintenance
OM&R	-	Operation, Maintenance and Replacement
P&G	-	Principals and Guidelines
psf	-	pounds per square foot
RM	-	river mile
SHPO	-	State Historic Preservation Office
sq. mi.	-	square mile
TMDL	-	Total Maximum Daily Load

U.S.	-	United States
USACE	-	United States Army Corp of Engineers
USFWS	-	United States Fish and Wildlife Service
USGS	-	United States Geological Survey
WAPA	-	Western Area Power Administration
WRDA	-	Water Resource Development Act
XS	-	cross section

1.0 INTRODUCTION

The Montana Department of Fish, Wildlife and Parks (FWP) is evaluating the feasibility and cost of modifying the Cartersville irrigation dam to allow proper passage of fish and specifically, shovelnose sturgeon. FWP is the lead state agency responsible for the preparation of the Montana Environmental Policy Act (MEPA) Environmental Assessment, which is required prior to any state action that may affect the human or physical environment.

The Cartersville irrigation dam is located on the Yellowstone River at the town of Forsyth in Rosebud County, Montana (Figure 1-1 through 1-5). The legal description of the site is Sec 14, T67N, R 40E. The dam is owned and operated by the Cartersville Irrigation District. The Cartersville Irrigation District has water right 42KJ 177092 00 with a priority date of April 17, 1903 to divert up to 425.55 cubic feet per second (cfs) of water for irrigation purposes. The condition of the dam has deteriorated since it was constructed and has required ongoing annual maintenance in recent years. Constructed in the early 1900's, the dam is made of timber and rock-rubble riprap capped with concrete. The dam is over 800-ft in length and spans the entire channel of the Yellowstone River, and acts as a barrier to fish and boaters, particularly during periods of lower flows (Bureau of Reclamation and FWP, 1999).

Montana Fish, Wildlife & Parks is required by law to implement programs that manage sensitive fish species in a manner that assists in the maintenance or recovery of those species, and that prevents the need to list species under 87-5-107 or the federal Endangered Species Act. Section 87-1-201(9)(a), M.C.A. The impediment to fish passage created by Cartersville Dam impacts shovelnose sturgeon and other migratory fish species. Consequently, modification of the dam to improve passage falls within the legal purview of FWP. Another fish passage barrier is created by the Intake Dam, which is located downstream of the Cartersville Dam in Dawson County, Montana. This dam creates a fish barrier for pallid sturgeon (Scaphirhynchus albus), an endangered species that is found only downstream of the Intake Dam. The U.S. Army Corps of Engineers is currently working on a project that will provide fish passage at the Intake dam. Once that project is complete, the Cartersville Dam will be the next barrier that precludes the upstream movement of pallid sturgeon, shovelnose sturgeon, and other fish species.

This Feasibility Report was prepared under contract "Cartersville Irrigation Dam Fish Passage Alternative Analysis and Environmental Assessment Project, FWP #3885" with the Montana Department of Fish, Wildlife and Parks (FWP) dated June 26, 2009.

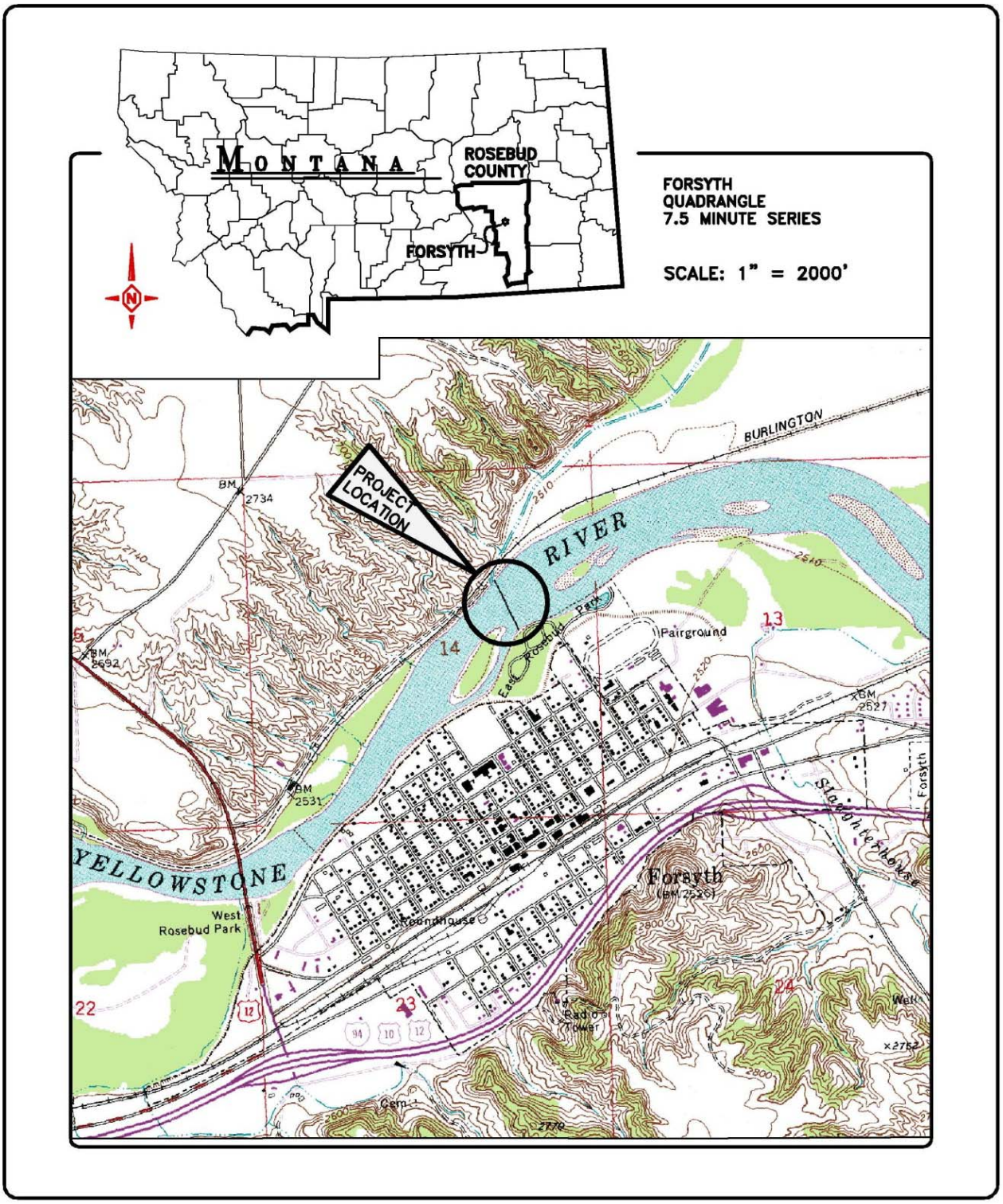


Figure 1-1 Location and Vicinity Map

Figure 1-2 Cartersville Irrigation Dam from South Bank

Figure 1-3 State Park, Boat Ramp, Fishing Access, Island Downstream of Dam

Figure 1-4 Cartersville Irrigation District Headgate, North Bank

Figure 1-5 State Park on South Bank

Permits:

Agency Name	Permits
Montana Fish, Wildlife & Parks	124 Permit (Stream Protection Act)
U.S. Army Corps of Engineers	Section 404 Permit
Montana Department of Environmental Quality	318 Authorization
Rosebud County Floodplain Coordinator and/or MT DNRC	Floodplain Permit
U.S. Army Corps of Engineers	Section 10 Permit
Montana Department of Environmental Quality	Stormwater Discharge General Permit

Funding (funding not obtained yet):

Agency Name	Funding Amount
Montana Fish, Wildlife & Parks	N/A
U.S. Army Corps of Engineers	N/A

Other Overlapping or Additional Jurisdictional Responsibilities:

Agency Name	Type of Responsibility
Montana Department of Natural Resources and Conservation	Water Rights
Montana State Historic Preservation Office	Section 106
Montana Department of Natural Resources and Conservation	Land Use License or Easement
Montana Department of Environmental Quality	401 Water Quality Certification
Natural Resources Conservation Service	Farmland Protection Policy Act
U.S. Fish Wildlife Service	Fish and Wildlife Coordination Act and Migratory Bird Treaty Act

2.0 REPORT FORMAT

The U.S. Army Corps of Engineers (USACE) will provide permits for this project and may be the source of funds for construction. Therefore, based on conversations with the USACE, Omaha District, this report follows instructions in the USACE document "Planning Guidance Notebook", ER 1105-2-100, dated 22 April 2000. That document provides an outline for a feasibility study report and an environmental assessment (EA), which can either be bound to the feasibility report as a separate, stand-alone appendix or integrated into the feasibility report (recommended). For the Cartersville Dam feasibility report we have chosen to integrate the EA into the document rather than append it. The planning guidance notebook categorizes this fish passage project as an "ecosystem restoration" project and as such, the specific guidelines for ecosystem restoration projects were followed.

This report is organized as follows:

Section	Information Presented
Study Purpose and Need	Describes the study purpose and need.
Prior Studies, Reports and Existing Water Projects	Describes prior studies, reports and/or existing water projects.
Plan Formulation	Six step planning process defined by USACE.
Affected Environment	Describes the area of the environment to be affected by proposed alternatives.
Environmental Consequences	Describes the environmental consequences that may result from this project and associated environmental mitigation.
Descriptions of Selected Plan	Describes the selected plan including design and operation, maintenance considerations, and plan accomplishments.
Plan Implementation	Describes institutional requirements, plan responsibilities, and views of agencies.
Consultation and Coordination	Describes consultation and coordination activities.
Recommendations	Provides recommendation for further action.

3.0 STUDY PURPOSE AND NEED

One goal within Montana Fish, Wildlife and Parks six year operations plan for the fisheries program is to "restore and enhance degraded habitats" by implementing habitat restoration projects and administering the Future Fisheries Improvement Program to restore important habitats on public and private lands. The proposed Cartersville Dam fish passage improvement project would help meet this goal.

Since it was built in the early 1900's, this dam has likely impeded the upstream migration of shovelnose sturgeon and other fish species native to the Yellowstone River. Another fish passage barrier is created by the Intake Dam (River Mile 73.0), which is located downstream of the Cartersville Dam (River Mile 238.5) in Dawson County, Montana. This dam creates a fish barrier for pallid sturgeon (Scaphirhynchus albus), an endangered species that is found only downstream of the Intake Dam. The U.S. Army Corps of Engineers is currently working on a project that will provide fish passage at the Intake dam. Once that project is complete, the Cartersville Dam will be the next barrier that precludes the upstream movement of pallid sturgeon, shovelnose sturgeon, and other fish species.

The overall intent of the Cartersville Dam project is to modify the dam to improve fish passage through this section of the Yellowstone River, while continuing to provide the water needed for the Cartersville Irrigation District. The primary project objectives are to:

1. Maintain the ability of the irrigation district to divert water at all flow levels
2. Allow upstream passage of native fishes, particularly sturgeon
3. Provide minimal maintenance requirements
4. Increase public safety
5. Maintain recreation opportunities at the adjacent city park

4.0 PRIOR STUDIES, REPORTS AND EXISTING WATER PROJECTS

Initial alternatives were developed for this project as part of a 2-day "Cartersville Diversion Dam Project Study" conducted February 25-26, 2009. The purpose of the study was to expand the existing list of project alternatives and prioritize them. Agencies and stakeholders represented at this 2-day meeting included:

- U.S. Fish and Wildlife Service (USFWS)
- U.S. Army Corps of Engineers (USACE)
- Montana Department of Fish, Wildlife, and Parks (FWP)
- Montana Department of Environmental Quality (DEQ)
- Natural Resource Conservation Service (NRCS)
- Yellowstone River Conservation District
- Cartersville Irrigation District
- Nature Conservancy

Through this process, the participants generated 60 ideas for various alternatives. Of these, seven were selected for further development.

4.1 Controlled Notch in Crest of Dam Controlled by Inflatable Bladder

This alternative would utilize the existing dam with the modification of constructing a 200-foot (ft) long notch in the crest of the dam (Figure 4-1). The notch would be about 3-ft deep measured from the crest, to allow fish to pass. A 1-ft high roller compacted soil cement type of apron would be constructed on the downstream side of the notch to control flow velocity and stabilize the river bed.

A 3-ft high rubber bladder dam would be installed on the downstream edge of the notch. It would remain deflated for most of the year and inflated only when needed, typically in August and September to provide head to divert water into the slough.

The bladder would only be inflated during periods of very low flow below 4,000 – 5,000 cubic feet per second (cfs). Fish passage could still be provided for about 2 hours a day by utilizing the storage capacity of the slough.

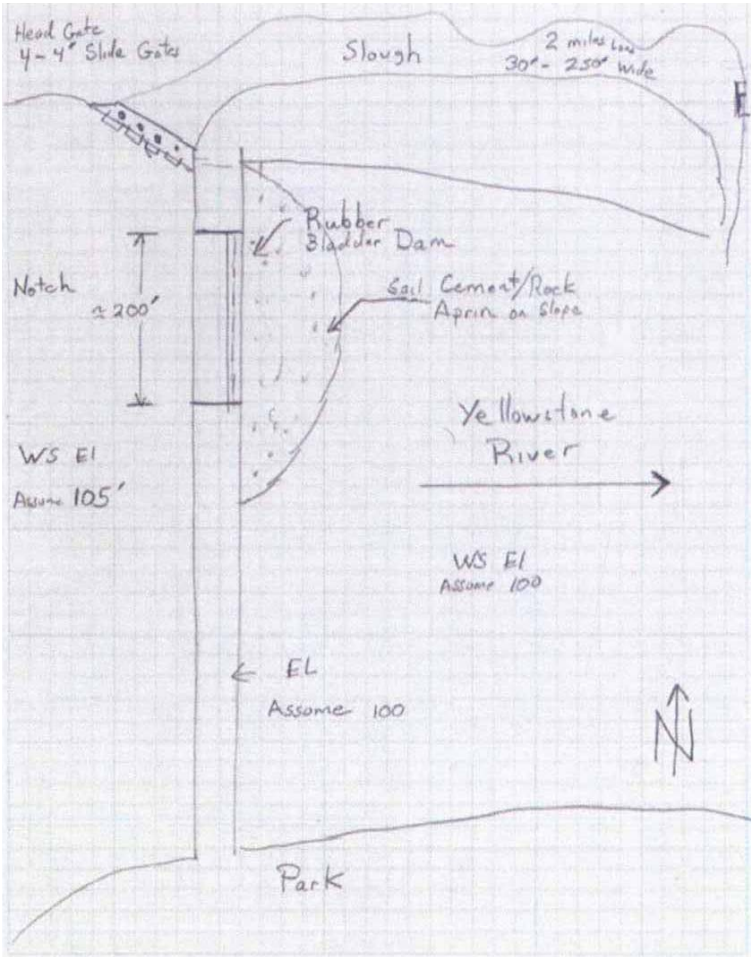


Figure 4-1 Inflatable Dam, February 2009

While the dam is raised, the slough would be filled to capacity, at which time the headgates could be shut and the dam lowered to provide fish passage for a short period of time while canal diversions continue from the slough. When the slough elevation drops too low for adequate canal diversion, the bladder dam would be raised and diversion into the slough would resume.

Advantages:

- Dam remains mostly intact; community acceptance
- Allows fish passage most of the year – especially in spring and fall
- Provides head to divert water at current elevation of dam crest
- Does not create potential for increased flood risk upstream
- Increased safety could be incorporated

This alternative was dismissed from further consideration due to the following:

- Notch near headgate may increase entrainment
- Possible bank erosion downstream
- Damage from trees, ice, debris, boats, and potential vandalism may necessitate periodic bladder replacement

4.2 Engineered Fishway Around South Abutment of Existing Dam

A rock channel fishway with boulder weirs would be constructed around the south abutment of the existing dam (Figures 4-2 and 4-3). The channel would have 8-ft bottom with 2:1 side slopes, and a top width of 24-ft. To achieve a 4-ft height, a 200-ft channel would be at 2% slope, which is the maximum recommended to pass native fish in the Yellowstone River. The entrance would be just below the existing dam on the south side, and just upstream of the existing boat ramp. Boulder weirs would be used to baffle velocities; 10 weirs spaced every 20-ft would be recommended. The upstream exit of the fishway would tie into the existing side channel of the Yellowstone River. Based on rough estimation compared to a similar proposal at Intake Diversion Dam near Glendive, Montana, an 8-ft bottom fishway would convey 1-5% of the flow of the river.

Advantages:

- Simple, inexpensive to implement
- Contained on State Property
- Side channel would alleviate concerns with ice damage to engineered structures
- Keeps dam intact for social and historic considerations
- Possible enhancement of recreational boat passage

This alternative was dismissed from further consideration due to the following:

- Attraction flows may not be adequate to efficiently pass all species of fish.
- Dam would need to be stabilized – future maintenance without stabilization would likely consist of continued addition of rock that could move downstream and interfere with the proper function of the fishway.
- Relies on continued flow in the side channel to provide fishway flow – if the side channel deactivates in the future the fishway would not function.
- Possible impacts to the campground / recreation area.

Figure 4-2 Location of Proposed Fishway

Figure 4-3 Muggli Fishway on the Tongue River (similar to proposed)

4.3 Partial Diversion Dam

This alternative would replace the existing diversion structure with a partial span diversion dam, creating a relatively natural gradient open channel on the southern side of the river (Figure 4-4). A physical model investigation would be needed to ensure optimization of water delivery and fish passage requirements and determine structure configuration and length. For conceptual purposes, a half to three-quarter span straight structure constructed of sheet pile was considered. Pile cells would be filled with native cobble

and capped with concrete. Riprap would be added up and downstream of the sheet pile and at open end of structure for reinforcement. Structure would be designed for no operation and maintenance (O&M) for 30 years but will require addition of riprap downstream periodically in the future.

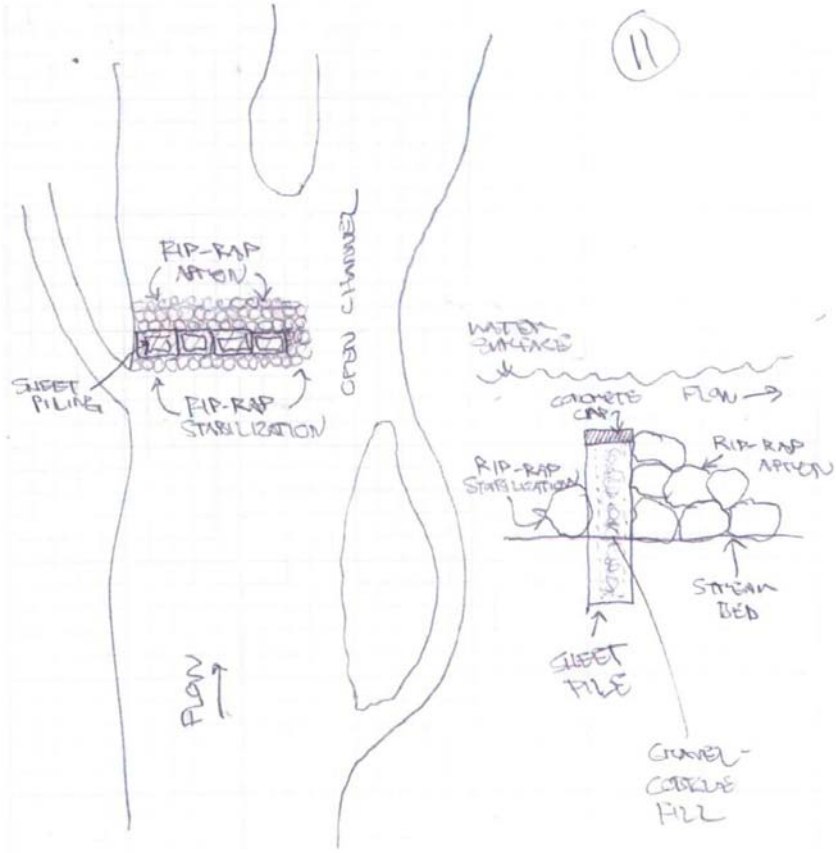


Figure 4-4 Partial Diversion Dam

Advantages:

- High likelihood of achieving intended purpose of year-round passage for all fish species because it more closely approximates an open channel.
- High likelihood of providing passage for "design" species (shovelnose sturgeon)
- Alternative will enhance recreation by providing boat passage
- Alternative may reduce entrainment of attracting fish
- Has advantage of being able to construct without dewatering

This alternative was dismissed from further consideration due to the following:

- Channel may change – physical modeling would be required to address post-construction effects

- More force will occur on a partial dam than a similarly constructed full width structure – design should consider and plan for no O&M for 30+ years following construction
- There may be some flow conditions that result in loss of head with some design configurations – physical modeling would be needed to optimize structure and minimize this risk
- Some bank stabilization may be required along island and south bank

4.4 Island – South Channel Passage

This alternative would open the south channel to fish passage by connecting the east end of the island to the existing dam, and removing a section of the dam at the southern terminus, to allow a natural gradient channel through that area.

As shown on Figure 4-5, a natural channel exists to the south of a large, well-established island that extends approximately 2,000 feet upstream from the dam. The channel is capped with cobble and gravel riffles at either end, and a deep slow moving portion through the remainder with gravel / fines / mud substrates. Lateral channel migration is prohibited by a large earthen dike to the south and the island bank to the north.

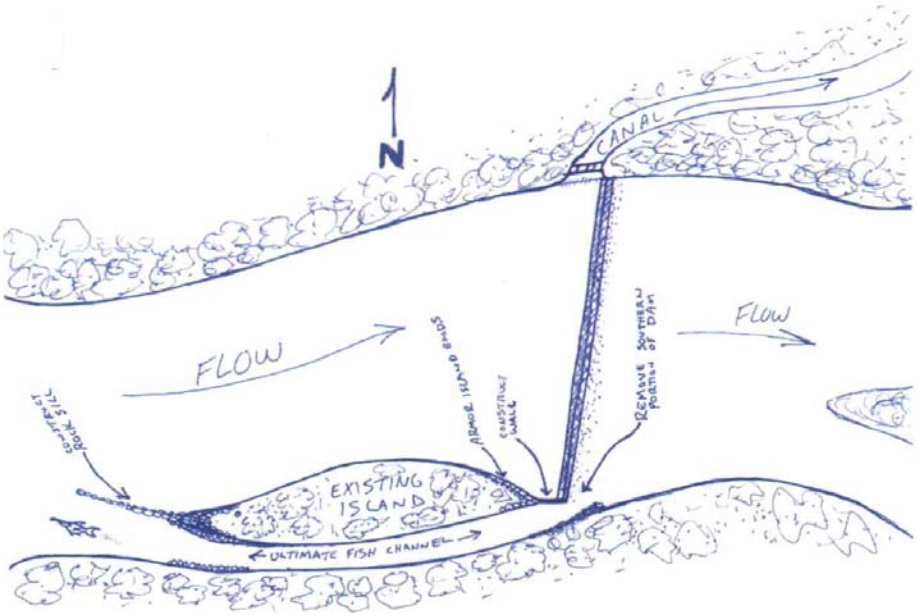


Figure 4-5 Island – South Channel Passage

This alternative would remove a southern portion of the dam comparable in width to the existing south channel. The dam would be removed down to the elevation of the current stream-bottom depth on the downstream side, therefore leaving the foundation portion of the dam as a grade control and erosion prevention structure. A deep pool exists immediately upstream from the dam in the short distance from the riffle to the dam. This pool would be filled to the level of the dam foundation and downstream stream bottom as well to prevent formation of deep plunge pool which may prohibit sturgeon and other less capable swimmers from accessing the channel. The remaining dam foundation would be armored on either side to prevent scour of the river bottom and erosion/loss of foundation.

A concrete wall would be built extending from the eastern tip of the island to the existing dam at or near its southern terminus. This wall should be higher than the water surface and current dam height to prevent overflow and scour of the new passage channel.

Low flow (attraction flow as well as passage flow over existing riffles) may be the limiting factor for this alternative. To assure adequate flow, we would extend a sill from upstream (western) tip of island essentially parallel to river flow. The sill would be low elevation. Riprap or hardening of upstream and downstream ends of the island may be necessary as well to prevent erosion.

Advantages:

- Provides passage to all fish species at all ages
- Provides fish passage by taking advantage of existing natural channel while maintaining current diversion capabilities.
- Recreational opportunities should not be lost with this option; boat and small vessel (kayak, canoe, tubes) passage will be enhanced.

This alternative was dismissed from further consideration due to the following:

- Less accessibility for O&M.
- Concern about low flow conditions and whether irrigation ditch will still be able to receive adequate flow.
- Risk of capture by channel by river, which could threaten the dike, the park, or even the community.

4.5 Raceway Notch Fish Passage

This alternative includes a passage channel through the dam with continuous gradient that meets minimum swim criteria and allows control of flow through the notch (Figure 4-6). The design configuration would be done to absorb energy and maintain head under most flow conditions.

- Channel will operate with a raceway shaped baffle on the upstream side.
- Under very low flows the notch can be closed to maintain head.
- Will require a reconfiguration of the dam plan view to help attract fish.
- Would require construction of road access on north side.
- Could require extra design to improve drowning safety.

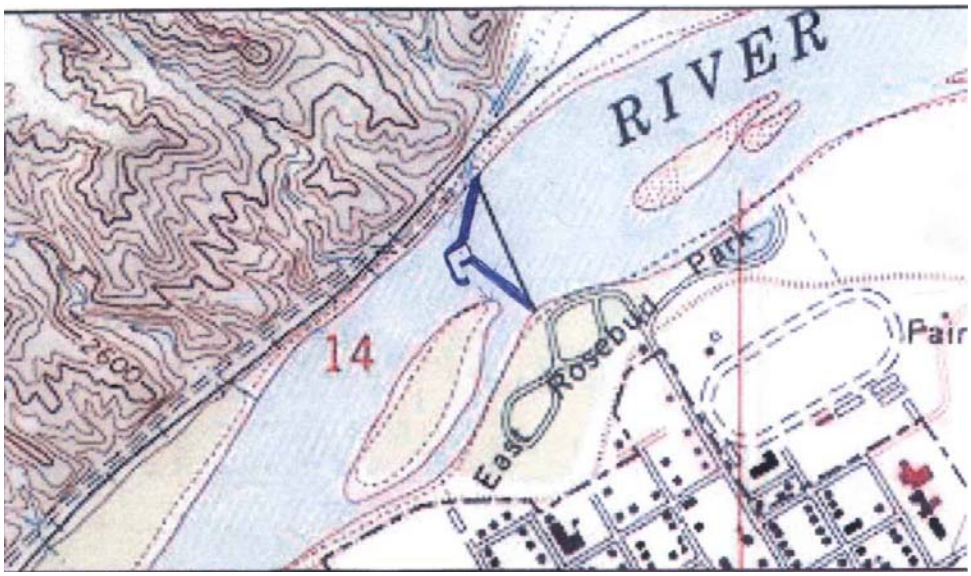


Figure 4-6 Raceway Notch Fish Passage

<u>Advantages</u>:

- Flows can be totally arrested by incorporating ability to dam notch channel
- Overall update to structure through reconstruction of dam
- Fish would be in main channel, would not have to navigate an artificial structure
- Would be designed not to change the head vis-à-vis city water intake

This alternative was dismissed from further consideration due to the following:

- Risk of loss of head
- Fish could be directed toward headgates.

- There could be loss of fish passage if damming of notch is necessary.
- May cause ice problems to island and park on one side and headworks on other
- Reconfiguring dam could require recreational facilities to be moved.
- Would have to evaluate sediment transport and effect on downstream geomorphology.
- Notch structure could be a sediment trap.

Unknowns: necessary velocity to meet swim criteria, width of channel to control velocity, and bathymetry

4.6 Rock Ramp (Preferred Alternative, February 2009 Study)

Under this alternative, the streambed would be reconfigured through either a U-shaped configuration (Figure 4-7) or a boulder weir (Figure 4-8) to reduce the channel gradient downstream from the existing diversion dam, allowing for fish movement upstream of the dam. The rock ramp would be designed to lower velocities and turbulence, so that migrating fish could easily make their way past the dam.

4.6.1 Streambed Reconfiguration (Boulder Weir)

The boulder weir design is used quite extensively in Europe, and has also been successfully implemented to pass lake sturgeon in Minnesota and Wisconsin. The design uses a 3% slope and 1-ft drops between the boulder weirs. To be conservative, since lake sturgeon could be stronger swimmers, the proposed conceptual design uses 1% slope with 0.5-ft drop between weirs, resulting in a structure with 16 boulder rows, 25-ft between rows, and 400-ft long. If a less conservative design is used (e.g. 2% slope) half the number of weirs (8) and half the length (200-ft) would be required.

Advantages of the boulder weirs:

- Provides a variety of velocities to pass all sizes and species of fish.
- The half circle configuration of boulders results in focusing low flow into the center during high flow conditions, lower fish friendly flows are along the sides.
- Use of boulders minimizes the amount of “fill” placed in the river.
- Boulders would be sized to resist ice (4-5 ft).

Figure 4-7 U-Shaped Rock Ramp

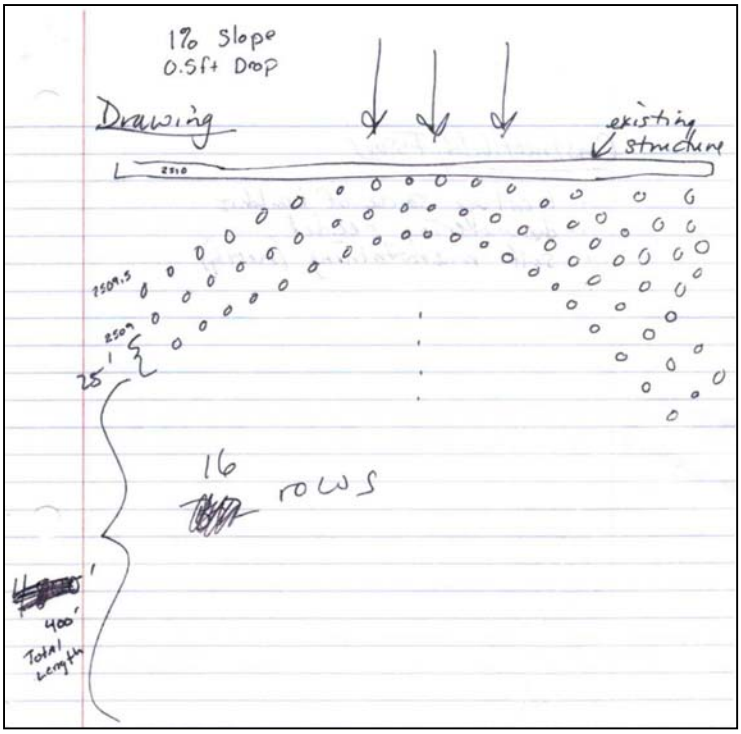


Figure 4-8 Boulder Weir

4.6.2 Streambed Reconfiguration (U-Shaped)

A modification to the streambed reconfiguration using boulder weirs is to construct a rock ramp utilizing an inverted "U" configuration to re-grade the river to the current crest height. The center of the "U" would be constructed at a 0.3% slope and the edges would be at 0.15% slope.

Advantages of the smooth inverted "U" rock ramp:

- Facilitates maintaining thalweg at engineered location
- Provides a variety of velocity diversity throughout structure
- Maintains or improves diversion stability (need to rebuild dam)
- Eliminates undertow factor (public safety)
- Makes dam passable by boat
- Provides passage for a variety of species year-round

4.7 Summary of Alternatives Comparison

The following matrices summarize how each alternative was measured against the screening criteria used during the alternatives analysis (Figures 4-9 and 4-10). The study participants prioritized the top four alternatives as follows:

- Streambed reconfiguration (U-shaped)
- Boulder weir
- Controlled notch
- Bypass channel

The Cartersville Irrigation District supported the first three alternative choices. The first two are variations of a rock ramp. The rock ramp alternative, with several options, and the controlled notch (inflatable bladder) will be further addressed in this document. Inflatable bladder options may consider widening the bladder up to full width of the dam.

ALTERNATIVE/ DESCRIPTION / FACTOR	DO NOTHING	PF 2&6	PF 9, 10, 12, AND 32	PF 9, 10, 12, AND 32	PF 11	PF 30	PF 40	PF 42
	EXISTING CONDITIONS	BYPASS CHANNEL; CIRCUMVENT OBSTRUCTIONS	STREAM BED RECONFIGURATION (BOULDER WEIR)	STREAM BED RECONFIGURATION (U-SHAPED)	PARTIAL DIVERSION DAM	ISLAND & SOUTH CHANNEL (DRAWING A).	NOTCH DAM	CONTROLLED NOTCH
CONSTRUCTIBILITY (BUILDABILITY, OPERABILITY, AND MAINTAINABILITY)	EASIER THAN AVERAGE	EASIER THAN AVERAGE	HARDER THAN AVERAGE	AVERAGE	HARDER THAN AVERAGE	HARDER THAN AVERAGE	HARDER THAN AVERAGE	HARDER THAN AVERAGE
ABILITY TO RELIABLY CONVEY WATER	BASELINE	LESS THAN BASELINE	EQUAL TO BASELINE	EQUAL TO BASELINE	LESS THAN BASELINE	LESS THAN BASELINE	EQUAL TO BASELINE	EQUAL TO BASELINE
ABILITY TO PROVIDE UPSTREAM PASSAGE FOR FISH	BASELINE	SLIGHTLY BETTER THAN BASELINE	BETTER THAN BASELINE	SIGNIFICANTLY BETTER THAN BASELINE	BEST	SLIGHTLY BETTER THAN BASELINE	BETTER THAN BASELINE	SLIGHTLY BETTER THAN BASELINE
LIKELY COMMUNITY ACCEPTANCE	NEUTRAL	MODERATE RESISTANCE	MODERATE RESISTANCE	MODERATE RESISTANCE	SIGNIFICANT RESISTANCE	MODERATE RESISTANCE	SLIGHT RESISTANCE	NEUTRAL
LIFE SPAN (50 TO 100 YEARS)	50	50	50+	50+	100	50	100	100
RECREATION	BASELINE	SOMEWHAT LESS OPPORTUNITY	DIMINISHED OPPORTUNITY	SOMEWHAT IMPROVED OPPORTUNITY	SOMEWHAT IMPROVED OPPORTUNITY	SOMEWHAT IMPROVED OPPORTUNITY	EQUAL TO BASELINE	SOMEWHAT IMPROVED OPPORTUNITY
POTENTIAL FLOOD PLAIN IMPACTS	BASELINE	EQUAL TO BASELINE	SLIGHT NEGATIVE IMPACT	SLIGHT NEGATIVE IMPACT	SLIGHT NEGATIVE IMPACT	SLIGHT NEGATIVE IMPACT	EQUAL TO BASELINE	SLIGHT POSITIVE IMPACT
REDUCE DROWNING RISK	BASELINE	EQUAL TO BASELINE	POSITIVE IMPACT	POSITIVE IMPACT	SLIGHT POSITIVE IMPACT	EQUAL TO BASELINE	EQUAL TO BASELINE	EQUAL TO BASELINE
COST		**3**	**1**	**2**	**1**	**3**	**1**	**2**

Figure 4-9 Summary of Alternatives, February 2009

	PF 2&6	PF 9, 10, 12, AND 32	PF 9, 10, 12, AND 32	PF 11	PF 30	PF 40	PF 42
	BYPASS CHANNEL; CIRCUMVENT OBSTRUCTIONS	STREAM BED RECONFIGURATION (BOULDER WEIR)	STREAM BED RECONFIGURATION (U-SHAPED)	PARTIAL DIVERSION DAM	ISLAND & SOUTH CHANNEL (DRAWING A).	NOTCH DAM	CONTROLLED NOTCH
First	1	1	16	4	0	0	0
Second	1	9	1	2	3	2	5
Third	3	3	1	0	5	4	6
Fourth	7	2	0	2	5	3	2
Fifth	2	1	0	4	2	4	0
Sixth	1	2	0	1	0	1	4
Seventh	2	0	0	2	0	2	0
Total Votes	**17**	**18**	**18**	**15**	**15**	**16**	**17**

Figure 4-10 Summary of Participant Rankings, February 2009

5.0 PLANNING PROCESS

5.1 Introduction

The Plan Formulation section of this document follows the six step planning process defined by the USACE in the Principles and Guidelines (P&G) for water and related land resources adopted by the Water Resources Council (USACE, 2000):

Step 1 Identify problems and opportunities
Step 2 Inventory and forecast conditions
Step 3 Formulate alternative plans
Step 4 Evaluate alternative plans
Step 5 Compare alternative plans
Step 6 Select a plan

5.2 Step 1 - Problems and Opportunities

5.2.1 Problems

As discussed in Section 3.0, Study Purpose and Need, Cartersville Dam presents the following problems:

- The dam is a barrier to upstream passage of native fishes, particularly sturgeon;
- The dam is at risk for failure; and
- The dam is a public safety hazard.

5.2.2 Opportunities

If the Cartersville Dam was made passable to shovelnose sturgeon, it would create the following opportunities:

1. Reinforcing the existing dam will increase the longevity of the structure, thereby providing a more reliable supply of water to irrigators. This would also reduce the cost of maintenance for the ditch company.
2. Allow passage to habitat upstream of Cartersville Dam.
3. Eliminate hydraulic conditions at the dam that create a life-threatening hazard to swimmers and boaters.
4. Allow suitably equipped boats to travel upstream and downstream over the dam.

5.2.3 Planning Objectives

The primary project objectives are:

1. Maintain the ability of the irrigation district to divert water at all water levels
2. Allow upstream passage of native fishes, particularly sturgeon
3. Provide minimal maintenance requirements
4. Increase public safety
5. Maintain recreation opportunities at adjacent city park

5.2.4 Constraints

General types of constraints, as defined by the USACE, include resource constraints and legal and policy constraints. Potential resource constraints include limits on knowledge, expertise, experience, ability, data, information, money and time. The primary constraints for this project are availability of funding and acceptability to the Cartersville Irrigation District and local community.

5.3 Step 2 - Inventory and Forecast

5.3.1 Introduction

The following data is used to further define and characterize the problems and opportunities. Quantitative and qualitative descriptions are made for both current and future conditions and are used to define existing and future without-project conditions.

5.3.2 Inventory of Existing Conditions

Cartersville Dam is located at the town of Forsyth, Montana. The legal description of the site is: T67N R40E S14. The dam belongs to the Cartersville Irrigation District and was constructed during the early 1930's utilizing a rock- rubble riprap capped with concrete. The dam is over 800 feet in length and spans the entire channel of the Yellowstone River (Figure 5-1). The approximately 80-year old structure has experienced deterioration typical of aging dams and has required annual maintenance in recent years. The irrigation diversion dam has associated water rights dating to the late1800's.

Figure 5-1 Cartersville Dam Viewed From the Right (South) Bank During Low Discharge.

Because this dam spans the entire river bed, it is viewed as a passage barrier to fish and boaters. The greatest passage impediment likely occurs during periods of lower flows (Bureau of Reclamation and Montana Fish Wildlife and Parks 1999). Radio telemetry data provided by Matt Jaeger of Montana Fish, Wildlife & Parks (Figure 5-2) shows examples of two shovelnose sturgeon that migrated upstream to the base of Cartersville Dam but did not pass upstream of the structure. Jaeger (unpubl. data) found that 13 out of 37 (35%) shovelnose sturgeon he monitored exhibited similar migration patterns affected by Cartersville Dam. These data clearly suggest Cartersville Dam is an upstream passage impediment to shovelnose sturgeon.

There are four more irrigation diversion dams above Cartersville, including the Yellowstone, Rancher's Ditch, Waco-Custer, and Huntley diversions. Huntley has a side channel for fish passage and the other three diversion dams are relatively low, so they are likely to be navigable to fish at least during high flows when the diversions become submerged. The approximate number of river miles between the Cartersville and Yellowstone diversions is 56 miles. Consequently, the passage barrier at Cartersville effectively isolates as little as 56 miles of Yellowstone River channel, and as much as the entire river above Cartersville.

5.3.3 Future without Project Conditions

The following consequences may result if no action is taken to improve fish passage at Cartersville Dam.

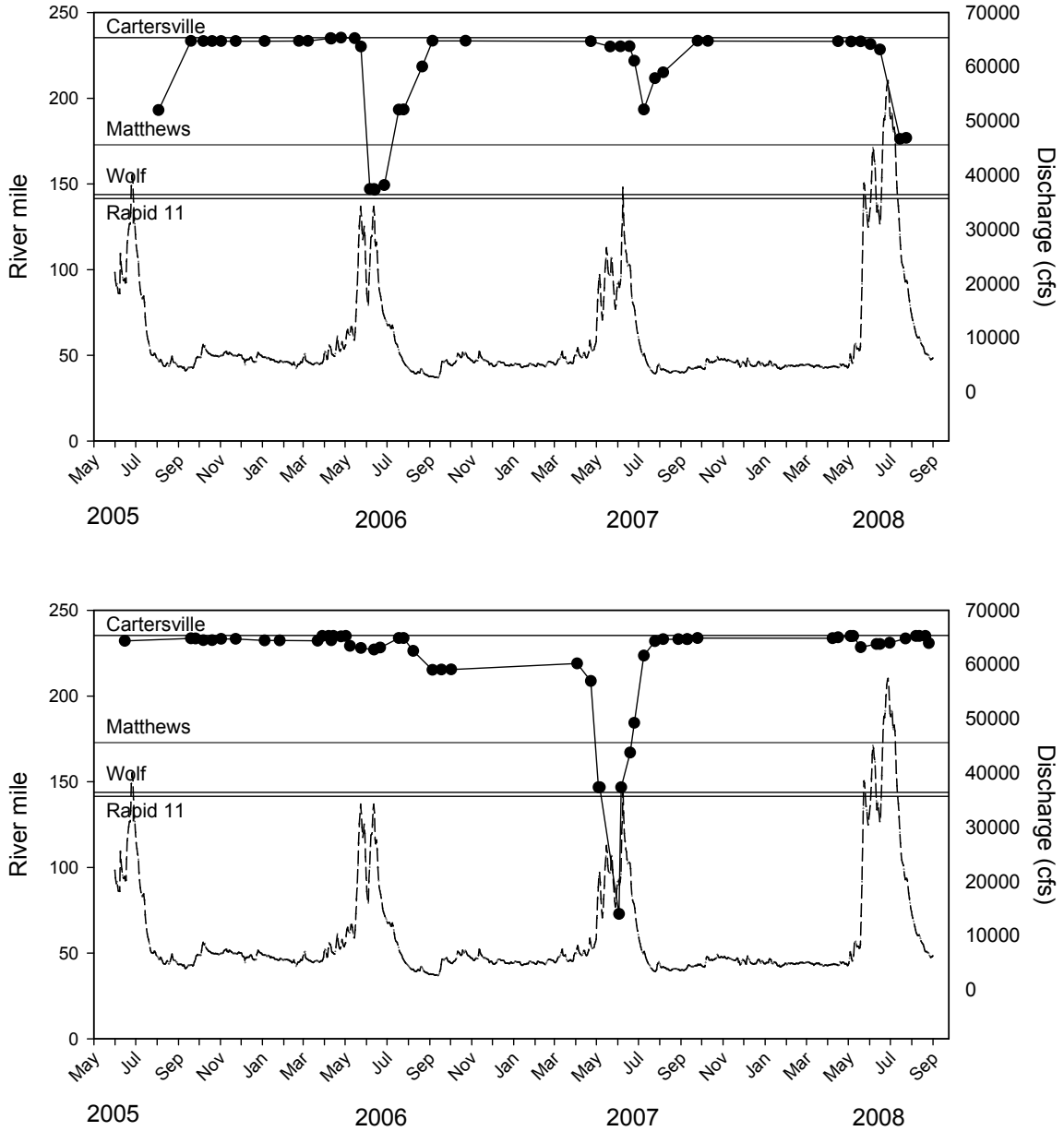


Figure 5-2 Movement of Shovelnose Sturgeon
Movements of shovelnose sturgeon number 420-27 (top figure) and 480-66 (bottom figure) in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11 (M. Jaeger unpubl. data).

5.3.3.1 Water Supply

Dam is in poor condition. The dam crest has been eroded in numerous locations and a deep scour hole has developed at the toe. Additional rock has been added on a regular basis to protect the dam from failure. Failure would lead to loss of irrigation water and city water supply.

5.3.3.2 Conservation and Ecology

Persistence of habitat fragmentation caused by the passage barrier at Cartersville Dam has negative consequences for conservation of sturgeon and other fish and macroinvertebrates. Habitat fragmentation isolates populations of organisms, thereby limiting the exchange of genetic material. Over time, isolated populations become increasingly homozygous. Reductions in genetic variability through inbreeding reduce an organism's potential to adapt to changing environmental conditions or diseases. Over time, isolation also leads to genetic drift and ultimately to distinctly different populations.

Habitat fragmentation also reduces the long-term viability of populations isolated by Cartersville Dam. For example, extirpation of a subpopulation upstream of the dam (from any cause) would lead to an irreversible reduction in overall population size as the barrier would prevent repopulation of the upstream reaches. This reduces the long-term viability of the larger population by increasing its vulnerability to local extinctions.

Persistence of the barrier may cause indirect ecological consequences for other organisms as well. For example, changes in community composition (e.g. loss a particular species) can have indirect or cascading trophic effects on predator, prey, and competing species. This may lead to far-ranging shifts in community structure, especially in simple systems or when keystone species such as top predators are involved.

In conclusion, the barrier at Cartersville Dam will continue to cause habitat fragmentation, which leads to a loss of genetic variability, decreased population viability, and other indirect ecological consequences.

5.3.3.3 Public Safety

Dam presents a hazard to boaters, fishermen, swimmers. Sharp drop-offs such as these create hydraulic conditions that are difficult to escape.

5.3.3.4 Boat Passage

Currently, boat passage from access ramp to upstream reaches is not possible. Due to the sharp drop, the only way to move upstream past the dam is to portage.

5.4 Step 3 - Formulation of Alternative Plans

5.4.1 Introduction

Alternative plans address specific ways to achieve planning objectives within constraints, which solve the problems and realize the opportunities discussed earlier. An alternative plan consists of structural and/or

nonstructural measures, strategies, or programs formulated to meet the identified study objective subject to constraints (USACE, 2000).

5.4.2 Pre-Design Site Assessment

5.4.2.1 Field Survey

A field survey was performed from which a topographic map of the Yellowstone River adjacent to the diversion dam could be developed (Figure 5-3).

Fishery and geomorphic team members also evaluated the dam site during the topographic survey.

5.4.2.2 Hydrology

The U.S. Geological Survey (USGS) has gage 06295000 Yellowstone River at Forsyth, Montana located approximately one mile upstream of the diversion dam (Figure 5-4). The statistics presented in Figure 5-4 describe the magnitude and frequency of flows to which the proposed project will be exposed.

5.4.2.3 Hydraulics

The existing conditions at the time of the survey were calibrated to two models; the USACE HEC-RAS model and River FLO-2D.

5.4.2.3.1 HEC-RAS

A HEC-RAS model was created using DOWL HKM field measured cross sections of the Yellowstone River at Forsyth, Montana. Cross section locations are shown on Figure 5-5. A divided flow option was used to model flow around the island downstream of Cartersville Dam. Stream flow at the time of the field survey of 6,500 cfs was obtained from the USGS gage Yellowstone River at Forsyth located approximately one mile upstream of the dam. The dam crest elevation could only safely be measured at the abutments. The measured crest elevation at south abutment was 2508.3 NGVD. The dam crest acts as a weir and is in disrepair, resulting in a variable crest elevation. The weir equation ($Q = CLH^{3/2}$) was used with the measured water surface elevations to estimate the average crest elevation of the dam. This analysis revealed that the weir coefficient (C) would be unrealistically high if the dam crest was elevation 2508.3 all the way across the 800 feet wide dam. A combination of the channel roughness coefficient (Manning's n) and the average dam crest elevation were adjusted to allow calibration of the model using reasonable parameters, yielding an estimated average crest elevation of 2507.8 (See Figures 5-6 and 5-7).

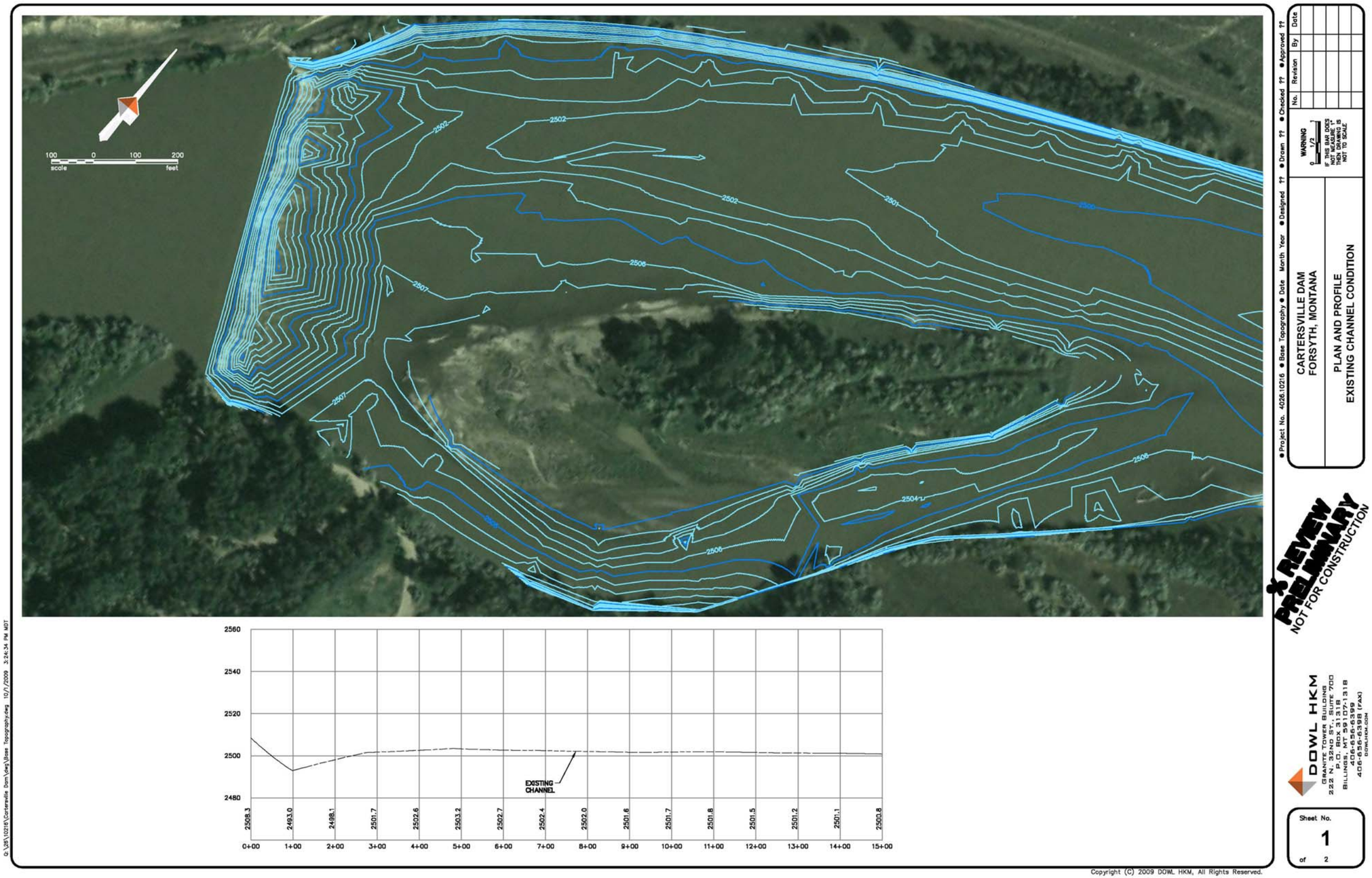


Figure 5-3 Plan and Profile of Existing Channel Condition

06295000 Yellowstone River at Forsyth, Mont.
Site Number 182

LOCATION.--Lat 46°15'58", long 106°41'24" (NAD 27), in NE¼NW¼NW¼ sec.23, T.6 N., R.40 E., Rosebud County, Hydrologic Unit 10100001, on right bank 0.3 mi downstream from U.S. Highway 12 bridge, at Forsyth, and at river mile 238.2.

DRAINAGE AREA.--40,146 mi^2.

PERIOD OF RECORD.--July 16, 1921, to September 30, 1923 (no winter records), October 1977 to current year (2002). Miscellaneous discharge measurements were made in 1974 to 1976 and are available in files of U.S. Geological Survey Montana District Office.

GAGE.--Water-stage recorder. Altitude of gage is 2,504.62 ft (NGVD 29), from nearby elevation determined by City of Forsyth. July 1921 to March 1922, nonrecording gage on discontinued highway bridge 10 ft downstream from gage at different datum. March 1922 to September 1923, nonrecording gage on discontinued highway bridge 10 ft downstream from gage at datum 2 ft higher.

REMARKS.--Diversions for irrigation of about 838,000 acres upstream from station. Flow regulated to some extent by Bighorn Lake, usable capacity, 1,312,000 acre-ft, on Bighorn River. Small diversion dam about 4,200 ft downstream from station. Bureau of Reclamation satellite telemeter at station.

Magnitude and probability of annual low flow based on 24 years of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	3,230	2,320	1,920	1,640	--	--
3	3,460	2,520	2,100	1,800	--	--
7	3,880	2,970	2,560	2,260	--	--
14	4,630	3,620	3,090	2,670	--	--
30	5,150	4,100	3,520	3,050	--	--
60	5,460	4,400	3,820	3,340	--	--
90	5,890	4,780	4,170	3,670	--	--
120	6,200	5,040	4,420	3,910	--	--
183	6,610	5,240	4,530	3,980	--	--

Magnitude and probability of seasonal low flow from March-June based on 25 seasons of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	5,200	3,600	2,830	2,250	1,690	--
3	5,320	3,760	3,000	2,440	1,880	--
7	5,460	4,060	3,400	2,900	2,390	--
14	5,900	4,610	4,030	3,590	3,150	--
30	6,260	4,850	4,240	3,790	3,340	--

Magnitude and probability of seasonal low flow from November-February based on 25 seasons of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	3,350	2,360	1,930	1,650	1,320	--
3	3,630	2,600	2,140	1,820	1,450	--
7	4,080	3,200	2,790	2,480	2,160	--
14	4,650	3,760	3,330	2,990	2,630	--
30	5,250	4,410	3,970	3,610	3,230	--

Duration of daily mean flows based on 25 years of record

Discharge, in ft^3/s, which was equaled or exceeded for indicated percent of time							
99%	98%	95%	90%	80%	70%	60%	50%
2,560	3,110	3,660	4,420	5,190	5,970	6,780	7,610
40%	30%	20%	15%	10%	5%	2%	1%
8,440	10,300	13,500	16,700	23,200	32,000	43,200	48,800

Magnitude and probability of annual high flow based on 25 years of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and exceedance probability, in percent					
	2	5	10	25	50	100
	50%	20%	10%	4%	2%	1%
1	41,500	57,300	69,100	85,500	99,000	--
3	39,600	54,000	64,000	77,200	87,400	--
7	36,100	49,500	58,900	71,400	81,300	--
15	33,300	45,500	53,900	65,000	73,600	--
30	30,000	40,500	47,500	56,400	63,100	--
60	25,300	33,800	39,300	46,100	51,100	--
90	21,100	28,000	32,300	37,600	41,500	--

Magnitude and probability of seasonal low flow from July-October based on 24 seasons of record

Period of consecutive days	Discharge, in ft^3/s, for indicated recurrence interval, in years, and non-exceedance probability, in percent					
	2	5	10	20	50	100
	50%	20%	10%	5%	2%	1%
1	5,520	4,030	3,300	2,740	--	--
3	5,630	4,080	3,330	2,760	--	--
7	5,790	4,180	3,410	2,830	--	--
14	5,970	4,280	3,480	2,880	--	--
30	6,230	4,450	3,650	3,060	--	--

Monthly and annual mean discharges

Month	Maximum (ft^3/s)	Minimum (ft^3/s)	Mean (ft^3/s)	Standard deviation (ft^3/s)	Years of record
October	10,700	3,520	7,490	2,120	25
November	10,500	4,190	6,990	1,700	25
December	8,930	3,620	6,110	1,190	25
January	7,800	3,240	5,720	1,120	25
February	10,200	3,510	6,140	1,590	25
March	15,100	3,220	7,060	2,530	25
April	13,300	4,220	7,720	2,340	25
May	27,800	10,000	17,300	4,270	25
June	63,700	10,000	29,800	12,000	25
July	34,400	6,140	18,300	8,680	25
August	17,600	2,740	8,150	3,590	25
September	11,300	2,720	6,960	2,370	25
Annual	17,600	6,030	10,600	2,630	25

Figure 5-4 USGS Gage Yellowstone R. at Forsyth (Scientific Investigations Rpt 2004-5266)

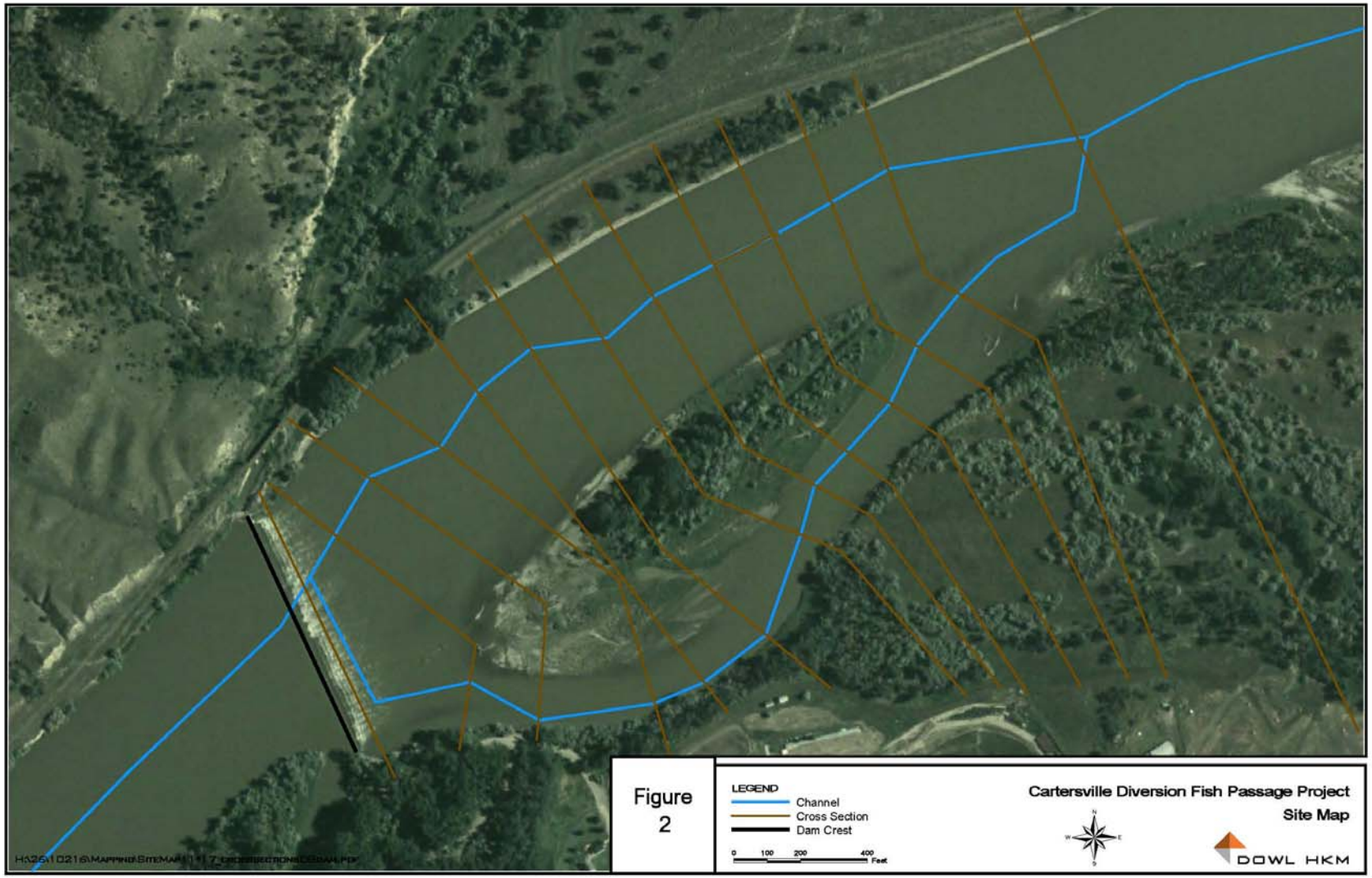


Figure 5-5 Surveyed River Cross Sections

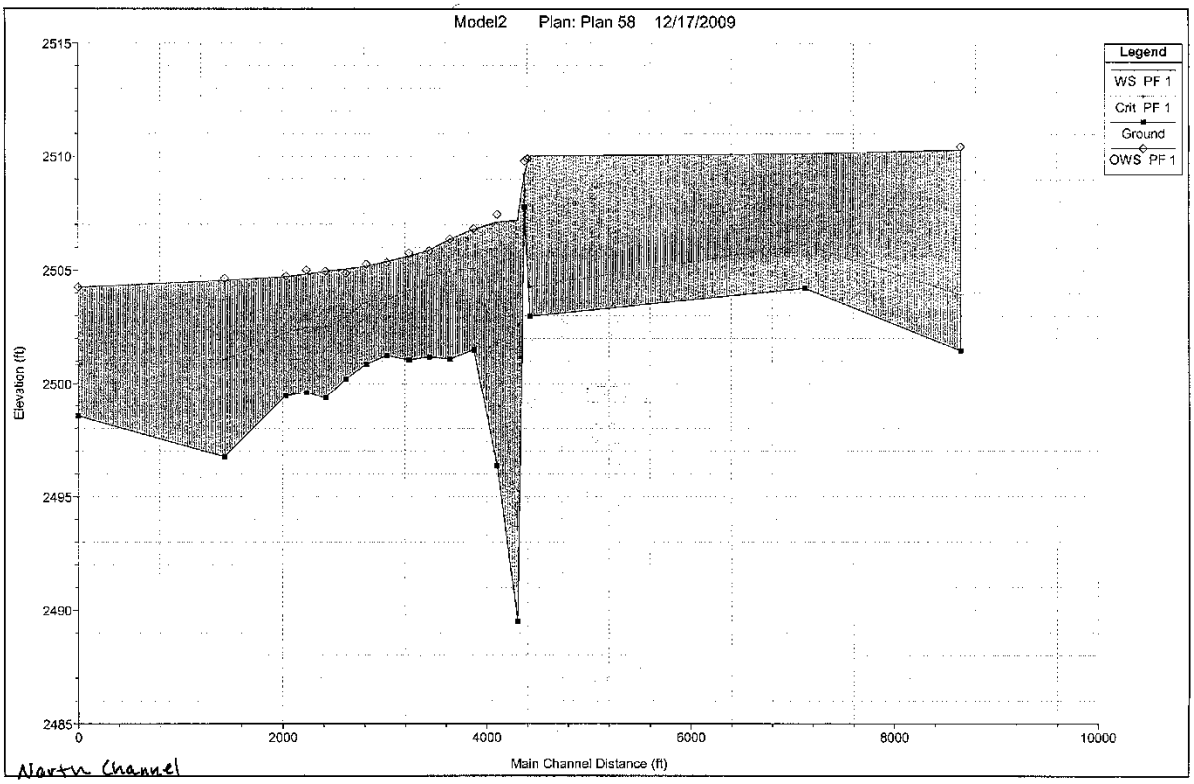


Figure 5-6 HEC RAS Calibrated Profile, North Channel

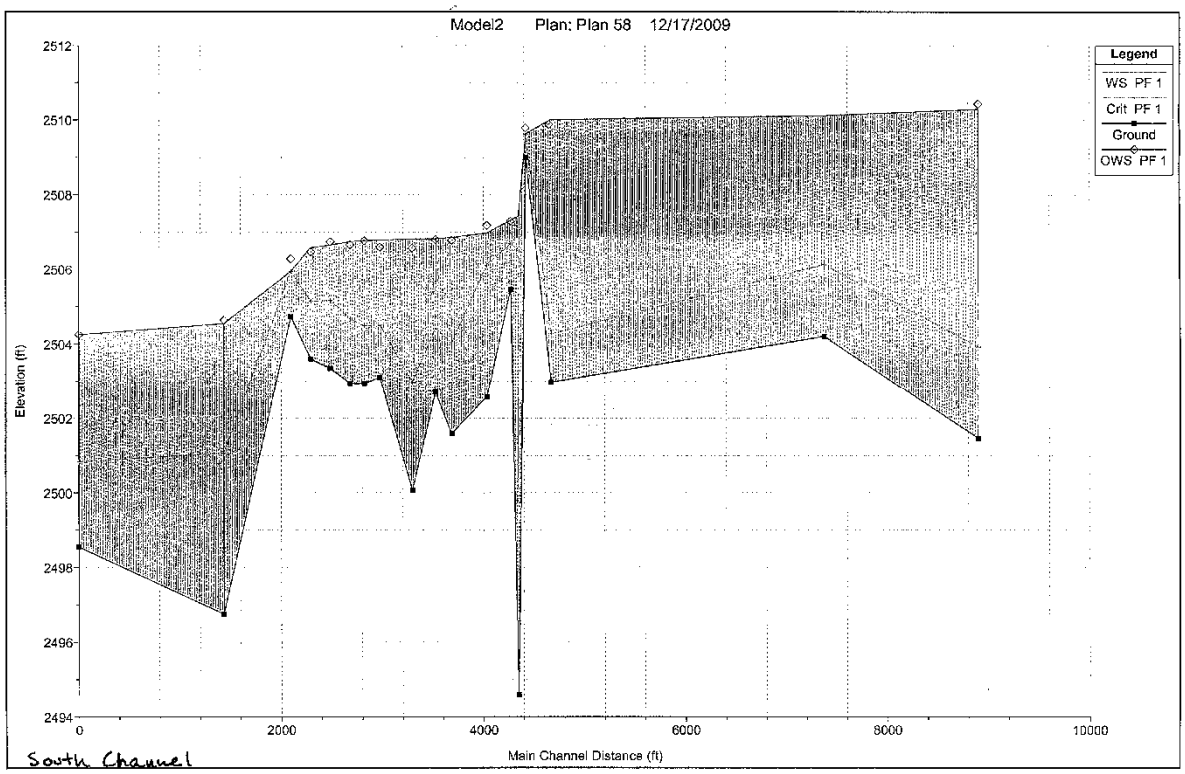


Figure 5-7 HEC-RAS Calibrated Profile, South Channel

5.4.2.3.2 River FLO-2D

The FLO-2D two-dimensional computer model was also utilized to model existing condition. Like HEC-RAS, the FLO-2D was able to match measured water surface elevations at a flow of 6500 cfs utilizing parameters within a reasonable range (Figures 5-8, 5-9, and 5-10). The velocities and depths for the existing conditions provide a comparison to proposed alternatives. The successful calibration indicates the FLO-2D model can be used to evaluate the proposed alternatives.

5.4.2.4 Floodplain

Federal Emergency Management Agency (FEMA) floodplain maps are available for the City of Forsyth and Rosebud County (Figures 5-11 and 5-12). Floodplain areas are mapped Zone A, which means the boundaries were developed by approximate methods and no base flood (100 year) water surface elevations have been determined.

5.4.3 Design Approach

The design for passage of fish and other aquatic organisms at dams can be defined in two general categories; geomorphic and hydraulic (Figure 5-13). Geomorphic design (stream simulation) is based on the premise that a channel that simulates characteristics of the natural channel will present no more of a challenge to movement of organisms than the natural channel. No part of the design is specifically directed at target species or their swimming capabilities (Bates and Love, 2009) (Figure 5-14). Alternatively, the more traditional approach of hydraulic design is based on specific fish passage design criteria that can include migration timing, swimming ability, and behavior of selected target species (Bates and Love, 2009).

> Stream Simulation Design: A channel that simulates characteristics of the natural channel, will present no more of a challenge to movement of organisms than the natural channel.

> Hydraulic Design: A structure with appropriate hydraulic conditions will allow target species to swim through it.

For this project, a combination of the geomorphic and hydraulic design approaches is being used. Reference reaches have been selected which are targeted to specific species, in this case shovelnose sturgeon. In addition to replicating the characteristics of the reference reaches, hydraulic conditions (e.g. depth and velocity) have been identified and replicated. Additional hydraulic design criteria have been developed based on laboratory testing performed by others and field studies.

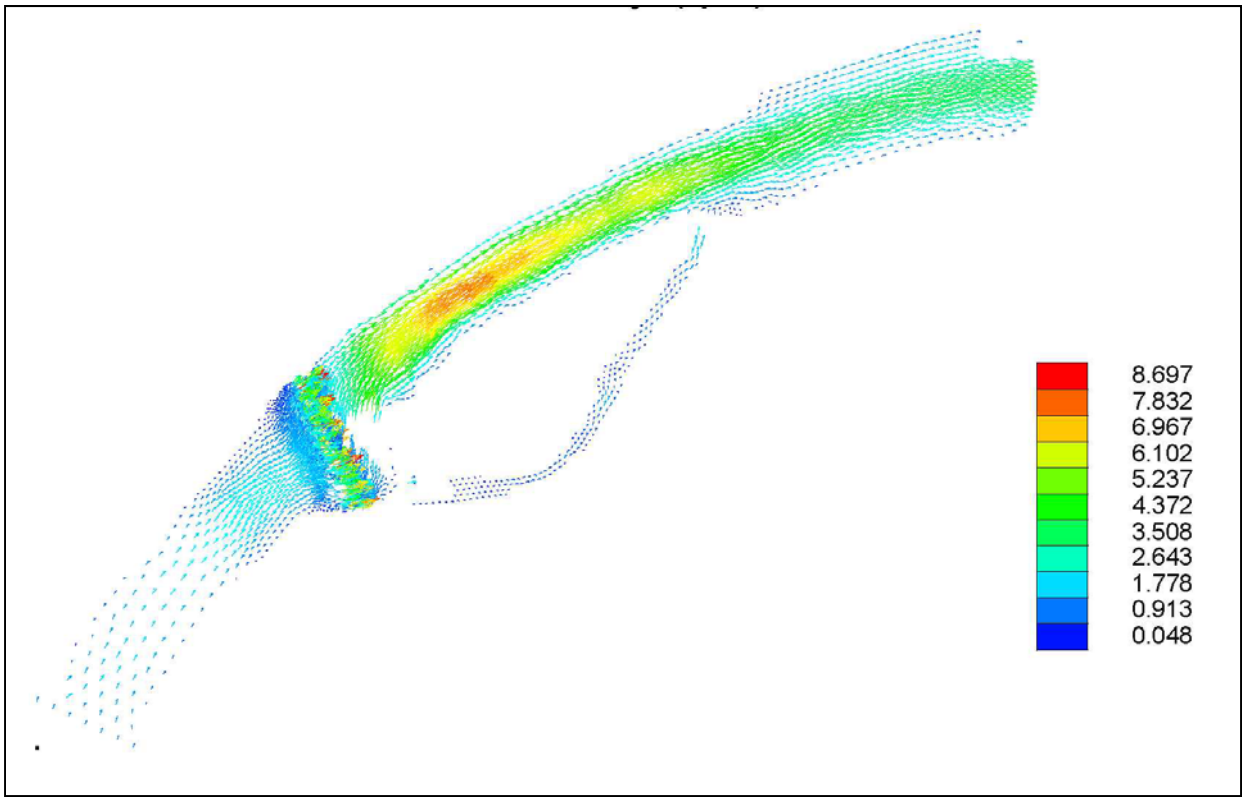


Figure 5-8 Existing Velocity (ft/s) Q = 6500 cfs

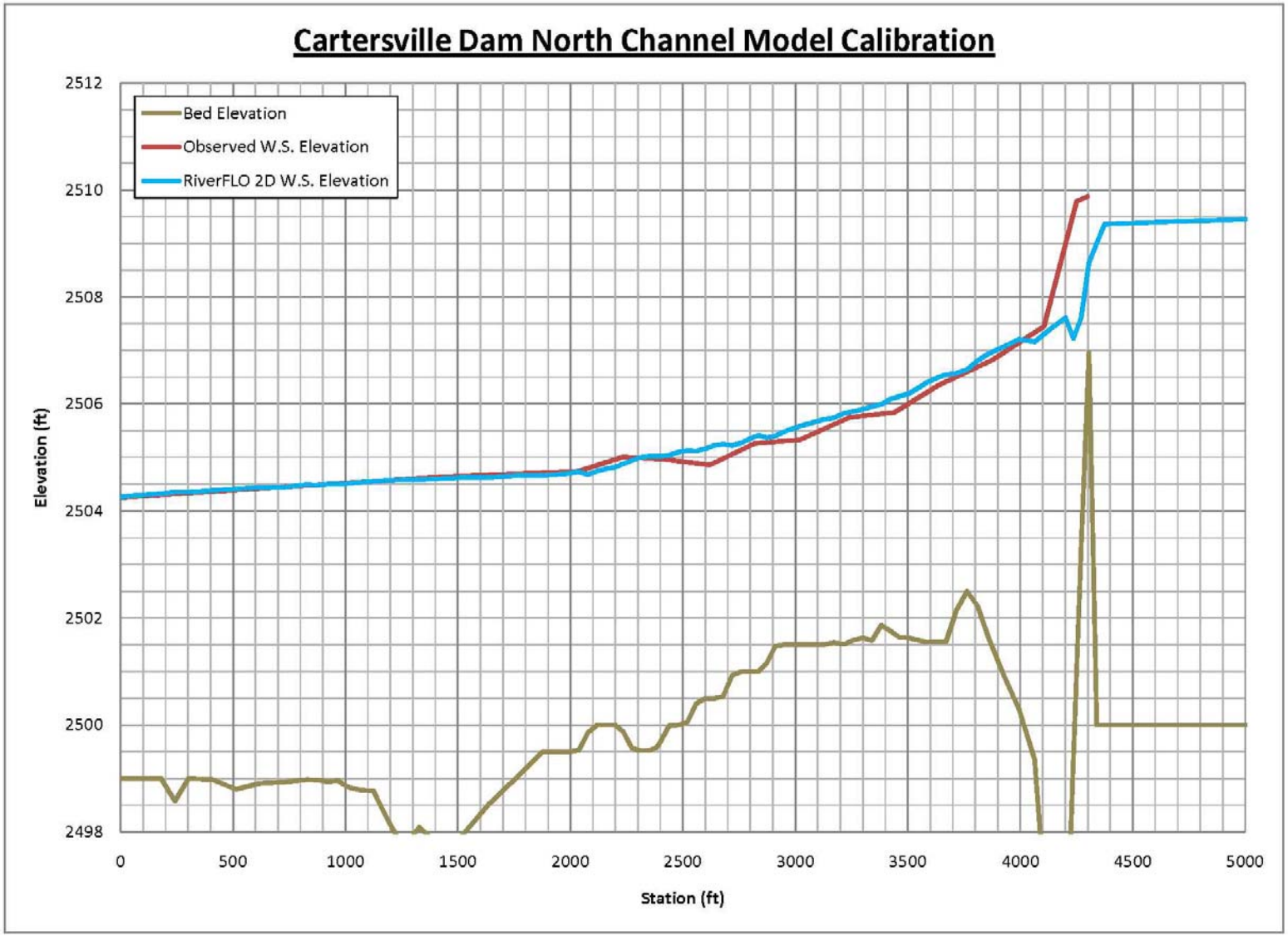


Figure 5-9 Cartersville Dam North Channel Model Calibration

Agreement between the observed (red line) and modeled (blue line) indicate the model is calibrated to field measurements.

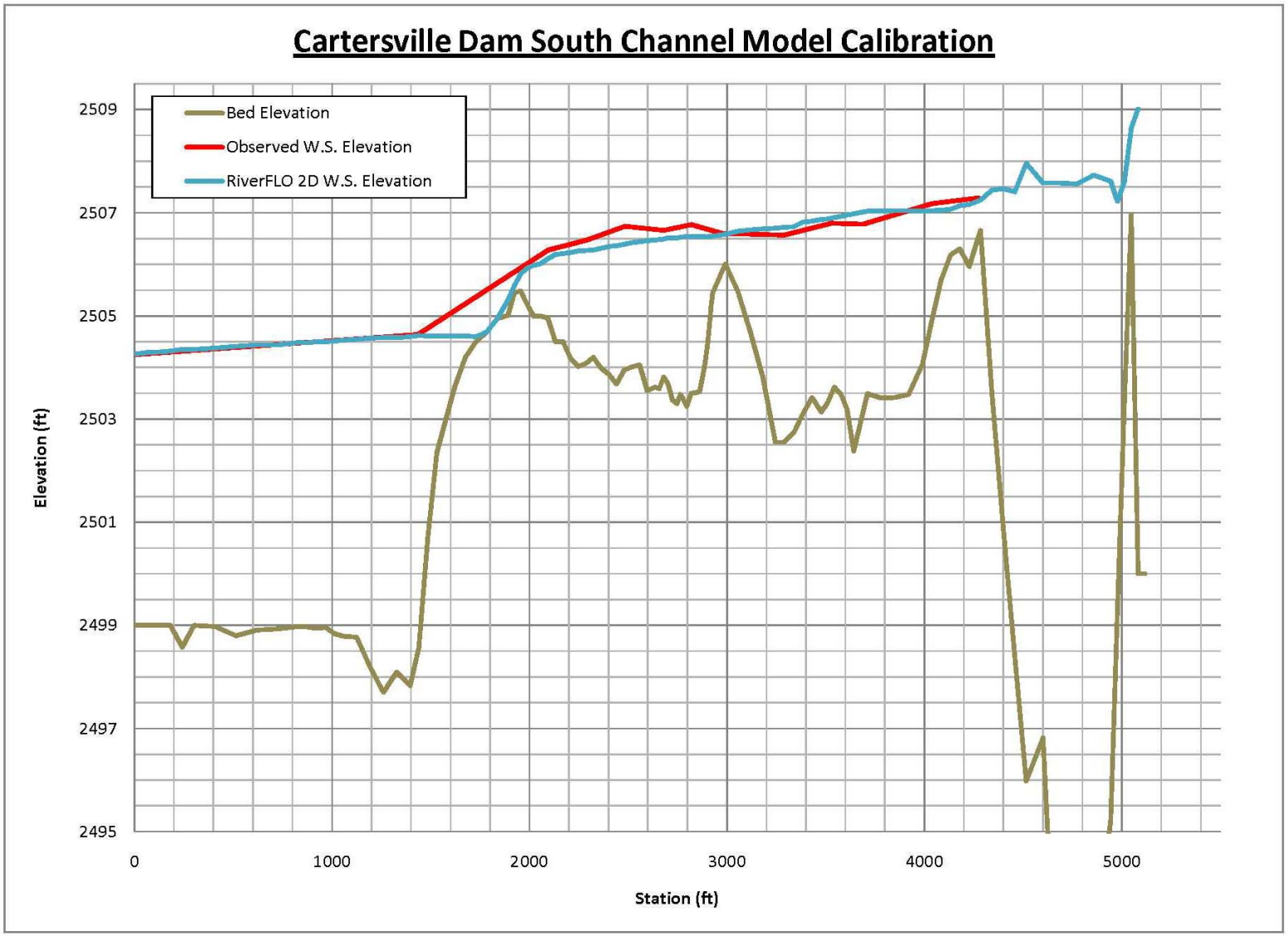


Figure 5-10 Cartersville Dam South Channel Model Calibration

Agreement between the observed (red line) and modeled (blue line) indicate the model is calibrated to field measurements.

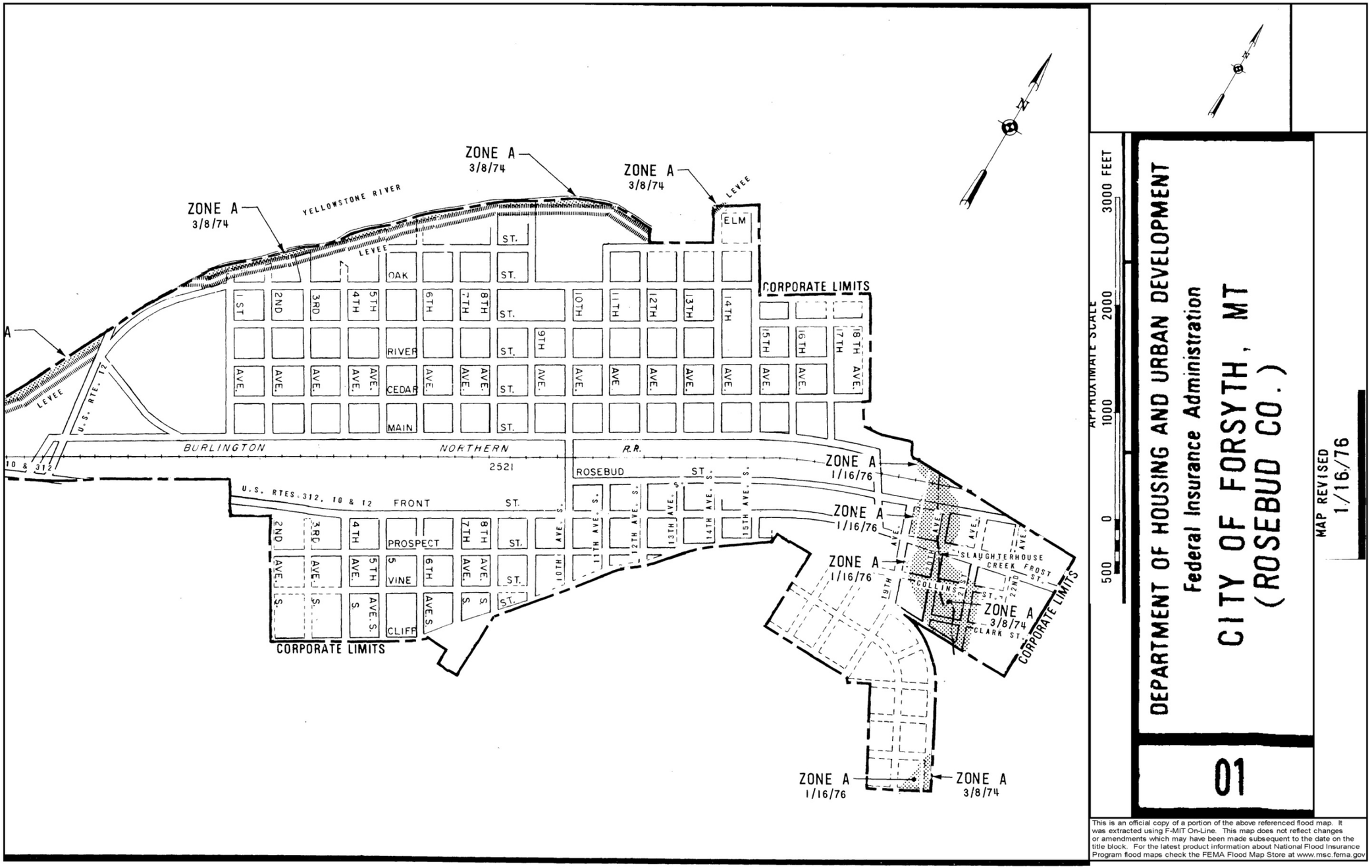


Figure 5-11 Floodplain Map for the City of Forsyth

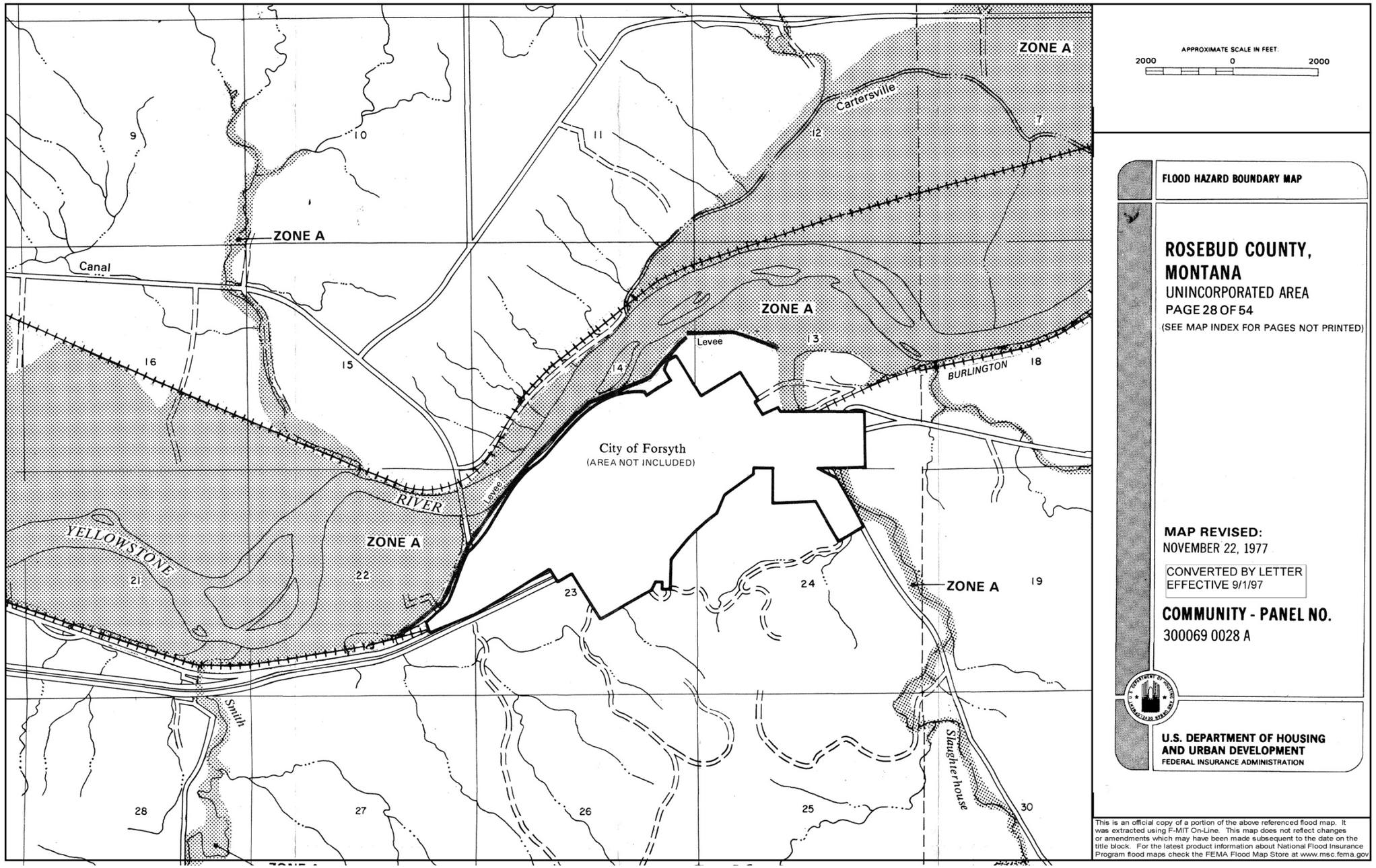


Figure 5-12 Floodplain Map for Rosebud County

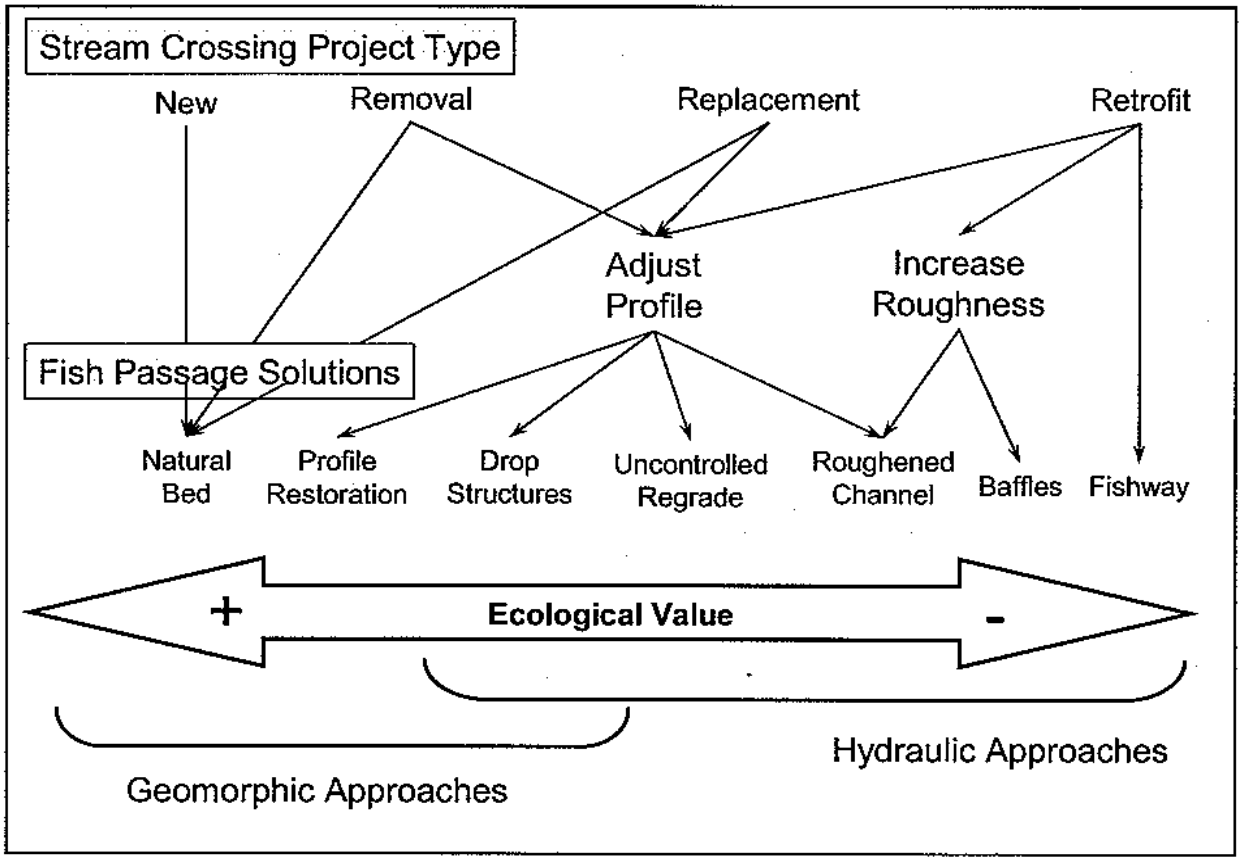


Figure 5-13 **Solutions for Fish Passage**

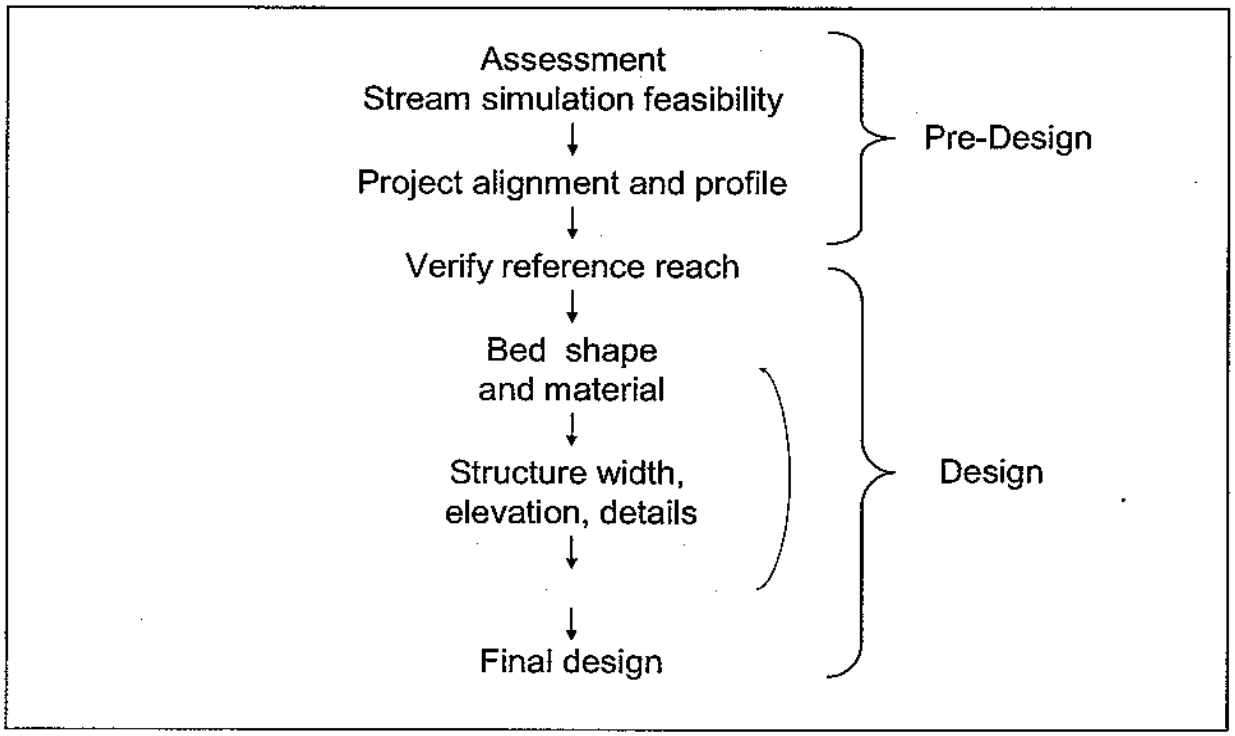


Figure 5-14 **Stream Simulation (geomorphic approach) Process Flowchart**

5.4.4 Sturgeon Swimming Abilities and Implications for Passage Design

The following section describes available information regarding the swimming abilities of sturgeon, both in the laboratory environment and on the Yellowstone River. In order provide for successful passage at Cartersville Dam, steep sections of the Yellowstone River where sturgeon passage events have been monitored are identified and assessed with regard to structure and hydraulics. These results are then combined to generate design guidelines for proposed alternatives that reflect conditions at these natural passage analogs that currently exist on the Yellowstone River.

5.4.4.1 Sturgeon Ecology and Swimming Behavior

5.4.4.1.1 Evolution, Distribution, Morphology

Sturgeons (Family Acipenseridae) are large, ancient fishes that occur in North America and Eurasia. The subfamily Scaphirhynchinae contains two genera; Pseudoscaphirhynchus, which occurs in Central Asia and Scaphirhynchus, which occurs in North America. The genus Scaphirhynchus is characterized by a flattened shovel-shaped snout; a long, slender, and completely armored caudal peduncle; prolonged upper lobe of the caudal fin; and the absence of a spiracle (Smith 1979). This morphology and features such as small eyes, a tough leathery skin (Cross and Collins 1975), dorsoventrally flattened body, and sensitive barbels are adaptations to a life in large, swift, and turbid rivers. Three species of Scaphirhynchus are known: pallid sturgeon (Scaphirhynchus albus), shovelnose sturgeon (S. platorynchus), and Alabama sturgeon (S. suttkusi). Pallid and shovelnose sturgeon occur in the Mississippi river basin, whereas Alabama sturgeon, only recently described, are found in the Mobile Bay Basin (Williams and Clemmer 1991).

shovelnose sturgeon
(IN Dept. of Natural Resources)

5.4.4.1.2 Life History

Shovelnose and pallid sturgeon are long-lived species, living up to perhaps 20-30 years or more. Adults do not spawn every year and spawning most likely takes place over hard substrates such as gravel or cobble (Keenlyne 1996). Following hatching of eggs, larval shovelnose and pallid sturgeon swim up above the bottom of the river such that they drift with the current and disperse downstream before they become benthically orientated (Kynard et al. 2002, Kynard et al. 2007, Braaten et al. 2008). Shovelnose sturgeon drift for about 6 days post-hatch whereas pallid sturgeon drift 11-17 days post-hatch (Braaten et al. 2008). Laboratory and field experiments with larval pallid and shovelnose sturgeon suggest that shovelnose sturgeon may drift 58 to 155 miles and pallid sturgeon may drift from 152 to 329 miles

depending on water velocity and when the transition to bottom orientation occurs (Kynard et al. 2007, Braaten et al. 2008). The long reaches of unimpeded river required demonstrate the need to provide passage at structures that block sturgeon spawning runs.

5.4.4.1.3 Status

Shovelnose sturgeon are likely extirpated from three states, and are of some level of concern in eight states (Keenlyne 1996). Shovelnose sturgeon are not a species of special concern in Montana (Montana Natural Heritage Program 2009). Pallid sturgeon, although likely never abundant (Bailey and Cross 1954), have undergone severe declines throughout their range and were listed as an Endangered Species by the US Fish and Wildlife Service in 1990 (Dryer and Sandvol 1993).

5.4.4.1.4 Field Observations of Habitat Use

Observations of habitat use by shovelnose and pallid sturgeon in rivers are primarily obtained by use of radio telemetry equipment. In the Yellowstone and Missouri rivers, Montana and North Dakota, adult shovelnose sturgeon used current velocities (measured about 0.33 ft above the bottom of the river) of 0.07 to 5.0 feet/second (mean = 2.6 ft/s) whereas adult pallid sturgeon used current velocities of 0.00 to 4.5 ft/s (mean = 2.1 ft/s; Bramblett 1996; Bramblett and White 2001). Pallid sturgeon movements and habitat use were studied in Lake Sharpe, South Dakota using sonic telemetry (Erickson 1992). Lake Sharpe is an 85-mile segment of the Missouri River below Oahe Dam and above Big Bend Dam; the upper segment is riverine. Pallid sturgeon were most often found at bottom current velocities from 0 to 2.4 ft/s. Mean bottom velocities were 1.5 to 1.6 ft/s at juvenile pallid sturgeon locations and from 1.6 to 1.8 ft/s for shovelnose sturgeon locations in the Missouri River above Fort Peck Reservoir (Gerrity et al. 2008).

Shovelnose and pallid sturgeon are generally found at moderate to deep depths. Shovelnose sturgeon depths ranged from 3.0 ft to 33.1 ft and pallid sturgeon depths ranged from 2.0 to 47.6 ft in the Yellowstone and Missouri rivers (Bramblett 1996; Bramblett and White 2001). Depths at pallid and shovelnose locations were shallower in the Missouri River above Fort Peck reservoir (Gerrity et al. 2008), and in the Kansas River (Quist et al. 1999), but were deeper at sturgeon locations in the Missouri River in South Dakota (Erickson 1992), and in the Mississippi River (Hurley et al. 1987; Curtis et al. 1997). The differences in depth at these sturgeon locations are likely due to differences in local availabilities of depths. Both shovelnose and pallid sturgeon use the deepest half of the channel cross-section most often (Bramblett and White 2001).

Shovelnose sturgeon have been observed using substrates ranging from silt to boulder (Hurley et al. 1987; Bramblett 1996; Quist et al. 1999; Bramblett and White 2001; Gerrity et al. 2008). In the Yellowstone and Missouri rivers, Montana and North Dakota, 69.2% of shovelnose sturgeon locations were over

gravel and cobble substrates, 26.6% were over sand, and 3.0% were over boulder (Bramblett 1996); the use of gravel and cobble and sand were not significantly different from their availability, but the use of boulder substrate was less than availability (Bramblett and White 2001). Shovelnose sturgeon used gravel and cobble substrates significantly more than pallid sturgeon whereas pallid sturgeon used sand significantly more than shovelnose sturgeon (Bramblett and White 2001). Most studies document that pallid sturgeon are largely associated with sand substrate (Bramblett 1996; Bramblett and White 2001; Gerrity et al. 2008), which likely coincides with their large-river distribution. However, hatchery-produced juvenile pallid sturgeon stocked into the Yellowstone River above Intake, Montana have maintained their positions in gravel/cobble-dominated reaches (Matt Jaeger, Montana Fish, Wildlife, and Parks, personal communication), rather than moving downstream to below Sidney, Montana where sand is the predominant substrate (Bramblett and White 2001).

5.4.4.1.5 Macrohabitat

Both shovelnose and pallid sturgeon occur in the Mississippi and Missouri River basins. However, whereas pallid sturgeon are largely limited to the mainstems of the Mississippi and Missouri rivers and the lower portions of a few large tributaries, shovelnose sturgeon occur in both mainstem habitats and large tributaries such as the Red, Arkansas, Ohio, upper Mississippi, and Yellowstone rivers (Bailey and Cross 1954; Lee et al. 1980).

In the Yellowstone and Missouri Rivers in Montana and North Dakota, channel widths at shovelnose sturgeon locations varied from 82 to 2,624 m and were significantly narrower than at pallid sturgeon locations, where width varied from 361 to 3,608 (Bramblett and White 2001). The channel pattern at shovelnose and pallid sturgeon locations was primarily sinuous or irregular; but pallid sturgeon rarely used straight channels and irregular meanders whereas shovelnose sturgeon observations were more evenly distributed among channel types. Both species were most often located near islands or bars. Pallid sturgeon appeared to use more dynamic reaches; as seral stage of islands and bars near pallid sturgeon locations was most often a sere preceding mature cottonwoods. Pallid sturgeon selected reaches with frequent islands and avoided reaches with fewer islands; shovelnose sturgeon were more generalized in channel use with respect to islands (Bramblett and White 2001). In the Missouri River above Fort Peck Reservoir, shovelnose and juvenile pallid sturgeon avoided reaches with islands and selected reaches without islands (Gerrity et al. 2008). The differences in island use in the two study areas may be related to depth; the areas around islands in the Missouri River above Fort Peck Reservoir were shallower than those in area studied by Bramblett and White (2001).

Radio-tagged shovelnose sturgeon were observed in the Yellowstone River (Matt Jaeger, Montana Fish, Wildlife, and Parks, unpublished data). During spring, channel crossovers were preferred, secondary

channels were avoided, and other habitats used proportional to availability. During the runoff period and summer, secondary channels were avoided; other habitats were used proportional to their availability. During winter, crossovers and secondary channels were avoided and other habitats were used in proportion to their availability. Diversion dam pools (Cartersville and Intake) were preferred in spring and summer, likely because diversion dams blocked upstream movement.

5.4.4.1.6 Movements and Home Range

Both shovelnose and pallid sturgeon are capable of rapid, long-distance movements in unimpeded river reaches (Schmulbach 1974; Moos 1978; Bramblett and White 2001; Matt Jaeger, Montana Fish, Wildlife, and Parks, unpublished data). Range of activity is largest in spring and summer, and movements decrease into fall and winter. Shovelnose sturgeon ranges averaged 18.0 miles in spring, 32.7 miles in summer, 8.9 miles in fall, and 0.6 miles in winter (Bramblett 1996). Shovelnose sturgeon movements averaged 0.6 miles/day, and ranged up to 9.3 miles/day. Pallid sturgeon ranges averaged 23.9 miles in spring, 29.0 miles in summer, 14.3 miles in fall, and 0.6 miles in winter (Bramblett 1996). Pallid sturgeon movements averaged 1.0-1.2 miles/day, and ranged up to 13.3 miles/day. In the Yellowstone River, shovelnose sturgeon movements were highest in spring and runoff (to > 2.5 miles/day), moderate in summer (to > 1.2 miles/day) and fish were relatively sedentary in winter (Matt Jaeger, Montana Fish, Wildlife, and Parks, unpublished data).

5.4.4.1.7 Laboratory Trials of Swimming Ability

Observation of swimming behavior and trials of swimming abilities have been conducted for adult and juvenile, hatchery-produced and wild-caught shovelnose and pallid sturgeon in laboratory settings (Adams et al.1999; White and Mefford 2002; Adams et al. 2003). These studies have demonstrated that shovelnose and pallid sturgeon have an affinity for the bottom of the test chamber and can maintain their position in flowing water by appression or "station-holding" (i.e., maintaining position while in contact without active swimming). The morphology of shovelnose and pallid sturgeon (specifically the broad pectoral fins, broad shovel-shaped head, and flat ventral surface) creates negative lift that presumably allows fish to maintain position without expending energy. Other swimming behaviors observed in the laboratory included substrate skimming, where the ventral surface is in contact with the bottom with propulsion generated by body and caudal fin undulation, and free swimming, where swimming occurs in the water column without contact with the substrate (Adams et al. 1999; Adams et al. 2003).

Free swimming is used less as velocities increase; juvenile shovelnose and pallid sturgeon used free swimming < 18 % of the time at current velocities > 0.50 ft/s. Hatchery-reared pallid sturgeon had maximum sustained (i.e., > 200 minutes) swimming speeds of 0.8 and 0.3 ft/s for large (6.7 – 8.0 inches FL) and small (5.2 – 6.6 inches FL) size groups, respectively. Burst (i.e., < 30 second) rates were 1.81-

2.30 and 1.31-2.30 ft/s for large and small size groups, respectively (Adams et al. 1999). In separate swimming trials (Adams et al. 2003), demonstrated that the mean 30-minute critical swimming speeds of hatchery-reared juvenile shovelnose and pallid sturgeon were 1.21 ft/s and 1.18 ft/s, respectively; these speeds were not significantly different. This suggests that under temperatures similar to the test conditions (50-68°F), juvenile shovelnose and pallid sturgeon probably do not segregate in rivers due to differing swimming abilities.

White and Mefford (2002) used experimental flumes and fishways to assess the swimming ability of 26 adult shovelnose sturgeon collected in July 2001 from the Yellowstone River. Fork lengths of experimental sturgeon ranged from 25.2 to 35.8 inches and weight ranged from 3.1 to 10.6 pounds. The swimming study had two phases. The first phase identified behavior of sturgeon exposed to a combination of flow depth, bed roughness, velocity, and turbulence (i.e., vertical and horizontal baffles) in a 3 by 30-foot flume and in a 3 by 60-foot adjustable-slope flume. Preliminary testing indicated that water depth in the flumes had no observable influence on sturgeon behavior, so depth was not manipulated in flume tests. The second phase observed the response of sturgeon to three types of fishways: a standard vertical slot baffled fishway, a dual-vertical slot baffled fishway, and a rock channel with boulder weirs.

Success rates for sturgeon negotiating the 30-foot flume with substrates ranging from sand to cobble increased with flow velocity to 3.0 ft/s and decreased slightly at velocities of 3.5 and 4.0 ft/s (67% at 0.8 ft/s, 83% at 1.2 and 1.6 ft/s, 100% at 2.0, 2.5, 3.0 ft/s, 92% at 3.5 ft/s, and 87% at 4.0 ft/s). Substrate type appeared to have little effect on fish passage, although cobble substrate may have reduced success at the highest velocities. At low velocities, fish were less oriented towards flow and milled around, moving up and down channel. Attraction velocities became strong at 2.0 ft/s and remained high to 4.0 ft/s. Down-channel movement was most common and more often headfirst at the slowest two velocities. Down-channel movement at higher velocities was all tail-first. Average time required to reach the top of the flume was shortest at 4.0 ft/s (0.8 minutes) and longest at 0.8 ft/s (8.8 minutes).

White and Mefford (2002) reported results of shovelnose sturgeon swimming abilities in terms of average water column velocity. However, they also measured and reported vertical velocity profiles. Velocities were reduced near the bed of the flume and the reduction in velocity increased with bed roughness. The boundary layer was most apparent in the first four inches above the bed. For example, in the 4 ft/s trial with a cobble bed, velocity at 2 inches above the bed was about 2.6 ft/s, at 4 inches above the bed velocity was about 3.2 ft/s, and at 6 inches above the bed, velocity was about 4 ft/s. White and Mefford (2002) do not explicitly discuss the position of test sturgeon in the water column. However, because sturgeon normally swim or station-hold along the bottom of their habitat (Adams et al. 1999), the water velocities

that test fish experienced at the scale of microhabitat were likely slower than mean water column velocities. Consequently, measurements of average current velocity may not be reflective of the slower microhabitat velocity sturgeon experience near the bed substrate. This is true for fish swimming in natural river beds as well.

Vertical baffles (15.5-inch and 22.5-inch) reduced successful flume negotiation overall, and successful passage decreased with baffle width. Overall percent of fish successfully negotiating the flume was 70% with 15.5 inch baffles (at average velocities ranging from 0.8 ft/s to 4.0 ft/s) whereas overall percent of fish successfully negotiating the flume was 40% with 22.5 inch baffles (at average velocities ranging from 0.8 ft/s to 4.0 ft/s). With the 22.5 inch baffles, sturgeon often circled in the eddy below the first baffle, and were often disoriented at velocities of 3 ft/s and higher.

Horizontal weir baffles of 4 heights ranging from 3 inches to 21 inches reduced successful passage from 12% to 53% relative to passage rates over sand to cobble substrates at the same water velocities without baffles. Although some fish negotiated all baffles tested, higher baffles reduced successful passage more than lower baffles. For example, overall passage (with velocities ranging from 0.8 to 4.0 ft/s) with 3-inch baffles was 78%, whereas it was 56% with 12-inch baffles, and 12.5% with 21-inch baffles. Most of the tested sturgeon that made it to the top of the flume did so immediately, rather than resting along the way, except with the 21-inch baffles, where only 2 of 16 fish successfully negotiated the flume. Orientation to flow was weak at 0.8 and 1.6 ft/s and strong at velocities of 2.0 ft/s and above.

A 60-foot, adjustable slope flume was used to test fish movement at velocities up to 6.5 ft/s, with smooth (plywood), coarse sand, gravel, and cobble substrates. Mean water velocities varied along the length of the flume because velocity increased as water moved down the flume. Water velocities also varied vertically. Water velocities decreased approaching the bed of the flume. For example, over a cobble bed with velocities at about 6 ft/s at 5 inches above the bed, velocity was about 2.6 ft/s at 2 inches above the bed. The near-bed decrease in velocity increased with increasing bed roughness. Overall passage success (all substrates) was 50-57% at the lowest two velocities (0.8 – 2.0 ft/s), and increased to 81% at 2.0 to 3.3 ft/s, before decreasing to 47% at 2.2-6.0 ft/s. Movement success was best over the smooth substrate (60-90%) and declined with increasing substrate size (25-50% over cobble). Sturgeon usually reached the top of the 60-foot flume in three or four spurts, resting for up to 3 minutes, apparently without effort, in maximum facing velocities (about 4 inches off the bed) of 6.5-7.8 ft/s. Fish usually rested no more than 3 minutes between “sprints”.

Shovelnose sturgeon passage and behavior was observed in three test fishways; a standard vertical slot baffle, a chevron-shaped dual-vertical-slot baffle (both were 5.5 ft wide by 5.5 ft deep, with a 5% bottom

slope, baffles were spaced 6 ft apart), and a rock-lined bypass channel with boulder weirs (70 ft long, rock-lined trapezoidal channel, 2% slope, 4 ft wide by 4 ft deep, constructed of rip rap, 2-3.5 ft artificial boulders placed in an upstream-facing chevron). Fishway tests were conducted on shovelnose sturgeon collected from the Yellowstone River in October 2001; these fish were generally less motivated to move than the group of fish collected in July. Two of eight fish passed all four slots in the vertical baffle fishway. Fish activity increased as velocity increased, and the fish that passed in the shortest time (4 minutes) avoided the eddies behind the baffles. Two of 10 fish successfully passed all four baffles in the dual-slot fishway, although fish appeared to be more motivated to pass this fishway than in the standard vertical slot baffle fishway. Of the three fishway designs, fish passage was best in the rock fishway. Water velocities in the rock fishway ranged up to 3.3 to 4.4 ft/s. Fifteen of 24 (62.5%) shovelnose sturgeon successfully negotiated the fishway in times ranging from 14 to 83 minutes. Passage rate may have been higher with motivated fish; seven fish were not motivated to move and remained near the bottom of the fishway throughout the tests. Sturgeon that appeared to be motivated to move had no difficulty passing the rock fishway. The movement pattern of tested sturgeon in the rock fishway was very consistent; most fish chose the same route and were able to maintain station in facing velocities of 4 ft/s. Fish appeared to search for and follow the best hydraulic conditions for passage.

In summary of White and Mefford's (2002) shovelnose sturgeon swimming trials, fish successfully negotiated average velocities ranging from 0.8 to 6.0 ft/s, and all substrates ranging from sand to cobble. Passage declined somewhat with increasing substrate grain size, but even over cobble substrate, overall passage was 81%. Fish showed poor orientation to average velocities less than 2.0 ft/s; fish were strongly oriented to flow at velocities of 2 to 6 ft/s. Passage success declined substantially from 81-87% at 4 ft/s to 47% at 6 ft/s. Depth of water did not affect sturgeon behavior in the range tested (0.7 to 4.5 ft). Sturgeon negotiated horizontal and vertical eddies, but larger eddies caused delays in fish passage, and eddies were not needed for fish to successfully pass test flumes. Fish collected from the Yellowstone River in October, and used in the fishway tests appeared to be less motivated to move, nonetheless fishway tests were useful. Fish passage was poor in the standard vertical-slot fishway and in the dual-slot fishway; however fish passage was much improved in the rock fishway.

White and Mefford (2002) recommend attraction flows of 2-4 ft/s, a depth of 4 ft, and a uniform transition from fishway flow to downstream flow. Passage velocity should be 3-4 ft/s, and a rock channel fishway should be used, because of positive results with shovelnose sturgeon. For example, the rock fishway tested by White and Mefford (2002) was constructed of rip rap with 15% of rock < 5 inches and 85% < 15 inches, with 2 to 3.5 foot boulder placed in an upstream-facing chevron, with 2-foot gaps between the boulders. The boulders certainly created a diversity of velocities as well as some turbulence. Although results from baffle test in flumes indicate that turbulence may reduce sturgeon passage success, sturgeon

were fairly successful at negotiating the fishway. Moreover, large boulders placed in a rock fishway would provide a diversity of velocities that would likely allow other fish species to pass the structure. However, large eddies that may mask attraction flow should be avoided. The study by White and Mefford (2002) and their recommendations probably provide the best inference for designing the fish passage structure at Cartersville for several reasons. The target species for passage at Cartersville is shovelnose sturgeon, which is the species that they tested. The fish were wild-caught from the Yellowstone River as opposed to hatchery-reared and they were adults. Their test flumes and fishways were of a relatively large size which enhances the inference and certainty of extrapolating from laboratory tests to field conditions.

5.4.4.2 Identification of Yellowstone River Slope Anomalies and Potential Rock Ramp Design Analogs

As described above, radio telemetry studies recorded shovelnose sturgeon passage through steep segments of the Yellowstone River downstream of Cartersville Dam. In order to support the design of a rock ramp passage structure at Cartersville Dam, these natural "rapids" were coarsely identified through an analysis of water surface slope from Cartersville Dam to the Missouri River. From these data, two notably steep passage areas were assessed as potential design analogs.

5.4.4.2.1 Identification of Slope Anomalies

Naturally steep segments of the Yellowstone River downstream of Cartersville Dam were initially identified by creating a LiDAR-generated water surface profile of the river centerline. A GIS project developed as part of the Yellowstone River Cumulative Effects Study (CES) includes a digitized centerline and river mileage reference dataset from the river mouth to Gardiner, Montana. In addition, LiDAR survey data of the river corridor includes water surface elevations at the time of the survey. To assess general river gradient downstream of Cartersville, the centerline was attributed with LiDAR-derived elevation data. Elevation points were applied to the centerline every 100 feet. This effort produced approximately 14,000 water surface elevation data points from RM 238 (Cartersville Dam at Forsyth) to RM 0. Water surface slope was then calculated at these 100-ft increments, and additional gradient calculations were made for 200, 400, 600, 1000, and 2000 ft centerline distances. The results were further screened to identify areas where channel lengths in excess of 400 feet have a slope of 0.3% or greater. These sites were tagged in the GIS and evaluated with air photos to assess their geomorphic context.

In addition to the slope assessment, potentially steep areas were identified using both air photos and historical references. Lewis and Clark described "rapids" on the river, and later accounts of these rapids are available. The rapids have been named, and attempts have been made here to apply the historic name

to the feature. However, as some of the descriptions of rapid locations are vague, it is possible that the names used here do not correlate to other sources. Consequently, all features described herein are also identified by river mile.

5.4.4.2.2 Site Identified as Potential Analogs

A total of eleven sites were identified as having anomalously steep water surface profiles over several hundred feet of channel length (Table 5-1). These include a long series of bedrock rapids formed in the Fort Union Formation between Miles City (RM 183) and Kinsey (RM 167). These rapids are collectively referred to as the "Buffalo Shoals". Matthews Rapid, located just downstream of Sunday Creek at the Matthews Recreation Area, is within this long series of bedrock exposures. Bear Rapid is located downstream, approximately 4.5 miles upstream of the Powder River at the mouth of Camp Creek. Wolf Rapid is located approximately 3 miles downstream of the Powder River, and Site 11 is 2 miles further downstream. All of these sites appear to have some bedrock influence, and the valley wall geology in this area is comprised of the Tullock Member of the Tertiary-age Fort Union Formation. This unit consists of interbedded sandstone, shale, mudstone and well indurated limestone (Vuke et al, 2001).

Table 5-1
Potential Reference Reaches

Site	Name	River Mile	Max 100-ft Slope
1	Uppermost Buffalo Shoals	184.0	0.26%
2	Buffalo Shoals above Sunday Cr	179.6	0.15%
3	Buffalo Shoals above Sunday Cr	178.2	0.18%
4	Buffalo Shoals above Sunday Cr	176.7	0.44%
5	Buffalo Shoals at Alkali Cr above Sunday Cr	176.0	0.21%
6	Buffalo Shoals just below Sunday Cr ("Matthews Rapid")	174.2	0.47%
7	Buffalo Shoals just upstream of railroad bridge	172.6	0.24%
8	Buffalo Shoals just downstream of railroad bridge	170.8	0.25%
9	Bear Rapid	153.4	0.39%
10	Wolf Rapid	146.0	0.37%
11	Unknown	144.0	0.58%

The results of this screening effort based on slope and length of slope indicated that the best potential reference riffles appear to be located at Matthews Rapid (RM 174.2), and Wolf Rapid (RM 146.0). Site 4 and Site 11 also showed promise as potential references, although they both have flow splits on the 2007 imagery. Based on overall slope and length, Matthews Rapid and Wolf Rapid were selected for further analysis.

5.4.4.2.3 Geomorphology of Matthews and Wolf Rapids

5.4.4.2.3.1 Matthews Rapid

Matthews Rapid, located a few miles downstream of Miles City at RM 174.2, consists of a long bedrock exposure and steep channel segment. The rapid has formed in sandstones of the Tullock Member of the Fort Union Formation (Vuke, et al, 2001). The steepest portion of the rapid extends between two mid channel bars, over a distance of approximately 0.6 miles (Figure 5-15). The LiDAR-derived water surface profile indicates that the rapid consists of a series of drops, each of which are several hundred feet long (Figure 5-16 and Figure 5-17).

Figure 5-15 2007 Aerial Photograph of Matthews Rapid RM 174.2, Yellowstone River; red line refers to extent of slope anomaly, and centerline points are 100 ft increments.

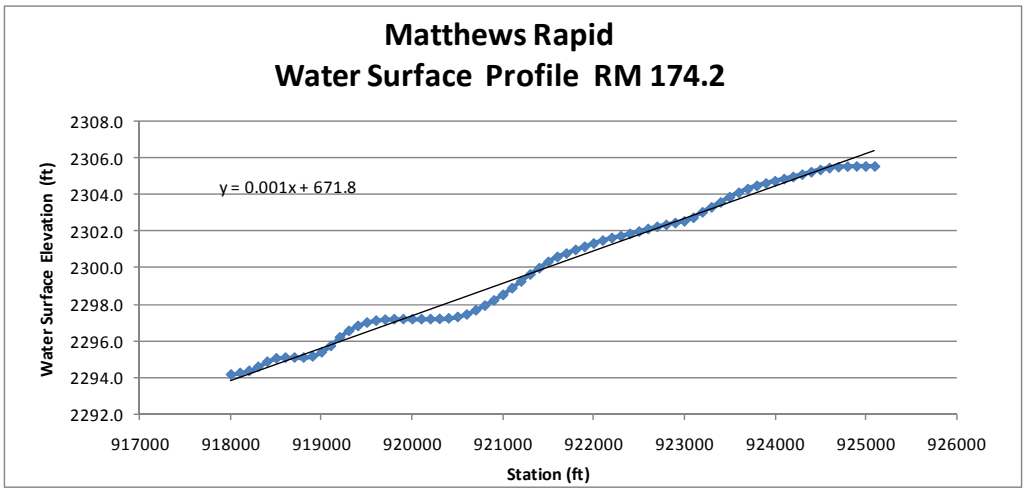


Figure 5-16 LiDAR-Derived Water Surface Profile, Matthews Rapid

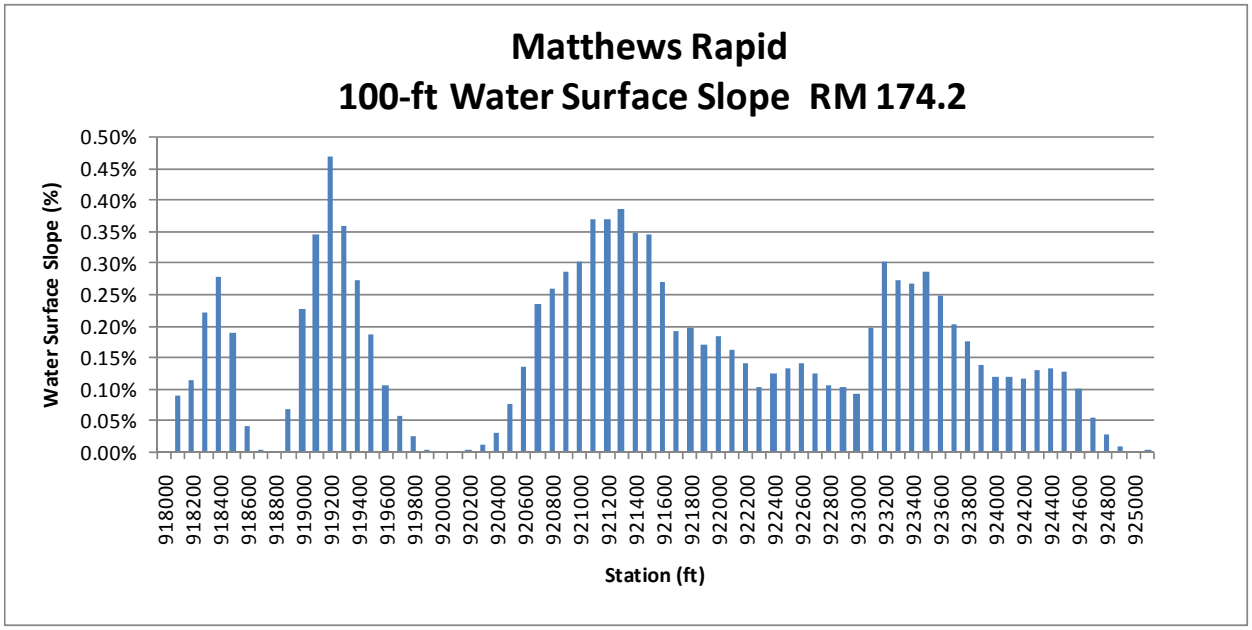


Figure 5-17 Water Surface Slope Calculated at 100-ft Increments, Matthews Rapid

The river bed at Matthews Rapid consists of a band of large, tabular, sandstone boulders spanning the entire river channel, but no discernable bedrock sills (Figure 5-18). The large boulders are interspersed by areas with gravel and large cobbles. Deeper flow pathways are present through the rapid and may provide migration routes for fish.

Figure 5-18 Matthews Rapid Looking North From the Right (southern) Bank

Adjacent to the steepest portion of Matthews Rapid, the right bankline is comprised of a coarse group of boulders that are continuous with the grade break in the channel (Figure 5-19). In order to estimate the size of the boulders in the rapid, a 92' X 28' cluster of boulders was flagged on the right riverbank adjacent to the steepest part of the rapid, and all boulders in the area were measured in terms of a-axis, b-axis, and c-axis lengths. A total of 144 clasts were measured and statistically summarized (Table 5-2). A box and whisker plot of the data shows that the range in 25th-75th percentile values (the "box") is relatively small, but that maximum values are notably large, reaching 148 inches (12.3 feet) for the largest boulder measured (c-axis; Figure 5-20). A histogram showing results for all measurements less than 65 inches shows that the highest number of occurrences for the a-axes is 5 to 15 inches, for b-axes is 15-20 inches, and for C axes is 30-35 inches (Figure 5-21).

Figure 5-19 View From Right (southern) Bank Showing Steep Section of Matthews Rapid with Course Boulder Field in Foreground.

Table 5-2
Statistical Summary of Matthews Rapid Boulder Measurements

Statistic (inches)	A-Axis	B-Axis	C-Axis
Min	3	10	15
Median	11	22	33
Mean	12	26	39
Max	31	105	148
25th Percentile	9	16	25
75th Percentile	14	30	44
N	137	143	143
Standard Deviation	5	15	23

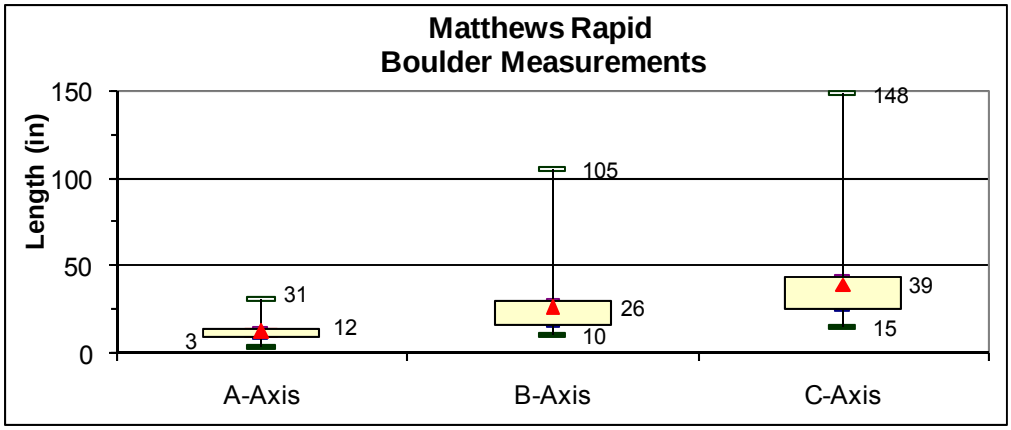


Figure 5-20 Box and Whisker Plot Showing Distribution of Boulder Measurements at Matthews Rapid; Minimum, Mean, and Max Values for Each Axis are Labeled

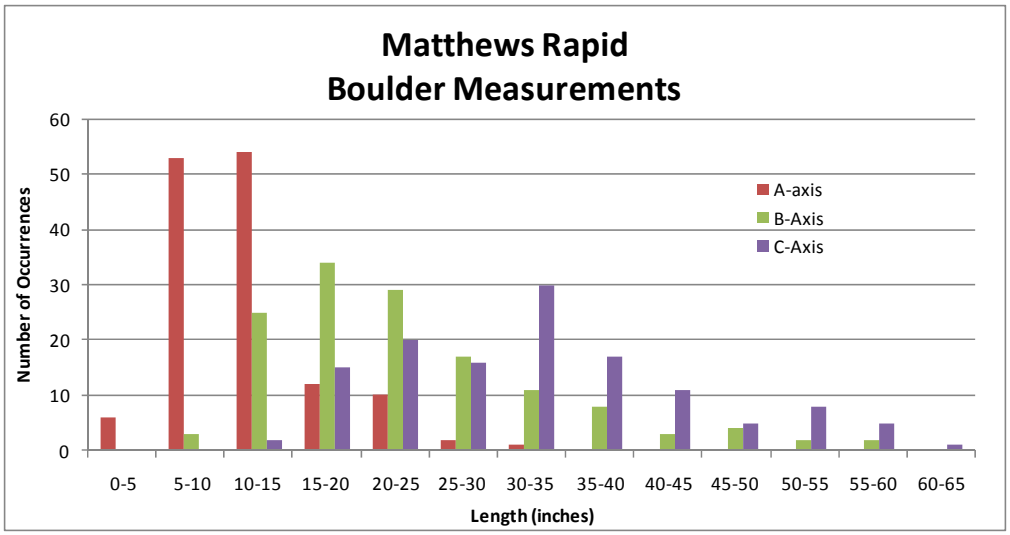


Figure 5-21 Histogram Showing Frequency of Number of Occurrences for Boulder Axis Measurements, Matthews Rapid

5.4.4.2.3.2 Wolf Rapid

Wolf Rapid is located at River Mile 146.0, approximately 3 miles downstream from the mouth of the Powder River (Figure 5-22). This rapid consists of a series of bedrock sills that extend across the channel on the apex of a large bendway. Similar to Matthews Rapid, the mapped geology on the base of the adjacent valley walls consists of interbedded sandstones, mudstones and limestone of the Tullock Member of the Fort Union Formation (Vuke and Colton, 2003). These hard sandstones appear to form the grade break at Wolf Rapid. At Wolf Rapid, the water surface slope is consistently steeper than 0.3% over several hundred feet of channel (Figure 5-23 and Figure 5-24).

Figure 5-22 2007 Aerial Photograph of Wolf Rapid, RM 146 Yellowstone River; red line refers to extent of slope anomaly and centerline points are 100ft increments.

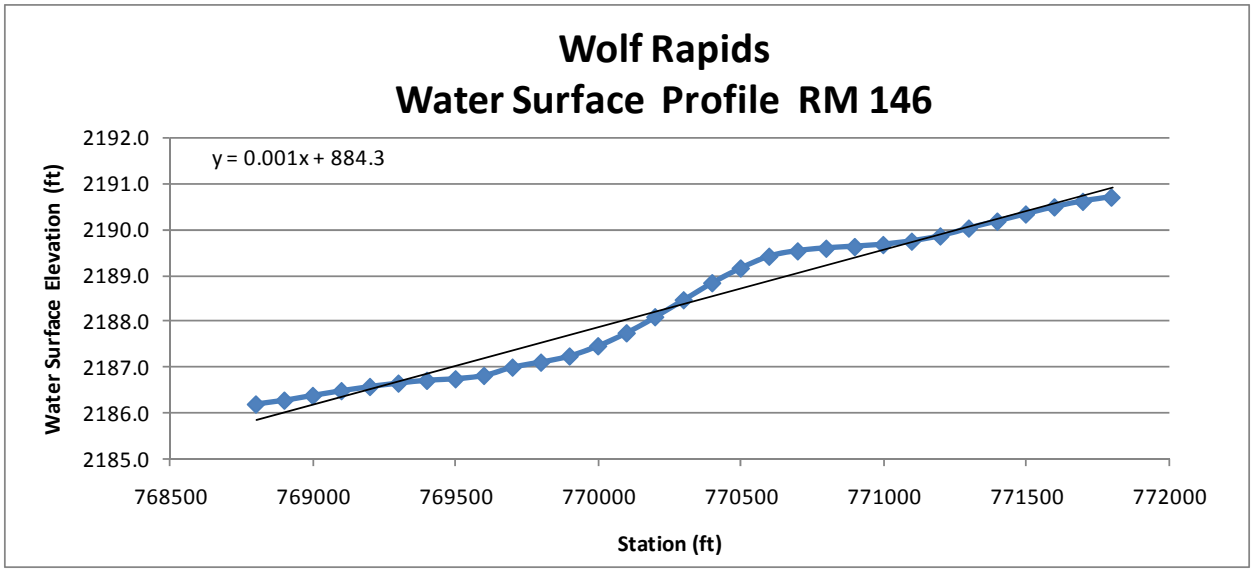


Figure 5-23 LiDAR-Derived Water Surface Profile, Wolf Rapid

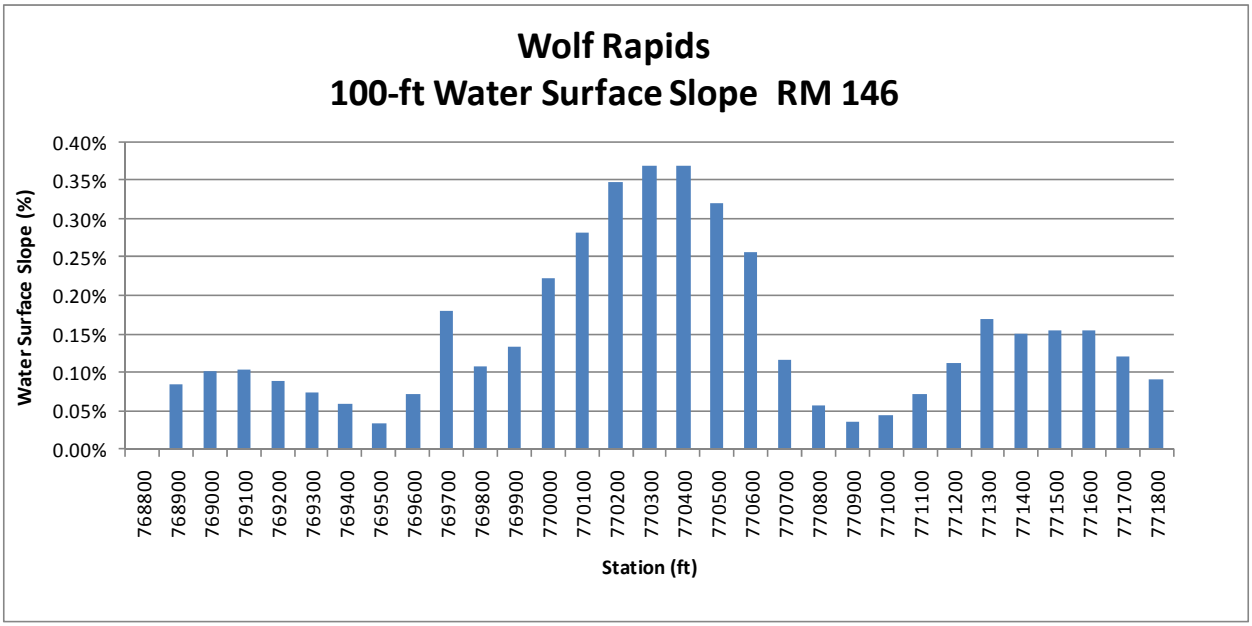


Figure 5-24 Water Surface Slope Calculated at 100-ft Increments, Wolf Rapid

The river bed at Wolf Rapid consists of a series of discontinuous sandstone steps created by bedrock sills (Figure 5-25). The rock sills cross the channel obliquely and slope downward from south to north. Consequently, flows on the north side of the rapid are deeper than on the south side. The sills are breached, creating chutes with well-defined, deeper flow pathways around and through the bedrock sills that might be used by sturgeon for passage. Flows over the tops of the rock sills exhibit supercritical flow conditions. The rock sills are interspersed by sections of river bed\ with more consistent grade and large cobble to large boulder substrates.

Figure 5-25 Wolf Rapid Looking Northwest From the Right (southeast) River Bank

5.4.4.2.4 Hydraulic Analysis of Matthews and Wolf Rapids

Based on the screening methodology described above, Matthews Rapid and Wolf Rapid were selected as potential design analogs for the rock ramp alternative. These features are characterized by water surface slopes that exceed 0.3% over several hundred feet of channel length. Cross sections (XS) and a stream bed profile at the two rapids were surveyed in September 2009 (Figure 5-26). Cross sections at each rapid were flagged to capture conditions through the slope anomalies. A total of five cross sections were surveyed at Matthews Rapid, and four at Wolf Rapids. These cross sections extend above and below the primary slope anomalies at each site.

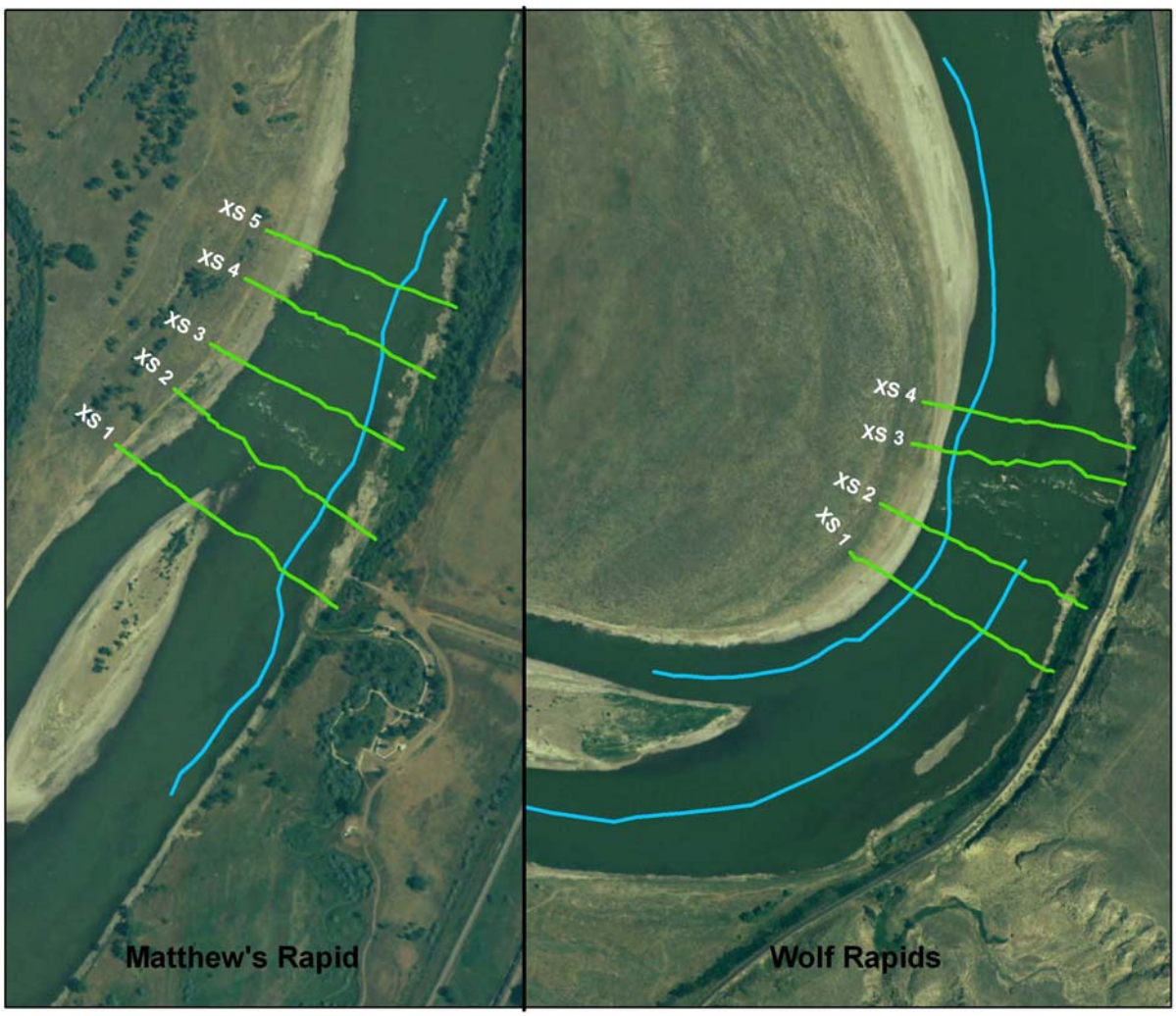


Figure 5-26 Cross-Sections (green lines) and Profiles (blue lines) Surveyed at Matthews Rapid and Wolf Rapid

For each suite of survey data, a simple, single station hydraulics package, WinXSPro, was used to evaluate the velocity and shear force at each cross-section for a range of discharges. WinXSPro calculates hydraulic parameters based on inputs of cross section geometry (surveyed station and elevation), channel slope, and Manning's n-value. The model can be run at a range of river stages (max water depth), to determine the hydraulic conditions (velocity, shear force) and discharge at that river stage.

The channel slope for each site was determined from the surveyed stream bed profile. In addition, the surveyed stream bed profile for each site was divided into segments based on visual interpretation of slope breaks. For Matthews Rapid, the profile was divided into two sections: upstream of XS 2 and downstream of XS 2 (see Figure 5-27). By applying a linear trendline to each section, we estimated a

slope of 0.12% for the upstream section (profile points between XS 1 and 2) and 0.52% for the downstream section (profile points from XS 2 through 5). For Wolf Rapid, the profile was divided into three sections: upstream of XS 2, from XS 2 to XS 3, and downstream of XS 3 (see Figure 5-28). By applying a linear trendline to each section, we estimated a slope of 0.21% for the upstream section (XS 1), 0.53% for the middle section (XS 2 and 3), and 0.14% for the downstream section (XS 4). The maximum bed slopes measured from the survey are 0.52% at Matthews Rapid and 0.53% at Wolf Rapid. These bed slope values are substantially steeper than the water surface slopes measured by the LiDAR-generated water surface profile at both sites, which is on the order of 0.35% (Figure 5-16 and Figure 5-23).

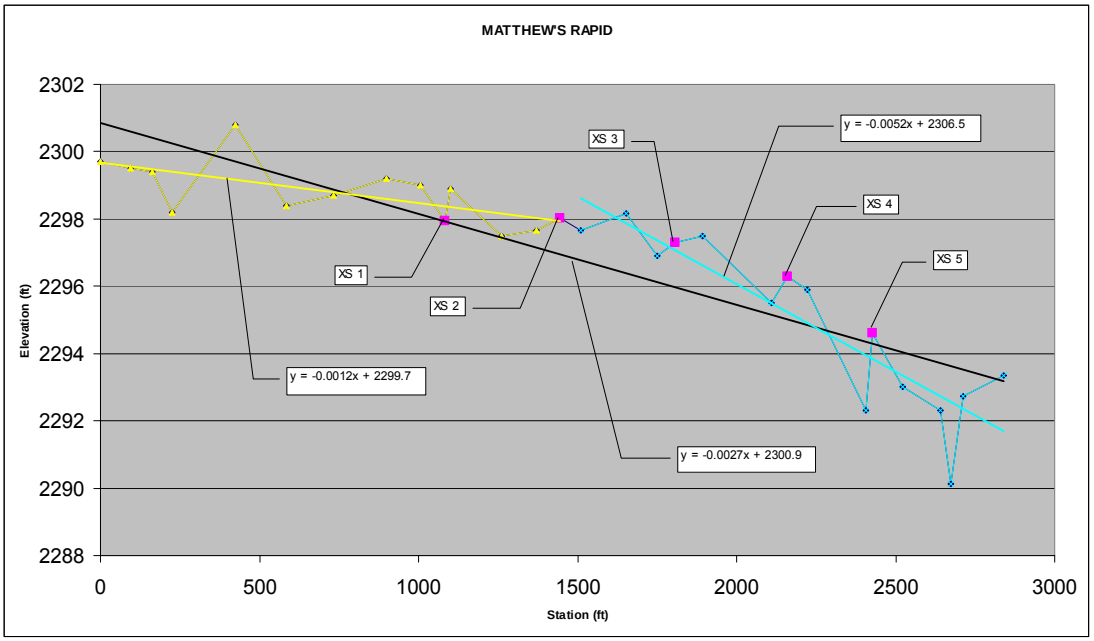


Figure 5-27 Surveyed Stream Bed Profile, Matthews Rapid, Broken Into Two Slope Segments

Manning's n-values for each cross section were calibrated based on two discharges, a low water event surveyed by DOWL HKM in September 2009, and a high water event surveyed by the USACE in June 2009. The low water discharge was measured at the USGS gage in Miles City: 7,490 cfs for Matthews Rapid and 7,510 cfs for Wolf Rapid. The high water event is determined from the velocity measurements on the days that data were collected by the USACE: 36,500 cfs for Matthews Rapid and 45,000 cfs for Wolf Rapid.

Using the edge of water points in each data set and the lowest cross-section point from the survey data, the maximum depth for each cross-section at each discharge was calculated. Each cross section was

iteratively run in WinXSPro for a range of Manning's n-values until the resulting discharge at the observed maximum depth was equal to the measured discharge at the time of the survey. Using these calibrated high and low water event Manning's n-values, each cross-section was again run in WinXSPro for a range of stages based on a 0.1 ft increment of change.

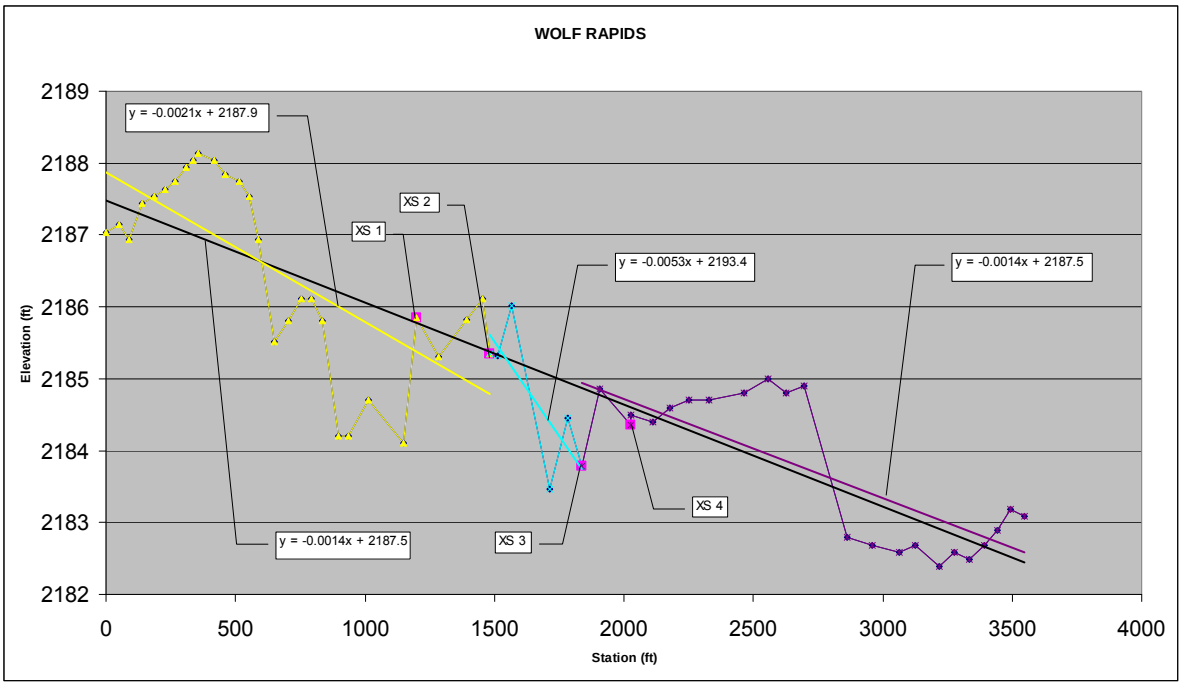


Figure 5-28 Surveyed Stream Bed Profile, Wolf Rapid, Broken Into Three Slope Segments

The river FLO-2D two-dimensional flow model was also calibrated to a flow of 7490 cfs at Matthews Rapid to verify its ability to accurately model these conditions (Figures 5-29 and 5-30).

5.4.5 Hydraulic Conditions at Natural Design Analogs During Known Passage Events

5.4.5.1 Discharge Range

Radio telemetry studies of sturgeon movements in the Yellowstone River have documented passage of 20 shovelnose sturgeon through Wolf Rapid at flows of at least 2,610 to 19,300 cfs (see Appendix A). At Matthews Rapid, 14 sturgeon were documented passing the feature at flows of at least 3,950 to 31,000 cfs (M. Jaeger, unpubl. data). Note that these flows represent the lowest discharges recorded during the time period when fish were captured below and then recaptured above the rapid. For example, fish number 480-66 was located on 6/3/2007 near river mile 70 when discharge was 19,300 cfs (Figure 5-31). This fish then swam approximately 75 miles upstream in 3 days and was recaptured just above Wolf Rapid near river mile 145 on 6/6/2007 when discharge was 37,700 cfs. Within this timeframe and range of

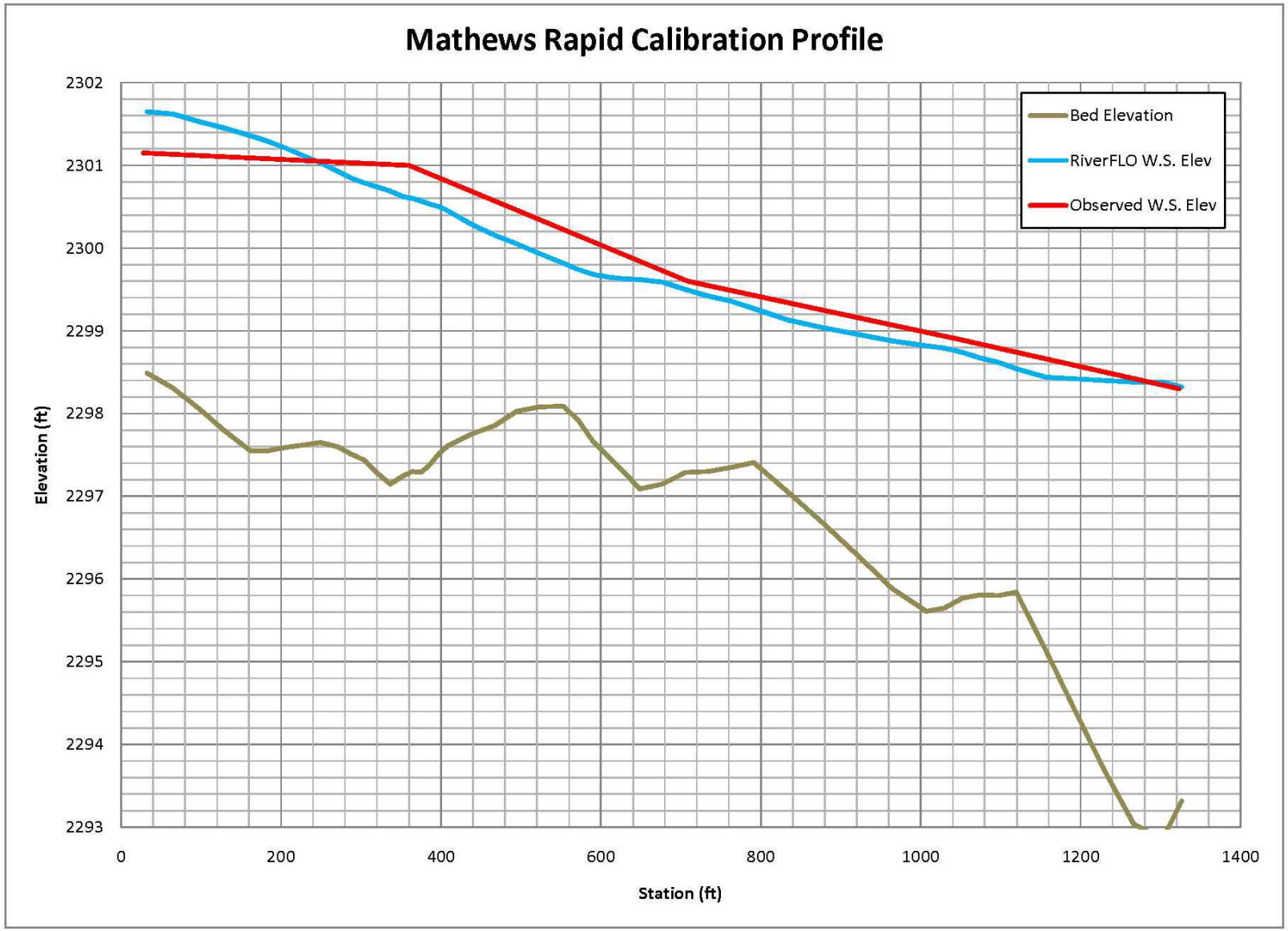


Figure 5-29 Matthews Rapid Calibration Profile

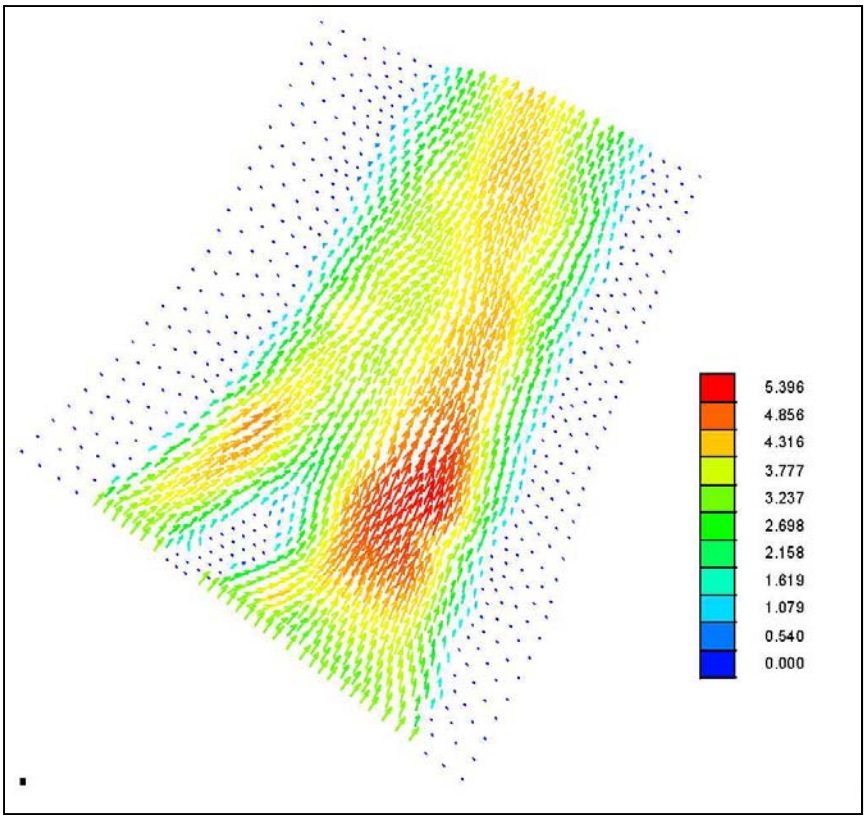


Figure 5-30 Matthews Rapid Velocity Profile (ft/s), Q = 7490 ft/s

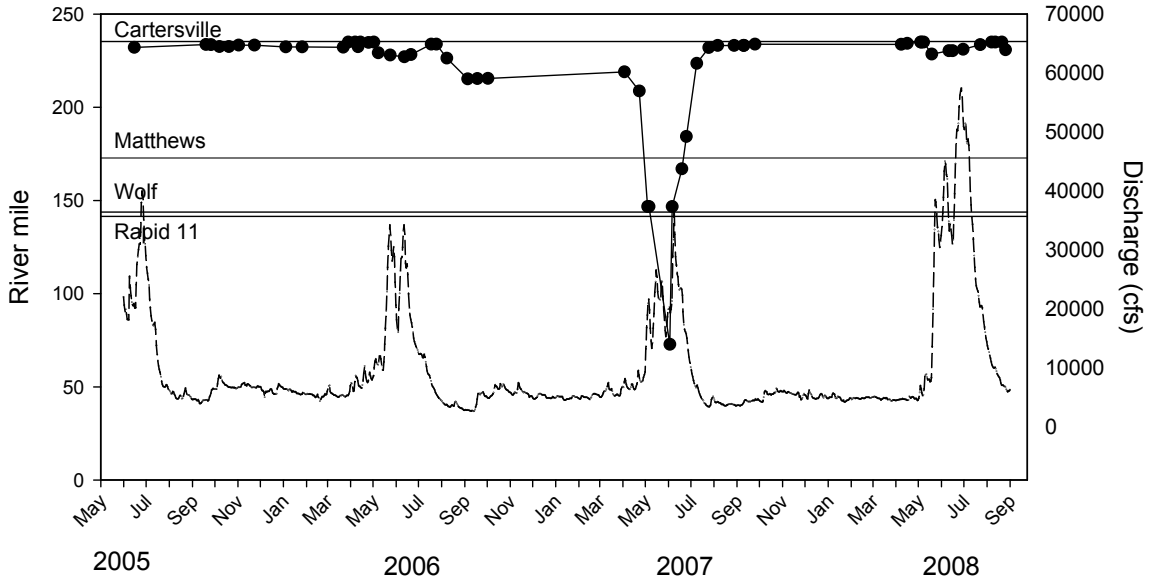


Figure 5-31 Movements of Shovelnose Sturgeon
Movements of shovelnose sturgeon number 480-66 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11 (M. Jaeger, unpubl. data).

flows it is uncertain exactly when this fish swam through Wolf Rapid. However, river flow rose consistently during this time period, so we know discharge had to be at least 19,300 cfs when 480-66 passed Wolf Rapid. Moreover, given the distance (nearly 75 miles) between the location where the fish was released and its recapture just above Wolf Rapid, it highly probable that the passage discharge was closer to the 37,700 cfs value recorded when the fish was recaptured. In the most extreme cases, therefore, we can conservatively conclude that one shovelnose sturgeon passed Wolf Rapid at a discharge of at least 19,300 cfs and two sturgeon passed Matthews Rapid at a discharge of at least 31,000 cfs. These extreme (but conservative) fish passage flows provide a glimpse of the potential swimming capability of shovelnose sturgeon in the wild.

5.4.5.2 Mean Velocity

The following tables (Table 5-3 and Table 5-4) show the results of WinXSPro runs for each cross-section at Wolf and Matthews rapids using discharges that bracket the extreme discharges where fish passage was documented.

Table 5-3
Hydraulic Analysis Results for Matthews Rapid
Bold values highlight the modeled discharge that is closest to the probable field discharge when two radio tagged shovelnose sturgeon passed this rapid.

XS	SLOPE (%)	N-VALUE	VELOCITY (ft/s)	SHEAR (psf)	DISCHARGE (cfs)	STAGE (ft)
1	0.12	0.030	5.30	0.40	29,232	8.9
		0.030	5.37	0.40	30,162	9.0
2	0.12	0.029	5.60	0.43	30,920	10.2
		0.063	5.68	0.43	31,867	10.3
3	0.52	**0.063**	**6.00**	**2.13**	**30,909**	**10.2**
		0.063	6.07	2.16	31,763	10.3
4	0.52	0.072	5.56	2.32	30,676	11.5
		0.071	5.61	2.34	31,373	11.6
5	0.52	0.080	5.19	2.45	30,633	12.2
		0.079	5.25	2.48	31,412	12.3

Table 5-4
Hydraulic Analysis Results for Wolf Rapid
Bold values highlight the modeled discharge that is closest to the probable field discharge when one radio tagged shovelnose sturgeon passed this rapid.

XS	SLOPE (%)	N-VALUE	VELOCITY (ft/s)	SHEAR (psf)	DISCHARGE (cfs)	STAGE (ft)
1	0.21	0.054	4.04	0.74	18,859	9.8
		0.054	4.10	0.76	19,477	9.9
2	0.53	0.087	4.13	2.00	18,805	9.4
		0.087	4.19	2.02	19,407	9.5
3	0.53	0.090	3.88	1.92	19,080	7.4
		0.090	3.91	1.95	19,566	7.5
4	0.14	**0.031**	**5.38**	**0.45**	**18,845**	**6.3**
		0.031	5.43	0.46	19,380	6.4

The model results indicate fish passed Matthews Rapid XS3 at average velocities at least as high as 6.00 ft/s, and Wolf Rapid XS4 at average velocities of at least 5.38 ft/s. As previously mentioned, actual passage may have occurred at higher discharges and velocities. It is important to note that these are averages of all velocities across the entire river cross-section and are not indicative of point velocities at specific locations within the cross-section. Point velocities may be significantly higher at some locations and significantly lower at others. Near the stream bed where sturgeon are typically found, flow velocities are often lower than average, especially when roughness is high.

The maximum recommended current velocity for sturgeon passage from laboratory flume studies is 4.0 ft/s (White and Mefford, 2002). However, field telemetry measurements for shovelnose and pallid sturgeon indicate sustained movement rates as high as 6.2 ft/s (6.8 km/h) and 8.6 ft/s (9.5 km/h), respectively (Bramblett 1996). These movement rates are based on the distance moved and the time elapsed between sequential locates of radio tagged fish within a time period <24 hours. It is important to note here that current velocity refers to the speed of flow past a stationary point; movement rate refers to the distance a fish moves in a given period of time regardless of current velocity; while swimming speed refers to the rate a fish travels through water. To illustrate, a fish that moves a distance of 3 feet in one second has a movement rate of 3 ft/s. If this fish is also swimming against a current velocity of 2 ft/s, it will have a net swimming speed of 5 ft/s. Similarly, a fish moving upstream at a rate of 4 ft/s in a current velocity of 0 ft/s will have a swimming speed of 4 ft/s. Movement rates are not the same as current velocity or swimming speed because the movement rates do not account for resting periods or any downstream movements the fish may have made between sequential locates. Moreover, movement rates assume a flow velocity of zero, so actual upstream swimming speed (rate of movement through water) in a riverine environment is actually higher than the movement rate. With these differences in mind, movement rates can provide a conservative surrogate estimate of the flow velocity fish may pass. Measured movement rates of 6.2 ft/s (Bramblett, 1996) support the WinXSPro results documenting shovelnose sturgeon pass Wolf and Matthews rapids when average flow velocities were at least 5.38 to 6.00 ft/s. We can conclude with some certainty, therefore, that, sturgeon are capable of passing natural rapids such as Wolf and Matthews Rapid at average flow velocities approaching 6.0 ft/s.

5.4.5.3 Roughness

As previously described, the channel bed at both reference rapids consisted of a complex mosaic of large boulders, bedrock sills, cobble, and gravel. This results in relatively high roughness (Manning's n) values, especially at low discharges. Indeed, low flow roughness at each rapid ranged from 0.026 to as high as 0.104 (Table 5-5). The boulders measured on the right bank adjacent to Matthews rapids indicate that discreet sandstone boulders larger than 4 feet in diameter are common. Within the 28-foot by 92-foot area within which individual rocks were measured, a total of 13 boulders had a b-axis in excess of 4 feet,

and 33 boulders had a c-axis greater than 4 feet. These large boulders are indicative of the high bed roughness conditions at Matthews Rapid.

Table 5-5
Maximum Roughness Values for Similar Discharges at Matthews Rapid and Wolf Rapid

Matthews Rapid				Wolf Rapid			
XS	SLOPE (%)	N-VALUE	DISCHARGE (cfs)	XS	SLOPE (%)	N-VALUE	DISCHARGE (cfs)
1	0.12	0.033	3,563	1	0.21	0.065	2,382
2	0.12	0.033	3,521	2	0.53	0.111	2,321
3	0.52	0.076	3,593	3	0.53	0.078	2,362
4	0.52	0.084	3,518	4	0.14	0.026	2,283
5	0.52	0.104	3,637				
Average N for XS 3, 4, 5:		0.088		Average N for XS 2 & 3:		0.096	

Design of a rock ramp based on these natural rapid analogs will need to incorporate similarly high roughness values by emulating bed materials and spacing of the reference rapids.

5.4.5.4 Variability / Pathways

As previously discussed, the velocities presented in Table 5-6 and Table 5-7 are average velocities for the entire cross-section. In contrast, substantially slower and faster flows are likely to occur at specific locations throughout a cross-section for any given discharge. For example, velocities near the river bed and behind flow obstructions are probably slower than velocities at locations higher the water column or between obstructions. Sturgeon are considered to be benthic rheophiles (R. Bramblett, pers. comm.) and it is likely they take advantage of this flow heterogeneity by selecting passage pathways with the most favorable velocities and turbulence. As previously noted, White and Mefford (2002) reported adult pallid sturgeon in flume studies using cobble substrates with boulder weirs with flow velocities of 4 ft/s appeared to consistently search for and follow the same pathway and hydraulic conditions. Selection of passage pathways with favorable hydraulic conditions would allow sturgeon to conserve energy and to pass through rapids at higher discharges (higher average velocities) compared to a more random passage pathway.

Acoustic doppler current profiler (ADCP) surveys conducted by the Army Corps of Engineers (USACE) provide a means of mapping potential fish passage pathways through Wolf and Matthews rapids. These surveys collected a series of velocity measurements at closely spaced cross-section segments through each rapid. By drawing a line to connect the minimum velocity segment within each cross-section, a potential fish passage pathway may be prescribed. Figure 5-32 shows the location of the ADCP velocity measurement points and the probable minimum velocity passage pathways for each rapid. Table 5-6 and Table 5-7 provide the minimum, maximum, and average measured velocity and the flow depth at each ADCP cross-section through Wolf and Matthews rapids.

All but one of the potential flow path velocities in the ADCP study are higher than the 4.0 ft/s maximum flow velocity recommended by White and Mefford (2002). However, as previously noted, shovelnose sturgeon have been documented to move for sustained periods of time at rates of 6.2 ft/s. All of the potential flow path velocities measured by ADCP are below this value (Table 5-6 and Table 5-7), suggesting that at high discharges (45,000 for Wolf and 36,500 for Matthews rapid); sturgeon may still be able to find and use pathways through cross-section segment exhibiting lower velocities within their swimming capability.

Table 5-6
Water Velocities and Depths for Potential Fish Passage Pathways at Wolf Rapid
Minimum velocities were used to simulate potential fish passage pathways through the rapid.

Wolf Rapid
Discharge: 45,000 cfs

Station (ft)	Flow Path Velocity (ft/s)	Depth (ft)	Max. Velocity (ft/s)	Depth (ft)	Average Velocity (ft/s)	Location Relative to DOWL HKM Cross-section
0	4.72	15.44	7.92	11.76	6.00	Downstream of XS 4
196	5.84	11.84	8.03	10.16	5.90	Downstream of XS 4
418	5.69	11.79	7.77	10.28	5.77	Downstream of XS 4
628	4.23	17.28	7.96	10.15	6.25	Downstream of XS 4
814	5.82	8.89	7.61	10.73	5.44	Downstream of XS 4
926	4.58	9.66				XS 4
1082	5.09	11.07	7.89	10.20	5.92	XS 3
1261	4.98	11.07	8.95	4.94	5.73	Between XS 3 and 2
1445	5.98	9.15	7.99	8.03	6.46	Downstream of XS 2
1556	5.29	9.35				XS 2
1717	5.65	9.79	8.59	10.95	6.40	Between XS 2 and 1
1933	5.01	8.32	7.70	11.78	6.11	XS 1
2176	5.12	8.00	7.83	13.58	5.54	Upstream of XS 1
2420	5.26	7.86	7.48	10.28	5.82	Upstream of XS 1
2683	5.17	7.91	7.58	10.28	6.04	Upstream of XS 1
2850	5.26	8.01	7.46	8.95	5.60	Upstream of XS 1
3128	5.27	9.18	7.59	10.65	5.49	Upstream of XS 1

Table 5-7
Water Velocities and Depths for Potential Fish Passage Pathways at Matthews Rapid
Minimum velocities were used to simulate potential fish passage pathways through the rapid.

Matthews Rapid

Discharge: 36,500 cfs

Station (ft)	Flow Path Velocity (ft/s)	Depth (ft)	Max. Velocity (ft/s)	Depth (ft)	Avg. Velocity (ft/s)	Location Relative to DOWL HKM Cross-section
Right Passage Pathway						
0	4.50	9.84	7.92	9.84	5.59	Downstream of XS 5
240	3.69	14.17	8.34	13.64	5.75	Downstream of XS 5
447	5.08	14.61	7.91	7.18	5.76	Downstream of XS 5
656	5.09	11.33	7.44	9.88	5.70	XS 5
863	5.49	9.06	8.22	8.56	5.67	XS 4
996	5.29	7.93	-	-	-	Between XS 4 and 3
1094	5.68	7.89	7.93	7.43	5.93	Between XS 4 and 3
1313	5.43	9.51	7.50	7.33	5.27	XS 3
1522	4.64	8.98	8.64	9.31	6.36	Downstream of XS 2
1724	4.44	7.11	8.41	7.61	6.25	Upstream of XS 2
1929	4.77	6.23	8.08	8.16	5.95	XS 1
2163	4.67	6.09	8.06	7.32	6.01	Upstream of XS 1
2357	5.10	5.62	7.49	8.56	6.01	Upstream of XS 1
Left Passage Pathway						
0	5.01	11.35	7.92	9.84	5.59	Downstream of XS 5
178	5.34	12.93	8.34	13.64	5.75	Downstream of XS 5
394	5.51	13.1	7.91	7.18	5.76	Downstream of XS 5
599	5.39	12.29	7.44	9.88	5.70	XS 5
800	4.04	11.82	8.22	8.56	5.67	XS 4
1021	4.98	9.47	7.93	7.43	5.93	Between XS 4 and 3
1211	4.08	10.33	7.50	7.33	5.27	XS 3
1423	4.25	6.49	8.64	9.31	6.36	Downstream of XS 2
1624	3.89	7.24	8.41	7.61	6.25	Upstream of XS 2

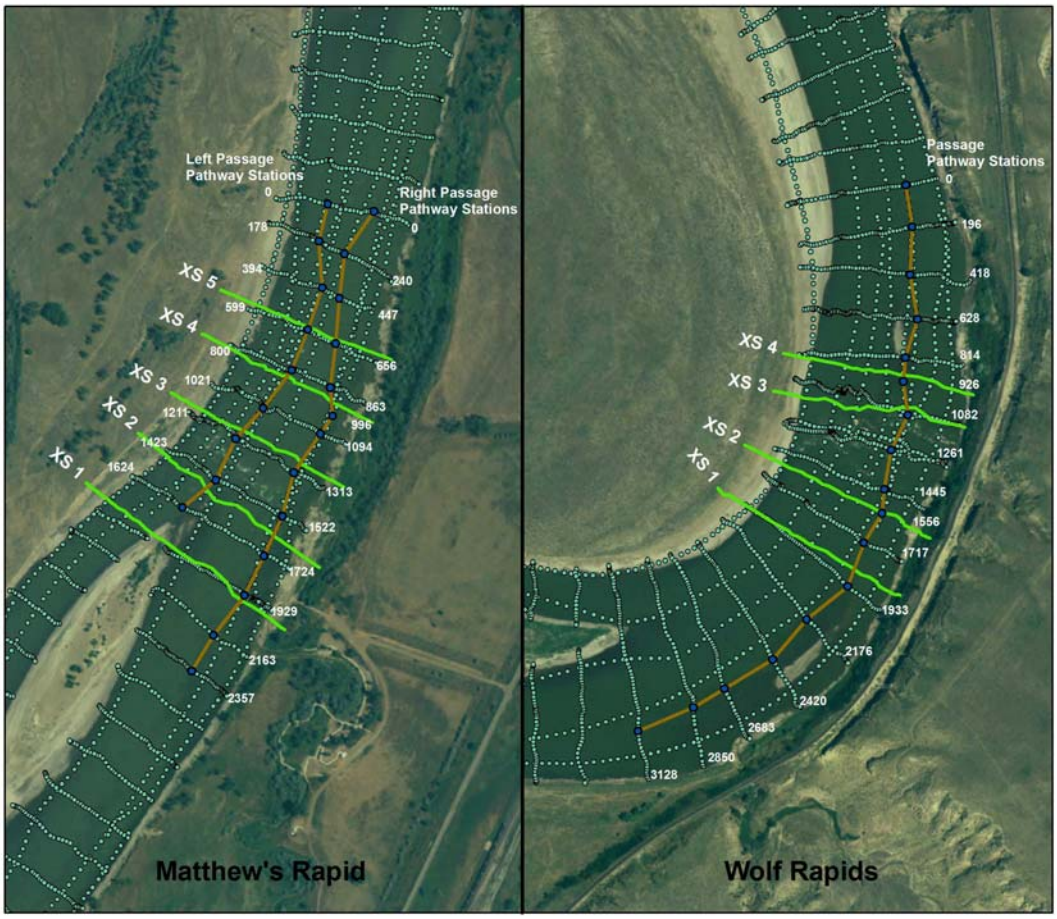


Figure 5-32 ADCP velocity measurement points (light green points) and potential fish passage pathways (brown lines) through Matthews Rapid and Wolf Rapids.

5.4.5.5 Slope and Slope Length

The reference riffles (Matthews Rapid and Wolf Rapid) are characterized by surveyed stream bed slopes ranging between 0.12% and 0.53%. For Matthews Rapid, the slope was divided into two sections: 0.12% for approximately 1445 ft and 0.52% for approximately 1395 ft (see Figure 5-27). For Wolf Rapid, the slope was divided into three sections: 0.21% for approximately 1482 ft, 0.53% for approximately 355 ft, and 0.14% for approximately 1710 ft (see Figure 5-28). These data demonstrate that shovelnose sturgeon are capable of passing bed slopes of 0.53% that are sustained over distances as high as 1,482 feet if channel.

5.4.6 Fish Passage Design Criteria

The preceding data and analyses are summarized here to create a suite of design criteria for sturgeon passage at Cartersville Dam. These criteria are based primarily on surveys and analyses of Wolf and Matthews Rapid on the Yellowstone River, but also incorporate data from published and unpublished literature. When applied to the design of a rock ramp fish passage structure, these criteria will help to

ensure the design replicates the conditions found in two rapids that shovelnose sturgeon have been documented to pass.

5.4.6.1 Mean Velocity

Mean cross-section velocity at Matthews Rapid was as high as 6.0 ft/s during discharges when sturgeon were known to pass (Table 5-7). Mean velocity of the proposed rock ramp should, therefore, not exceed 6.0 ft/s. Note, however, that fish are likely to pass at higher flows and velocities.

5.4.6.2 Roughness

The reference rapids had highly variable bed substrates that resulted in high roughness values. The proposed rock ramp surface should include a complex mosaic of large boulders, cobble, and gravel arranged to create roughness values greater than 0.07. The average roughness values for Matthews Rapid and Wolf Rapid were 0.054 and 0.070, respectively (Table 5-5). The mosaic of sandstone boulders measured at Matthews Rapid, which reach several feet in diameter, can be used to help define appropriate gradations and boulder shapes. The maximum side length of these boulders (c-axis) ranged from approximately 2 feet to 12 feet. In a 2576 square foot area, a total of 33 boulders had a C-axis length in excess of 4 feet.

5.4.6.3 Variability / Pathways

The arrangement of bed materials in the proposed rock ramp should create variable velocity pathways that fish may use to navigate through rapids at high flows. Wolf Rapid includes intact bedrock sills that would be difficult to construct and maintain. Consequently, we recommend using the size and distribution of bed materials in Matthews Rapid to design the rock ramp at Cartersville Dam.

5.4.6.4 Maximum Bed Slope

The steepest sections of Matthews and Wolf rapids have bed slopes of approximately 0.5%. This includes the lower section of Matthews Rapid (Figure 5-27) and the middle section of Wolf Rapid (Figure 5-28). Therefore, we recommend the slope of a rock ramp at Cartersville be < 0.5%.

5.4.6.5 Length of Maximum Slope

Maximum slopes at Matthews Rapid were sustained for distances of up to 1,482 feet. It is not known whether sturgeon can pass steeper or longer rapids, so the maximum length of 0.5% slope should not exceed 1,400 feet.

5.4.6.6 Design Criteria

The design criteria based on analysis of Matthews Rapid and Wolf Rapid are provided in Table 5-8.

Table 5-8
Rock Ramp Design Criteria

Criterion	Value
Maximum Slope	< 0.5%
Maximum Slope Length	< 1,400 ft
Mean Velocity	< 6 ft/s
Roughness	> 0.07

5.4.7 Biological Review Team Scoring Criteria

In 2006, the US Fish and Wildlife Service assembled a Biological Review Team (BRT) of pallid sturgeon experts to review preliminary fish passage design options for the Intake Dam (Jordan 2006). The BRT developed a series of scoring criteria to evaluate the relative merits of various pallid sturgeon passage design alternatives under consideration for the irrigation dam at Intake, Montana. While these criteria may not be directly applicable to passage of shovelnose sturgeon at Cartersville Dam, they are instructive as the more common shovelnose sturgeon are sometimes used as surrogates for understanding rare pallid sturgeon (Bramblett and White 2001; Adams et al. 2003). The scoring criteria included the following parameters:

1. Percentage of time the alternative provides flow velocities that are passable for juvenile and adult pallid sturgeon.
2. Percentage of the structure's surface area that meets the velocity criteria for passage of juvenile and adult pallid sturgeon.
3. Depth of structure meeting minimum depth requirements as well as velocity specifications (≤1-2 ft/s for juvenile and ≤4 ft/s for adults).
4. Presence of vertical sills greater than 0.3m either designed or likely to occur within alternative.
5. Ability to tune or modify structure to improve passage if needed.
6. Degree of uncertainty associated with the alternative.

For conceptual design of a fish passage solution for Cartersville Dam, a geomorphic/hydraulic design approach has been adopted that emulates as closely as possible the hydraulic conditions within natural rapids sturgeon routinely pass. These hydraulic conditions are determined by discharge, slope, depth, velocity, roughness, and the distribution of bed materials within the channel. To guide the design of a fish passage structure at Cartersville, we have developed a series of design criteria (Table 5-8) that capture many of the important hydraulic characteristics of natural rapids in the Yellowstone River. For clarity, we use the term "design criteria" to refer to the criteria developed from natural riffles, and the term "scoring criteria" to refer to the criteria developed by the BRT.

The following is a discussion of the BRT scoring criteria and how they compare to the geomorphic/hydraulic design criteria developed during this study.

Criterion 1 – Percentage of time the alternative provides flow velocities that are passable for juvenile and adult pallid sturgeon. This criterion is to be scored as follows:

Juveniles (Alternative provides ≤1-2 ft/sec velocities during April – September)

% of period criteria are met	Score
100	100
75	75
50	50
25	25
0	0

Adults (Alternative provides ≤4 ft/sec velocities during April – June)

% of period criteria are met	Score
100	100
99-75	50
<75	0

Discussion – It is assumed the BRT's velocity scoring criteria (≤1-2 ft/sec for juvenile sturgeon and < 4 ft/s for adult sturgeon) refer to average flow velocity through the water column in keeping with the results reported by White and Mefford (2002). In contrast, the proposed rock ramp design criterion of <6.0 ft/s for Cartersville refers to average velocity across the entire river cross-section. Please note these criteria (both design and scoring) may be difficult to evaluate in a meaningful way as velocity near the bed may be the most critical measure for sturgeon passage, and average water column or cross-section velocity does not indicate near-bed velocity conditions. Nevertheless, we are confident the < 6.0 ft/s design criterion is reasonable based on field measurements, which are typically more reliable than laboratory studies.

Criterion 2 – Percentage the structure's surface area that meets the velocity scoring criteria for passage of juvenile and adult pallid sturgeon. This criterion is to be scored as follows:

Juveniles (Alternative provides ≤1-2 ft/sec velocities during April – September)

% of structure meeting criteria	Score
≥ 30	100
30-20	50
< 20	0

Adults (Alternative provides ≤4 ft/sec velocities during April – June)

% of structure meeting criteria	Score
≥ 50	100
< 50	0

Discussion – This scoring criterion is intended to ensure that a relatively large percentage of the surface area of the proposed alternative meets the velocities presented in scoring criterion 1. However, it is uncertain what percentage of the surface area of Matthews and Wolf Rapids actually meets the scoring criterion of ≤1-2 ft/sec for juvenile sturgeon and ≤4 ft/s for adult sturgeon, especially at higher flows when sturgeon often move upstream. It is important to note that if less than 50% of Matthews or Wolf Rapids meets the ≤4 ft/s scoring criterion at any time during April to June, then these natural riffles would receive a score of zero for adult sturgeon passage even though they are known to pass adult fish at relatively high discharges within this time period. Consequently, this scoring criterion may be unreasonably conservative. A comparable design criterion was not developed for Cartersville Dam. Further evaluation of this scoring criterion is recommended based on 2-dimensional modeling of Matthews and Wolf Rapids at a range of flows to determine the percentage of the surface area of these natural rapids that have flow velocities meeting scoring criteria 1.

Criterion 3 – Depth of structure meeting minimum depth requirements as well as velocity specifications (≤1-2 ft/sec for juvenile and ≤4 ft/sec for adults). This criterion is to be scored as follows:

Juveniles (Alternative provides ≤1-2 ft/sec velocities at the specified depths)

Depth	Score
> 1 m	100
.99-0.5 m	50
< 0.5 m	0

Adults (Alternative provides ≤4 ft/sec velocities at the specified depths)

Depth	Score
> 1 m	100
.99-0.5 m	50
< 0.5 m	0

Discussion – It is assumed this scoring criterion is intended to ensure that a passage alternative has depths > 1 m while also meeting the preceding scoring criteria 1 and 2. To receive a score of 100 for adult sturgeon, this would mean >50% of the structure (scoring criterion 2) would have depths >1 m (scoring criterion 3) and velocities ≤4 ft/s from April through September (scoring criterion 1).

In the natural rapids surveyed on the Yellowstone River in September 2009, all cross-sections had some areas with depths exceeding 1 m. We have elected to use the higher gradient cross-sections 2, 3, and 4 at Matthews Rapid and cross-sections 2 and 4 at Wolf Rapid for the design of a rock ramp at Cartersville (Table 5-9). When considering depths averaged across the entire cross-section, only 1 of three cross-sections at Matthews Rapid exceeded an average depth of 1 m, while both of the cross-sections selected at Wolf Rapid had average depths >1 m. Moreover, the percentage of survey points that exceeded 1 m in depth was <50% for 2 of 3 cross-sections at Matthews Rapid and for 1 of 2 cross-sections at Wolf Rapid. This would suggest that the natural riffles used to develop design criteria for Cartersville Dam would receive low scores under the BRT's recommended depth scoring criteria. Consequently, the BRT's scoring criteria may be conservative with respect to replicating hydraulic conditions in natural rapids in the Yellowstone River.

Table 5-9
Average Depths and Percentage of All Depths Exceeding 1 m for Cross-Sections Surveyed at Matthews and Wolf Rapids on the Yellowstone River in September 2009

Matthews Rapid				Wolf Rapid			
XS	Avg. Depth (m)	Avg. Depth (ft)	% Depth >1m	XS	Avg. Depth (m)	Avg. Depth (ft)	% Depth >1m
2	**2.64**	**0.80**	**33%**	2	**3.68**	**1.12**	**52%**
3	**2.87**	**0.88**	**35%**	3	**3.34**	**1.02**	**42%**
4	**3.55**	**1.08**	**55%**				

Criterion 4 – Presence of vertical sills greater than 0.3m either designed or likely to occur within alternative. This criterion is to be scored as follows:

Vertical sill > 0.3 m	Score
No	100
Yes	0

Discussion – It is proposed to model the size and distribution of bed materials for the Cartersville rock ramp after Matthews Rapid, which contains large sandstone boulders and bedrock fragments, but no discernable rock sills. Consequently, the design for Cartersville Dam should meet this criterion. It is instructive to note, however, that Wolf Rapid contains numerous, extensive rock sills greater than 0.3 m high, yet this rapid is readily passable to shovelnose sturgeon.

Criterion 5 – Ability to tune or modify structure to improve passage if needed. This criterion is to be scored as follows:

Ability to Modify Structure	Score
Easy to modify structure	100
Moderately difficult to modify	75
Very difficult to modify	50

Discussion – Following our adaptive management philosophy, it is agreed any designs should provide the ability to tune or modify the structure to improve passage.

Criterion 6 – Degree of uncertainty associated with the alternative. This criterion is to be scored as follows:

Level of uncertainty	Score
Low	100
Med	50
High	0

Discussion – The empirical, geomorphic approach to designing fish passage at Cartersville Dam is founded upon replicating natural conditions that shovelnose sturgeon have been documented to successfully pass. As a result, the passage design criteria for Cartersville Dam have a very low level of uncertainty compared to alternative design criteria based solely on theoretical, or purely modeled criteria.

5.4.8 Plans

Based on results of the February 2009 study and subsequent meetings two alternative plans were selected for further evaluation:

- Alternative 1: Rock ramp
- Alternative 2: Inflatable bladder

5.4.8.1 Alternative 1: Rock Ramp

5.4.8.1.1 Introduction

The rock ramp alternative consists primarily of a rock ramp in the north channel of the Yellowstone River below the diversion dam, a berm from the south abutment of the diversion dam to the south edge of the north channel (north side of island) to control the split of river flows to the north and south channel, and bank protection/apron downstream of the rock ramp.

The rock ramp will be constructed of a four-foot thick layer of 1-4 foot riprap. The rock ramp begins at the crest elevation of the existing dam and terminates downstream where the top of the rock ramp intersect the existing river bed. Natural channel material will be excavated to a depth of four feet where necessary to install the riprap to the estimated depth of scour. The excavated bed material will be used to fill the scour hole at the toe of the existing dam, with any remaining material used to fill voids within the riprap rock ramp. At the downstream terminus of the rock ramp, a four-foot apron of riprap will be placed from bank to bank and will extend a distance of one-half the channel width downstream of the toe of the rock ramp to prevent erosion. The channel bottom will be excavated four feet to place the riprap, whereas on the banks, the riprap will be placed over the existing surface.

The south channel will be left intact based on the desires of the Cartersville Irrigation District and the community.

Criteria for development of the rock ramp alternative include design criteria developed in this study, input from the Cartersville Irrigation District and local community, and other rock ramp projects under design or already constructed.

5.4.8.1.2 Hydraulic Modeling

The rock ramp alternative is evaluated for three options each utilizing a different bed slope configuration.

5.4.8.1.2.1 Option 1: Slope 0.5% / 0.2% / 0.5%

The design criteria call for a maximum slope of 0.5% no longer than 1400 feet. This option utilizes a slope of 0.5% for 600 feet, a flatter slope of 0.02 for 200 feet, and another slope of 0.5% for 600 feet (Figure 5-33).

The design criteria also specify a maximum mean channel velocity of 6.0 ft/s. The proposed rock ramp was modeled with both the USACE HEC-RAS model and River FLO-2D, a two-dimensional model.

Results from HEC-RAS for a flow of 6500 cfs indicate a mean channel velocity of the rock ramp of less than 6 ft/s using a design “Manning’s n” of 0.070.

River FLO-2D was used to model three flow rates. The first is a flow of 2700 cfs which is the 99 percent exceedance flow at the USGS Forsyth gage. This means the flow at the gage equals or exceeds 2700 cfs 99 percent of the time. The second flow is 6500 cfs which was the flow at the time of the field survey. The third is a flow of 48,800 cfs which is equaled or exceeded one percent of the time.

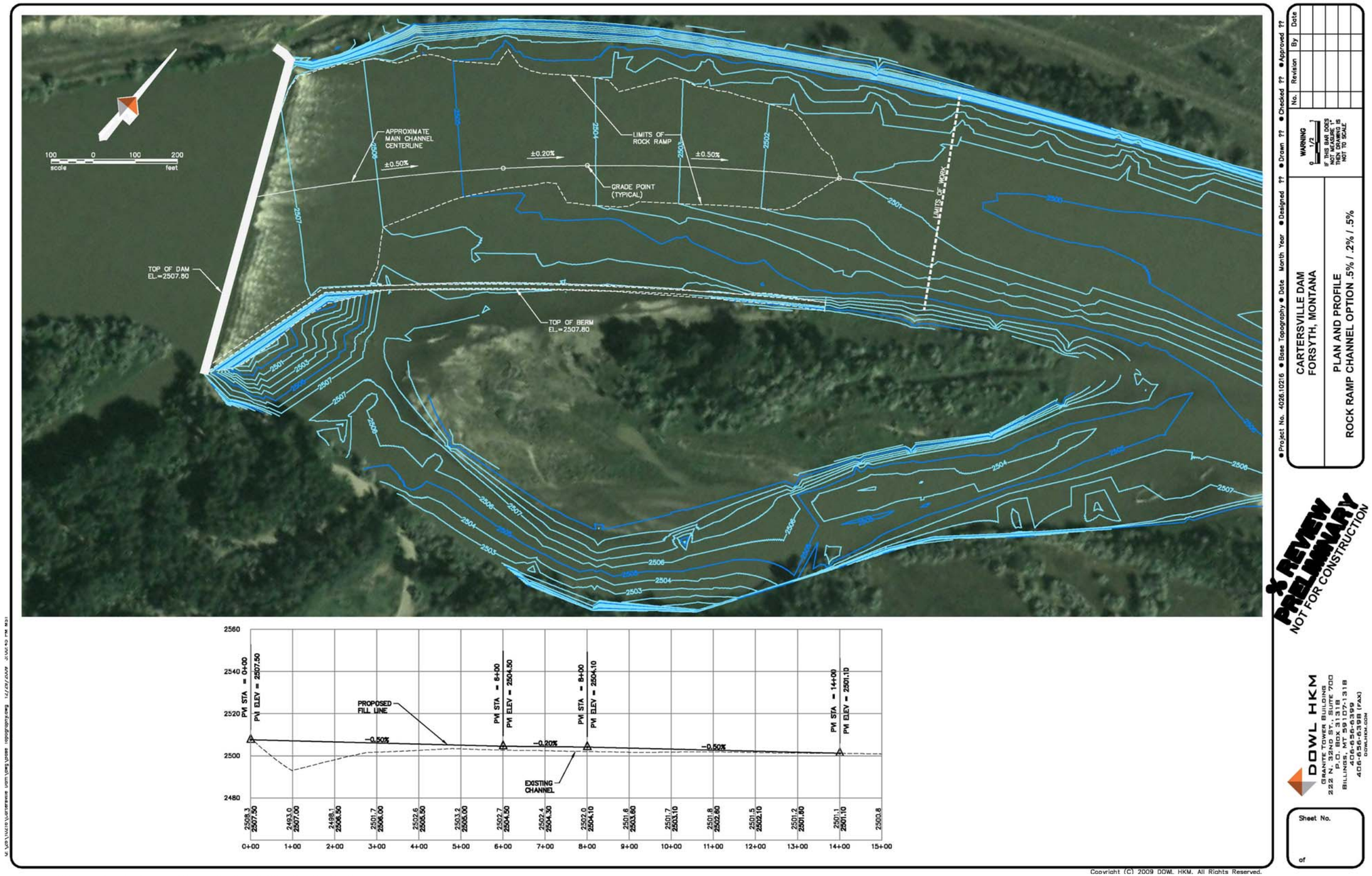


Figure 5-33 Rock Ramp, Slope 0.5% / 0.2% /0.5%, Option 1

For flows of 2700 cfs and 6500 cfs, mean water column velocities at all discrete points on the rock ramp are less than 5 ft/s (Figures 5-34, 5-35). For a flow of 48,800 cfs, the mean water column velocity on the rock ramp reaches a maximum of 6.3 ft/s (Figure 5-36). Water depths are shown on Figures 5-37, 5-38, and 5-39.

Water surface profiles for all three flows are shown on Figure 5-40. A cross section through the north and south channel is shown in Figure 5-41.

The division of flows between the north and south channels is shown in Table 5-10. Approximately 80 percent of the flow over the dam goes to the north channel under all flows. This should be adequate to maintain attraction flows that favor the north channel and the rock ramp structure while maintaining some flows in the south channel for recreational use.

Table 5-10
Rock Ramp Division of Flows

	Q = 48800	Q = 6500	Q = 2700
North Channel Totals:	38883.2	5178.1	2018.3
North Channel Percent of Total:	79.8%	80.9%	79.4%
South Channel Totals:	9872.6	1219.0	525.1
South Channel Percent of Total:	20.2%	19.1%	20.6%
Total Flow:	48755.8	6397.1	2543.4

5.4.8.1.2.2 Option 2: Slope 0.5%

This option is similar to Option 1 but utilizes a constant slope of 0.5% (Figure 5-42) by eliminating the 200-ft long section of 0.2% slope. A rock apron of ½ channel width is included. This option was also modeled and satisfies the geomorphic/hydraulic design criteria except for exceeding 6 ft/s slightly at a flow of 48,800 cfs. See Figures 5-43 through 5-50.

5.4.8.1.2.3 Option 3: Slope 0.5% / 1.27%

This option starts with a slope of 0.5% for a distance required to maintain subcritical flow over the full range of flows and then steepens at the downstream end to meet the streambed. Modeling indicated the 0.5% grade must continue for approximately 270 feet downstream from the dam to maintain subcritical flow. A slope of 1.27% was then utilized to meet a high point on the river bed downstream, thereby significantly reducing the amount of rock required (Figure 5-51). A rock apron of ½ channel width is included. This option satisfies all of the design criteria except for slope at the downstream end of the rock ramp. However, if the steeper slope section proves to be an impediment to sturgeon passage, the structure could be easily modified by adding more rock to the downstream end to emulate Option 2, which has a constant 0.5% slope. The Option 2 concept is also being considered by the USACE for Intake Dam.

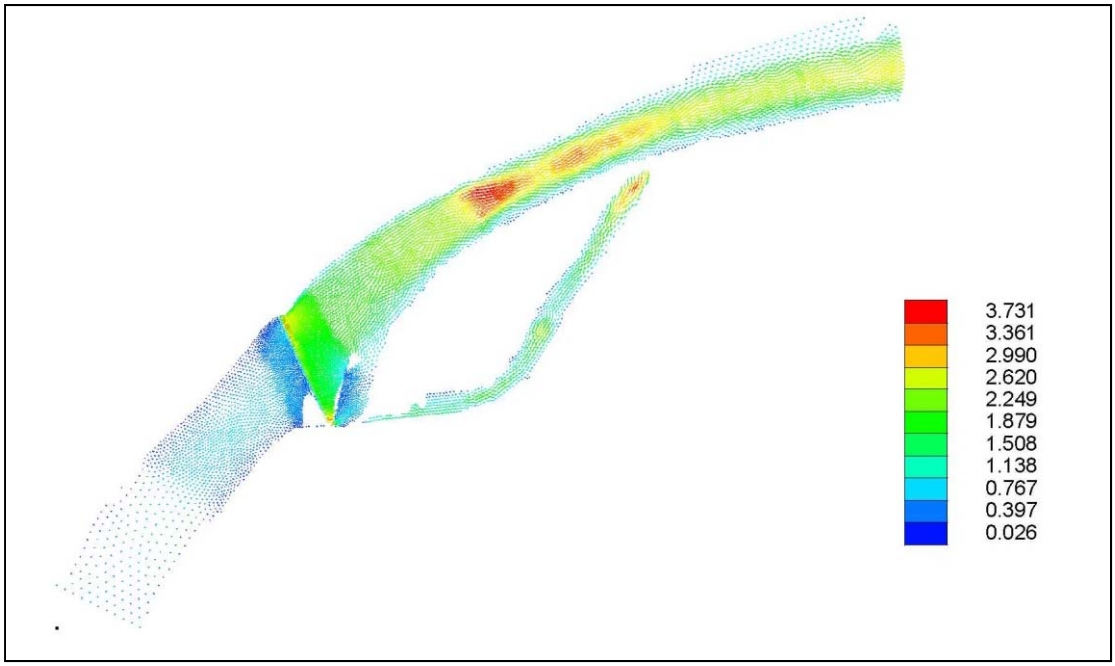


Figure 5-34 Mean Column Velocities (ft/s), Q = 2700 cfs, Option 1

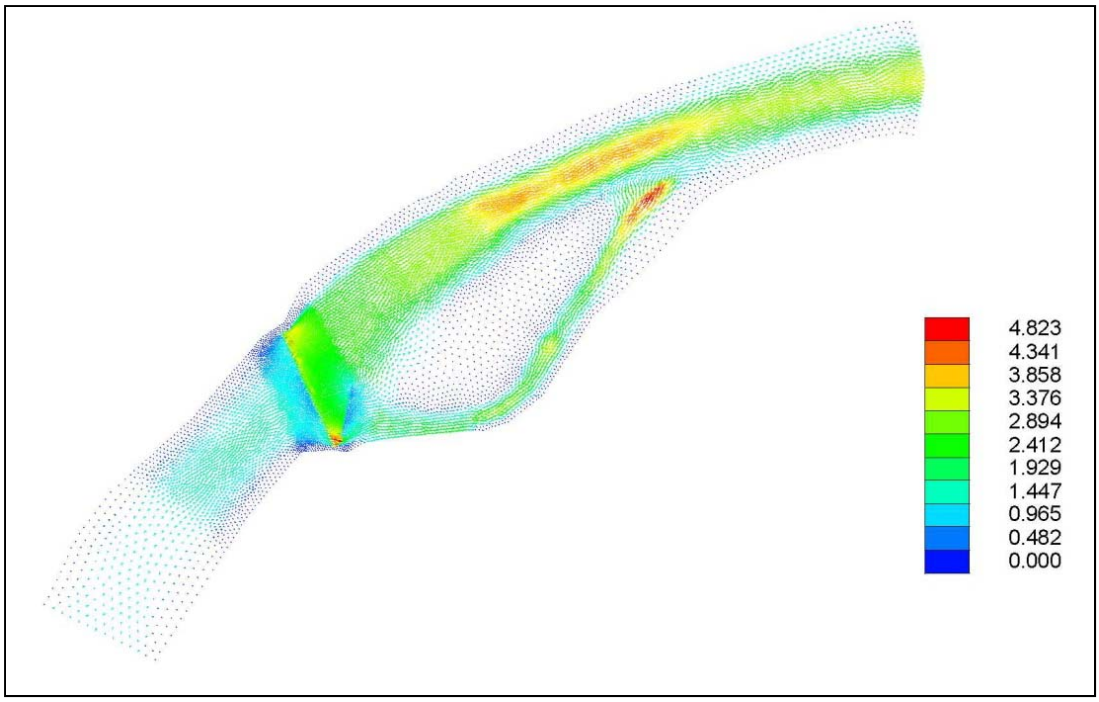


Figure 5-35 Mean Column Velocities (ft/s), Q = 6500 cfs, Option 1

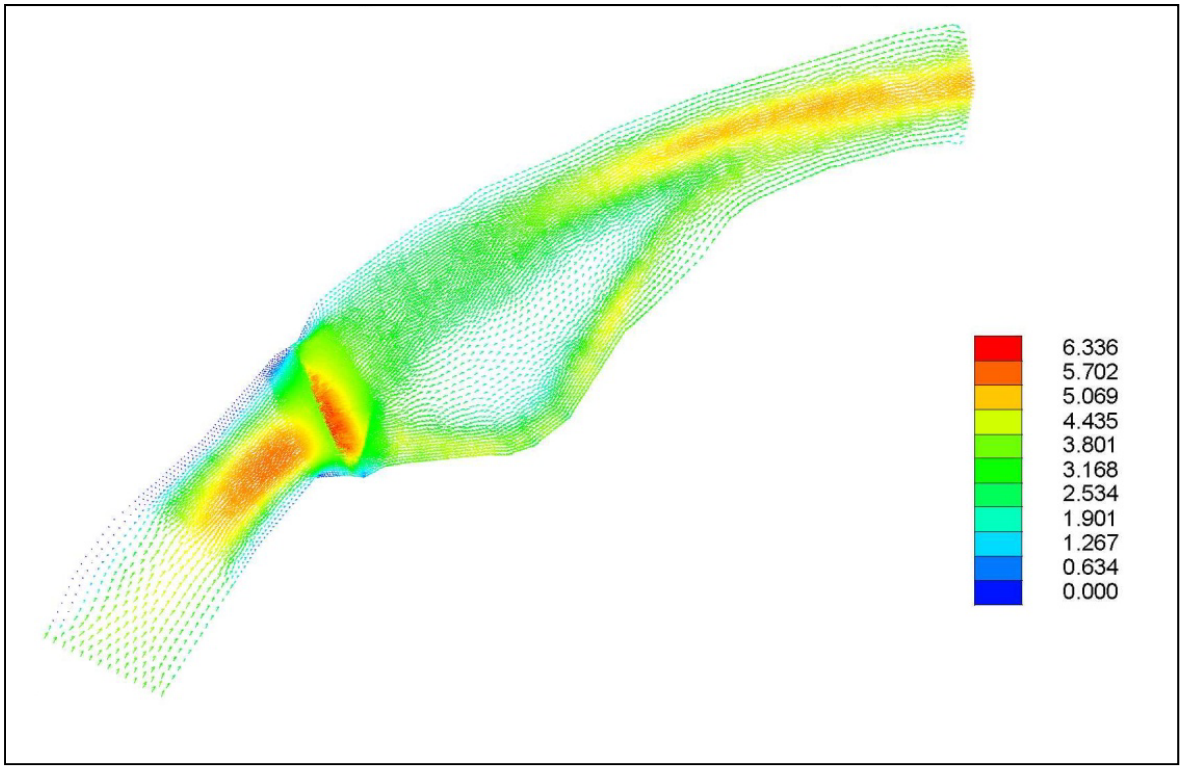


Figure 5-36 Mean Column Velocities (ft/s), Q = 48,800 cfs, Option 1

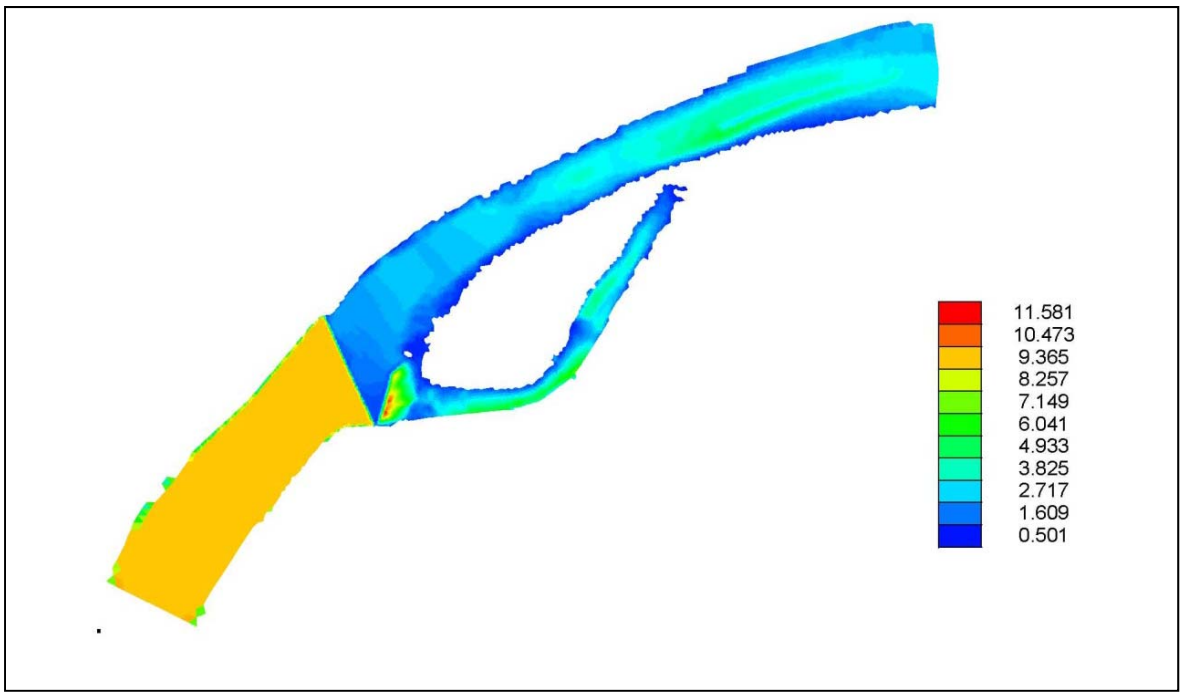


Figure 5-37 Water Depth (ft), Q = 2700 cfs, Option 1

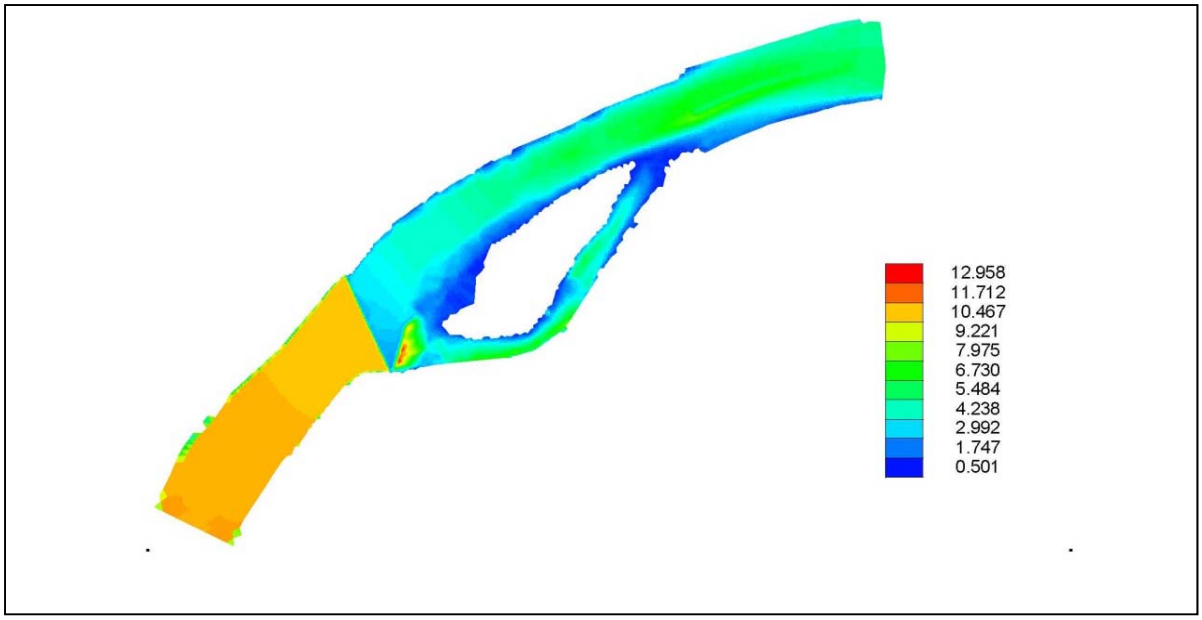


Figure 5-38 Water Depth (ft), Q = 6500 cfs, Option 1

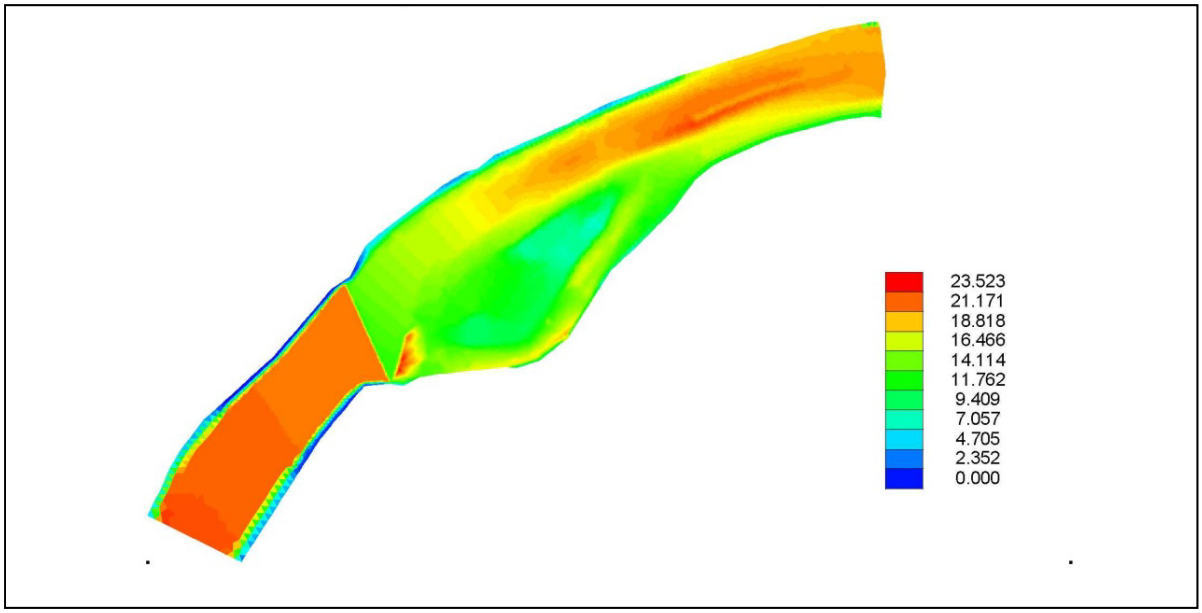


Figure 5-39 Water Depth (ft), Q = 48,800 cfs, Option 1

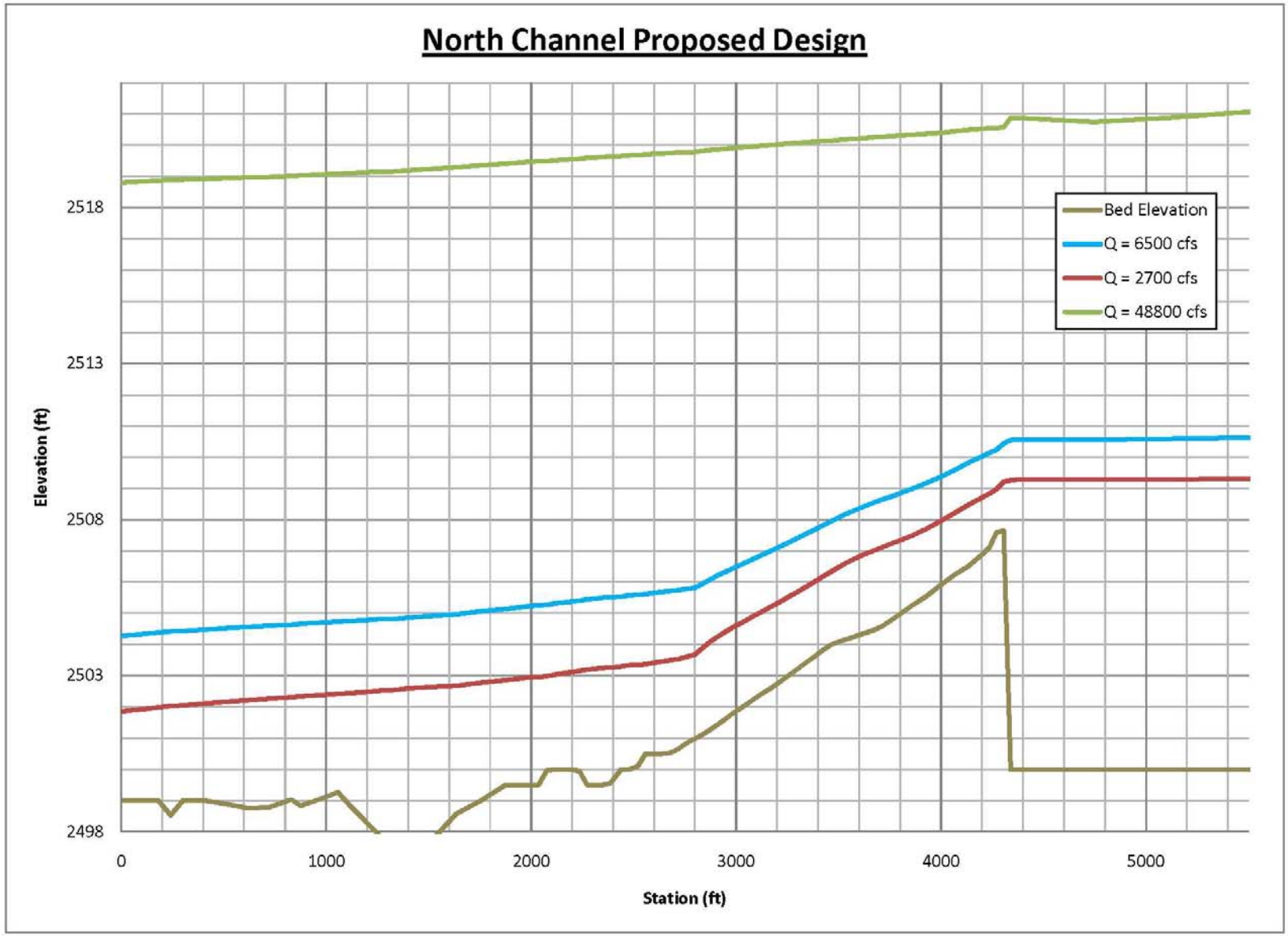


Figure 5-40 North Channel Proposed Design, Option 1

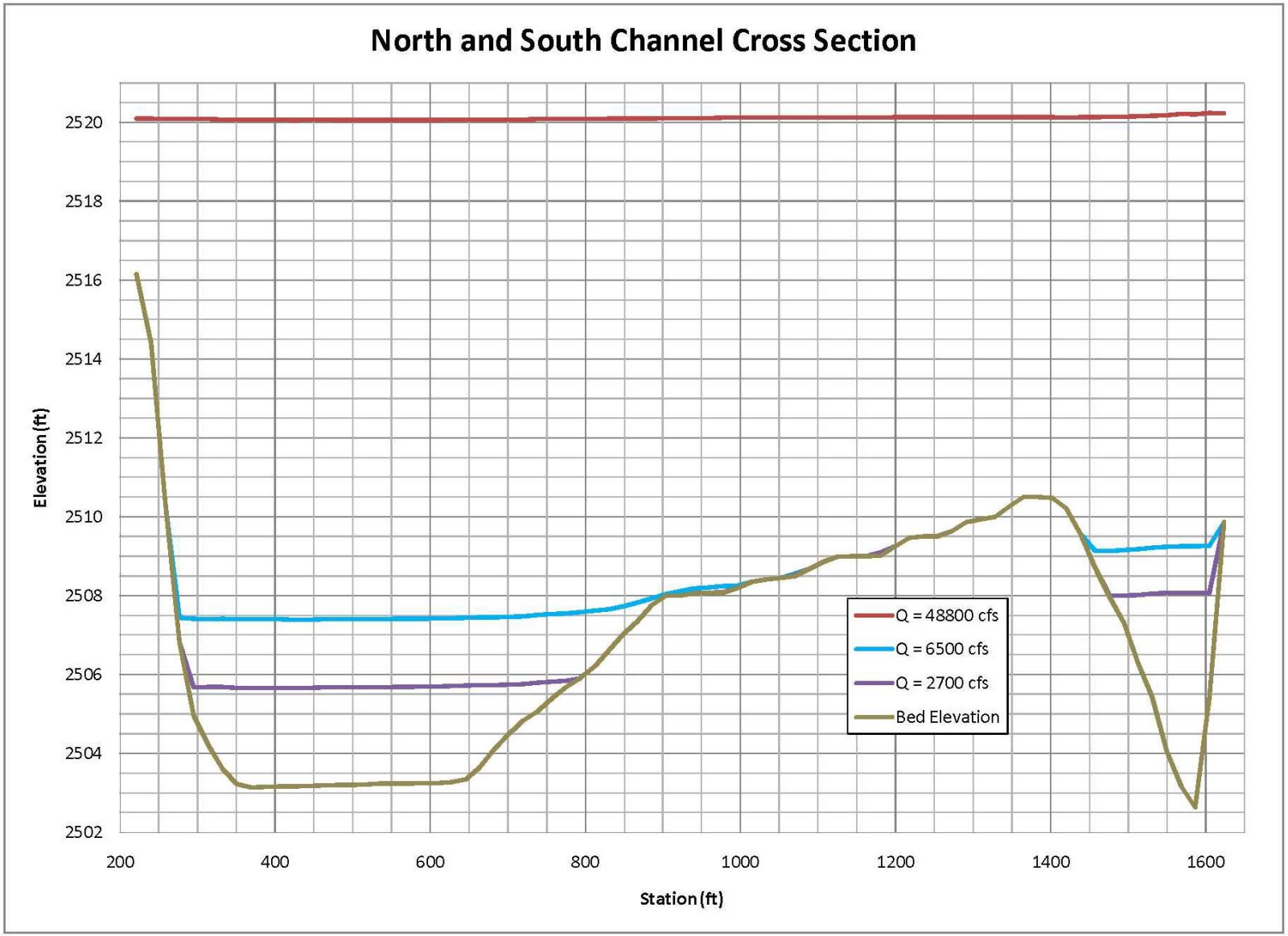


Figure 5-41 North and South Channel Cross Section, Option 1

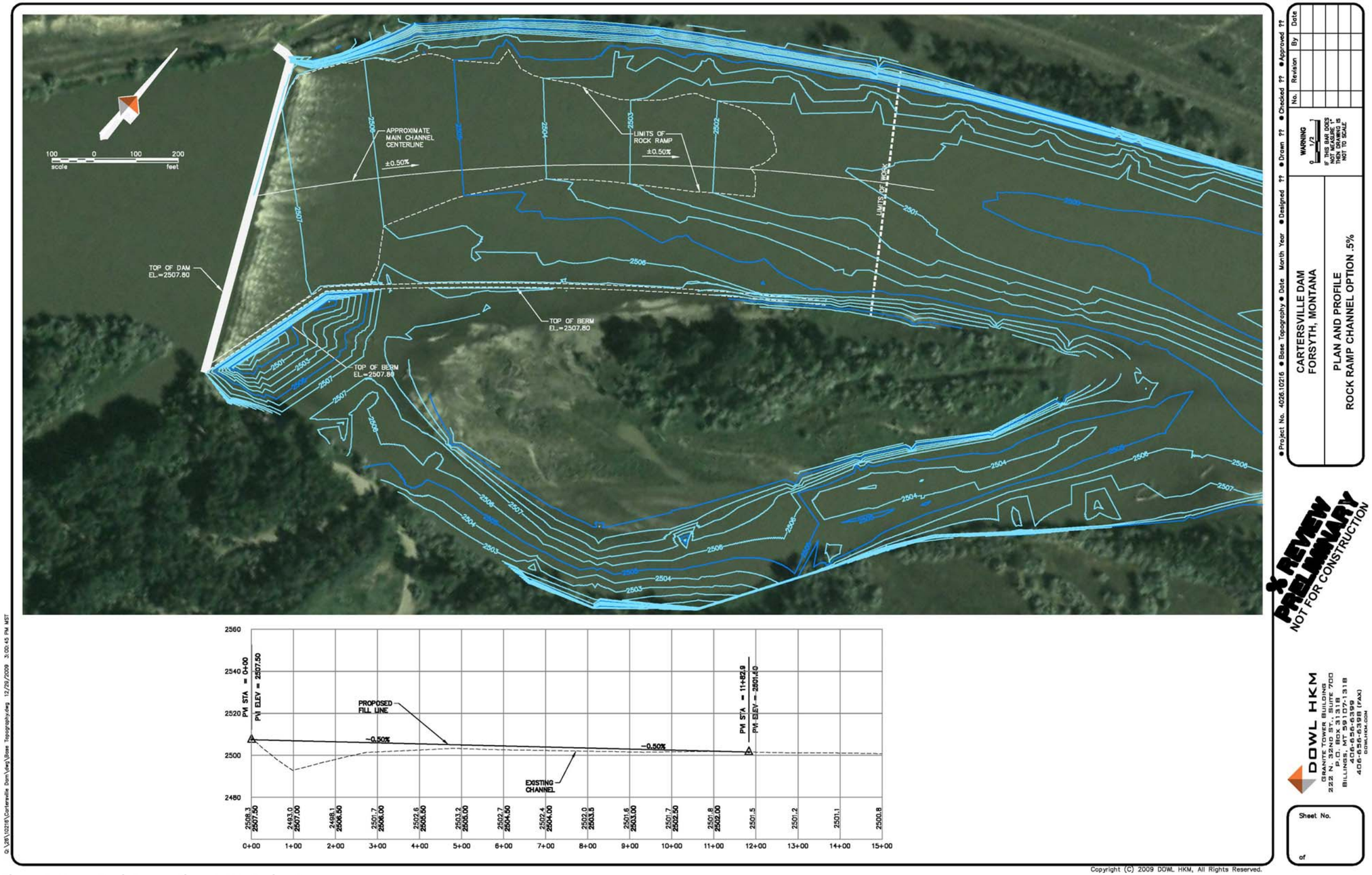


Figure 5-42 Rock Ramp, Slope 0.5%, Option 2

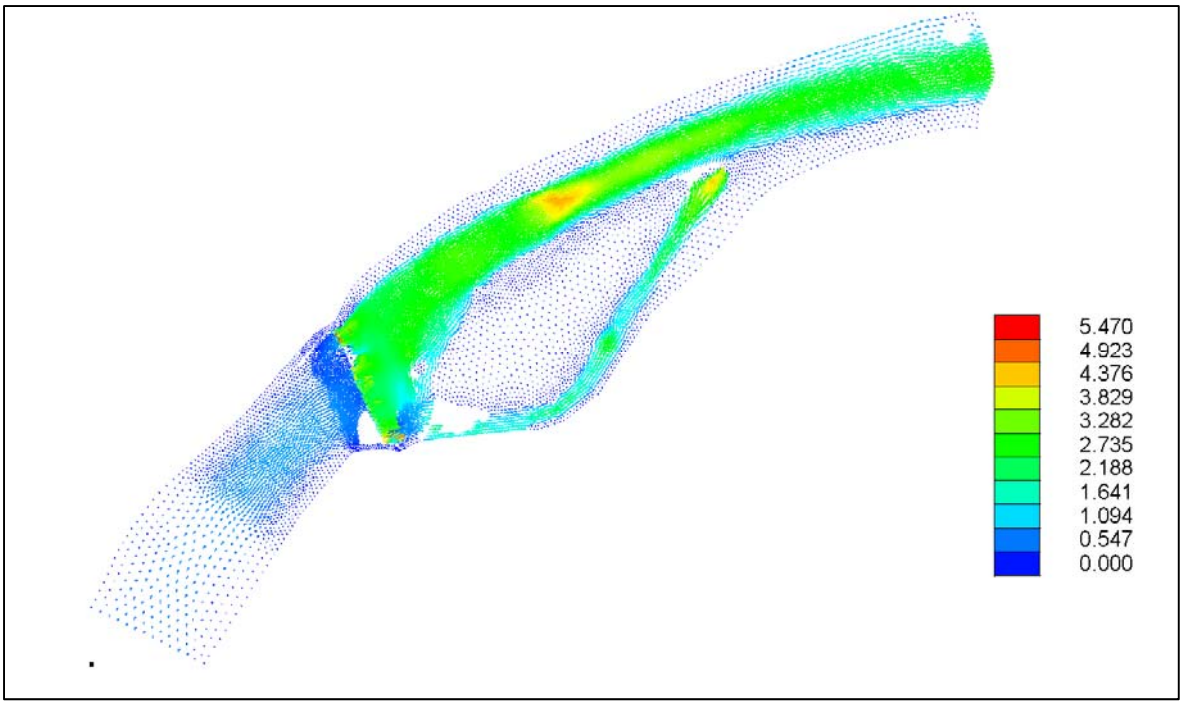


Figure 5-43 Mean Column Velocities (ft/s), Q=2700 cfs, Option 2

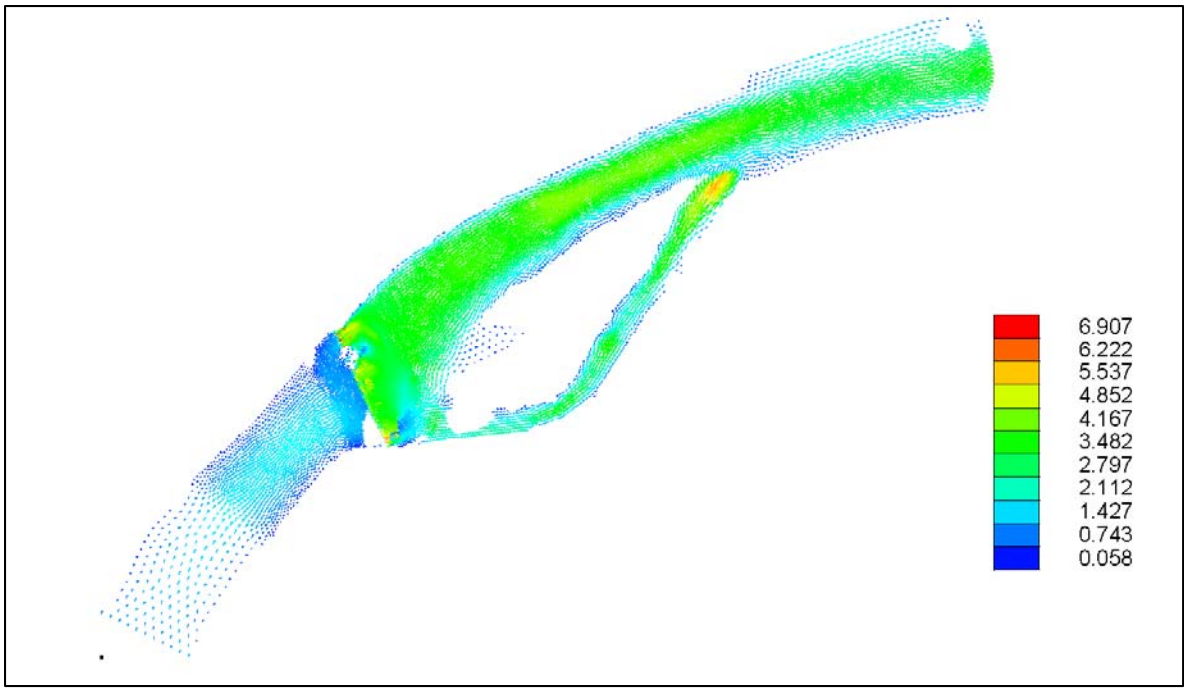


Figure 5-44 Mean Column Velocities (ft/s), Q=6500 cfs, Option 2

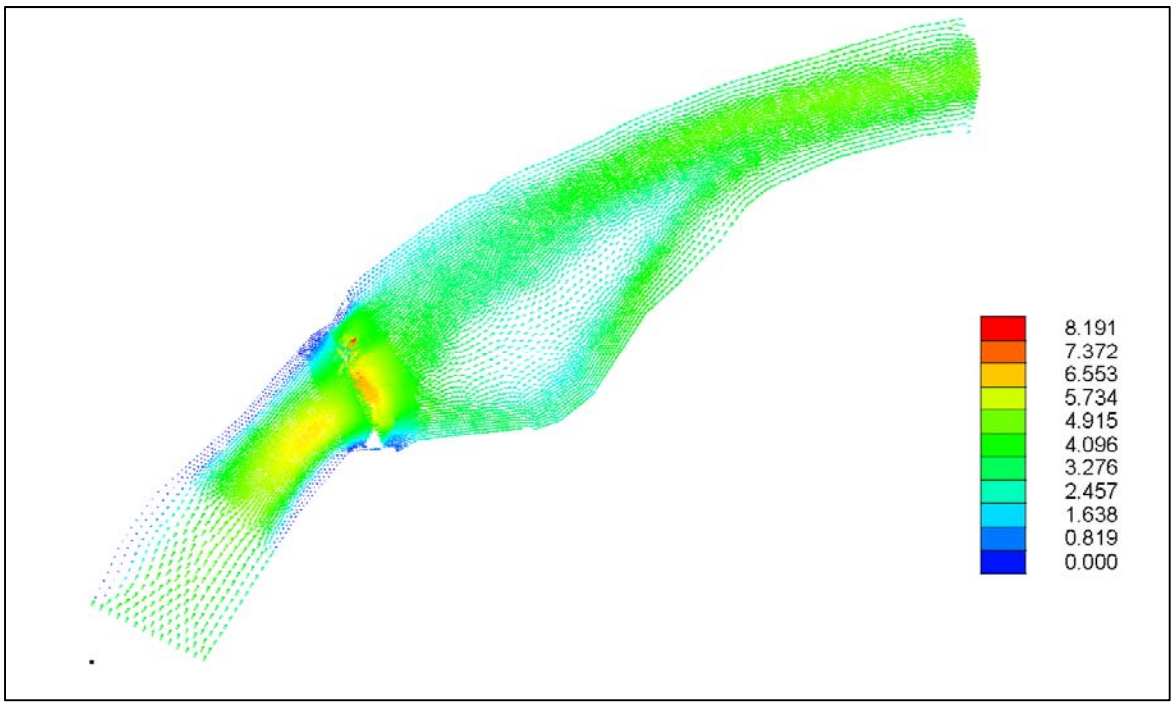


Figure 5-45 Mean Column Velocities (ft/s), Q=48,800 cfs, Option 2

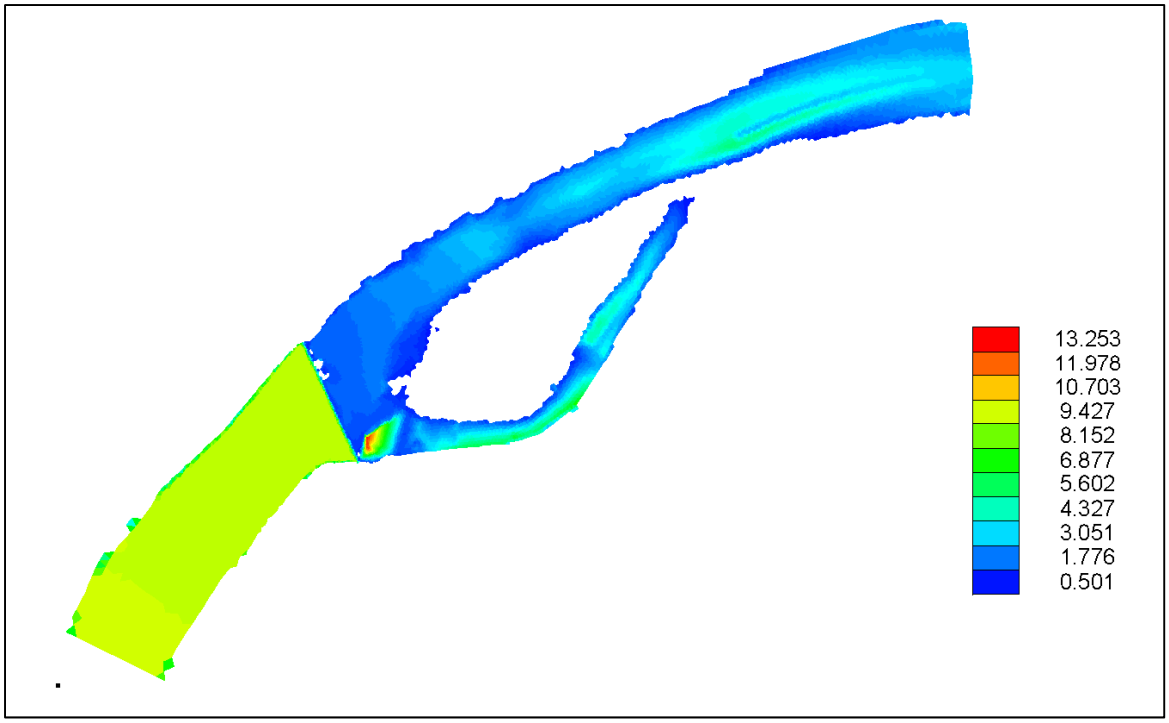


Figure 5-46 Water Depth (ft), Q=2700 cfs, Option 2

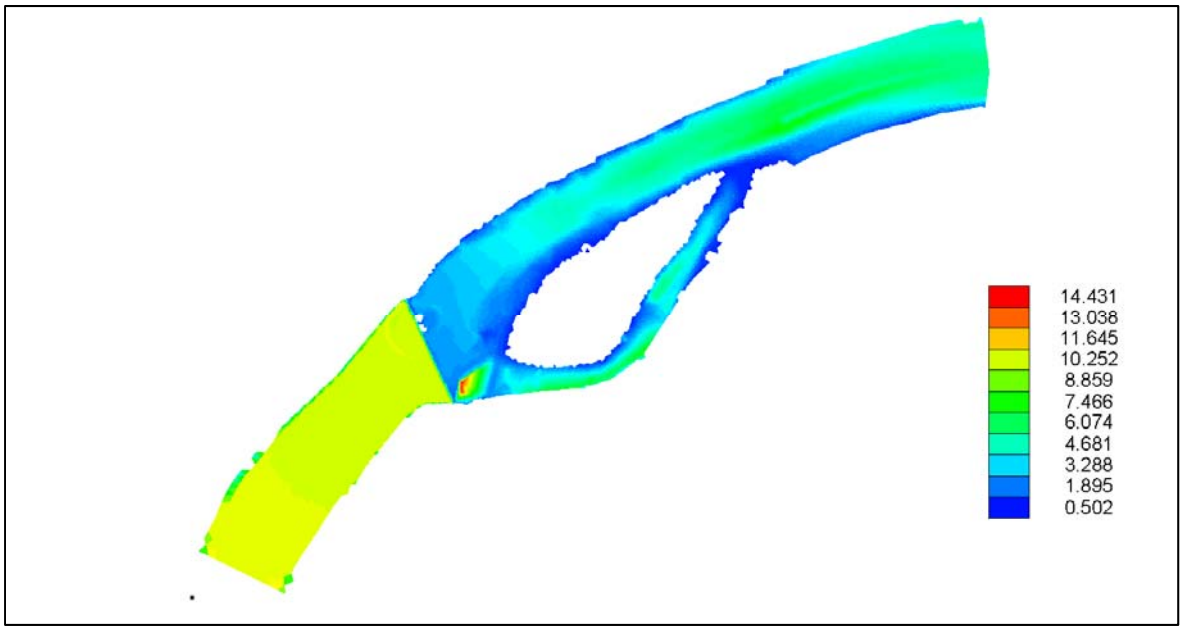


Figure 5-47 Water Depth (ft), Q=6500 cfs, Option 2

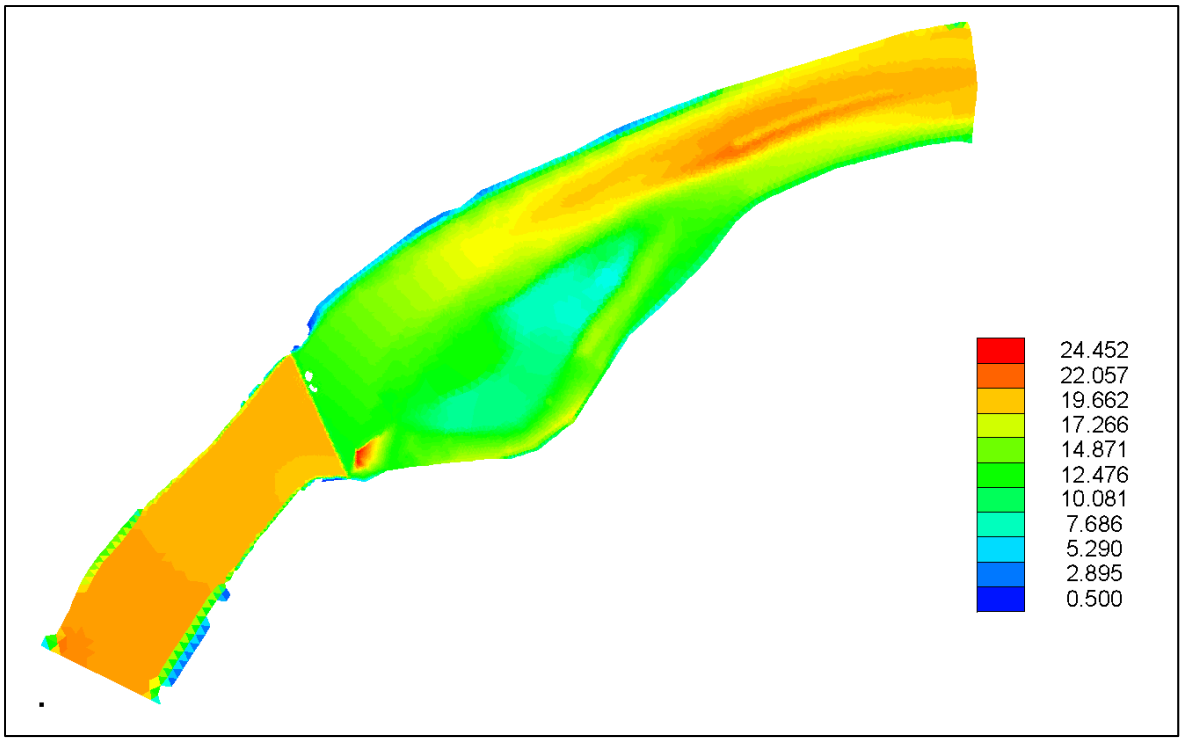


Figure 5-48 Water Depth (ft), Q=48,800 cfs, Option 2

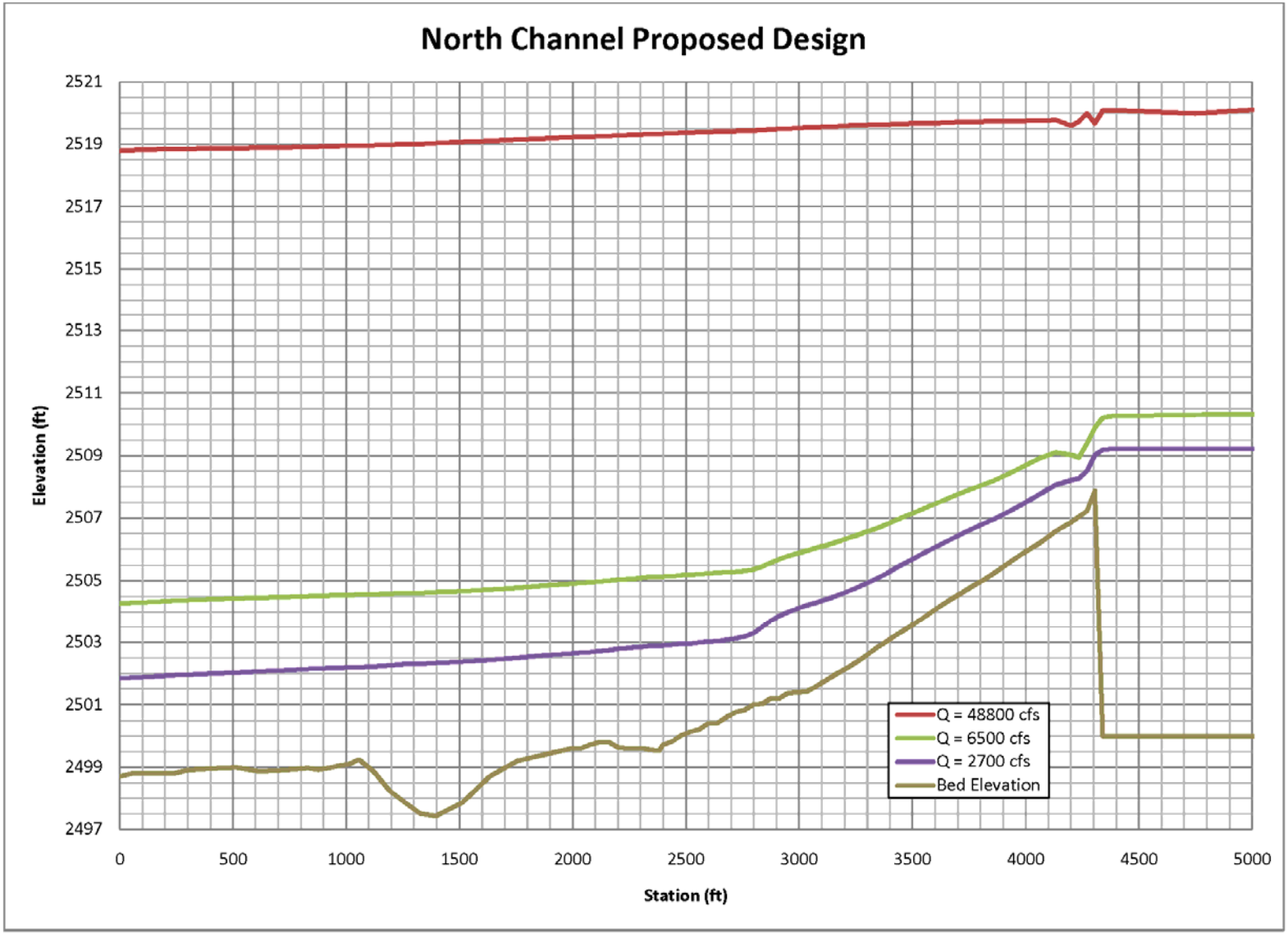


Figure 5-49 North Channel Proposed Design, Option 2

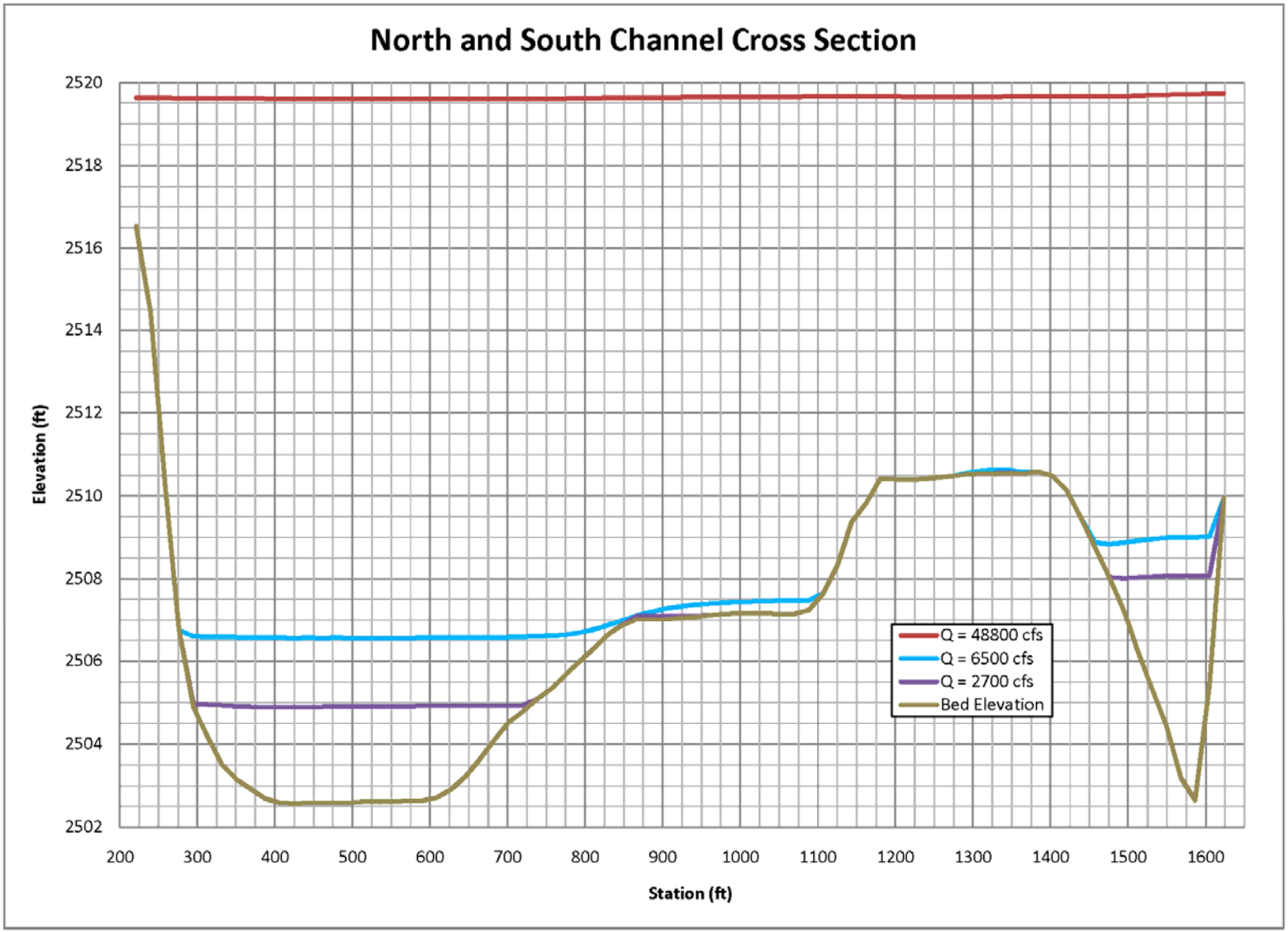


Figure 5-50 North and South Channel Cross Section, Option 2

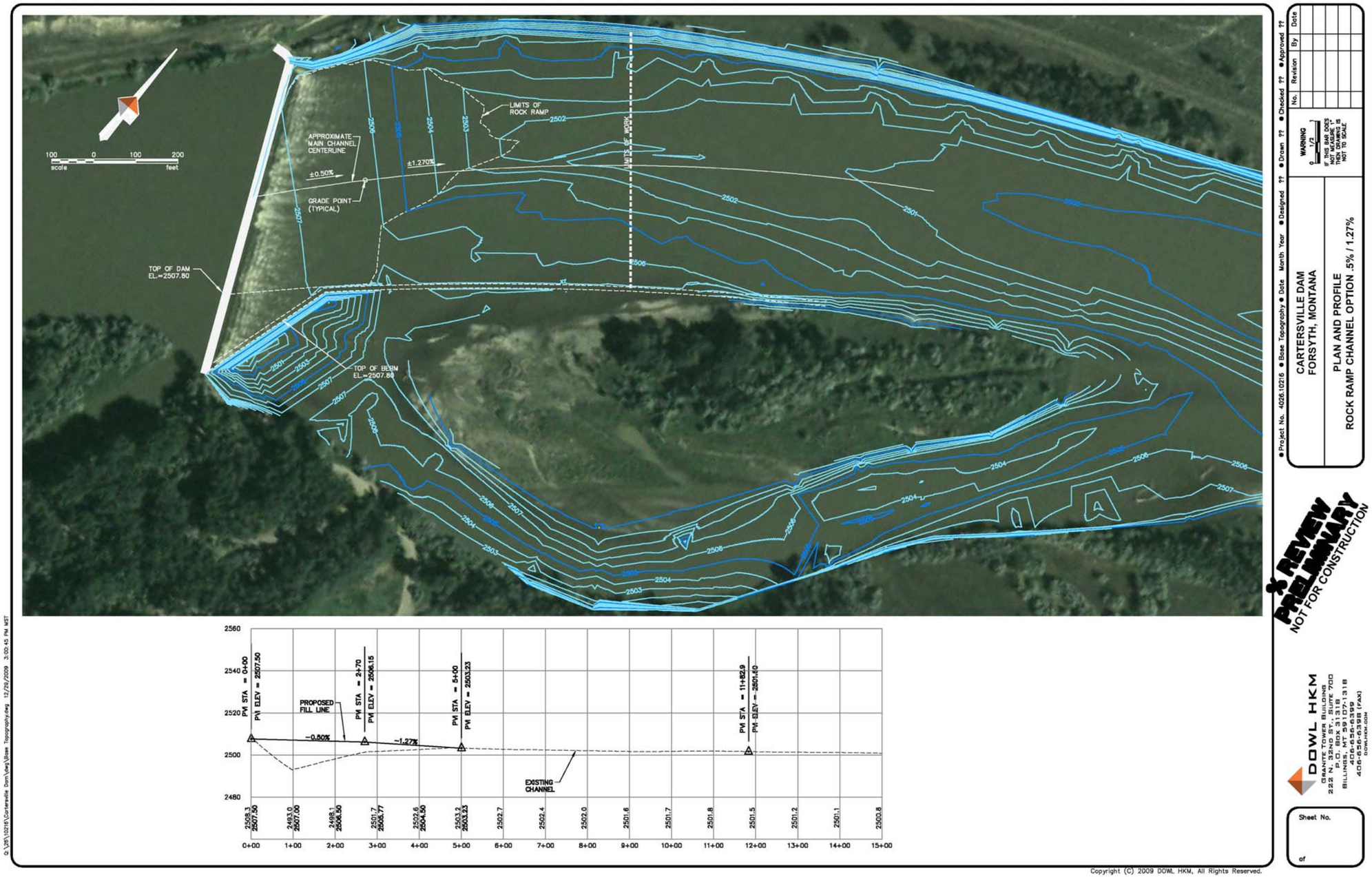


Figure 5-51 Rock Ramp, Slope 0.5% / 1.27%, Option 3

5.4.8.1.3 Potential Rock Sources and Types

Numerous suppliers were contacted to determine a source of rock for the project. Two sources were identified. The URS, Washington Division, Pipestone Quarry near Whitehall, Montana indicated the ability to deliver suitable rock in the desired quantities. The Basin Electric, Montana Limestone quarry at Warren, Montana can also supply the required rock.

5.4.8.1.3.1 Pipestone Quarry

The rock from Pipeston Quarry near Whitehall is upper Cretaceous age, porphyritic intrusive basalt/diorite (Figures 5-52 and 5-53). The rock is very dense, silicified and fractured, with no known occurrences of base or precious metal mineralization within the proposed quarry area. Refraction seismic data obtained on January 7, 1991 shows an average velocity of bedrock to be 5740 ft/sec. to a minimum depth of 50 feet (the bulk specific gravity of the bedrock is 2.852 and density of 2.4 tons per bank cubic yard). The rock would be loaded on Montana Rail Link (MRL) trains and delivered to Forsyth. Rock would then be transferred to trucks, delivered to the diversion dam, and placed in the river. A constraint is that MRL only has seven side-dump railcars which are used extensively for repairs to MRL facilities. Rock is priced at $9/ton for these quantities. Rail delivery to Forsyth is $2900/car (approximately 100 tons) or $2500/car if MRL doesn't supply the cars.

Figure 5-52 Riprap

5.4.8.1.3.2 Montana Limestone Quarry

The rock from the Montana Limestone Quarry at Warren is limestone (Figure 5-53). The rock is $20/ton FOB the Burlington Northern Santa Fe (BNSF) loading facility at Warren, Montana. BNSF will deliver the rock to Forsyth for $1369/car (approximately 100 tons). This is the least costly option.

Figure 5-53 Location of Riprap Sources

Map: MDT

5.4.8.1.4 Estimated Cost

Cost estimates are presented for two rock ramp options Table 5-11:

- Option 2: Slope 0.5%
- Option 3: Slope 0.5% / 1.27%

Option 1: Slope 0.5% / 0.2% / 0.5% was eliminated from further consideration due to cost and the unnecessary inclusion of the 0.2% slope section. Option 2 with a slope of 0.5% meets all the design criteria but has an estimated cost of nearly $15 million. Option 3 with slopes of 0.5% / 1.27% meets all the design criteria except for the steeper slope at the downstream end of the structure. Option 3 results in an estimated project cost of under $10 million. Operation, maintenance and replacement (OM&R) costs are assumed to be minimal for this alternative, therefore, life cycle costs are assumed equal to project costs.

Table 5-11
Rock Ramp Estimated Costs

	Slope 0.5%				Slope 0.5% / 1.27%	
	Quantity[1/]	Unit	Unit Price	Total	Quantity	Total
101 Mobilization & Bonds	1	LS	5% of #103-105	$59,191	1	$36,637
102 Taxes & Insurance	1	LS	5% of #103-105	$59,191	1	$36,637
103 Riprap	226,749	Ton	$20.00[2/]	$4,534,982	140,349	$2,806,982
104 Railroad Delivery of Riprap Warren to Forsyth	226,749	Ton	$13.69[3/]	$3,104,195	104,349	$1,921,379
105 Move Riprap from Railroad & Place in Yellowstone River	139,969	CY	$30.00[4/]	$4,199,058	86,635	$2,599,058
Subtotal				$11,956,618		$7,400,694
Contingency (20%)				$2,391,324		$1,480,139
Construction Cost				**$14,347,942**		**$8,880,833**
Geotechnical (.5%)				$71,740		$44,404
Survey (.5%)				$71,740		$44,404
Mitigation (1%)				$143,479		$88,808
Engineering				$100,000		$100,000
Construction Administration				$150,000		$150,000
Project Cost				$14,884,900		$9,308,449

[1/]Assume riprap with voids 120 lbs/cf
[2/]Basin Electric / Montana Limestone
[3/]BNSF
[4/]COP Construction

5.4.8.2 Alternative 2: Inflatable Bladder

5.4.8.2.1 Introduction

The inflatable bladder alternative consists of installing an inflatable bladder across the entire Yellowstone River at the location of the existing diversion dam (Figure 5-54).

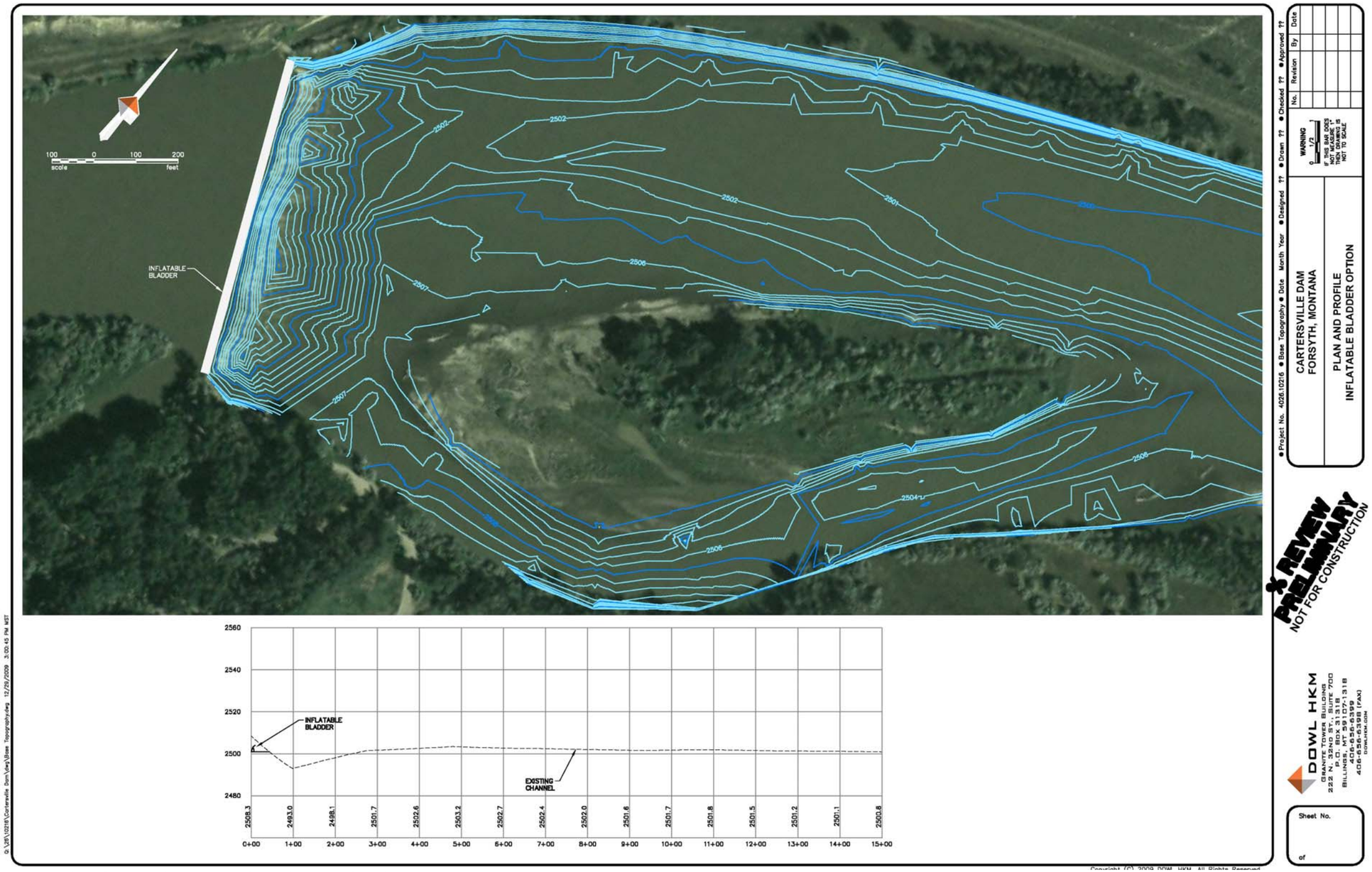


Figure 5-54 Plan and Profile of Inflatable Bladder Alternative

The bladder would be as manufactured by Obermeyer Hydro, Inc. The inflatable bladder would sit on a concrete pad with a steel plate on the upstream face to protect the bladder from damage due to ice and debris. These gates have been used extensively in areas with significant ice, such as Finland. The reinforced bladder is inflated at low pressure. The height of the bladder with steel plate would be approximately 6 feet, the estimated height of the existing dam (Figure 5-55). The bladder can be constructed in as many sections of specified width as desired. Each section can be operated independently to any desired height. This allows operation that best meets the needs of the irrigators and fish passage.

Some have voiced concern that an inflatable bladder would be vulnerable to puncture by gunshot. However, if a gunshot were to puncture the bladder the hole should self seal or the air loss could easily be made up with a small air compressor.

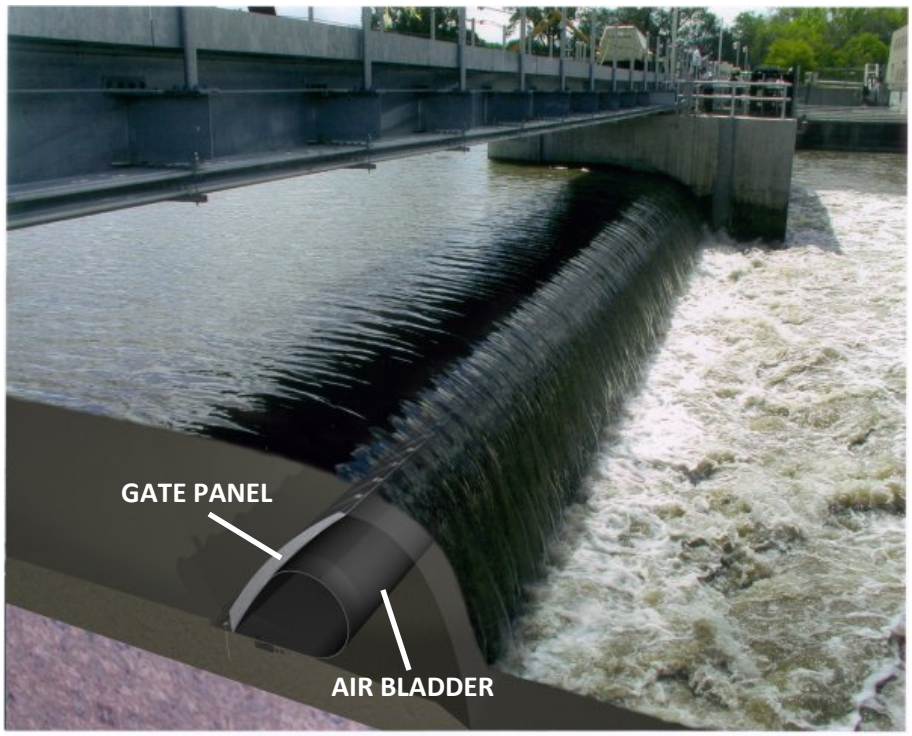


Figure 5-55 Obermeyer Gate

5.4.8.2.2 Hydraulics

With all segments of the inflatable bladder in the raised position, the dam hydraulics would approximate the existing condition. With all the segments in the lowered position the river would essentially return to a semi-natural condition, allowing unimpeded passage of fish and bedload.

5.4.8.2.3 Estimated Cost

The estimated cost for the inflatable bladder alternative is provided in Table 5-12.

Table 5-12
Inflatable Bladder Estimated Cost

	Quantity	Unit	Unit Price	Total
Mobilization & Bonds (5%)	1	LS	$281,500	$281,500
Taxes & Insurance (5%)	1	LS	$281,500	$281,500
Bladder / Steel Plate	1	LS	$2,200,000	$2,200,000
Concrete Foundation	800	ft	1/ $3,000	$2,400,000
Appurtenances	800	ft	2/ $1,000	$800,000
Demolish & Waste Existing Dam	5,000	CY	2/ $25.00	$125,000
Dewatering	1	LS	$100,000	$100,000
Subtotal				$6,188,000
Contingency (20%)				1,237,600
Construction Cost				**$7,425,600**
Geotechnical (.5%)				$37,128
Mitigation (1%)				$74,256
Engineering (6%)				$445,536
Construction Administration (10%)				$742,560
Project Cost				$8,725,080

1/6 feet high x 800 feet long, Obermeyer
2/Obermeyer

The project is assumed to have a life of 50 years. The rubber components of the gate should have a life of 35 years or more according to Obermeyer. The rubber components of the gate are approximately 40 percent of the gate cost ($2,200,000 * 0.40 = $880,000). The future value of the components is also $880,000 assuming zero inflation. Using a discount rate of 4.375% and 35 years, the present value is $197,000 (personnel communication with USACE, Omaha). The cost of operating the air compressor is minimal. Adding the replacement cost to the project cost yields a life-cycle cost of $8,725,080 + $197,000= $8,922,080. The Montana DNRC sometimes has an operator on site at their hydropower dams with inflatable bladders to monitor operation. No operator is anticipated for the inflatable bladder alternative at this site.

5.4.8.3 Alternatives Considered But Rejected

Alternatives considered but rejected are the same as those discussed in section 4.0 Prior Studies.

5.5 Step 4 - Evaluation of Alternative Plans

As per the USACE guidelines, the evaluation of effects compares the conditions with-project and without-project for each alternative. Two categories of effects are evaluated: costs and outputs.

Environmental outputs (or benefits) are the desired or anticipated measurable products or results of restoration measures or plans. The evaluation consists of the following:

Forecast with-project conditions expected under each alternative.

- Compare each with-project condition to without-project conditions.
- Characterize beneficial and adverse effects by magnitude, location, timing and duration.
- Qualify plans for future consideration.

All USACE water resources development projects must be evaluated in terms of acceptability; completeness; effectiveness; and efficiency. Ecosystem restoration alternatives are also evaluated on the basis of cost effectiveness and incremental cost analyses.

5.5.1 Acceptability

Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations and public policies. The proposed alternatives are acceptable in terms of applicable laws, regulations and public policies.

5.5.2 Completeness

Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including action by other Federal and non-Federal entities. The proposed alternatives account for all necessary investments/actions necessary to ensure realization of the planning objectives.

5.5.3 Effectiveness

Effectiveness is the extent to which the alternative plans contribute to achieve the planning objectives. The proposed alternatives will make a significant contribution to restoring fish passage in the Yellowstone River system.

5.5.4 Efficiency

Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. The proposed alternatives provide a cost effective means of achieving the project objectives. Refer to Section "Cost Effectiveness and Incremental Cost" for additional information.

5.5.5 Cost Effectiveness and Incremental Cost

This analysis must show through cost effectiveness that an alternative restoration plan's output cannot be produced more cost effectively by another alternative. The term "cost effective" means that, for a given

level of non-monetary output, no other plan costs less and no other plan yields more output for less money. "Incremental cost analysis" evaluates a variety of implementable alternatives and various sized alternatives to arrive at the "best" level of output within the limits of the sponsor's capabilities.

5.5.5.1 Potential Solutions

Potential solutions include a rock ramp or an inflatable bladder.

5.5.5.2 Cost Effectiveness

Potentially implementable solutions for achieving the desired ecosystem outputs include a rock ramp and an inflatable bladder.

The project/life-cycle costs of a rock ramp with slope = 0.5% on the north channel is $14,900,000. The project/life-cycle costs of a rock ramp with slopes = 0.5%/1.27% on the north channel is $9,400,000. The associated output is that shovelnose sturgeon and other species will be able to pass the Cartersville Dam.

The estimated project cost of an inflatable bladder is $8,800,000. The estimated life-cycle cost is $9,000,000. The associated output is the same as for the rock ramp.

Both the rock ramp and the inflatable bladder are assumed to have the same output.

The inflatable bladder (Alternative 2) appears is the most cost effective solution to fish passage, but may not be a locally acceptable alternative due to the associated OM&R responsibilities and costs. The rock ramp (Alternative 1) with slopes of 0.5% and 1.27% (Option 3) is the next most cost effective if a variable slope is acceptable. Therefore, a rock ramp with a 0.5% slope is ultimately the most cost effective.

5.5.5.3 Incremental Cost

The intent is to identify the "Best Buy" plan that provides the greatest increase in output for the least increase in cost. The incremental cost of choosing between these alternatives does not yield a measurable increase in output.

5.5.5.4 Evaluation Criteria

5.5.5.4.1 Output Target

No specific output target has been established. Both the rock ramp and inflatable bladder will accomplish the objective of passing sturgeon.

5.5.5.4.2 Output Threshold

No specific output threshold has been established. Both the rock ramp and inflatable bladder will accomplish the objective of passing sturgeon.

5.5.5.4.3 Cost Affordability

USACE funding programs include Section 206 of the Water Resource Development Act (WRDA) of 1997 and Section 3110 of WRDA 2007. Section 206 provides federal funding up to $5,000,000 for eco-system restoration projects with the project cost split 65% federal and 35% non-federal. With $5,000,000 of federal contribution, the non-federal contribution would be $2,692,308, for a project cost of $7,692,308. Larger projects would require additional non-federal contributions in excess of 35%. The terms of Section 3110 of WRDA 2007 have not been established. A one-time appropriation of $30,000,000 for the Yellowstone River has been approved. The Bureau of Reclamation and WAPA may also be a source of funding. Non-federal cost-share funds include the future fisheries fund or state appropriations.

5.5.5.4.4 Unintended Consequences

The rock ramp alternative raises the water level in the north channel downstream of the diversion dam and distributes the energy loss that now is dissipated at the toe of the dam.

5.5.6 Significance of Ecosystem Outputs

The significance of ecosystem output plays an important role in the ecosystem restoration evaluation along with cost effectiveness/incremental cost analysis, as well as information about acceptability, completeness, and effectiveness. The significance of outputs from the proposed alternatives is demonstrated by Institutional, Public and Technical Recognition.

5.5.6.1 Institutional Recognition

"Institutional Recognition" means that the importance of an environmental resource is acknowledged in the law, adopted plans, a policy statement of public agencies, tribes, and private groups. The U.S. Fish and Wildlife Service; Montana Fish, Wildlife & Parks; and Yellowstone Conservation District Council have an interest in providing fish passage at Cartersville Dam for all native fish species. Moreover, once pallid sturgeon passage is provided at the downstream Intake dam, the passage barrier at Cartersville may become an issue for the endangered pallid sturgeon. (See Appendix B).

5.5.6.2 Public Recognition

"Public Recognition" requires some segment or the general public recognizes the environmental resource as important by engaging in activities that reflect an interest/concern in the resource. Organizations with

a demonstrated interest in this project include the Nature Conservancy and the Rosebud/Treasure County Wildlife Association. The Cartersville Irrigation District owns the Cartersville Dam and supports the proposed rock ramp which would strengthen the dam, reducing operation and maintenance costs while providing fish passage. The residents of Forsyth support the project because it will protect and maintain an integral part of the customs and traditions of the community. (See Appendix B)

5.5.6.3 Technical Recognition

"Technical Recognition" requires the project has merit in terms of scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity.

5.5.6.3.1 Scarcity

The Yellowstone River is the longest undammed river in the United States and as such offers resources that are scarce.

5.5.6.3.2 Representativeness

The Yellowstone River has historically provided habitat for threatened and endangered species including the pallid sturgeon.

5.5.6.3.3 Status and Trends

Over time, a number of diversion (non-storage) dams have been constructed along the Yellowstone River. These dams, including Cartersville, have contributed to declining populations of fish species such as pallid and shovelnose sturgeon. Providing fish passage at these dams will help restore the Yellowstone River fishery.

5.5.6.3.4 Connectivity

Providing for fish passage at Cartersville will restore connectivity with the Yellowstone River. Currently, Cartersville Dam appears to block upstream movement of shovelnose sturgeon (Jaeger et al. 2009) as well as juvenile sauger (Jaeger et al. 2005). Although Helfrich et al. (1999) reported that Cartersville Dam did not create any disjunct fish populations; it is likely that upstream passage is impeded for some proportion of the 40-50 fish species present in the project area. For example, total numbers of shorthead redhorse, goldeye, Hybognathus sp. (likely western silvery minnow), emerald shiner, and river carpsucker were higher below Cartersville Dam than above it. The total number of all fish species captured was also higher below Cartersville.

5.5.6.3.5 Limiting Habitat

Removing the fish barrier at Cartersville Dam is essential for the conservation, survival, and recovery of the threatened and endangered species such as the pallid sturgeon. After fish passage is restored at the downstream Intake Dam, pallid sturgeon will need to pass Cartersville Dam.

5.5.6.3.6 Biodiversity

Removing the fish barrier at Cartersville Dam will increase the diversity of this reach of the Yellowstone River by more evenly distributing the fish species currently limited by the dam.

5.5.7 Risk and Uncertainty

The proposed rock ramp alternative with a slope of 0.5% was configured to match reference reaches in the Yellowstone River (Matthews and Wolf Rapids), scoring criteria developed by the biological review team for the similar, downstream Intake Dam, and design criteria developed specifically for this project. As such, the risk and uncertainty should be low.

A rock ramp with variable slope of 0.5%/1.27% may have a higher level of uncertainty than the constant slope of 0.5%, but could be easily modified in the future by placing more rock to provide a constant slope of 0.5%.

Replacement of the dam with an inflatable bladder would allow the bladder to be lowered during periods of high flow during periods of fish passage, while still providing water levels sufficient to supply irrigation water and water for the City of Forsyth.

5.6 Step 5 - Plan Comparison

The rock ramp alternative is acceptable to the Cartersville Irrigation District. It stabilizes their existing diversion dam while providing for fish passage and maintaining the south channel in its current configuration. A rock ramp with a constant slope of 0.5% satisfies all of the design criteria. A rock ramp with a variable slope of 0.5% and 1.27% is not supported by evaluations of the Matthews and Wolf Rapids reference reaches, but may be acceptable contingent on the ability to place additional rock in the future to provide a constant slope of 0.5% if necessary to promote fish passage.

The inflatable bladder is unlikely to be supported by the Cartersville Irrigation District due to operation, maintenance, and replacement costs. The most significant cost being replacement of the rubber bladder in approximately 35 years.

5.7 Step 6 - Selection of Ecosystem Restoration Plan

The rock ramp alternative with a constant slope of 0.5% is the preferred plan for meeting the goals/objectives of this project. While not the least cost alternative, it meets all of the goals and objectives for the project.

6.0 AFFECTED ENVIRONMENT

6.1 Introduction

This chapter describes the area of the environment to be affected by the alternatives proposed for Cartersville Dam. Impacts to the environment are described in the next chapter.

Issues or resources are organized in the following categories:

- Ecological Resources
- Cultural Resources
- Aesthetic Resources
- Water Quality and Related Requirements
- Air Quality

6.2 Ecological Resources

6.2.1 Introduction

This section emphasizes ecological resources and ecosystems restoration, with particular consideration of fish and wildlife resources. Ecological resources include a natural form, process system or other phenomenon that is related to land, water, atmosphere, plants, or animals which has attributes or properties which sustain and enrich human life (USACE, 2000). Categories include:

- Hydrology
- Geomorphology
- Federally-Listed Species and State Species of Special Concern
- Lands and Vegetation
- Aquatic Assemblages
- Recreation
- Wetlands

6.2.2 Hydrology

6.2.2.1 Introduction

This section describes the existing hydrologic conditions for the Yellowstone River at Forsyth, Montana.

6.2.2.2 Method

Data from U.S. Geological Survey (USGS) gage 06295000, Yellowstone River at Forsyth, located approximately one mile upstream was used in this study. The period of record for this gage is July 16, 1921 to September 30, 1923 (no winter records) and October 1977 to the current year.

6.2.2.3 Existing Conditions

Annual mean discharge for the gage is 10,600 cubic feet per second (cfs). Daily mean discharge which was equaled or exceeded for 99 percent of time and 1 percent of time based on 25 years of record was 2560 cfs and 48,800 cfs, respectively. The one-day 20-year recurrence low flow is 1640 cfs. The one-day 50-year recurrence high flow is 99,000 cfs. The maximum peak flow was 106,000 cfs on May 21, 1978. The lowest daily mean was 1400 cfs on November 23, 1977.

6.2.3 Geomorphology

This section describes the geomorphologic characteristics of the Yellowstone River that may be affected by the Cartersville Dam fish passage project. The geomorphic characteristics of the area that may be affected include channel characteristics (morphology) and channel modifications such as extents of bank armor.

6.2.3.1 Method

Available literature and existing GIS data were reviewed as part of the assessment of the geomorphology of the Yellowstone River in the project area. Historic aerial photographs from 1950, 1976, 1995, 2001, and 2007 were utilized to identify historic changes in planform in the area, and to measure bank erosion rates and mid-channel bar area at the site.

6.2.3.2 Existing Conditions

A mid-1970's report by Koch (1977) characterizes the Yellowstone River as having a branching and braided reaches with wooded islands and gravel bars, separated by reaches with very few islands and minimal bars. River valley and valley wall configurations largely control the form of the river; in general, the river follows the valley walls until the orientation of the river valley axis changes. At that point, the channel commonly crosses the valley bottom to the opposite valley wall. In areas where the river is not directly against a valley wall, the channel is more dynamic, and assumes a braided or a branching (multi-channeled) planform (Koch, 1977).

In the vicinity of Forsyth, the Yellowstone River follows a meandering planform that is partially confined by a bedrock valley wall to the north (AGI and DTM, 2004). This valley wall is comprised of Late Cretaceous-age (66 to 71 million year old) Lance Formation, which consists of sandstones and shales that

are up to 300 feet thick near Forsyth (Vuke et al, 2001). Upstream of the diversion dam, on the south bank of the river, a floodplain dike separates the city of Forsyth from the active river corridor. The armored and levied bankline at Forsyth coupled with the bedrock bluff on the opposite bank has confined the Yellowstone River into a narrow corridor that has shown little change in the last 50 years (Figure 6-1 and Figure 6-2).

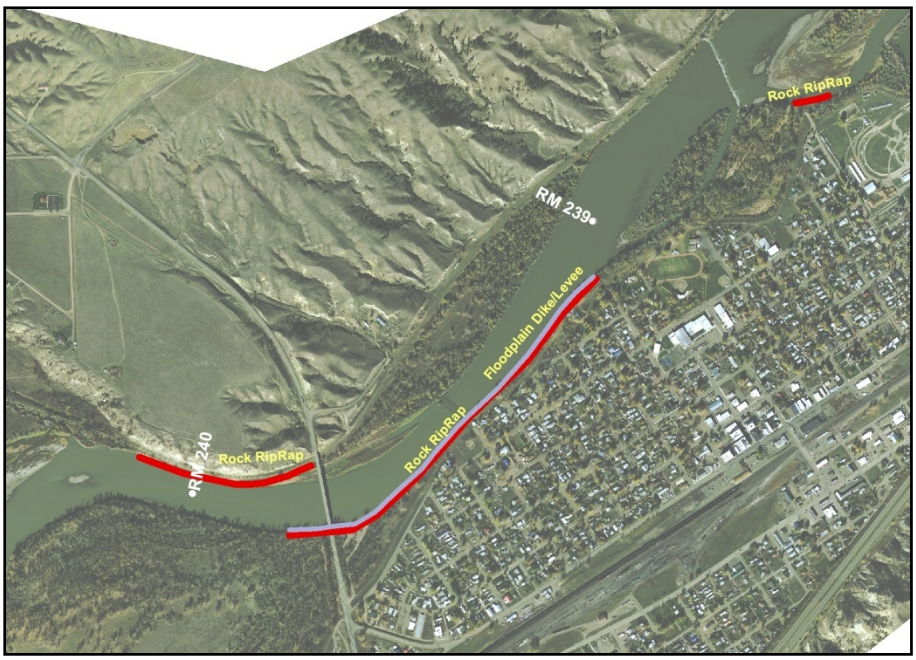


Figure 6-1 Aerial Photograph of Yellowstone River Above Cartersville Dam Shows Mapped Extents of Riprap (red) and Floodplain Dike/Levee (lavender)

6.2.3.3 Sediment Sourcing From Upstream Cutoffs

Several miles upstream of Cartersville Dam, the Yellowstone River flows through the Hammond Valley. In this section of river, the river is largely unconfined, flowing through a series of broad meander bends. Two bendways have cut off in the Hammond Valley in the past 50 years; one between 1950 and 1976, and another during the 1996/1997 flood events (Figure 6-3 and Figure 6-4). These bendway cutoffs have been characterized by the excavation of a new channel across the neck of the bend, and abandonment of the old bend as an oxbow channel remnant. Such events create accelerated sediment loading downstream (Whitaker et al, 2008). For example, the cutoff at River Mile 243.8 (Figure 6-3 and Figure 6-4) occurred during the floods of 1996 and 1997. Approximately 28 acres of land were eroded out as the new channel formed. If an excavation depth of 6 feet over the eroded area is assumed, the event produced on the order of 268,000 cubic yards of material.

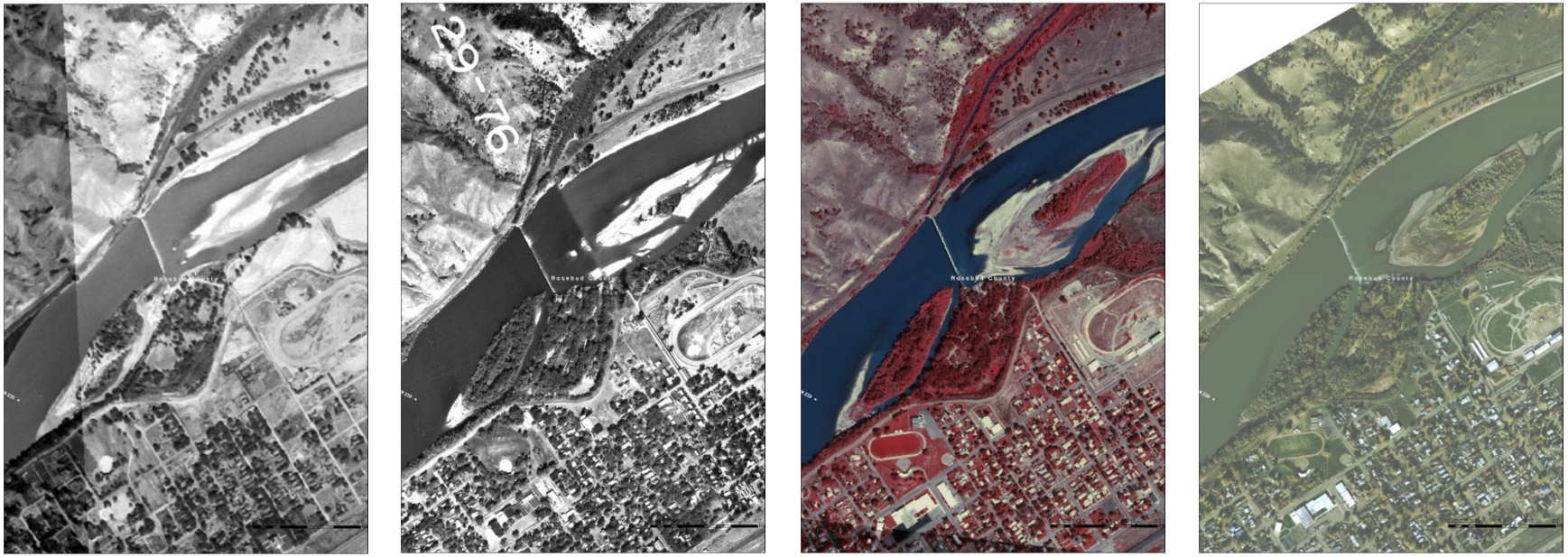


Figure 6-2 Yellowstone River at Cartersville Dam Showing (left to right), 1950, 1976, 2001, and 2007 Conditions

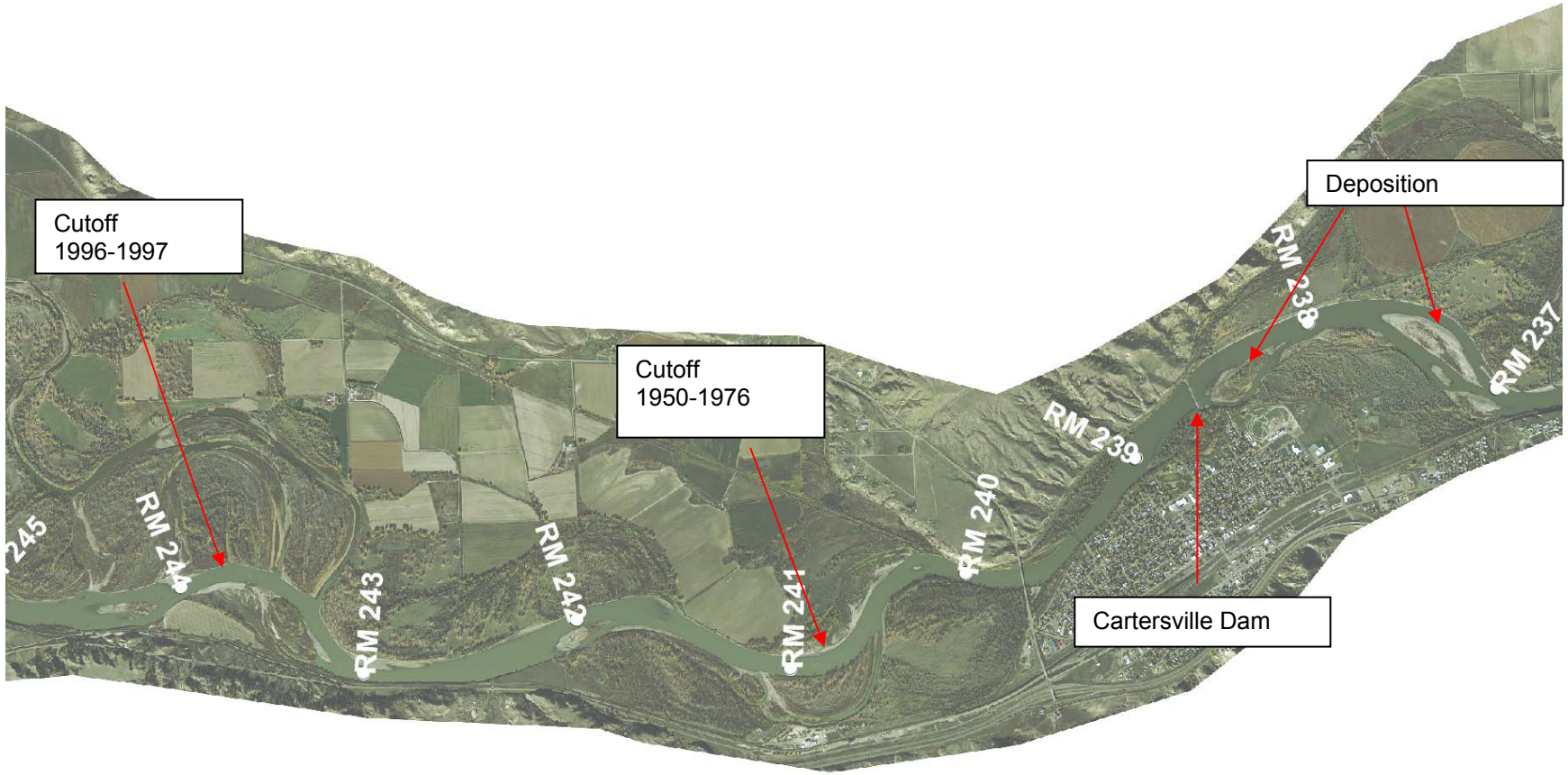


Figure 6-3 Yellowstone River at Cartersville Dam, 2007 Showing Areas of Bendway Cutoff and Downstream Deposition

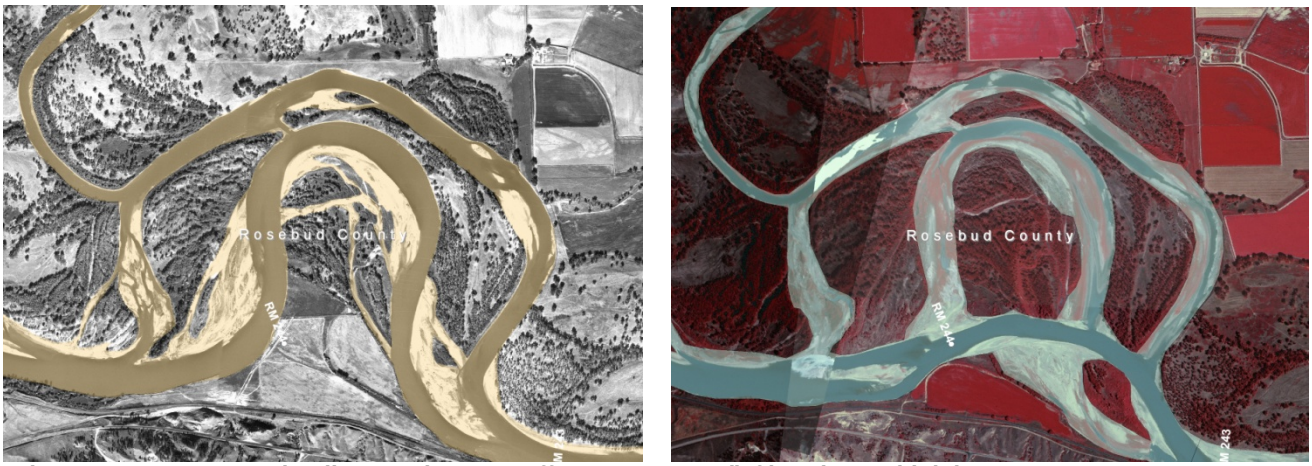


Figure 6-4 Hammond Valley Bendway Cutoff Between 1976 (left) and 2001 (right)

Bendway cutoffs create a sediment pulse that typically results in deposition downstream (Schumm, 1977). Just upstream of Cartersville Dam, the Yellowstone River is confined between the bluff line and Forsyth dike, and there is no evidence of recent deposition in this reach. Downstream of Cartersville Dam, however, the channel flows away from the valley wall and hence is less confined and prone to more active planform change. Two areas, located at RM 237.5 and RM 238.5, are within one mile of the dam and have shown substantial bank migration and mid-channel bar growth since 1950 (Figure 6-5). The downstream site, at RM 237.5, consists of a large bendway that is actively migrating to the northeast. The bendway has migrated approximately 470 feet between 1950 and 2007, reflecting an 8.2 feet per year average migration rate. The second site is located immediately downstream of the dam, where mid-channel bar growth has been accompanied by right (south) bank erosion (Figure 6-6). Since 1950, the bank has migrated approximately 270 feet at the site, reflecting an average migration rate of 4.7 feet per year. This site is currently protected by discontinuous bank armor.

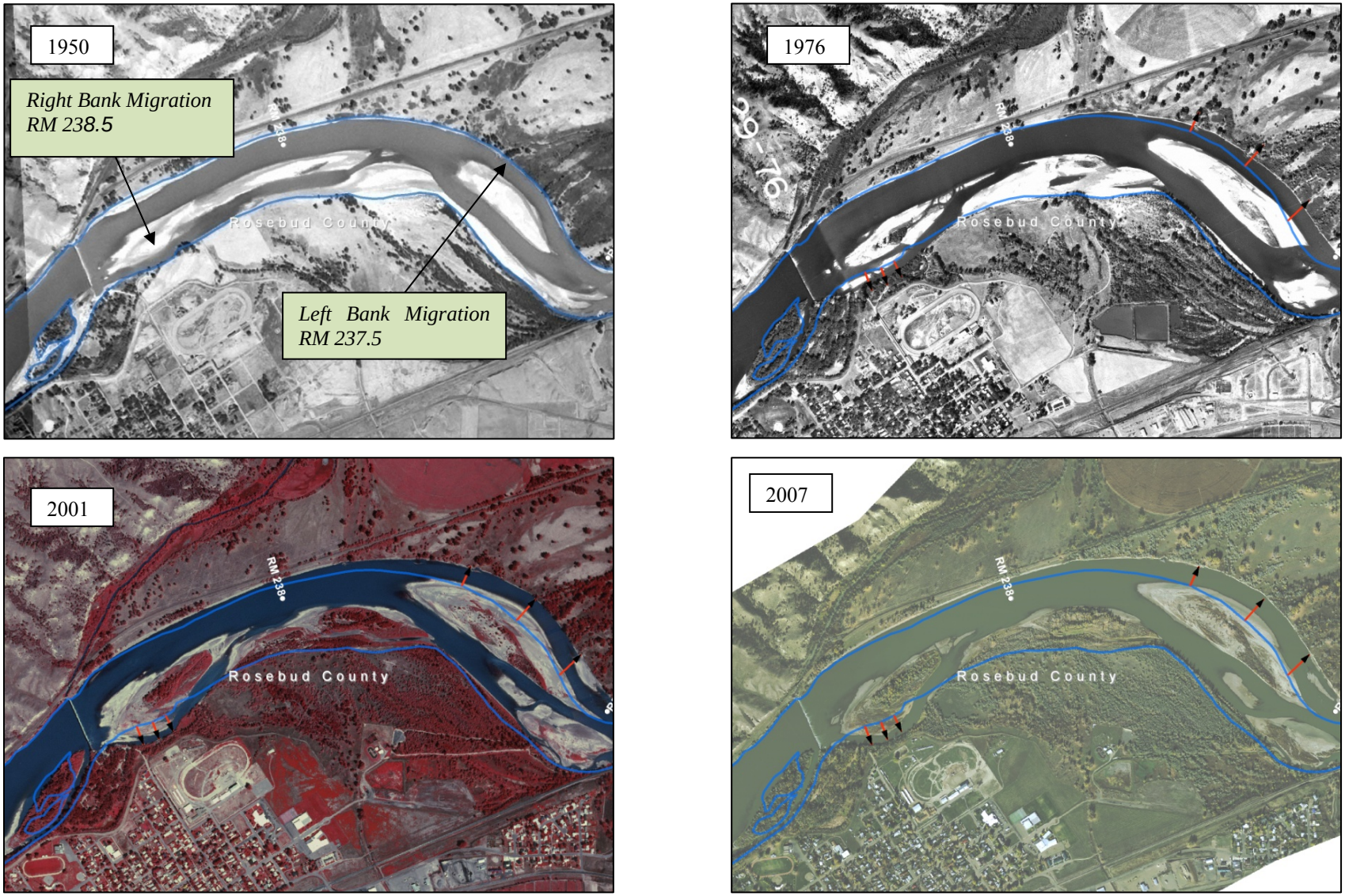


Figure 6-5 1950-2001 Bank Erosion (red arrows), Showing Island Growth and Bank Retreat Downstream of Cartersville Dam. Blue Lines are 1950 Bankfull Boundaries

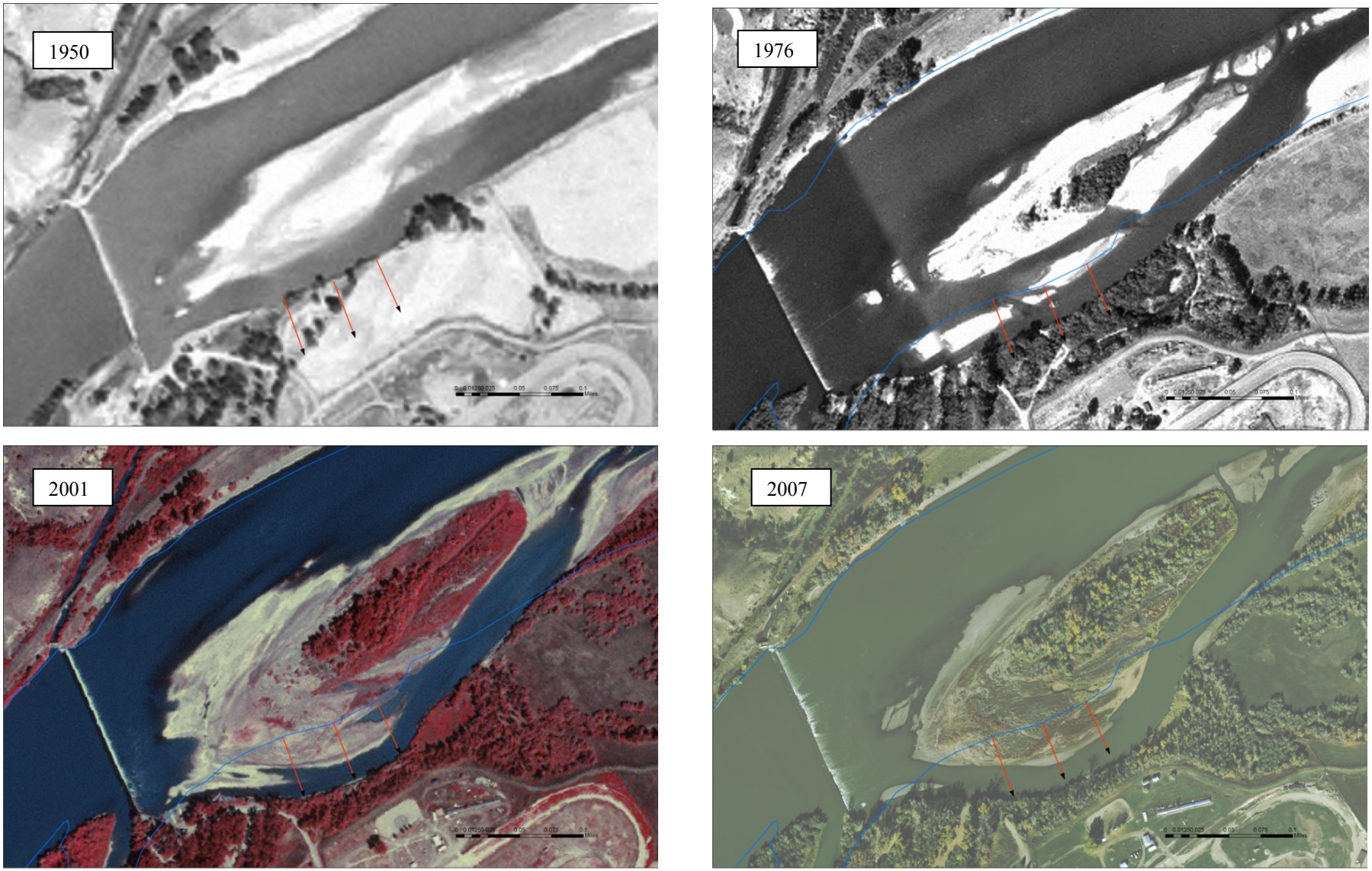


Figure 6-6 Close Up View of 1950-2001 Bank Erosion (red arrows) Immediately Downstream of Cartersville Dam. Blue Lines are 1950 Bankfull Boundaries

An assessment of channel migration rates through time indicates that at both sites, the highest rates of channel movement occurred between 1995 and 2001 (Figure 6-7). During this time frame, the right bank site immediately downstream of the dam migrated at an average rate of approximately 8 feet per year, and the downstream site moved at an average rate of 10 feet per year. The time frame between 1950 and 1976 was characterized by the average migration rates of over 6 feet per year at both sites. Channel migration was less active from 1976 to 1995 and from 2001 to 2007.

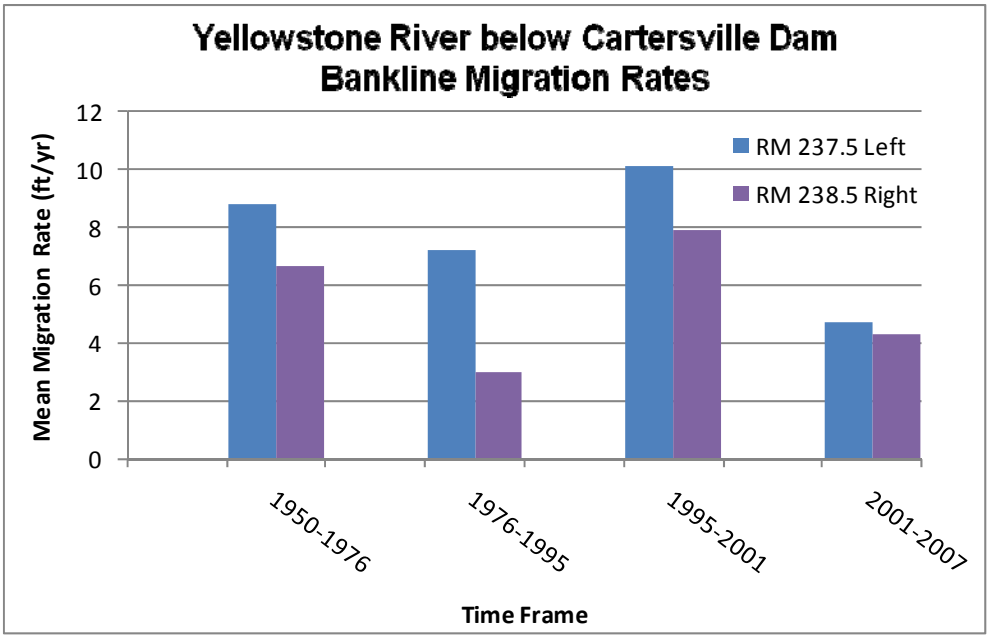


Figure 6-7 Measured Bankline Migration Rates Immediately Downstream of Cartersville Dam

Right Bank at RM 238.5, and Approximately One Mile Downstream on the Left Bank at RM 237.5

A measurement of the aerial extent of the bar features through time indicates that the bars have grown since 1950, but that the growth rates have tapered off since 2001 (Figure 6-8). As the flows varied during the timeframes in which the air photos were taken, the measured expansion of mid-channel bars could reflect differences in river stage. Table 6-1 lists the approximate discharges present at the time of the aerial flight. The lowest flow conditions captured in the photography are during the 1950 and 2001 flights, when flows were approximately 3500 cfs. Although the flows were similar, the downstream bar was over two times larger during the more recent flight. This is similar for the 1995 and 2007 measurements; although the flows were similar, the later timeframe is characterized by a larger bar extent. The results of the bankline migration and bar development assessment indicate that downstream of Cartersville Dam, bank migration that has occurred over the last 50 years has been accompanied by mid-channel bar growth.

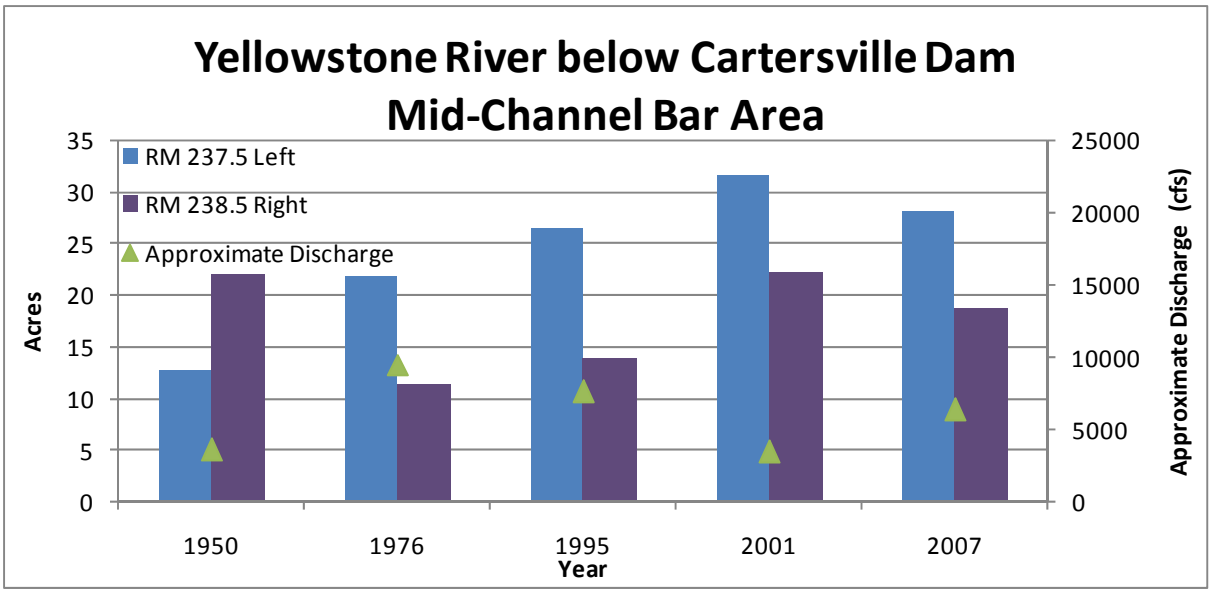


Figure 6-8 Exposed Area of Mid-Channel Bars Downstream of Cartersville Dam

Table 6-1
Measured Extent of Two Primary Mid-Channel Bars Downstream of Cartersville Dam Through Time

Date	Approximate Discharge (cfs)	Bar Size RM 237.5 (acres)	Bar Size RM 238.5 (acres)
1950	3620	12.8	22.0
1976	9520	21.8	11.4
1995	7650	14.0	26.6
2001	3500	31.6	22.3
2007	6400	28.1	18.7

There is no clear evidence of deposition and bar growth upstream of Cartersville Dam, where the river is confined between bedrock bluffs and a floodplain dike. However, bar growth and bank erosion have been measured downstream of the dam structure where the river is less confined. The proximity of the Hammond Valley upstream, coupled with the evidence of sediment production from cutoff events, suggests that periodically, accelerated sediment loading has occurred through the reach, which may have resulted in bar growth downstream of Cartersville Dam. It is unclear whether these bars will continue to grow in the future; a measurement of bar area indicates that at both sites, bar growth has tapered off. However, the results indicate that the geomorphology of the Yellowstone River downstream of Cartersville Dam is in part a reflection of periodic influxes of sediment from bendway cutoff events in the Hammond Valley. These natural processes of bendway formation, cutoff, and sediment transport downstream are likely to continue in the future, indicating that periods of accelerated sediment delivery, bar formation, and bank erosion will be characteristic of the site.

6.2.4 Federally-Listed Species and State Species of Special Concern

6.2.4.1 Introduction

This section describes the federal and state conservation status of plant and animal species in the vicinity of the Cartersville Dam site. These species have the potential to be affected by proposed improvements to the Cartersville Dam.

6.2.4.2 Method

All information about species of special concern in the vicinity of Cartersville Dam were obtained from the Montana Natural Heritage Program website (http://mtnhp.org/). This information is summarized in Table 6-2. Because few studies have been conducted in the Forsyth area, information is provided for each species from a variety of geographic area..

6.2.4.3 Existing Conditions

6.2.4.3.1 Golden Eagle

6.2.4.3.1.1 Habitat

Golden eagles nest on cliffs and in large trees (occasionally on power poles), and hunt over prairie and open woodlands. Cliff nesting sites are selected for southern or eastern aspect, less than 200 inches of snowfall, low elevation, and availability of sagebrush/grassland hunting areas. Golden Eagle — *Aquila chrysaetos.* Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_ABNKC22010.aspx

6.2.4.3.1.2 Food Habits

In Montana, golden eagles eat primarily jackrabbits, ground squirrels, and carrion (dead animals). They occasionally prey on deer and antelope (mostly fawns), waterfowl, grouse, weasels, skunks, and other animals. Golden eagles rarely prey on livestock, but when they do, losses usually occur in areas where migrating eagles congregate. Golden eagles can carry no more than about seven pounds while flying.

6.2.4.3.1.3 Ecology

Nesting density varies year to year from 55 to 105 sq.mi./pair. Eagles move to higher elevations after leaving nest.

Table 6-2
Species of Special Concern in the Vicinity of Cartersville Dam (Montana Natural Heritage Program)

Species of Concern

Common Name			Scientific Name						
Class	Family	Species	Class	Family	Species	Global Rank	State Rank	ESA Rank	Habitat
Birds	Hawks / Eagles	Golden Eagle	Aves	Accipitridae	Aquila chrysaetos	G5	S3		Grasslands
Birds	Herons	Great Blue Heron	Aves	Ardeidae	Ardea herodias	G5	S3		Riparian forest
Birds	Upland Game Birds	Greater Sage-Grouse	Aves	Phasianidae	Centrocercus uropha	G4	S2		Sagebrush
Birds	Hawks / Eagles	Bald Eagle	Aves	Accipitridae	Haliaeetus leucocep	G5	S3	DM	Riparian forest
Reptiles	Softshell Turtles	Spiny Softshell	Reptilia	Trionychidae	Apalone spinifera	G5	S3		Prairie rivers and larger streams
Reptiles	Sagebush / Spiny Lizards	Greater Short-horned Lizard	Reptilia	Phrynosomatidae	Phrynosoma hernan	G5	S3		Sandy / gravelly soils
Fish	Suckers	Blue Sucker	Actinopterygii	Catostomidae	Cycleptus elongatus	G3G4	S2S3		Large prairie rivers
Fish	Minnows	Sturgeon Chub	Actinopterygii	Cyprinidae	Macrhybopsis gelida	G3	S2S3		Large prairie rivers
Fish	Paddlefishes	Paddlefish	Actinopterygii	Polyodontidae	Polyodon spathula	G4	S1S2		Large prairie rivers
Fish	Perches	Sauger	Actinopterygii	Percidae	Sander canadensis	G5	S2		Large prairie rivers

Potential Species of Concern

Common Name			Scientific Name						
Class	Species	Family	Class	Species	Family	Global Rank	State Rank	ESA Rank	Habitat
Birds	Swifts	Chimney Swift	Aves	Apodidae	Chaetura pelagica	G5	S3S4B		Chimneys, caves, hollow trees
Fish	Minnows	Plains Minnow	Actinopterygii	Cyprinidae	Hybognathus placitu	G4	SU		Small and large prairie rivers
Fish	Burbot	Burbot	Actinopterygii	Gadidae	Lota lota	G5	SU		Large rivers, lakes

LEGEND

Global Rank	State Rank	Definition
G1	S1	At high risk because of **extremely limited** and/or **rapidly declining** population numbers, range and/or habitat, making it highly vulnerable to global extinction or extirpation in the state.
G2	S2	At risk because of **very limited** and/or **potentially declining** population numbers, range and/or habitat, making it vulnerable to global extinction or extirpation in the state.
G3	S3	Potentially at risk because of **limited** and/or **declining** numbers, range and/or habitat, even though it may be abundant in some areas.
G4	S4	Apparently secure, though it may be quite rare in parts of its range, and/or suspected to be declining.
G5	S5	Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range.

ESA Rank	Definition
LE	**Listed endangered:** Any species in danger of extinction throughout all or a significant portion of its range (16 U.S.C. 1532(6)).
LT	**Listed threatened:** Any species likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (16 U.S.C. 1532(20)).
PE	**Proposed endangered:** Any species for which a proposed rule to list the species as endangered has been published in the Federal Register.
PT	**Proposed threatened:** Any species for which a proposed rule to list the species as threatened has been published in the Federal Register.
C	**Candidate:** Those taxa for which sufficient information on biological status and threats exists to propose to list them as threatened or endangered. We encourage their consideration in environmental planning and partnerships; however, none of the substantive or procedural provisions of the Act apply to candidate species.
DM	**Recovered, delisted, and being monitored** - Any previously listed species that is now recovered, has been delisted, and is being monitored.
NL	**Not listed** - No designation.
XE	**Experimental - Essential population** - An experimental population whose loss would be likely to appreciably reduce the likelihood of the survival of the species in the wild.
XN	**Experimental - Nonessential population** - An experimental population of a listed species reintroduced into a specific area that receives more flexible management under the Act.
CH	**Critical Habitat** - The specific areas (i) within the geographic area occupied by a species, at the time it is listed, on which are found those physical or biological features (I) essential to conserve the species and (II) that may require special management considerations or protection; and (ii) specific areas outside the geographic area occupied by the species at the time it is listed upon determination that such areas are essential to conserve the species.
PS	**Partial status** - status in only a portion of the species' range. Typically indicated in a "full" species record where an infraspecific taxon or population, that has a record in the database has USESA status, but the entire species does not.

6.2.4.3.1.4 Reproductive Characteristics

Golden eagles first breed when four to five years old. The same pair often uses the same nest year after year; nests are sometimes over six feet in diameter. One to three eggs are laid in March or April, and incubated for about 45 days. The eaglets fly in June or July when about 10 weeks old. Eggs laid early April hatch in mid-May, and fledge in mid-July to early August.

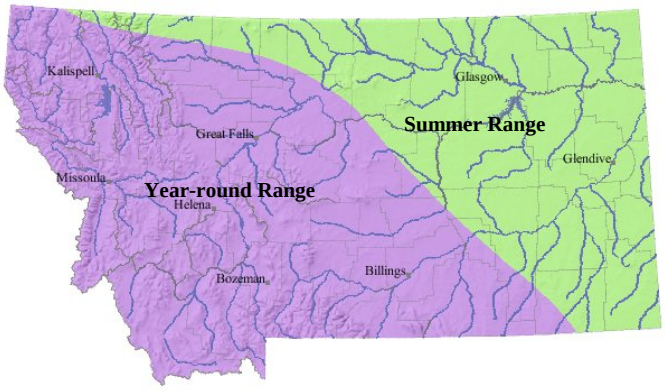
6.2.4.3.2 Great Blue Heron

6.2.4.3.2.1 Habitat

Great Blue Herons in northwestern Montana nested primarily in cottonwoods in riparian zones, and also in drier, coniferous sites. Nesting trees are the largest available. Active colonies are farther from rivers than inactive colonies. The number of nests in the colony corresponded to the distance from roads.
Great Blue Heron — *Ardea herodias*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_ABNGA04010.aspx

6.2.4.3.2.2 Food Habits

Great Blue Herons feed mostly in slow moving or calm freshwater, eating mostly fish but also amphibians, invertebrates, reptiles, mammals, and birds.



6.2.4.3.2.3 Reproductive Characteristics

Great Blue Herons are mostly monogamous, choosing new mates each year. Nests are most commonly constructed in trees up to 30 meters or more above the ground. Where trees are not available, nests are constructed on the ground. Clutch size ranges from 2 to 6 eggs. Breeding begins in April, and young may still be in the nest in July. However, rookery activity has been seen as early as March 23.

6.2.4.3.3 Greater Sage-Grouse

6.2.4.3.3.1 Habitat

Sagebrush is the preferred habitat of the Greater Sage Grouse. Birds use 6 to 18 inch high sagebrush covered benches in June to July (average 213 acres); move to alfalfa fields (144 acres) or greasewood

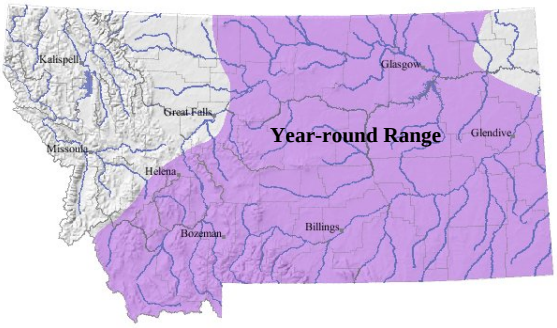
bottoms (91 acres) when forbs on the benches dry out; and move back to sagebrush (average 128 acres) in late August to early September. Greater Sage-Grouse — *Centrocercus urophasianus*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_ABNLC12010.aspx

6.2.4.3.3.2 Food Habits

Chicks eat mostly insects (60%); juveniles mostly forbs (75%) (dandelion and salsify); adults mostly big sagebrush and dandelion (79%).

6.2.4.3.3.3 Ecology

Lek activity extends from March to May. Mating sites move from year to year with nests located 0.2 to 6.5 miles from the lek. Birds populations were abundant in the last century but many are now gone. Grazing and agricultural development led to a 50% decrease in populations by the 1930s.



6.2.4.3.3.4 Reproductive Characteristics

In southwest Montana 34% of hens observed had broods, with the average brood size being 4.3 chicks. Courtship starts in early March and persists until nesting in May. Egg records are probably similar to Wyoming: April 18 to July 27.

6.2.4.3.4 Bald Eagle

6.2.4.3.4.1 Habitat

In Montana, as elsewhere, the Bald Eagle is primarily a species of riparian and lacustrine habitats (forested areas along rivers and lakes), especially during the breeding season. Important year-round habitat includes wetlands, major water bodies, spring spawning streams, ungulate winter ranges and open water areas. Wintering habitat may include upland sites. Nesting sites are generally located within larger forested areas near large lakes and rivers where nests are usually built in the tallest, oldest, large diameter trees. Nesting site selection is dependent upon maximum local food availability and minimum disturbance from human activity. Bald Eagle — *Haliaeetus leucocephalus*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_ABNKC10010.aspx.

6.2.4.3.4.2 Food Habits

The majority of their diet is comprised of fish. Important prey for Bald Eagles are waterfowl (especially in the winter), salmonids, suckers, whitefish, carrion, and small mammals and birds.

6.2.4.3.4.3 Ecology

The number of Bald Eagles in January increased from about 260 in 1980 to about 450 in 1984. Eagles on McDonald Creek in Glacier National Park increased from a peak of less than 50 in 1939 to a peak of more than 500, and have since declined because of a drop in the number of kokanee salmon spawning on McDonald Creek. Fall/winter concentrations have been noted on the Missouri River at Canyon Ferry Dam and at Fort Peck. Bald Eagles were removed from the endangered species list in June 2007 because their populations recovered sufficiently.

6.2.4.3.4.4 Reproductive Characteristics

The Bald Eagle breeds at approximately 5 to 6 years of age. Nests are often massive structures of branches and sticks with an interior cup lined with grass, pine needles, and plant stems. Nests may be used year after year, resulting in huge constructions, sometimes up to 12 feet in height and 8 feet in diameter. Most nests are in timber stands, 1.2 hectares with a canopy closure less than 80%. The most common nest trees are ponderosa pine, Douglas fir and cottonwood. The eggs are white, non-glossy, short ovals averaging 71 x 54 mm in size. The clutch, usually consisting of two eggs, but may range from one to three, is laid in March or April. Incubation, performed by both sexes, lasts about 5 weeks. Mortality for the second young to hatch is high. First flight occurs at 10 to 12.5 weeks. The young are cared for by the adults at this time and may remain around the nest for several weeks after fledging. Adults may not reproduce every year.

Breeding dates in Montana range from March to July. The Montana Department of Fish, Wildlife and Parks coordinates nest monitoring annually to assess nesting success. In 2001, approximately 180 nests were examined. Nesting attempts at twenty-three nests were unsuccessful; 28 were either unoccupied during the breeding season, were occupied by another species, or the fate was unknown; and the remaining nests produced 256 fledglings.

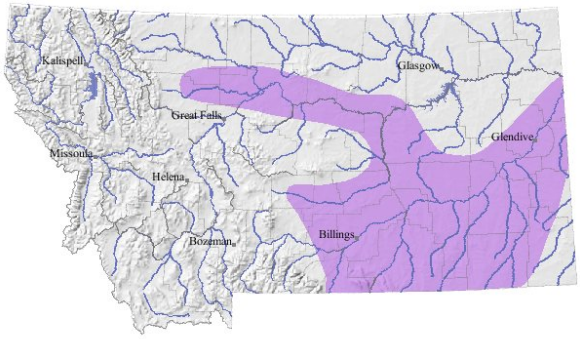
6.2.4.3.4.5 Management

General objectives of habitat management for Bald Eagles in Montana include: maintaining prey bases; maintaining forest stands currently used or suitable for nesting, roosting, and foraging; planning for future potential nesting, roosting, and foraging habitat; and minimizing disturbances from human activities in nest territories, at communal roosts, and at important feeding sites. The Montana Bald Eagle Management Plan (MBEWG 1994) directs management of this species in the state.

6.2.4.3.5 Spiny Softshell

6.2.4.3.5.1 Habitat

Habitat use by spiny softshells in Montana is probably similar to elsewhere in the range, but studies are lacking and there is little qualitative information available. They occupy larger rivers and tributaries. Both sexes have been observed basking together on partially submerged logs in backwater sites of slow-moving water, and on sandy or muddy riverbanks. Spiny Softshell — *Apalone spinifera*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_ARAAG01030.aspx



The spiny softshell is primarily a riverine species, occupying large rivers and river impoundments, but also occurs in lakes, ponds along rivers, pools along intermittent streams, bayous, irrigation canals, and oxbows. It usually is found in areas with open sandy or mud banks, a soft bottom, and submerged brush and other debris. Spiny softshells bask on shores or on partially submerged logs. They burrow into the bottoms of permanent water bodies, either shallow or relatively deep (0.5 to 7.0 meters), where they spend winter. Eggs are laid in nests dug in open areas in sand, gravel, or soft soil near water.

6.2.4.3.5.2 Food Habits

The food habits in Montana have not been studied. Elsewhere, spiny softshells forage in the water, often in shallows with vegetation. They are considered to be generalist carnivores, and usually feed on the bottom. Major foods are crayfish, aquatic insects (of at least seven orders), and fishes, but mollusks, worms, isopods, amphibians, carrion, and vegetation also are eaten. The diet in an Iowa study was about 25% insects, 36.5% fish as carrion, 5.8% small fish as live prey, and 55% crayfish, with plant material in 61% of the stomachs sampled; this breakdown of categories appears representative for other states. Prey may be chased, ambushed, or flushed and pursued.

6.2.4.3.5.3 Ecology

Animals are active from April to October (usually May to September) in Kentucky and Colorado. Water temperatures of 12˚ C appear to determine when animals enter or emerge from hibernation in Vermont). Adults emerge earlier from hibernation, and remain active longer into the fall, than juveniles. The period of activity in Montana is poorly documented, with records from early June to late July. Egg predators

include striped and spotted skunks, raccoons, red foxes, and probably coyotes; young turtles are captured and eaten by predatory fish, wading birds, and muskrats. Some individuals are caught by anglers using live or dead bait, and then killed. No information on predators is available from Montana, but some adults are incidentally captured and killed by anglers.

6.2.4.3.5.4 Reproductive Characteristics

No specific information is available for Montana, but data from other locations indicate that eggs are laid mostly in the second half of May and in June (most areas), mainly in the first half of June in southern Ontario and mid-June to early July in the far north. In Colorado evidence indicates nesting is from late May to early July, with June as the norm. In the more arid Great Plains and Rocky Mountain states, nesting activities may be stimulated by spring and early summer rains; most nesting occurs in either the morning or evening. Nests are bowl-shaped, with a narrower opening descending to a larger egg chamber; depths are usually from 7 to 18 centimeters, but may be up to 26 centimeters or more.

Clutch size averages 20 to 40 eggs, but may be as few as 6 or as high as 109. A single clutch is produced, with most mature females nesting each year, although some may skip a year. Hatchlings emerge in 55 to 125 days in late August to early October (mainly September).

Females are sexually mature in about 8 years in Iowa, 10 to 20 years in Ontario (later in north than in south), and 11 to 16 years in southeastern Michigan. Also in Ontario, the mean age of first nesting was estimated at 17 to 19 years; size at maturity is about 26 centimeters carapace length in Colorado. In Ontario, the mean age of nesting females was estimated at 33 to 40 years. Total reproductive failure (nest loss) is common. In Michigan, nest survivorship over 17 years ranged from 0 to 64% and averaged 23%. In Ontario, growth rate and reproductive output increased with habitat productivity. In Michigan, minimum reproductive frequency was less than annual (0.85). The longevity record for the snapping turtle is nearly 39 years (a captive animal); estimated ages are commonly 20 to 30 years in wild populations.

6.2.4.3.5.5 Management

Montana populations of the spiny softshell are poorly understood, making management of them more difficult. It is apparent that the construction of dams and large reservoirs on rivers (e.g. Fort Peck Dam and Reservoir) is detrimental to population continuity, effectively creating smaller isolated populations. Impacts of other habitat disturbances are not clear. Studies of nesting success, population structure, dispersal, and population size need to be conducted throughout the range of both Montana sub-populations (Missouri River and Yellowstone River).

6.2.4.3.6 Greater Short-horned Lizard

6.2.4.3.6.1 Habitat

Habitat use in Montana is poorly described, but appears to be similar to other regions. Reports mention individuals on ridge crests between coulees, and in sparse, short grass and sagebrush with sun-baked soil. On the southern exposures of the Pryor Mountains, Carbon County, individuals occur among limestone outcrops in canyon bottoms of sandy soil with an open canopy of limber pine-Utah juniper, and are also present on flats of relatively pebbly or stony soil with sparse grass and sagebrush cover. Greater Short-horned Lizard — *Phrynosoma hernandesi*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_ARACF12080.aspx

6.2.4.3.6.2 Food Habits

This species is an invertivore. The diet of short-horned lizards includes especially ants and beetles, as well as other insects, spiders, snails, sowbugs, and other invertebrates. Individuals may sometimes gorge themselves on a single type of prey. The diet in Montana is virtually undescribed; stomach contents of three individuals from coulees near the Marias River in Toole County included mostly ants with a few beetles, grasshoppers, and spiders.

6.2.4.3.6.3 Ecology

Adult short-horned lizards are diurnal and active during the warmer daylight hours. Specific information for Montana is limited, but information from other areas within their range indicates they may appear as early as late March, with most surface activity in the northern parts of the range occurring from mid-April to mid-September. Extreme records in Alberta extend from April 1 to November 10, but most have disappeared by the mean date of the first fall frost. Young-of-the-year are generally not active during mid-day hours, and small lizards appear more dependent on air temperatures than on substrate temperatures, while large ones are more dependent on substrate temperature. Predators of this species are mostly unknown, but striped whipsnake (*Masticophis taeniatus*) and Burrowing Owls (*Speotyto cunicularia*) have been reported, and birds have been identified as the primary predatory group. The annual period of activity in Montana in poorly defined, and no predators have been reported.

6.2.4.3.7 Reproductive Characteristics

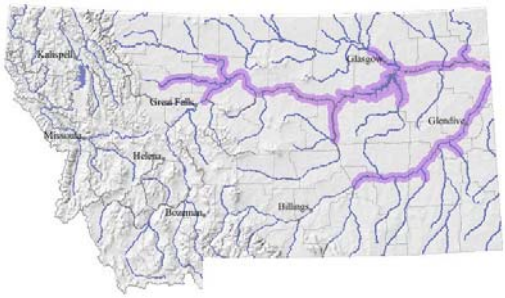
No studies of the life history and reproduction of this species have been conducted in the state. In extreme southern Montana, young about 3.0 to 3.5 centimeters snout-vent length have been observed in early August and early September.

Based upon information gathered from other areas within the species' range, adult short-horned lizards mate shortly after emerging from hibernation in late March to early June, depending on location, and young are born about two or three months after eggs are fertilized. The short-horned lizard is viviparous, giving live birth to 5 to 36 young (3 to 15 in the Pacific Northwest) during July to September. The size of 8 litters from Alberta, born in late July to early August, ranged from 6 to 13 young and 5 litters in Colorado ranged from 14 to 18 young. A litter of 13 young was born in southern Wyoming in early August (2.3 to 2.4 centimeters snout-vent length at birth) and consisted of two color morphs; 4 young were stillborn. Sexual maturity is reached in at least two years.

6.2.4.3.7.1 Management

Threats to this species in Montana are speculative, due to lack of study and poor survey coverage. The short-horned lizard was considered the most abundant reptile along the Missouri River in Montana in the late 19th century, second only to the western rattlesnake, but it is no longer thought common anywhere in the state, with the possible exception of southern Carbon County. The relatively few records in recent years parallel the pattern for Colorado, but inadequate survey coverage makes conclusions regarding trends in Montana tenuous. Habitat loss due to the conversion of prairie to cropland has undoubtedly contributed to the apparent decline, but livestock grazing is probably not a serious threat to any population, judging from reports in other regions. However, clearing of sagebrush to increase grass production for livestock could have detrimental impacts on local populations of short-horned lizards. Off-road recreational vehicle traffic and increased traffic associated with road building to oil and gas developments in eastern Montana could also have negative impacts on some populations. Indiscriminant use of insecticides to control some insect species could also affect the food supply of this lizard. No management activity for this species in Montana is currently underway, nor is any proposed at this time, but the conversion of native prairie to cropland or other use will contribute to the decline of this species in the state. Within the range of the short-horned lizard in Montana where sagebrush control is planned, some sage should be left in a network of patches to insure population persistence of these lizards. Given the small home range size of the species, thinning of sagebrush or removal in small patches is probably a better management guideline than removing sagebrush entirely or in large patches.

6.2.4.3.8 Blue Sucker



6.2.4.3.8.1 Migration

In the spring blue suckers migrate upriver and congregate in fast, rocky areas to spawn. Blue suckers make long spawning movements from the lower Missouri River to upstream areas and tributary streams. Large numbers have been observed migrating up tributary streams to spawn. Dispersal downstream follows. Blue Sucker — *Cycleptus elongatus*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_AFCJC04010.aspx

6.2.4.3.8.2 Habitat

The blue sucker is adapted for life in swift currents and prefers waters with low turbidity. The Tongue, Marias, Milk and Teton Rivers are the tributary streams most heavily used.

6.2.4.3.8.3 Food Habits

The species feeds mainly on aquatic insects in cobble areas.

6.2.4.3.8.4 Ecology

Blue suckers can live longer than 17 years. Blue suckers sampled in Montana are typically older and larger fish, with lengths of 60 to 75 centimeters and weights of 3 to 5 kilograms. Approximately 93% of sampled fish in the upper Missouri were 9 to 14 years old. The blue sucker is monogenetic and is not known to hybridize with any other species.

6.2.4.3.8.5 Reproductive Characteristics

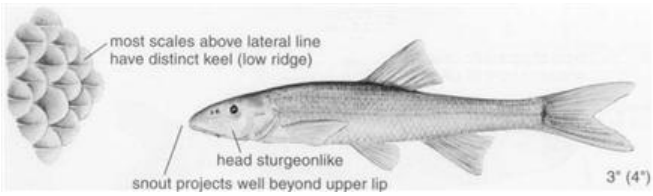
Reproductive success may be a problem for this habitat-specific species. Very few young-of-the-year blue suckers have been collected while sampling with a variety of methods. Moreover, the populations are dominated by older fish, indicative of minimal recruitment. Blue sucker larvae have been collected from the Milk River, Big Muddy Creek, and in the lower Missouri and Yellowstone Rivers. Additionally, young-of-the-year blue suckers have been sampled at the Milk River confluence and in Big Muddy Creek of the lower Missouri River. Blue suckers are probably sexually mature at 2 to 3 years. They spawn in April to June at temperatures of 50˚ F.

6.2.4.3.8.6 Management

Management of the blue sucker consists mainly of routine monitoring of population status and habitat protection. The blue sucker is considered an indicator species for ecosystem health because of its habitat-

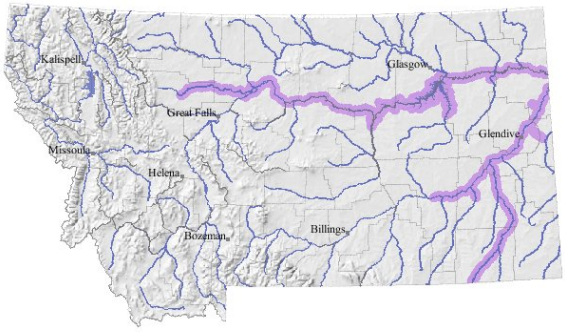
specific requirements. Current monitoring information indicates the populations are in stable condition. Efforts to locate spawning and rearing areas should be continued. Habitat protection includes protecting or promoting the natural spring-time hydrograph. Establishment of more natural seasonal flow conditions are presently being discussed and initiated for three storage reservoirs in Montana.

6.2.4.3.9 Sturgeon Chub



6.2.4.3.9.1 Habitat

Sturgeon chub are found in turbid water with moderate to strong current over bottoms ranging from rocks and gravel to coarse sand. In the Powder River, sturgeon chub were taken most frequently at sites with depths less than 51 centimeters and depth velocities of less than 90 centimeters per second at 0.6 depth. Sturgeon Chub — *Macrhybopsis gelida*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_AFCJB53020.aspx



6.2.4.3.9.2 Food Habits

A Powder River, Wyoming study showed sturgeon chub to feed mostly on small invertebrates living on the bottom substrate.

6.2.4.3.9.3 Ecology

Sturgeon chub are often found with longnose dace. Young of the year may be associated with a sand bottom. Dam building disrupts required habitat. Average lengths at ages 1 through 3 were calculated to be 48, 69 and 80 millimeters respectively. Apparently few fish reach age 4 (Stewart 1981).

6.2.4.3.9.4 Reproductive Characteristics

The biology of sturgeon chub is not well known. It apparently spawns from June through July. Ripe fish have been found in waters of about 18 to 25˚ C. Sexual maturity is obtained by age 2 at sizes of about 76 millimeters total length. Females produce 2000 to 3500 eggs.

6.2.4.3.9.5 Management

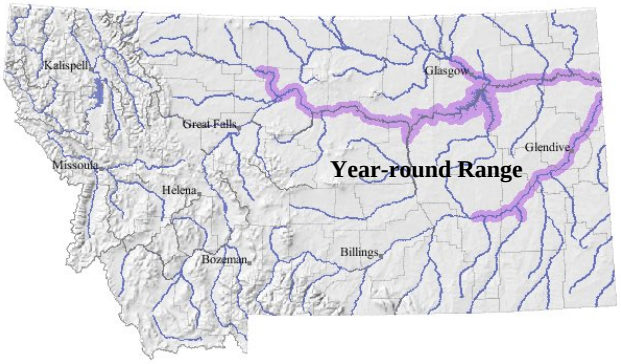
The management of this species should involve routine monitoring (once every 2 to 3 years) of existing populations. The program should be designed to monitor population trends, range expansion or losses and collect additional information on life history and ecology. This could be conducted while sampling for

other species. Recommendations for operating reservoir and irrigation projects should be developed for improving and maintaining sturgeon chub populations and habitats in Montana.

6.2.4.3.10 Paddlefish

6.2.4.3.10.1 Migration

Spawning migrations of paddlefish are tied closely with the timing of spring high water. Paddlefish — *Polyodon spathula.* Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_AFCAB01010.aspxPrivacy & Security



6.2.4.3.10.2 Habitat

Habitat includes slow or quiet waters of large rivers or impoundments. They spawn on gravel bars of large rivers during spring high water. Paddlefish tolerate, or perhaps seek, turbid water.

6.2.4.3.10.3 Food Habits

Young-of-year paddlefish will "bite" at small food particles, but eventually (within a year) switch to filtering for food as they grow and need more food. Young paddlefish are pale, nearly transparent, and swim in loose groups, preferring to feed on a large zooplankton called *Leptodora kindtii*.

When feeding, adult paddlefish swim with their mouths wide open and filter the zooplankton from the water with filament-like gill rakers. In some places, adult paddlefish also filter aquatic insects and, occasionally, tiny fish. Recent research has shown conclusively that the paddle is an electrosensory structure that functions much like an antenna. It detects weak electric fields. The paddle, head and gill flaps are covered with tiny sensory pores that it uses to detect food organisms. The paddle may also function to keep the fish level in the water while it is continually moving and feeding. The paddle would then provide "lift" much like airplane wings to keep the fish from nose-diving to the bottom.

6.2.4.3.10.4 Ecology

The paddle is not developed at all on very young fish, but by the time the fish reaches 8 inches, the paddle may be half the total length of the fish. As the fish gets larger, the paddle becomes relatively shorter compared to the total length of the fish. Adult paddlefish can live without a paddle, but there is some evidence that the fish that have lost their paddles feed less efficiently and are thinner than those with their paddles intact.

Most of the large fish (40 to 90 pounds) at Intake are females which range from 15 to 50 years of age and average about 26 years. Most of the small fish (10 to 40 pounds) are males that range from 9 to 50 years old and average about 16 years. Paddlefish can occasionally live past age 50, with fish in the Yellowstone and upper Missouri River living longer than those farther south.

The Montana record is 142 1/2 pounds, caught above Fort Peck, in 1973. Fish of the Yellowstone-Sakakawea stock seldom exceed 100 pounds. Fish living in lakes and reservoirs often grow faster and larger than those living solely in rivers.

6.2.4.3.10.5 Reproductive Characteristics

When paddlefish mature, at about age 9 to 10 for males and age 16 to 17 for females, they migrate up river to spawn. Adult fish do not as a rule die after spawning, but we know from tagging studies that a given female only spawns about every 3 years, and a given male about every 2 years.

The males and females have evolved different strategies for reproducing and passing on their genes to the next generation. The larger a female is the more eggs she can produce, and the more young paddlefish she will probably produce. A male gains less by becoming large because even a small male will have millions of sperm--enough to fertilize all of the eggs from the largest female. It is preferable for males to mature at a younger age than females so they may reproduce more often, as opposed to taking the time to grow large, risking death before they spawn. Conversely, a female benefits more from the gamble she takes in delaying maturity because of the additional eggs she will produce.

Paddlefish spawn in rivers during high water periods in late spring or early summer (May to June). In the Yellowstone River, most evidence indicates that downriver areas near Sidney and Fairview are primary spawning areas, and to a lesser extent farther upriver toward Intake. Many spawning sites are not yet well identified, however, and paddlefish undoubtedly spawn over gravel bars and areas of finer substrate in several areas of the Yellowstone River.

6.2.4.3.10.6 Management

Paddlefish stocks in Montana are adequate to support a recreational fishery. Current research and monitoring are designed to prevent over-harvest and insure a sustainable wild fishery. Managers accurately estimate the ages of the fish caught in the fisheries. Changes in the age structure of the population are being monitored to insure that young fish are added, and old fish retained, in the populations The aging of the population, along with decline in fishing success rates and higher harvest of tagged (adult) paddlefish account for the reduction of the paddlefish limit from two per person per year to

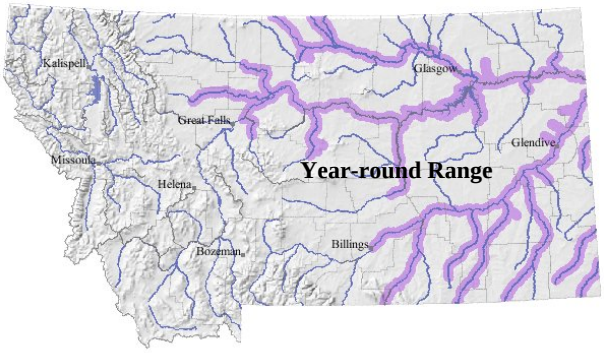
one per person per year in both Montana and North Dakota, and the proposed reduction to a 1,000 fish annual harvest cap per state. The aim is to stabilize the population at 30,000 fish and avoid over-harvest of this unique, slowly-maturing species. With a fish like paddlefish that matures at an old age, has a record of reproductive problems, and is not seen often until it is large and on its upstream migration, we need to watch constantly for signs of over-harvest.

6.2.4.3.11 Sauger

6.2.4.3.11.1 Migration

Spawning is often accompanied by migration upstream and/or into tributary streams in the spring. Long migration occurs in the Yellowstone and Missouri rivers. Sauger — *Sander canadensis*. Montana Field Guide. Retrieved on January 21, 2010, from http://FieldGuide.mt.gov/detail_AFCQC05010.aspx

6.2.4.3.11.2 Habitat



Sauger inhabit the larger turbid rivers and the muddy shallows of lakes and reservoirs. They spawn in gravelly or rocky areas in shallow water and seem to prefer turbid water.

6.2.4.3.11.3 Food Habits

The young eat aquatic insects and crustaceans. Adults feed mainly on fish. The very young feed on zooplankton. Young-of-the-year in the Missouri River are largely piscivorous.

6.2.4.3.11.4 Ecology

A large, vital spawning and feeding migration has been observed to occur from the lower reaches of the middle Missouri River to an area between Fort Benton and Morony Dam. The Tongue and Powder rivers are vital spawning areas for the Yellowstone River population.

6.2.4.3.11.5 Reproductive Characteristics

Sauger spawn from mid-April to May at water temperatures of 50 degrees F., with peaks early in May in a middle Missouri River study. They are sexually mature at 3 to 4 years. Eggs are cast over the bottom and incubate in 12 to 18 days at 50 degrees F.

6.2.5 Lands and Vegetation

6.2.5.1 Introduction

This section describes the soils and vegetation in the vicinity of the Cartersville Dam site that may potentially be affected by proposed improvements to Cartersville Dam.

6.2.5.2 Method

To inventory lands and vegetation downstream of the Cartersville Dam, GIS layers were used. These layers were developed using state and federal land use databases. This inventory was done by superimposing alternative features over land use data sets and identifying the types of lands that coincide with the project area downstream of the Cartersville Dam. These features covered soil series, topography, and existing 2005 aerial photos. These data sets were provided by the Montana State Library's National Resource Information System. Additional soil series data was provided by the National Resources Conservation Service. Vegetation and ecosystem data was provided by Montana Natural Heritage Program.

6.2.5.3 Existing Conditions

6.2.5.3.1 Ecoregion

The study area (Figure 6-9) is located directly downstream of the Cartersville Dam near Forsyth, Montana in Rosebud County. This is location is within the Northwestern Great Plains Level III ecoregion. The study area is classified by the Natural Heritage as Aquatic Ecological System Type A001 and A002, a Large River Valley. Substrate characteristics of this community are typically cobbled in the riffles, sand and gravel dominated runs and pools, with gravel and/or finer-textured side channels. The surrounding landscape is a plains cottonwood/ western snowberry woodland with evidence of existing wetlands.

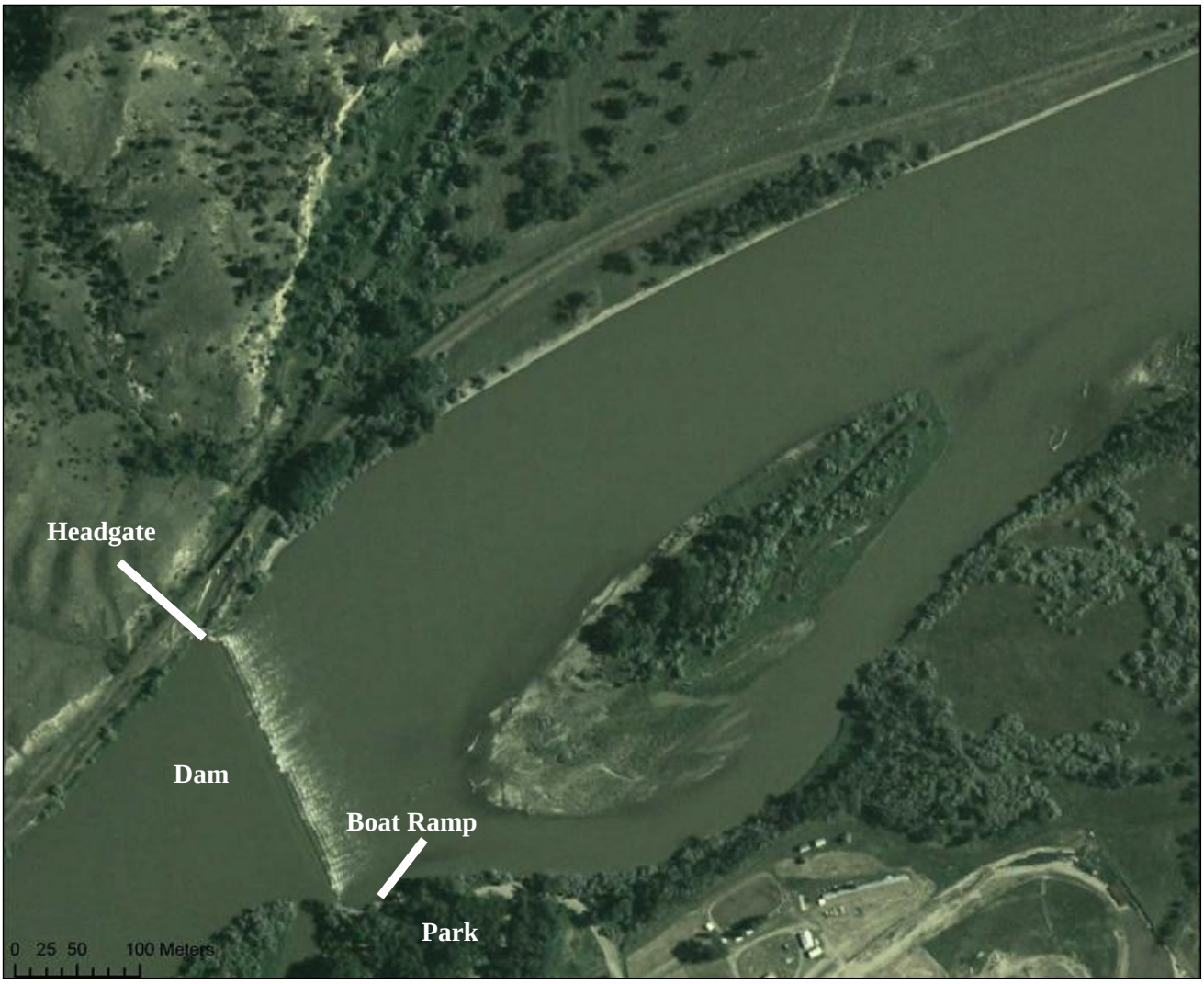


Figure 6-9 Cartersville Dam Study Area

6.2.5.3.2 Soil Series

The soils along the southern bank of the Yellowstone River have been mapped by the NRCS as Havre fine-loamy soil with mixed parent material (Figure 6-10 and Table 6-3). This is a superactive soil indicating that the area may be regularly flooded.

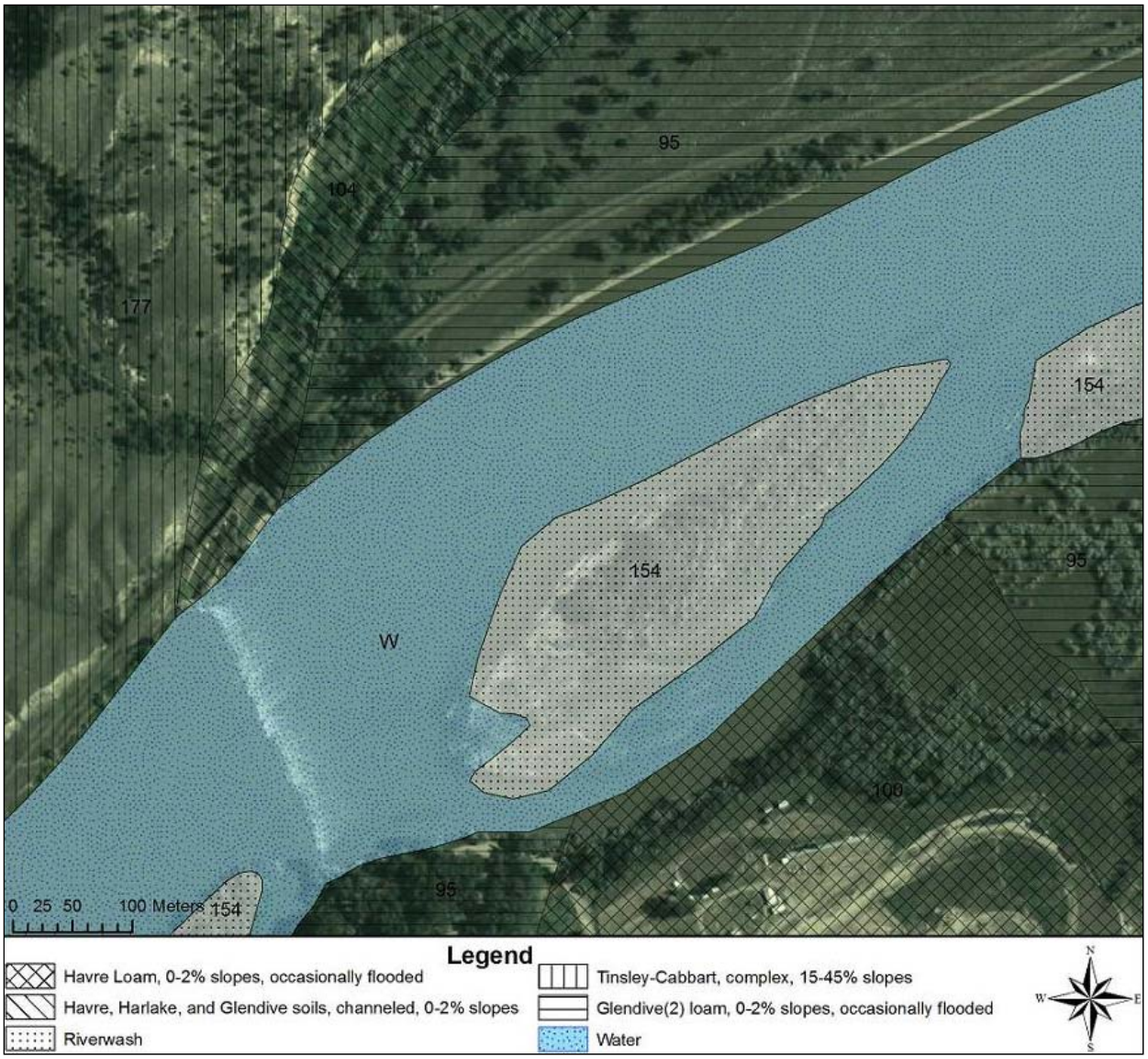


Figure 6-10 Extent of NRCS Mapped Soil Series

Table 6-3
Soil Characteristics and Descriptions

Soil Name	Family of higher taxonomic classification
Cabbart	Loamy,mixed (calcareous), frigid Ustic Torriorthents
Glendive	Coarse-loamy, mixed, superactive, calcareous, frigid Aridic Ustifluvents
Glendive(2)	Coarse-loamy, mixed (calcareous), frigid Ustic Torrifluvents
Harlake	Fine, smectitic, calcareous, frigid Aridic Ustifluvents
Harlem	Fine, montmorillonitic (calcareous), frigid Ustic Torrifluvents
Havre	Fine-loamy, mixed, superactive, calcareous, frigid Aridic Ustifluvents
Tinsley	Sandy-skeletal, mixed, frigid Ustorhents

Glendive loam soil series were mapped along the northern banks of the Yellowstone downstream of the dam and can also be found along sections of the southern bank. These soils are commonly found along floodplains and stream terraces. Like the Havre loam that dominates the southern bank, Glendive loams

are superactive aridic ustifluvents, suggesting periodic overbank flooding and saturation. Glendive loams are usually well drained and are formed in stratified calcareous alluvium.

6.2.5.3.3 Wetlands

Wetland mapping data was unavailable from the MFWP NWI program, but these soils were identified on the Montana hydric soils list. Because the soil is classified as a frigid aridic ustifluvent and is identified on the Montana hydric soils list, the land on the southern bank is likely a wetland.

6.2.6 Aquatic Assemblages

6.2.6.1 Introduction

This section identifies the fish, macroinvertebrate, and mussel assemblages that exist in the project area that may be affected by the proposed alternatives.

6.2.6.2 Methods

We reviewed literature that describes the composition of the aquatic communities in the project area. Information on fish assemblages came from White and Bramblett (1993), invertebrates from Newell (1977), and mussels from the Montana Natural Heritage Program's website and from Dan Gustafson's website. We considered the relationships between fish species, movements, and habitats that may be affected by the proposed alternatives.

6.2.6.3 Existing Conditions

6.2.6.3.1 Fish Assemblages

The Yellowstone River supports a moderately diverse assemblage of fishes comprised of about 56 species representing 16 to 19 families (White and Bramblett 1993; Montana Fisheries Information System 2009). The distribution of fish species varies from headwaters to mouth, with increasing species richness proceeding downstream. The Yellowstone River has been characterized as having three fish zones. The salmonid or coldwater zone, beginning in the headwaters and continuing 221 miles downstream to the Boulder River near Big Timber, Montana supports 16 species, with mountain whitefish, rainbow trout, brown trout, Yellowstone cutthroat trout, longnose sucker, white sucker, and mottled sculpin being abundant (White and Bramblett 1993). The transition zone, located downstream of the salmonid zone, extends downstream about 160 miles to the mouth of the Bighorn River. The transition zone is now considered to be much shorter, from the confluence with the Clarks Fork to Huntley (Frazer, Verbal Communication 2010). Fish species diversity increases in the transition zone, with about 30 species present. Common species are flathead chub, longnose dace, emerald shiner, river carpsucker, shorthead redhorse, channel catfish, burbot, smallmouth bass, and sauger (White and Bramblett 1993, Mike Duncan,

Montana Cooperative Fishery Research Unit, personal communication). A large change in the fish assemblage occurs in the warmwater zone, where about 49 fish species occur. Common species in this zone include shovelnose sturgeon, longnose dace, emerald shiner, flathead chub, western silvery minnow, river carpsucker, shorthead redhorse, blue sucker, smallmouth buffalo, bigmouth buffalo, channel catfish, stonecat, burbot, sauger, and freshwater drum.

The location of Cartersville Dam in the species-rich warmwater fish zone means that this structure potentially affects the connectivity of a large number of fish species. Fish assemblages in large rivers such as the Yellowstone contain many species of "big river" fishes that are noted for their long-range migrations (Schmutz and Jungwirth 1999; Pringel et al. 2000). It is very likely that the Cartersville Dam blocks upstream movement of shovelnose sturgeon as well as most if not all fish species in this reach. Matt Jaeger of Montana Fish, Wildlife and Parks observed movements of shovelnose sturgeon in this reach using radio telemetry (Jaeger et al. 2009). Twelve of 36 (33%) of radio-tagged shovelnose sturgeon had their most-upstream locations directly below the Cartersville Dam, and were apparently blocked from passing upstream of the structure (Appendix A). Shovelnose sturgeon are probably limited from the Yellowstone River above Cartersville Reservoir (Helfrich 1999; Jaeger et al. 2009; Frazer, Verbal Communication 2010), however their former distribution probably extended upstream in the Yellowstone River at least to the mouth of the Bighorn River.

The blue sucker is a highly migratory fish species and the Yellowstone River populations are likely fragmented by diversion dams, including Cartersville (Gardner 1998; Jaeger et al. 2009). Burbot and channel catfish are important fish species for recreational fishing. Jaeger et al. (2009), suggest that Cartersville and the other four upstream diversion dams may be size-selective barriers to channel catfish. Very little is known about burbot movements in the Yellowstone River, but diversion dams are a concern for this species (Jaeger et al. 2009). Sauger are important game fish in the lower Yellowstone River. Although adult radio-tagged sauger were documented passing all diversion dams on the Yellowstone River (except Huntley Diversion), diversion dams are probably a barrier to juvenile sauger (Jaeger et al. 2005). Emerald shiner have been observed aggregating and presumably blocked from upstream movement below the Cartersville Dam (Robert G. Bramblett, personal observation).

Currently, Cartersville Dam appears to block upstream movement of shovelnose sturgeon (Jaeger et al. 2009) as well as juvenile sauger (Jaeger et al. 2005). Although Helfrich et al. (1999) reported that Cartersville Dam did not create any disjunct fish populations; it is likely that upstream passage is impeded for some proportion of the 40-50 fish species present in the project area. For example, total numbers of shorthead redhorse, goldeye, *Hybognathus* sp. (likely western silvery minnow), emerald shiner, and river

carpsucker were higher below Cartersville Dam than above it. The total number of all fish species fish captured was also higher below Cartersville.

No experiments directly testing fish passage have been performed at Cartersville Dam; however fish passage was studied at Intake and Huntley diversion dams (Helfrich et al. 1999). Individual fish were captured, marked, and released above and below Intake and Huntley diversion dams. Of 4,430 representing 37 species marked below Huntley Dam, 13 fish representing 7 species were recaptured upstream of the dam. At Intake dam, 4,080 fishes were marked and 17 fish of 4 species were recaptured above the dam (Helfrich et al. 1999). Species documented as passing Huntley dam were white sucker, common carp, goldeye, brown trout, shorthead redhorse, longnose sucker, and flathead chub. Species documented as passing Intake dam were goldeye, walleye, sauger, and smallmouth buffalo. Recapture of fish passing dams was unrelated to abundance of marked fish or size of marked fish. The authors speculate that passage was related to swimming ability, because those species in which passage was thought to occur were strong swimmers, although no swimming performance data are available for most warmwater nongame species. The experiments were conducted during summer, and the fish that passed the dams did so in July and September. River discharges were high during the experimental periods, and the presence of natural bypass channels around both dams during high flows may have allowed fish to pass upstream of the dams without actually negotiating the dams. Although few fish were recaptured above the dams, some fish may have passed and continued upstream without being detected during recapture efforts.

6.2.6.3.2 Macroinvertebrates

Little information exists for macroinvertebrate communities on the Yellowstone River (White and Bramblett 1993). Newell (1977) sampled macroinvertebrate communities at 20 sites arrayed longitudinally from just below Yellowstone National Park to just above the confluence of the Missouri River in North Dakota in late summer and fall of 1975. Species richness and diversity declined from upstream to downstream. Mayflies (Order Ephemeroptera) totaled 37 species and ranged from 19 species per site in the salmonid zone to 10 species at the two lowermost sites. Thirty seven stonefly (Order Plecoptera) species were collected; species richness was 21 species at the uppermost site and declined rapidly downstream in the transition zone. Caddisflies (Order Trichoptera) had a similar species richness pattern, totaling 36 species and declining from upstream to downstream. The river near Cartersville Dam probably supports about 15-20 mayfly species, 10-15 caddisfly species, and 1-5 stonefly species. True flies (Order Diptera) were found throughout the river, as were beetles (Order Coleoptera), whereas dragonflies (Order Odonata), true bugs (Order Hemiptera) were found only in the transition and warm water zones. Noninsect macroinvertebrates collected included turbellarians, oligochaetes, mollusks, isopods, amphipods, and acarians (Newell 1977).

Aquatic insect dispersal is probably not currently affected by Cartersville Dam. Aquatic insects drift downstream with the current; Cartersville Dam does not prevent drift. Following emergence as adults, aquatic insects are able to fly upstream to lay eggs, thereby preventing depletion of upstream habitats.

6.2.6.3.3 Mussels

There is one mussel species (Family Unionidae) in the project area, the fatmucket (*Lampsilis siliquoidea*). This species is native in the larger prairie rivers of Montana and found in areas with gravel, sand and silt substrates. It is fairly tolerant of silt and warm to cool water temperatures. It is considered to be an S5 species by the Montana Natural Heritage program, meaning it is common, widespread, and abundant (although it may be rare in parts of its range), but not vulnerable in most of its range. Larval freshwater mussels (glochidia) are parasites of fish, and attach themselves to the gills or fins of the fish for a period of time. Eventually the glochidia break free and settles to the bottom of the river to begin an independent life. This parasitic phase allows mussels to move and disperse with fish through watersheds, including in an upstream direction. Host fish species for the fatmucket in Montana are the freshwater drum, channel catfish, stonecat, sturgeons, common carp, black bullhead, sunfishes and bass, and yellow perch. Fingernail clams (Family Sphaeriidae) are present in Montana, but there is little information on their identity, distribution, or ecology.

6.2.7 Recreation

6.2.7.1 Introduction

This section describes the existing conditions regarding recreational activities including fishing in the project area.

6.2.7.2 Methods

We consulted Montana Fish, Wildlife and Parks MFISH webpage and existing literature for information on fishing in the project area. In addition we have obtained information from members of the community.

6.2.7.3 Existing Conditions

The Yellowstone River is one of North America's most highly regarded fishing rivers. The salmonid zone attracts the highest fishing activity and Montana Fish Wildlife, and Parks considers the upper river as an outstanding Fisheries Resource Value (MFISH). In the warmwater zone, very few trout are present and fishing pressure decreases (Frazer, Verbal Communication 2010). However, FWP considers the Fisheries Resource Value to be high-value in the project area.

Game fish in the project area include channel catfish, northern pike, burbot, smallmouth bass, sauger, and walleye (White and Bramblett 1993). The area adjacent to and below the Cartersville Dam is a popular fishing location and a boat ramp is located at the state park just downstream of the dam on the right bank (Figure 6-9). Fish that are unable to pass upstream of the diversion dam likely aggregate and are available for angling.

In addition, the community uses the state park on the south bank of the Yellowstone River at the dam extensively for swimming, picnicking, boating, and other social events.

6.3 Cultural Resources

6.3.1 Introduction

Historic property includes any prehistoric or historic district, site, building, structure or object included in or eligible for inclusion on the Natural Register of Historic Places (National Register). This can also include sites, locations, or areas valued by Native Americans (USACE, 2000).

A cultural resources study is defined as a scientific investigation conducted for the following purposes (USACE, 2000):

- Discovering cultural resources;
- Confirming their location, extent, and character;
- Evaluating their significance;
- Determining their research potential;
- Determining potential project effects; and
- Developing alternate preservation and/or mitigation plans.

Feasibility phase cultural resources investigations shall usually begin with a literature and records review (USACE, 2000).

6.3.2 Method

Consultation with SHPO in Helena, Montana was used to determine whether any cultural resources exist in the project area.

6.3.3 Existing Conditions

The Montana Historical Society indicates there have been a few previously recorded sites with the designated search locale. Site 24RB1000 is the Cartersville Irrigation system which is eligible for listing

on the National Register of Historic Places. In addition to the site there have been inventories done in the area.

6.4 Aesthetic Resources

6.4.1 Introduction

Aesthetic resources include those natural resources, landform, vegetation and man-made structures in the environment which generate one or more sensory reactions and evaluations by the observer, particularly in regard to pleasurable response (USACE, 2000).

6.4.2 Method

Members of the community have expressed their feelings regarding the aesthetic value of the project.

6.4.3 Existing Conditions

Members of the community indicate the diversion dam and adjacent park are an important aesthetic resource that should be protected.

6.5 Water Quality

6.5.1 Introduction

The following section contains a summary of surface water quality conditions at the site. This includes a summary of available water quality data collected by the US Geological Survey, as well as a description of water quality impairment listings developed by the State of Montana.

6.5.2 Method

The summary provided is based on publications produced by the Montana Department of Agriculture (http://agr.mt.gov), Montana Department of Environmental quality (http://deq.mt.gov), and the United States Geological Survey (Zelt, et al, 1998; Miller et al, 2004).

6.5.3 Existing Conditions

From the mouth of the Big Horn River to the mouth of the Powder River, the Yellowstone River has been classified as by the state of Montana a Class B-3 water body (http://cwaic.mt.gov). Class B-3 standards are as follows: Suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply (http://deq.mt.gov).

From the Big Horn River to Cartersville Dam, the river has been listed as partially supporting of the warm water fishery, and the probable cause of this impairment is listed as a fish passage barrier. Between Cartersville Dam and the Powder River, the Yellowstone has been listed as partially supporting of aquatic life and the warm water fishery. The probable causes for this impairment include riparian alterations, nitrate/nitrite, pH, sediment, copper, lead, and zinc. To date, Total Maximum Daily Loads (TMDLs) have not been developed for listed waterbody.

6.5.3.1 Suspended Sediment

Zelt and others (1998) broadly summarized water quality conditions of the Yellowstone River basin using suspended sediment and dissolved solids concentrations data. They noted that land disturbances caused by human activities contribute to suspended sediment and dissolved solids in surface waters. In addition, suspended sediment concentrations relate to the types of rock units exposed on the land surface. Suspended sediment concentrations tend to be higher in stream flow through less resistant sedimentary rocks that are Mesozoic in age or younger (Zelt, et al, 1998); at Cartersville Dam, sediments in both the valley bottom and bluff line are all within this category.

Suspended sediment concentrations and suspended sediment discharge values are available for the USGS gaging station at Forsyth (Station #06295000) from 1978 to 1981. These data show that during that time, suspended sediment concentrations reached 4,000 mg/l during a 97,000 cfs flood event in May of 1978 (Figure 6-11). This flood event was also characterized by a suspended sediment discharge of 761,000 tons per day (Figure 6-12). More typically, however, spring runoff events in the 1978-1981 time frame are characterized by suspended sediment concentrations of less than 1,000 mg/l, and suspended sediment discharges of less than 150,000 tons per day (Figure 6-11 and Figure 6-12). Data derived from 42 samples collected at Forsyth between 1999 and 2001 show median suspended sediment concentration values of approximately 40 mg/l (Figure 6-13; Miller, et al, 2004).

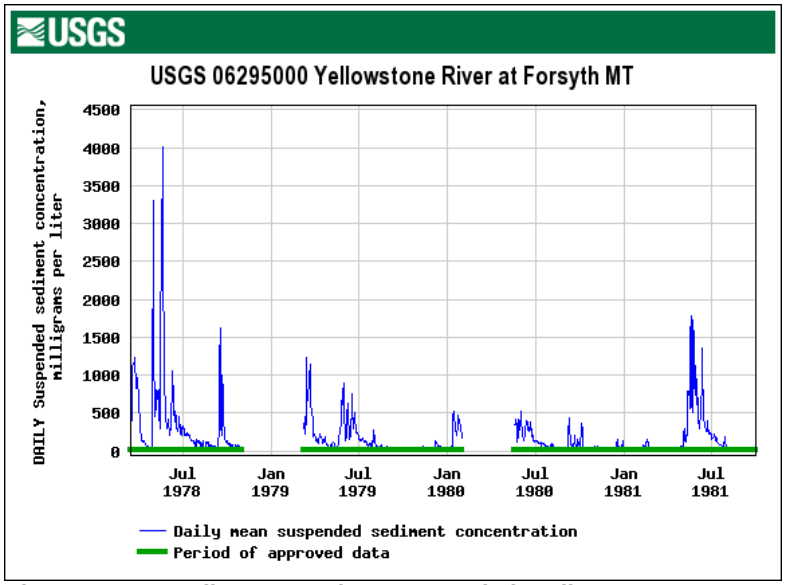


Figure 6-11 Yellowstone River Suspended Sediment Concentration Values Measured at Forsyth, 1978-1981

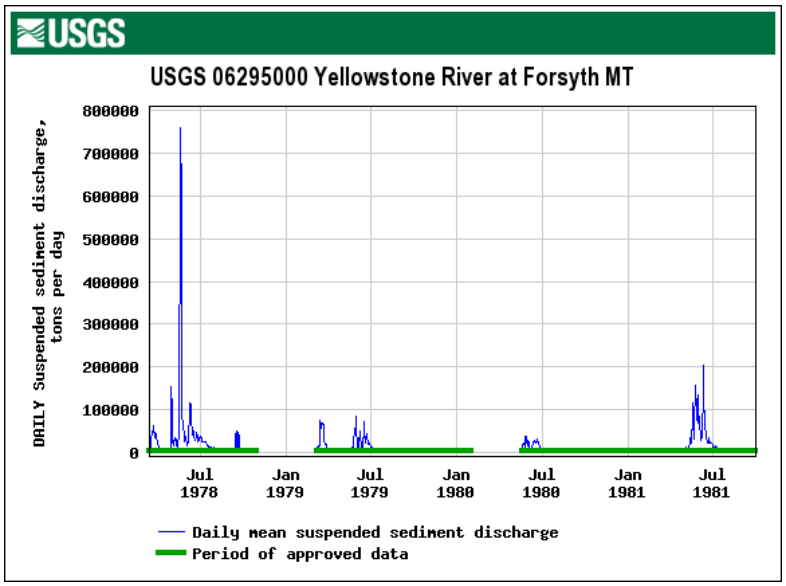


Figure 6-12 Yellowstone River Suspended Sediment Discharge Values Measured at Forsyth, 1978-1981

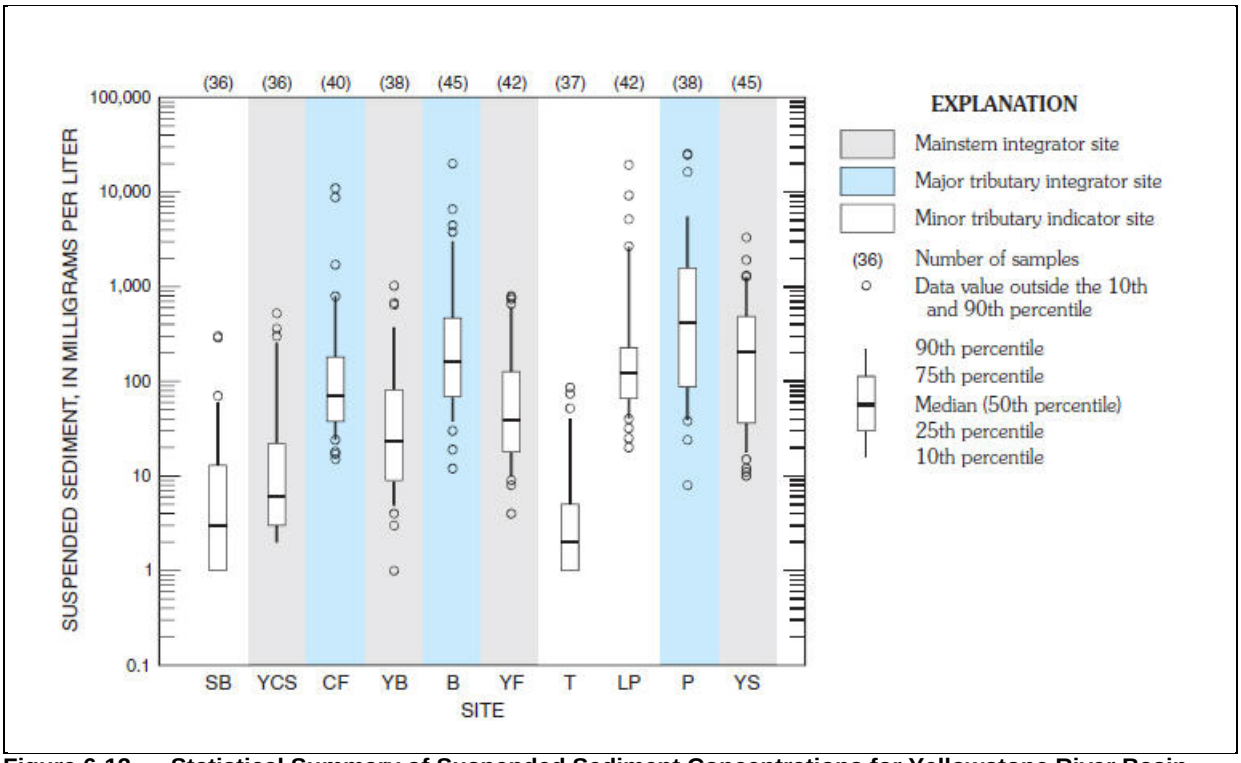


Figure 6-13 Statistical Summary of Suspended Sediment Concentrations for Yellowstone River Basin Sites, 1999-2001; YF is Yellowstone River at Forsyth (Miller, et al, 2004)

6.5.3.2 Dissolved Solids

The concentrations of dissolved solids in the Yellowstone River basin tend to be higher in streams that flow through the basins and plains areas (Zelt, et al, 1998). Dissolved solids tend to be low where crystalline rocks predominate, and higher where younger sedimentary rocks are present. Dissolved solids concentrations tend to be higher at low river discharges. The 75th percentile values of dissolved solids calculated from gage records at Billings and Sydney are approximately 250 mg/l and 400 mg/l, respectively (Zelt, et al, 1998). Data collected at Forsyth between 1999 and 2001 show that based on 42 samples, the median dissolved solids concentration values is approximately 400 mg/l (Figure 6-14; Miller, et al, 2004).

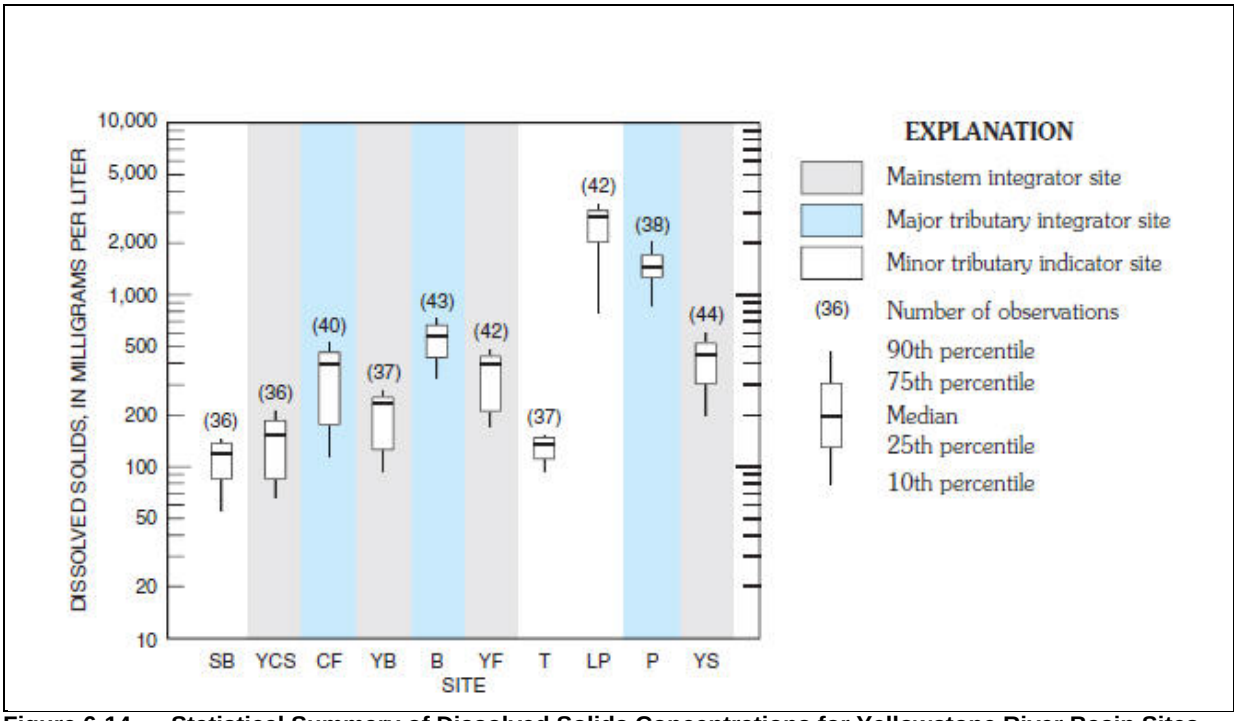


Figure 6-14 Statistical Summary of Dissolved Solids Concentrations for Yellowstone River Basin Sites, 1999-2001; YF is Yellowstone River at Forsyth (Miller, et al, 2004)

6.5.3.3 Pesticides

The USGS collected monthly water samples between January 1999 and September 2001 from the Yellowstone River near Forsyth for pesticide analysis (Miller, et al, 2004). The Montana Department of agriculture has summarized USGS sampling that extends from 1999 to 2004 (http://agr.mt.gov). The most commonly detected pesticides were atrizine, triallate, metolachlor, prometon, and cyanazine (Figure 6-15). These pesticides, with the exception of prometon, tend to be associated with agricultural uses such as with corn, sugar beets, and small grain crops. Prometon, in contrast, tends to be used in more urban areas. All of the pesticide concentrations were below any existing human health standards or aquatic life standards. Herbicides typically used in noxious weed control, such as 2,4-D, picloram, and imazapyr, were not analyzed in this effort.

6.5.3.4 Nitrates

A suite of nitrate analyses from the Yellowstone River near Forsyth were developed by the USGS, using 74 samples collected from the river between 1999 and 2004. Nitrate was detected in 72 of the 74 samples at concentrations ranging from 0.03 to 0.65 mg/l (Figure 6-15). The median concentration measured was 0.2mg/l (http://agr.mt.gov). Seasonal variations in nitrate levels were observed, with higher concentrations occurring between October and March, and lower concentrations between April and September.

Summary of Pesticide*/Nitrate Detections in the Yellowstone River near Forsyth from 1999 through September 2004 Collected by the U.S. Geological Survey							
Pesticide Compound	Number of Samples Collected	Number of Samples with Pesticide Detected	Percent of Samples with Pesticide Detected	Minimum Concentration (µg/L)	Maximum Concentration (µg/L)	Drinking Water Standard (µg/L)	Aquatic Life Standard (µg/L)
Atrazine	65	51	78.5	E 0.003	0.328	3	1.80
Benfluralin	65	1	1.5	--	E 0.003	--	--
Carbaryl	65	1	1.5	--	0.005	700	0.20
Carbofuran	65	1	1.5	--	E 0.034	40	1.80
Chlorpyrifos	65	1	1.5	--	E 0.002	20	0.041
Cyanazine	65	10	15.4	E 0.003	0.018	1	2.0
EPTC	65	7	10.8	E 0.001	0.16	--	--
Malathion	65	1	1.5	--	E 0.004	100	0.10
Metolachlor	65	29	44.6	E 0.002	0.034	100	7.80
Prometon	65	19	29.2	M	E 0.01	100	--
Propargite	65	1	1.5	--	0.41	--	--
Simazine	65	1	1.5	--	E 0.003	4	10
Tebuthiuron	65	2	3.1	M	E 0.01	500	1.60
Triallate	65	33	50.8	E 0.001	0.012	--	0.24
Trifluralin	65	1	1.5	--	E 0.002	5	0.20
Nutrient Compound	Number of Samples Collected	Number of Samples with Nitrate Detected	Percent of Samples with Nitrate Detected	Minimum Concentration (mg/L)	Maximum Concentration (mg/L)	Drinking Water Standard (mg/L)	Aquatic Life Standard (mg/L)
Nitrate + Nitrite	74	72	97.3	0.03 E	0.65	10	--

E = Estimated value M = Presence of chemical verified but not quantified
* This table only contains a summary of pesticides detected; many other pesticides were analyzed for and not detected

Figure 6-15 Summary of Pesticide and Nitrate Detections in Yellowstone River Near Forsyth, 1999-2004 (http://agr.mt.gov)

6.6 Air Quality

6.6.1 Introduction

The section addresses ambient air quality at the project site in Forsyth, Montana.

6.6.2 Method

The Montana Department of Environmental Quality (DEQ) was contacted to determine if any ambient air quality data exists in the Forsyth area.

6.6.3 Existing Conditions

The DEQ indicates the closest air quality station to Forsyth is located in Colstrip, Montana, approximately 26 miles to the south.

7.0 ENVIRONMENTAL CONSEQUENCES

7.1 Introduction

This section describes the environmental consequences that may result from this project and associated environmental mitigation. Two alternatives are addressed: the no action alternative and a rock ramp. The proposed rock ramp consists of a constant slope of 0.5%. However, the environmental consequences for each of the slope options are essentially the same, except for their respective footprints.

7.2 Adaptive Management

The rock ramp riprap will not be grouted to allow for future modifications to improve fish passage.

7.3 Ecological Resources

7.3.1 Hydrology

7.3.1.1 Introduction

This section describes the anticipated effects of the proposed alternatives on the hydrology of the Yellowstone River.

7.3.1.2 Methods

Hydrologic data from the USGS are used to evaluate hydrologic effects.

7.3.1.3 Results

7.3.1.3.1 No Action

No changes to hydrology would occur.

7.3.1.3.2 Rock Ramp Alternative

No change to hydrology is anticipated with the rock ramp alternative.

7.3.1.4 Cumulative Effects

This project has no effect on hydrology and there are no other projects in the area that would affect hydrology. Therefore, there are no anticipated cumulative effects on hydrology.

7.3.1.5 Environmental Mitigation

No mitigation measures are proposed.

7.3.1.6 Summary

There are no effects on hydrology associated with either the no action or rock ramp alternative.

7.3.2 Geomorphology

7.3.2.1 Introduction

The following section describes the anticipated effects of proposed alternatives on the geomorphology of the Yellowstone River. The characteristics assessed include bed slope, in-stream erosion/depositional patterns, and impacts to the boundaries of the active channel migration corridor.

7.3.2.2 Methods

To evaluate the effects on stream geomorphology, the effects of the proposed alternative as well as No Action have been considered based on air photo assessments of historic channel behavior, channel migration zone mapping (DTM and AGI, 2009), and existing bank protection extent (AGI and DTM, 2004).

7.3.2.3 Results

7.3.2.3.1 Channel Slope

7.3.2.3.1.1 No Action

No changes to the channel slope would be anticipated. The existing condition, which consists of a steep drop over the existing dam crest, would remain.

7.3.2.3.1.2 Rock Ramp Alternative

The Rock Ramp alternative would modify the channel slope for its entire extent. The slope would be markedly reduced at the dam face, and downstream, the channel would be steepened as the ramp feature absorbs grade in the downstream direction. The final design of the feature would define the degree to which the existing bed slope is ultimately altered; the slope of the rock ramp will likely be on the order of 0.5%. The materials used in the ramp will be designed to withstand the hydraulic changes imposed by the altered channel grade. The steep drop created by the dam will be removed and extended over a longer channel distance, improving conditions for overall connectivity and fish passage in the reach.

7.3.2.3.2 Channel Dynamics

7.3.2.3.2.1 No Action

No changes in channel dynamics would be anticipated. Bar growth, channel migration, and bank erosion would be expected to continue downstream of the dam.

7.3.2.3.2.2 Rock Ramp Alternative

The conceptual design for the rock ramp includes the construction of a berm feature between the existing island downstream of the dam and the main channel. This berm would effectively armor the riverward side of the island to prevent erosion on the margin of the ramp. Southward, the right bank of the river along the side channel would be armored as well. This bank is currently armored with concrete rubble, however that armor is discontinuous. These project elements will serve to reduce bar growth and bank erosion on the right bank downstream of the dam. Left bank armor along the ramp margin would similarly reduce erosion potential. This revetment would isolate approximately 15 acres of channel migration area mapped by DTM and AGI (2009).

The project is located in Reach C10 of the Yellowstone River Cumulative Effects Study (AGI and DTM, 2004). The reach extends approximately 4.5 miles upstream of Cartersville Dam, and 2.5 miles downstream. Within this 6.9-mile long reach, a physical features inventory performed in 2002 indicated that a total of 22% of the bankline was armored at that time. The rock ramp alternative with a slope of 0.5% will include armoring of approximately 1,200 feet on the left bank and 700 feet on the right bank. With an estimated additional 1,900 feet of bank armor, the total length of armored bankline in the reach will increase from 22% to 25% (Table 7-1).

Table 7-1
Bank Protection Inventory, Reach C10

Feature	Existing (ft)	Existing (% of bank length)	Proposed (ft)	Proposed (%)
Dike/Levee	4859	7%	4859	7%
Bank Armor	15959	22%	17,859	25%

Because Cartersville Dam is located at Forsyth, the reach shows relatively high extents of existing bank protection. From Billings to Miles City, 29 mapped reaches depict an average bank armor extent of 15% (AGI and DTM, 2004). In Reach C10 at Forsyth, 22% of bank length currently protected by armor. The relatively high armoring extents in this reach reflect the urbanized condition in the reach, and the associated attempts to prevent lateral channel migration and bank erosion. As such, although the project

will increase the extent of bank armor in the reach by approximately three percent, the fact that the reach is in a relatively developed area renders it prone to armoring regardless of project implementation.

The rock ramp alternative will reduce the scour potential of the river bed downstream of the dam structure. When the armored berm is overtopped, scour on its downstream side is likely, and this scour may result in the erosion of the edge of the existing island. Final design efforts will consider this scour potential and design the downstream-sloping face of the berm accordingly.

7.3.2.4 Cumulative Effects

From Billings to Miles City, mapped erosion control features occupy approximately 322,000 feet of bankline, or approximately 15% of banks (AGI and DTM, 2004). An addition of 1,900 feet, or less, of bank armor at Cartersville will increase the total bank armor length by 0.1%. This increase in cumulative bank protection is offset by the net benefit of the project to the Yellowstone River fishery.

7.3.2.5 Environmental Mitigation

For the rock ramp alternative, no mitigation measures are proposed due to the net benefit of the project to the Yellowstone River fishery. Bank armor should be designed to minimize the impacts to fishing access.

7.3.2.6 Summary

The No Action Alternative will not affect channel slope, bank migration patterns, bar development, or channel migration zone area.

The long term effects of the Rock Ramp Alternative include a modification of the channel slope at Cartersville Diversion to a more natural gradient such as that surveyed at Matthews Rapid downstream. The inclusion of bank armor on the margins of the structure will increase in a 3% increase in total armored bank length in the reach, and a 0.1% increase in bank armor length in the river segment that extends from Billings to Miles City. This armoring will result in the isolation of approximately 15 acres of area previously mapped as within the 100-year channel migration zone. The armored berm that extends from dam downstream to the northern margin of the island area will increase scour potential on its downstream side. This scour potential will be considered in final design.

7.3.3 Federally-Listed Species and State Species of Special Concern

7.3.3.1 Introduction

The following section describes the anticipated effects of proposed alternatives on federally-listed species and state species of special concern in the vicinity of Cartersville Dam. The species considered include:

golden eagle, great blue heron, greater sage-grouse, bald eagle, spiny softshell, greater short-horned lizard, blue sucker, sturgeon chub, paddlefish, and sauger.

7.3.3.2 Methods

To evaluate the effects on federally-listed species and state species of special concern, the effects of the proposed rock ramp alternative as well as no action have been considered based on potential impacts to migration, feeding, nesting, and reproduction.

7.3.3.3 Results

7.3.3.3.1 Golden Eagle

7.3.3.3.1.1 No Action

The no action alternative will have little or no effect on golden eagle populations.

7.3.3.3.1.2 Rock Ramp Alternative

Golden eagles tend to inhabit upland grassland habitats. Consequently, the rock ramp alternative is not anticipated to affect migration patterns or feeding or nesting habitat for golden eagles.

7.3.3.3.2 Great Blue Heron

7.3.3.3.2.1 No Action

The no action alternative will have little or no effect on great blue heron populations.

7.3.3.3.2.2 Rock Ramp Alternative

The rock ramp alternative is not anticipated to affect nesting habitat or migration patterns of great blue herons. However, the rock ramp alternative may have some impact on great blue heron feeding. These birds prefer to feed by wading in slow-moving water up to 18 inches deep or from the shoreline or occasionally when perched on rocks in deeper water. The rock ramp alternative will transform approximately 20 acres of the Yellowstone River from slower moving, deep water habitat to fast-moving, shallower rapid habitat. This may reduce the amount of feeding habitat available to great blue herons, especially along the shoreline where they are more likely to feed. Most of the river away from the shoreline is probably not used by herons and therefore, will not result in any loss of feeding habitat.

7.3.3.3.3 Greater Sage-Grouse

7.3.3.3.3.1 No Action

The no action alternative will have little or no effect on greater sage grouse populations.

7.3.3.3.3.2 Rock Ramp Alternative

Greater sage grouse tend to inhabit upland grassland habitats. Consequently, the rock ramp alternative is not anticipated to affect migration patterns or feeding or nesting habitat for greater sage grouse.

7.3.3.3.4 Bald Eagle

7.3.3.3.4.1 No Action

The no action alternative is expected to have little or no impact on bald eagle populations.

7.3.3.3.4.2 Rock Ramp Alternative

The rock ramp alternative is not anticipated to affect nesting habitat or migration patterns of bald eagles. However, the Cartersville Dam is likely to concentrate fish at the toe of the dam, thereby increasing food availability for bald eagles. At the same time, the dam also limits the extent of some fish species that bald eagles utilize for food. Consequently, the rock ramp alternative is expected reduce food availability locally, but may benefit bald eagle feeding regionally by improving fish populations bald eagles rely upon as food.

7.3.3.3.5 Spiny Softshell

7.3.3.3.5.1 No Action

Dams are thought to create migration impediments or barriers for spiny softshell turtles. Although the dam at Cartersville is relatively low and spiny softshells may be able to walk around the dam abutments, the existing structure is likely to impede the upstream movement of this species. Consequently, the no action alternative is anticipated to continue having a negative impact on spiny softshell populations.

7.3.3.3.5.2 Rock Ramp Alternative

The rock ramp alternative will transform approximately 22 acres of the Yellowstone River from slower moving, deep water habitat to fast-moving, shallower water rapid habitat. This section of river is currently too swift to be considered optimal habitat for spiny softshells, so the overall impact of constructing the rock ramp is expected to be slight. The rock ramp is also expected to have positive impacts by removing a potential migration barrier to spiny softshells.

7.3.3.3.6 Greater Short-horned Lizard

7.3.3.3.6.1 No Action

The no action alternative will have little or no effect on greater short-horned lizard populations.

7.3.3.3.6.2 Rock Ramp Alternative

Greater short-horned lizards tend to inhabit uplands with sandy or gravelly soils. Impacts of the rock ramp alternative will be limited primarily to the river channel and, therefore, are not expected of affect greater short-horned lizard populations.

7.3.3.3.7 Blue Sucker

7.3.3.3.7.1 No Action

Blue suckers make long upstream migrations to spawn. Helfrich et al. (1999) found that the distribution of several native riverine species were restricted by diversion dams on the Yellowstone River during low water years. They reported the upstream distribution above Cartersville Dam for several fish species, including blue sucker, is restricted by this structure. Consequently, the no action alternative will continue to have a negative impact on blue sucker populations.

7.3.3.3.7.2 Rock Ramp Alternative

The rock ramp alternative will benefit blue sucker populations by providing passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.3.8 Sturgeon Chub

7.3.3.3.8.1 No Action

It is unclear whether Cartersville Dam creates a migration barrier to sturgeon chubs. Helfrich et al. (1999) did not include sturgeon chub in their list of several native riverine species that were restricted by diversion dams on the Yellowstone River. However, the small size of this fish species would suggest that Cartersville Dam may present a passage impediment. Consequently, we suggest that the no action alternative will negatively impact sturgeon chub populations.

7.3.3.3.8.2 Rock Ramp Alternative

Assuming sturgeon chub are capable of passing natural rapids in the Yellowstone River, the rock ramp alternative will benefit sturgeon chub populations by improving passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.3.9 Paddlefish

7.3.3.3.9.1 No Action

Paddlefish make long upstream migrations to spawn. Helfrich et al. (1999) found that the distribution of several native riverine species were restricted by diversion dams on the Yellowstone River during low water years. They reported the upstream distribution above Cartersville Dam for several fish species, including paddlefish, is restricted by this structure. Consequently, the no action alternative will continue to have a negative impact on paddlefish populations.

7.3.3.3.9.2 Rock Ramp Alternative

The rock ramp alternative will benefit paddlefish populations by providing passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.3.10 Sauger

Spawning by sauger is often accompanied by migration upstream and/or into tributary streams in the spring, with long migrations occurring in the Yellowstone River. Helfrich et al. (1999) found that the distribution of several native riverine species were restricted by diversion dams (including Cartersville) on the Yellowstone River during low water years. They reported the upstream distribution above Cartersville Dam for several fish species, including sauger (especially juvenile sauger), is restricted by this structure. Consequently, the no action alternative will continue to have a negative impact on paddlefish populations.

7.3.3.3.10.1 Rock Ramp Alternative

The rock ramp alternative will benefit sauger populations by providing passage and connectivity for this fish species to habitat upstream in the Yellowstone River and its tributaries.

7.3.3.4 Cumulative Effects

The construction of a rock ramp fish passage structure at Cartersville Dam will benefit federally-listed species and state species of special concern in the same way natural riffles benefit these species. When added to the effects of modifying Intake Dam on the Yellowstone River, and the T&Y and SH dams on the Tongue River, the cumulative effect of these fish passage improvements will have significant positive benefits for fish (e.g. paddlefish, blue sucker and fish-dependent species (e.g. bald eagle) in the Yellowstone River. Negative cumulative effects for other species are expected to be negligible.

7.3.3.5 Environmental Mitigation

For the rock ramp alternative, no mitigation measures are proposed due to the net benefit of the project to the Yellowstone River fishery.

7.3.3.6 Summary

The no action alternative will have no affect on most species, but will have negative impacts on fish (e.g. sturgeon) and fish-dependent species (e.g. piscivors).

In contrast, the rock ramp alternative will transform 22 acres of the Yellowstone River from slower moving, deep water habitat to fast-moving, shallower water rapid habitat. In addition, this alternative will result in armoring approximately 2,100 feet of river bank with rock riprap. These channel alterations are expected to have a net benefit to federally-listed species and state species of special concern.

7.3.4 Lands and Vegetation

7.3.4.1 Introduction

The following section describes potential impacts to lands and vegetation by the "No Action" alternative and the Rock Ramp alternative for Cartersville Dam.

7.3.4.2 Methods

Impacts of each alternative (No Action and Rock Ramp) were overlaid on existing lands and vegetation maps to estimate potential impacts to these resources.

7.3.4.3 Results

7.3.4.3.1 Vegetation

7.3.4.3.1.1 No Action

The no action alternative will have little or no impact on existing vegetation at the Cartersville Dam site.

7.3.4.3.1.2 Rock Ramp Alternative

Construction of the rock ramp alternative will be limited primarily to the area between the tops of the river banks. In the north channel, the rock ramp will extend from the dam downstream for a distance of 1400 feet, or less, with the north river bank receiving rock bank protection and the north island bank receiving a rock berm. The south channel will be armored on the south bank for approximately 700 feet. Most of the impacts to vegetation will be associated with placement of 2100 feet of bank protection. The river bank on both sides of the channel is relatively devoid of vegetation except for sparse forbs and grasses below the high water mark. In addition, the south bank is already protected with some bank armor, which limits vegetation. As such, the rock ramp alternative is expected to have relatively minor impacts to vegetation communities.

7.3.4.3.2 Wetlands

7.3.4.3.2.1 No Action

The no action alternative will have little or no impact on existing wetlands at the Cartersville Dam site.

7.3.4.3.2.2 Rock Ramp Alternative

Construction of the rock ramp alternative will result in filling approximately 22 acres of waters of the US. In addition, the rock ramp will result in filling jurisdictional wetlands along the banks where rock protection is installed. In all, approximately 2100 feet of bank will receive rock protection. Assuming an average width of approximately 30 feet, the total impact would be 1.45 acres. A wetland delineation will need to be completed during final design to determine exact quantities impacts to wetlands and other waters of the US.

7.3.4.4 Cumulative Effects

Cumulative effects of the rock ramp alternative will be limited primarily to wetlands. According to Montana's Department of Environmental Quality, Montana has lost approximately one-third of its naturally occurring wetlands since settlement. The proposed rock ramp alternative will add to the cumulative loss of wetlands in Montana and, therefore, will require mitigation to offset this loss.

7.3.4.5 Environmental Mitigation

Placement of fill within the river channel to construct the rock ramp is expected to be self mitigating as it will result in transforming approximately 22 acres of slower moving, deep water riverine habitat to fast-moving, shallower water rapid habitat. Placement of fill to protect the river banks will result in filling an estimated 1.45 acres of jurisdictional wetlands, which will require mitigation. Assuming these wetlands can be mitigated at a ratio of 2:1, the project would require the construction of approximately 3.9 acres of mitigation wetlands. Final mitigation requirements for placement of fill and wetlands will need to be worked out with the Army Corps of Engineers, Montana Department of Environmental Quality, and other responsible agencies following a wetland delineation and final design of the rock ramp alternative.

7.3.4.6 Summary

The no action alternative will have no impacts to existing lands or vegetation. In contrast, the proposed rock ramp will impact waters of the US and jurisdictional wetlands and, therefore will require mitigative actions.

7.3.5 Aquatic Assemblages

7.3.5.1 Introduction

This section describes the anticipated effects of proposed alternatives on the aquatic communities in the project area. The communities assessed include fish, macroinvertebrate, and mussels.

7.3.5.2 Methods

We reviewed the literature pertaining to aquatic communities in the area, and studies that assessed fish movement at diversion dams in the Yellowstone River.

7.3.5.3 Results

7.3.5.3.1 Fish Assemblages

7.3.5.3.1.1 No Action

Currently, Cartersville Dam appears to block upstream movement of shovelnose sturgeon (Jaeger et al. 2009) as well as juvenile sauger (Jaeger et al. 2005). Although Helfrich et al. (1999) reported that Cartersville Dam did create any disjunct fish populations; it is likely that upstream passage is impeded for some proportion of the 40-50 fish species present in the project area. For example, total numbers of shorthead redhorse, goldeye, *Hybognathus sp*. (likely western silvery minnow), emerald shiner, and river carpsucker were higher below Cartersville Dam than above it. The total number of all fish species fish captured was also higher below Cartersville.

7.3.5.3.1.2 Rock Ramp Alternative

The rock ramp design for Cartersville is based on the experiments of White and Mefford (1993) and the characterization of flow conditions at Matthews rapid, which is known to allow upstream passage of shovelnose sturgeon (Jaeger et al. 2006; sturgeon movement figures in Appendix A). The resultant design is very likely to allow upstream passage of shovelnose sturgeon as well as the endangered pallid sturgeon, because shovelnose sturgeon and pallid sturgeon have similar morphology and appear to have similar swimming abilities (Bramblett and White 2001; Adams et al. 2003). Swimming performance data are lacking for most of the diverse fish assemblage in this reach of the Yellowstone River. However, the Cartersville rock ramp will very likely allow passage of most of the other fish because there are no fish species know to occur downstream of Matthews Rapid and not upstream of this rapid (Montana Fish, Wildlife and Parks, Montana Fisheries Information System (MFISH)). Therefore, Matthews Rapid is likely not a barrier to fish species in the Yellowstone River, and presumably a rock ramp design based on hydraulic conditions at Matthews Rapid will allow passage of all fish species. Improving upstream passage would increase connectivity among fish populations in the Yellowstone River. This is a benefit

to the fish populations because well-connected populations are less vulnerable to extirpation and have more genetic diversity. Increasing connectivity may allow access to previously unavailable spawning, rearing and foraging areas and may therefore increase fish populations in the Yellowstone River. Improved passage of game fish species such as sauger, channel catfish, and paddlefish may allow for improved recreational fishing opportunities above Cartersville.

Reconnecting anthropogenically-disconnected river reaches entails a risk of allowing unwanted or invasive species access to newly-reconnected habitats. For example, there are about 20 introduced fish species in the Yellowstone River (White and Bramblett 1993). Of these, 16 species already occur above and below Cartersville Dam; therefore proving upstream passage will not affect their distribution (MFISH). This includes piscivorous (fish-eating) species such as smallmouth bass, northern pike, and walleye. Four species (rock bass, white bass, rainbow smelt, and goldfish) occur within the Yellowstone River basin only below the Cartersville Dam. Rock bass and smallmouth bass likely gained access to the Yellowstone River after stocking in Tongue River Reservoir. Perhaps smallmouth bass, a strong swimmer, were able to pass upstream of Cartersville Dam whereas rock bass were not. Rock bass eat invertebrates and also prey upon small fishes (Scott and Crossman 1973), such as the abundant minnows that occur in the Yellowstone River.

White bass and rainbow smelt occur in the Yellowstone River below Intake diversion dam (MFISH). These two species gained access to the lower Yellowstone River following stocking in Lake Sakakawea in North Dakota. White bass are visual piscivores that prefer clear water and tolerate cool water temperatures (Scott and Crossman 1973). Apparently they are not well-established in the lower Yellowstone River; perhaps due to the higher turbidities common there. Rainbow smelt are an anadromous species where there is access to the ocean, but they have become established in freshwaters such as the Great Lakes. Rainbow smelt are primarily invertivorous, tolerate cool water temperatures, and can move long distances in rivers (Scott and Crossman 1973). It may be limited by high turbidities in the lower Yellowstone River, but may thrive in upper reaches where there is lower turbidity. If fish passage is provided at Intake, these two species may ascend the river to Cartersville, and above Cartersville if fish passage is provided there. If white bass were to gain access to the middle and upper river, they may become established and prey upon native minnows such as emerald shiners, and compete with native fishes such as sauger. Rainbow smelt would prey upon invertebrates and small fishes, as well as provide forage for piscivorous fishes. Goldfish have not become well established in the Yellowstone River basin (Brown 1973; Holton and Johnson 2003); therefore they are unlikely to expand their distribution if passage is provided at Intake and Cartersville.

Construction activities will disturb approximately 22 acres of river bottom. This will minimally impact fish assemblages. Adult and juvenile fishes are mobile and most will likely be able to avoid construction activities that could cause direct mortality. Larval fishes have low mobility and may be killed by construction activities. However, fishes typically produce abundant larvae that suffer high levels of natural mortality and are resilient to moderate and short-term increases in mortality rates. The localized spatial and short-term temporal impacts of this project will likely not significantly increase mortality rates of fishes in lower Yellowstone River.

The river at the project site has two channels; a primary channel to the north of the existing island and a smaller side channel south of the island. The conceptual design for the rock ramp includes the construction of a berm feature beginning on the south river bank, and continuing to and extending along the north bank of the existing island. The design also includes a "fishing hole" in the south channel, adjacent to the city park. The rock ramp will allow fish passage in the main (north) channel, but not in the side channel south of the island. Fish entering the south (side) channel will not be able to pass upstream directly, but would have to turn around, enter the north (main) channel and then pass upstream over the rock ramp. This design may temporarily impede upstream movement of some fish. The slower, shallower, and potentially warmer water in the south channel may attract fish species such as minnows, and potentially some game fish such as channel catfish or sauger. It is likely that a local concentration of fish will occupy the "fishing hole" at the upstream end of the south channel where they could be exposed to considerable angling pressure. However, because the majority (80%) of the flow will be in the north channel, and this channel will have more attraction flow and will be deeper and wider, it is likely that a large majority of the fish will use the north channel and will be able to pass upstream. Shovelnose sturgeon do not orient strongly to current velocities below 2.0-2.5 ft/s, and attraction flows of 2 to 4 ft/s are recommended for fishway designs to pass shovelnose sturgeon (White and Mefford 1999). Therefore, shovelnose sturgeon will likely avoid the south channel and use the north channel to pass the rock ramp. Although passage of a proportion of fish will be impeded because of the design of the south channel as a whole the rock ramp will likely allow a large majority of fish to pass upstream. Therefore, the lack of passage in the south channel will be a minor and localized impact, and allowing fish passage on the north channel will be a major benefit to the fish assemblage.

7.3.5.3.2 Macroinvertebrates

7.3.5.3.2.1 No Action

No changes in macroinvertebrate comminutes is anticipated.

7.3.5.3.2.2 Rock Ramp Alternative

Aquatic insect dispersal is probably not currently affected by Cartersville Dam. Aquatic insects drift downstream with the current; Cartersville Dam does not prevent drift. Following emergence as adults, aquatic insects are able to fly upstream to lay eggs, thereby preventing depletion of upstream habitats. Construction of a rock ramp fishway at Cartersville will not affect aquatic insect dispersal. Disturbance of the river bottom associated with rock ramp construction will kill large numbers of aquatic invertebrates. Newell (1973) reported invertebrate densities of 100 to over 10,000 individuals/ft^2. Construction activities will also create turbidity and sediment deposition locally. Sediment fills interstices in gravel and cobble and can smother invertebrates living there. However, these impacts will be localized and will not affect macroinvertebrate communities at larger scales for several reasons. Macroinvertebrates readily drift from upstream to colonize disturbed areas, macroinvertebrates have short life cycles and can repopulate rapidly, and macroinvertebrates in the project are adapted to relatively high levels of turbidity and sedimentation.

7.3.5.3.3 Mussels

7.3.5.3.3.1 No Action

No changes in mussel communities are anticipated.

7.3.5.3.3.2 Rock Ramp Alternative

Freshwater mussels disperse upstream in streams and river when the host fish to which their parasitic larvae (glochidia) are attached move upstream. The glochidia later drop off and begin an independent life on the stream bottom. The only mussel currently found in the project area is the fatmucket (*Lampsilis siliquoidea*). However, the general distribution of this species will not change with construction of a rock ramp fishway at Cartersville, because fatmuckets are already found upstream in the Yellowstone River basin at least as far as the mouth of the Bighorn River (Aquatic Invertebrates of Montana webpage, Daniel L. Gustafson, Montana State University). Three introduced freshwater mussel species (giant floater, *Pyganodon grandis*; white heelsplitter, *Lasmigona complanata*; black sandshell, *Ligumia recta*) occur in the Missouri River basin, including below Fort Peck Reservoir. These species may eventually colonize the Yellowstone River if fish passage improves and their host fish move out of the Missouri River and up the Yellowstone River. Disturbance of the river bottom associated with rock ramp construction may kill unknown numbers of freshwater mussels. However, this impact will be localized and will likely affect a very small portion of the mussel population of the lower Yellowstone River.

7.3.5.4 Cumulative Effects

The cumulative effect of fish passage projects at Intake Dam and Cartersville is to open up a large section of the Yellowstone River for fish passage.

7.3.5.4.1 Environmental Mitigation

For the rock ramp alternative, no mitigation measures are proposed due to the net benefit of the project to the Yellowstone River fishery and minimal impacts to the macroinvertebrate and mussel communities.

7.3.5.5 Summary

The No Action Alternative will benefit fish assemblages as a whole, albeit with a low risk of allowing white bass and rainbow smelt to colonize the middle Yellowstone River. There will minimal impact to macroinvertebrate and mussel communities.

7.3.6 Recreation

7.3.6.1 Introduction

This section describes the anticipated effects of proposed alternatives on recreation in the project area.

7.3.6.2 Methods

We consulted Montana Fish, Wildlife and Parks MFISH webpage and existing literature for information on fishing in the project area.

7.3.6.3 Results

7.3.6.3.1 Recreational Fishing

7.3.6.3.1.1 No Action

The area adjacent to and below Cartersville Dam would remain a popular fishing location.

7.3.6.3.1.2 Rock Ramp Alternative

The river at the project site has two channels; a primary channel to the north of the existing island and a smaller side channel south of the island. The conceptual design for the rock ramp includes the construction of a berm feature beginning on the south river bank, and continuing to and extending along the north bank of the existing island. The design also includes a “fishing hole” in the south channel, adjacent to the city park. The rock ramp will allow fish passage in the main (north) channel, but not in the side channel south of the island. Fish entering the south (side) channel will not be able to pass upstream directly, but would have to turn around, enter the north (main) channel and then pass upstream

over the rock ramp. This design may temporarily impede upstream movement of some fish, and the "fishing hole" may allow fish to stay below the berm. The slower, shallower, and potentially warmer water in the south channel may attract fish species such as minnows, and potentially some game fish such as channel catfish or sauger. It is likely that a local concentration of fish will occupy the "fishing hole" at the upstream end of the south channel where they could provide very good recreational fishing. However, it is difficult to predict precisely how fishing may change as a result of providing fish passage at Cartersville. It is likely that fish will stage below the rock ramp and continue to provide good fishing at the project site. Fish passage is an important component in providing healthy fish populations and will benefit the Yellowstone River fishery as a whole.

People using the existing boat ramp on the south bank immediately downstream of the dam would proceed around the upstream end of the island to deep water in the north channel. With the rock ramp alternative, this will not be possible and the south channel frequently does not have enough water for boat passage.

7.3.6.4 Cumulative Effects

It is anticipated that this project and the proposed Intake Dam fish passage project downstream near Glendive, Montana will benefit the Yellowstone River fishery as a whole.

7.3.6.5 Environmental Mitigation

With the rock ramp alternative a new boat ramp will be pursued on property currently privately owned downstream of the existing state park on the south bank of the river downstream of the dam (Figures 7-1 and 7-2).

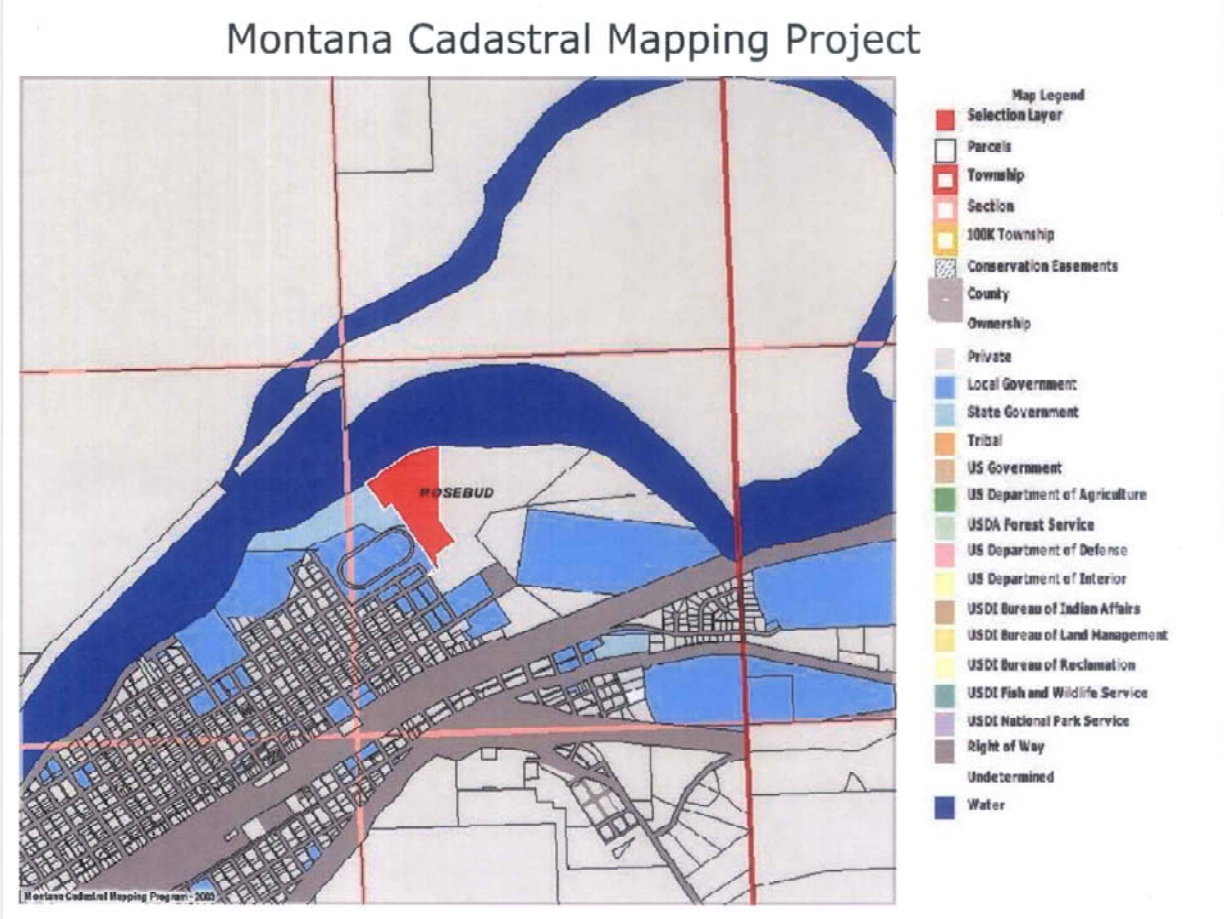


Figure 7-1 Ownership Map for New Boat Ramp

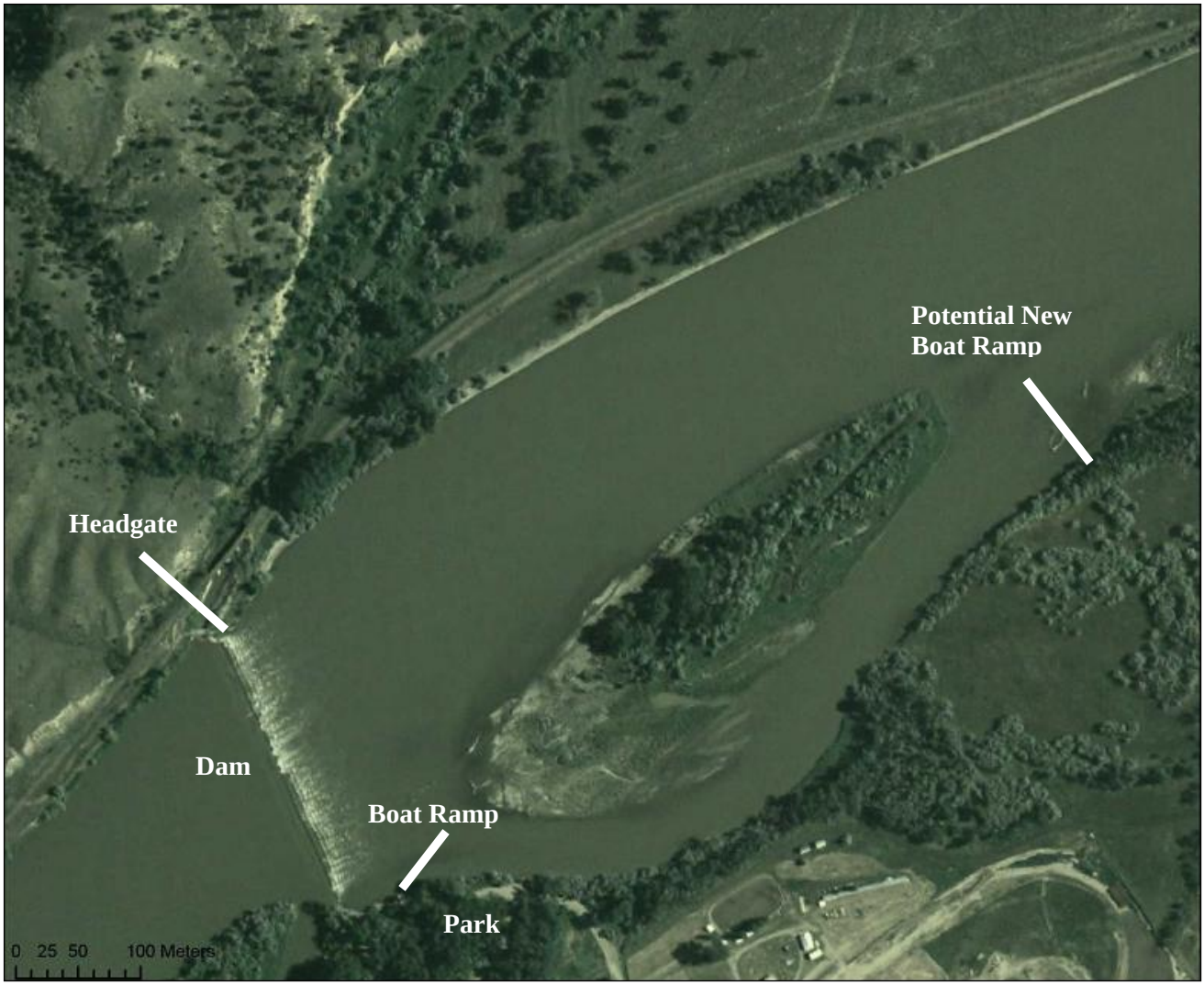


Figure 7-2 Location of New Boat Ramp

7.3.6.6 Summary

The rock ramp alternative will benefit the Yellowstone River fishery. A new boat ramp will allow boaters to continue to access the river near the park, downstream of the dam.

7.4 Cultural Resources

7.4.1 Introduction

This section addresses the anticipated effects of proposed alternatives on cultural resources.

7.4.2 Methods

The Montana Historical Society, State Historic Preservation Office was consulted regarding potential effects.

7.4.3 Results

7.4.3.1 No Action

The no action alternative could potentially result in failure of the dam and the loss of this cultural resource.

7.4.3.2 Rock Ramp Alternative

The rock ramp alternative would buttress the downstream side of the dam, but leave the existing dam intact. The benefit of preventing a failure of the dam outweighs any negative consequences.

7.4.4 Cumulative Effects

The proposed project to construct a rock ramp at Intake Dam near Glendive is similar in nature to that proposed at Cartersville. If their construction is similar, there may be cumulative cultural resource impacts.

7.4.5 Environmental Mitigation

During the design/permitting phase of the project there must be coordination with SHPO to determine what mitigation, if any, is required.

7.4.6 Summary

The rock ramp alternative may have an impact on cultural resources, and a cultural resource inventory should be performed during design/permitting to identify the need for any mitigation.

7.5 Aesthetic Resources

7.5.1 Introduction

This following section addresses anticipated effects of proposed alternatives on an aesthetic resources.

7.5.2 Methods

Information regarding potential effects was obtained by input from the community.

7.5.3 Results

7.5.3.1 No Action

The no action alternative could potentially result in failure of the dam and the loss of its aesthetic value to the community.

7.5.3.2 Rock Ramp Alternative

The rock ramp alternative would buttress the downstream side of the dam, minimizing the risk of failure. In addition, the rock ramp would provide aesthetic values similar to natural rapids, which many people find appealing. The south channel of the Yellowstone River will stay in its current configuration, as desired by the community. The community has expressed approval of the concept of a rock ramp in the north channel.

7.5.4 Cumulative Effects

There should be no cumulative effects to people in the community.

7.5.5 Environmental Mitigation

No environmental mitigation is anticipated.

7.5.6 Summary

The no action alternative could result in failure of the dam and its aesthetic value. The rock ramp alternative should reduce the probability of failure and perpetuate the aesthetic resources of the park and river.

7.6 Surface Water Quality

7.6.1 Introduction

The following section describes the anticipated effects of proposed alternatives on the surface water quality of the Yellowstone River. Anticipated impacts are associated with channel bed disturbances during project construction, and as such are temporary.

7.6.2 Methods

The summary provided is based on publications produced by the Montana Department of Agriculture (http://agr.mt.gov), Montana Department of Environmental Quality (http://deq.mt.gov), and the United States Geological Survey (Zelt, et al, 1998; Miller et al, 2004).

7.6.3 Results

As a Class B-3 water body, the Yellowstone River at the project site is subjected to the following standards: Suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply (http://deq.mt.gov).

From the Big Horn River to Cartersville Dam, the river has been listed as partially supporting of the warm water fishery, and the probable cause of this impairment is listed as a fish passage barrier. Between Cartersville Dam and the Powder River, the Yellowstone has been listed as partially supporting of aquatic life and the warm water fishery. The probable causes for this impairment include riparian alterations, nitrate/nitrite, pH, sediment, copper, lead, and zinc. To date, Total Maximum Daily Loads (TMDLs) have not been developed for listed waterbody.

Potential impacts to the surface water quality associated with the project include increases in turbidity or other chemical parameters due to disturbance of the channel bed during construction.

7.6.3.1 Suspended Sediment

7.6.3.1.1 No Action

No impact to suspended sediment concentrations are anticipated under a No Action Alternative.

7.6.3.1.1 Rock Ramp Alternative

The excavation and associated disturbance of the river bed as part of construction efforts will result in a temporary increase in downstream turbidity. A sediment management plan designed to monitor, control, and minimize that turbidity will be required by project contractors. Upstream of the existing dam, sediment deposition will continue in a similar fashion as the No Action alternative.

7.6.3.2 Dissolved Solids, Pesticides, and Nutrients

7.6.3.2.1 No Action

No impact to dissolved solids, pesticides, or nutrient concentrations area anticipated under a No Action Alternative.

7.6.3.2.1 Rock Ramp Alternative

Where the channel bed is to be disturbed or excavated, no sediment samples are available to compare their chemistry to that of the existing water column. As such, there is no means of assessing the relationship between any disturbed substrate and existing dissolved solid, pesticide, or nutrient

concentrations. Any potential contaminants identified during construction will be addressed to minimize impacts to the surface water chemistry.

7.6.4 Cumulative Effects

The implementation of appropriate environmental mitigation measures will result in minimal and temporary impacts to surface water quality. The project will address the existing water quality impairment listing for the river upstream of the dam by removing the existing warm water fish passage barrier.

7.6.5 Environmental Mitigation

Environmental mitigation during and following project construction will include appropriate best management practices to minimize increases in turbidity and water quality degradation, to minimize the potential for aquatic life impacts downstream. These approaches will include materials handling procedures to prevent the spillage of materials into the active channel, revegetation of disturbed areas, application of erosion control measures and monitoring of those measures to ensure that both wind and water erosion is minimized, and safe handling of spills on the construction site such as fuel, lubricants, or chemicals in accordance with state laws and regulations.

7.6.6 Summary

The effects of the project on surface water quality can be mitigated using appropriate best management practices.

7.7 Air Quality

7.7.1 Introduction

The following section describes the anticipated effects of the proposed alternatives on air quality.

7.7.2 Methods

There is no ambient air quality data available in the vicinity of Forsyth, Montana.

7.7.3 Results

7.7.3.1 No Action

No impact to air quality is anticipated under the No Action Alternative.

7.7.3.2 Rock Ramp Alternative

Any short-term effects from such things as dust and exhaust fumes from construction equipment should be minor.

7.7.4 Cumulative Effects

This project will not combine with other projects in the area to impact air quality.

7.7.5 Environmental Mitigation

Environmental mitigation during construction will include appropriate best management practices. Construction activities that could raise dust should be coordinated with the Rosebud County Fair.

7.7.6 Summary

The proposed alternatives will have only short term effects on air quality.

8.0 DESCRIPTIONS OF SELECTED PLAN

8.1 Plan Components; including mitigation

The proposed fish passage alternative consists of construction a rock ramp with a slope of 0.5% in the north channel of the Yellowstone River below Cartersville Dam. The rock ramp will buttress the downstream face of the dam reducing the risk of failure, while providing fish passage and continued water supplies for the Cartersville Irrigation District and City of Forsyth. A new boat ramp may be constructed to mitigate loss of the current boat ramp downstream of the dam.

8.2 Design and Construction Considerations

8.2.1 Design

Primary design considerations included:

- Providing a rock ramp for fish passage while maintaining water supply for the Cartersville Irrigation District and City of Forsyth
- Finding a riprap source with appropriate quantity/quality/cost
- Maintaining the south channel of the Yellowstone River intact
- Finding an alternate boat ramp location
- Minimizing operation, maintenance, and replacement costs
- Protection from ice and debris

The proposed plan addresses all of these considerations.

8.2.2 Construction

Construction considerations include:

- Challenges presented by working in a large river
- Logistics of obtaining, delivering, and placing rock
    - Quarries need adequate time to process the required quantity of rock (probably six months time is required)
    - There needs to be sufficient space to unload and temporarily stockpile rock in Forsyth until the contractor can reload and place the rock
    - The contractor most have capacity to move and place the rock matching deliveries from the quarry

None of these considerations are a fatal flow. Ideally, work could be completed in one construction season, between high runoff periods. Construction would not disrupt water deliveries to either the Cartersville Irrigation District or the City of Forsyth.

8.3 LERRD Considerations

The State of Montana and the Cartersville Irrigation District will provide lands, easements, rights-of-way, relocations, and disposal areas (LERRD) required for this project.

8.4 Operation and Maintenance Considerations

The rock ramp alternative is designed for minimal operation and maintenance costs.

8.5 Plan Accomplishments

The rock ramp alternative accomplishers all of the primary project objections:

- Maintain the ability of the irrigation district to divert water at all water levels
- Allow upstream passage of native fishes, particularly sturgeon
- Provide minimal maintenance requirements
- Increase public safety
- Maintain recreation opportunities at adjacent city park

8.6 Summary of Economic, Environmental and Other Social Effects

The rock ramp will have no significant economic, environmental, or other social effects.

9.0 PLAN IMPLEMENTATION

9.1 Institutional Requirements

There are no institutional requirements for this project.

9.2 Division of Plan Responsibilities, Cost Sharing and Other Non-Federal Responsibilities

Non-Federal responsibilities consist of:

- Cost-sharing - The level of cost sharing depends on the funding source utilized. Cost-sharing sources could include the State of Montana, the Cartersville Irrigation District, and others.
- LERRD – The State of Montana and the Cartersville Irrigation District will provide lands, easements, rights-of-way, relocations, and disposal areas required for this project.

9.3 Views of Non-Federal Sponsor(s) and Any Other Agencies

The Cartersville Irrigation District, Montana Department of Fish, Wildlife and Parks; Montana Department of Natural Resources and Conservation, and Montana Department of Environmental Quality all support this project.

10.0 CONSULTATION AND COORDINATION

10.1 Public Involvement Program

The public involvement program consists of having a series of meetings throughout the feasibility study/EA process.

10.2 Cooperating Agency Team

Cooperative Agencies include:

- U.S. Army Corps of Engineers
- Montana Department of Natural Resources and Conservation
- Montana Department of Environmental Quality

These agencies were selected because they have direct permitting responsibilities.

10.3 Meetings

To date, two public involvement meetings have been held:

- July 28, 2009 meeting with Cartersville Irrigation District and other interested parties in Forsyth, Montana.
- November 3, 2009 meeting with the Rosebud/Treasure County Wildlife Association and other interested parties in Forsyth, Montana.

10.4 Endangered Species Act Consultation

The U.S. Fish and Wildlife Service has been contacted regarding Endangered Species Act Consultation.

10.5 Coordination and Compliance with Other Applicable Laws, Regulations, and Policies

Analysis and implementation of the Cartersville Project requires consistency, coordination and compliance with multiple federal and state laws, regulations, executive orders, and policies. The following have known application to the Cartersville Project.

10.5.1 Clean Water Act of 1977

The Clean Water Act is the principal law governing pollution control and water quality of navigable waterways of the United States. Section 402 of the Act establishes a National Pollution Discharge Elimination System permitting program to regulate the point source discharge of pollutants into waters of the United States. Both Montana and North Dakota administer state-level programs pursuant to authority delegated by the EPA.

Section 404, administered by the USACE with oversight from EPA, is another permitting program that regulates activities of the placement of dredged or fill materials into waters of the United States. The USACE issues nationwide permits on a state, regional, or nationwide basis for similar activities that cause only minimal adverse environmental effects both individually and cumulatively. Individual permits may also be issued for specific activities on specific water bodies under Section 404. It is anticipated that the USACE will determine that an individual Section 404 permit is required for the Intake Project. If so, a Montana State Water Quality Certification Permit (Section 401) would also be required. The USACE will complete the 404(b)1 analysis for the Carterville Project.

10.5.2 Farmland Protection Policy Act of 1995

The purpose of this Act is to ensure that impacts to prime or unique farmlands are considered in federal projects. It requires federal agencies to consider alternative actions that could lessen impacts and to ensure that their actions are compatible with state, local government, and private programs to protect prime and unique farmland. The Natural Resources Conservation Service is responsible for administering this Act. Farmlands were considered in the Cartersville Project analysis using the key indicators of changes in farm acreage and production. Prime and unique farmlands would be protected to the extent possible during implementation of the Cartersville Project consistent with the Act.

10.5.3 Fish and Wildlife Coordination Act of 1958

The Fish and Wildlife Coordination Act (FWCA, 48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) provides a procedural framework for the orderly consideration of fish and wildlife conservation measures to be incorporated into federal projects and federally permitted or licensed water resource development projects. Agencies that construct, permit, or license projects impacting a water body must consult with the Service and FWP, the state agency having jurisdiction over fish and wildlife resources. Full consideration must be given to the recommendations made through this consultation process.

Section 2 states that fish and wildlife conservation shall receive equal consideration with other project purposes and will be coordinated with other features of water resource development projects. The FWCA

specifically authorizes the Secretary of the Interior to prepare a report and recommendations on the fish and wildlife aspects of projects, including mitigation. The FWCA report provides input to preparation of draft environmental impact statements.

The USFWS and FWP have been working closely with the Corps and Reclamation to initiate and implement studies, surveys, gather and analyze data and contribute to reports regarding fish passage in the Yellowstone River since 1994. This continuous input into the decision making process reduces the need for a technical 2(b) FWCA report to prevent or reduce the adverse impacts to fish and wildlife. Therefore, there will be no FWCA report issued for the project. The final NEPA documents will provide preventive measures to avoid impacts and mitigation to offset impacts that are unavoidable. Consultation with the Service under Section 7(a)(2) of the ESA will also provide conservation measures to avoid and minimize adverse impacts.

10.5.4 Migratory Bird Treaty Act and Executive Order 13186

Under the provisions of this Act it is unlawful "by any means or manner to pursue, hunt, take, capture [or] kill" any migratory birds except as permitted by regulations issued by the USFWS. Migratory birds include all native birds in the United States with the exception of non-migratory species managed by states. The USFWS has defined "take" to mean "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture or collect" any migratory bird or any part, nest, or egg of any migratory bird (50 *Code of Federal Regulations* Section 10.12). Project level compliance with this law would be accomplished through specific environmental commitments for all of the action alternatives.

10.5.5 National Historic Preservation Act of 1966

The Act establishes protection of historic properties as federal policy in cooperation with states, tribes, local governments, and the public. Historic properties are those buildings, structures, sites, objects, and districts, or properties of traditional religious and cultural importance to Native Americans, determined to be eligible for inclusion in the National Register of Historic Places. Section 106 of the Act requires federal agencies to consider the effects of proposed actions on historic properties and gives the Advisory Council on Historic Preservation an opportunity to comment. Reclamation is responsible for consultation with the SHPO and/or Tribal Historic Preservation Offices, tribes, applicants, interested parties, and local governments regarding federal undertakings. Compliance with this law would be accomplished through specific environmental commitments for all of the action alternatives.

10.5.6 Rivers and Harbors Appropriation Act of 1899

Under Section 10 of the Act, the construction of any structure in or over any navigable water of the United States, the excavating from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters is unlawful unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army. This Cartersville Project would be implemented with design measures deemed compatible with the Act. However, Cartersville Project design features requiring recommendation and approval would be reviewed by the USACE for permitting consideration in compliance with the Act.

10.5.7 Executive Order 13112 for Invasive Species

In 1999, an executive order was issued to prevent the introduction of invasive species and to provide for their control. It directs federal agencies to identify applicable actions and to use programs and authorities to minimize the economic, ecological, and human health impacts caused by invasive species. To meet the intent of this order, the Cartersville Project includes environmental commitments to prevent and control the spread of invasive species.

10.5.8 Other Executive Orders

Executive Order 11988 (Floodplain Management) requires federal agencies to avoid developments on floodplains whenever possible or to minimize potential harm to the floodplains. Executive Order 11990 (Protection of Wetlands) directs federal agencies to avoid destruction, loss, or degradation of wetlands. Executive Order 13007 (Indian Sacred Sites) orders federal agencies to accommodate Indian tribes' requirements for access to and ceremonial use of sacred sites on public lands and to avoid damaging the physical integrity of such sites. Executive Order 12898 (Environmental Justice) directs federal agencies to identify and address disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. Compliance with these orders was considered in the development of action alternatives in this EA.

10.5.9 State Water Rights

Montana waters belong to the state, with ownership on behalf of all state citizens. Because water belongs to the state, water rights holders do not own the water; they have a right to use the water within state guidelines. Water rights in Montana are guided by the prior appropriation doctrine, or first in time, first in right. A person's right to use a specific quantity of water depends on when the use first began. The first person to use water from a specific source established the first right, the second established a right to the remaining water and so on. Water rights holders are limited to the amount of water that can be beneficially used. Beneficial uses of water include agricultural purposes, domestic, fish and wildlife, industrial, mining, municipal, power, and recreational uses.

The Montana Water Use Act passed July 1, 1973, changed water rights administration by requiring a statewide adjudication process on all water right claims existing at that time. It also established a permit system for obtaining water rights for new or additional water developments, created an authorization system for changing water rights and a centralized records system, and provided a system to reserve water for future consumptive uses and maintain minimum instream flows for water quality and fish and wildlife. Senate Bill 76 and House Bill 22 further defined the adjudication process and established a funding mechanism to complete statewide adjudication in 2015.

The Cartersville Irrigation District holds the following unadjudicated water rights in Montana totaling 425.55 cfs (42KJ 177092 00).

10.5.10 Montana Environmental Policy Act

State agencies on the Cooperating Agency Team provided input for compliance with the Montana Environmental Policy Act (MEPA). MEPA was passed in 1971 instituting a policy requiring state agencies to consider the environmental, social, cultural and economic impacts of proposals prior to project approval. The purpose of MEPA is to foster state government decisions that are informed, accountable, open to public participation, and balanced. MEPA gives a community the ability to provide input into decision making and help resolve issues before they become a problem. No other law allows consideration of such issues. The agencies may adopt the Cartersville Project EA completed by the co-leads or complete further documentation as they see fit to comply with the MEPA process.

10.5.11 Stream Protection Act

Any agency or subdivision of federal, state, county, or city government proposing a project that may affect the bed or banks of any stream in Montana for any project including the construction of new facilities or the modification, operation, and maintenance of an existing facility that may affect the natural existing shape and form of any stream or its banks or tributaries must comply with this act. The purpose of the Act is to protect and preserve fish and wildlife resources and to maintain streams and rivers in their natural or existing state. FWP administers the law. Their concerns regarding fish, wildlife and riverine environments have been addressed in this document.

10.5.12 Short-Term Water Quality Standards for Turbidity (318)

Any person, agency, or entity, both public and private, initiating construction activity that will cause short term or temporary violations of state surface water quality standards for turbidity requires a state permit. The purpose of the permit is to provide a short term water quality turbidity standard for construction activities, so that construction is carried out in accordance with conditions prescribed by the Montana

Department of Environmental Quality (MT DEQ), to protect water quality and to minimize sedimentation. MT DEQ administers the permit and their concerns regarding water quality, sedimentation and the Cartersville Project have been addressed in this EA.

10.5.13 Montana Land-Use License of Easement on Navigable Waters

Any entity proposing a project on lands below the low water mark of navigable waters requires a state license. Projects include the construction, placement, or modification of a structure or improvements in, over, below, or above a navigable stream. The purpose of the law is to protect riparian area and the navigable status of the water body and to provide for the beneficial use of state lands for public and private purposes in a manner that will provide revenues without harming the long term capability of the land or restricting the original commercial navigability. The Department of Natural Resources and Conservation (DNRC) administers the law, and their concerns have been addressed in Lands and Vegetation and Recreation sections in this EA. A historic land use easement for the dam including any modification resulting from this project will be filed for and take place when all construction is final. A land-use license covers the construction phase of the project.

10.5.14 Stormwater Discharge General Permits

Any person, agency, or entity, either public or private, proposing a construction, industrial, mining, or other defined activity that has a discharge of storm water into surface waters must obtain a permit. Under the authority of the Montana Water Quality Act, permit authorization is typically obtained under a Montana Pollutant Discharge Elimination System "General Permit." A permit is generally required for construction activity that will disturb one or more acres, including clearing, grading, and excavating activities.

The purpose of the law is to prevent degradation of surface waters from pollutants; such as sediment, waste materials, industrial chemicals or materials, heavy metals, and petroleum products; to protect existing water quality and to implement and monitor the effectiveness of Best Management Practices (erosion and sediment controls, etc.) used to reduce pollutant loads. The MT DEQ administers the permit. Their concerns regarding water quality, sedimentation and the overall project have been addressed in Hydrology and Geomorphology, Surface Water Quality, and Lands and Vegetation section in this EA.

10.5.15 401 Water Quality Certification for Other Federal Permits and Licenses

Under Section 401 of the federal Clean Water Act, states and tribes can review and approve, condition, or deny all federal permits or licenses that might result in a discharge to state or tribal waters, including wetlands. The major federal licenses and permits subject to Section 401 are Section 402 and 404 permits (in non-delegated states), Federal Energy Regulatory Commission hydropower licenses, and Rivers and

Harbors Act Section 9 and 10 permits. States and tribes may choose to waive their Section 401 certification authority.

States and tribes make their decisions to deny, certify, or condition permits or licenses primarily by ensuring the activity will comply with state water quality standards. In addition, states and tribes look at whether the activity will violate effluent limitations, new source performance standards, toxic pollutants, and other water resource requirements of state/tribal law or regulation. The Section 401 review allows for better consideration of state-specific concerns.

10.6 List of Preparers

Gary Elwell, P.E.	Civil Engineer, DOWL HKM, Billings, Montana
Karin Boyd	Applied Geomorphology, Bozeman, Montana
Jim Lovell	Confluence, Inc., Bozeman, Montana
Bob Bramblett, PhD	Bozeman, Montana

10.7 Distribution List

The following entities received an Executive Summary with a compact disk containing an electronic copy of this document.

Jim Darling	Montana Fish Wildlife & Parks, Helena
Matt Jaeger	Montana Fish Wildlife &Parks, Miles City
Ken Frazer	Montana Fish Wildlife & Parks, Billings
Brad Schmitz	Montana Fish Wildlife & Parks, Miles City
Mark McNearney	Montana Fish Wildlife & Parks, Helena
John Little	Montana Fish Wildlife & Parks, Miles City
Pam Ash	Cartersville Irrigations District, Forsyth
Burt Williams	Nature Conservancy, Billings
Cathy Juhas	U.S. Army Corps of Engineers, Billings
Jeff Ryan	Montana Department of Environmental Quality, Helena
Toney Ott	U.S. Environmental Protection Agency, Denver
Paula A. Seliski	Rosebud/Treasure County Wildlife Association, Forsyth
Don Youngbauer	Yellowstone River Conservation District Council, Forsyth
Marc Aberg	Montana Department of Natural Resources and Conservation, Miles City
Chuck Dalby	Montana Department of Natural Resources and Conservation, Helena
George Jordan	U.S. Fish and Wildlife Service, Billings
Lou Hanebury	U.S. Fish and Wildlife Service, Billings

11.0 RECOMMENDATIONS

It is recommended that the proposed rock ramp Alternative 1 with slope of 0.5% (Option 2) be pursued.

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Appendix A
Sturgeon Movement Data

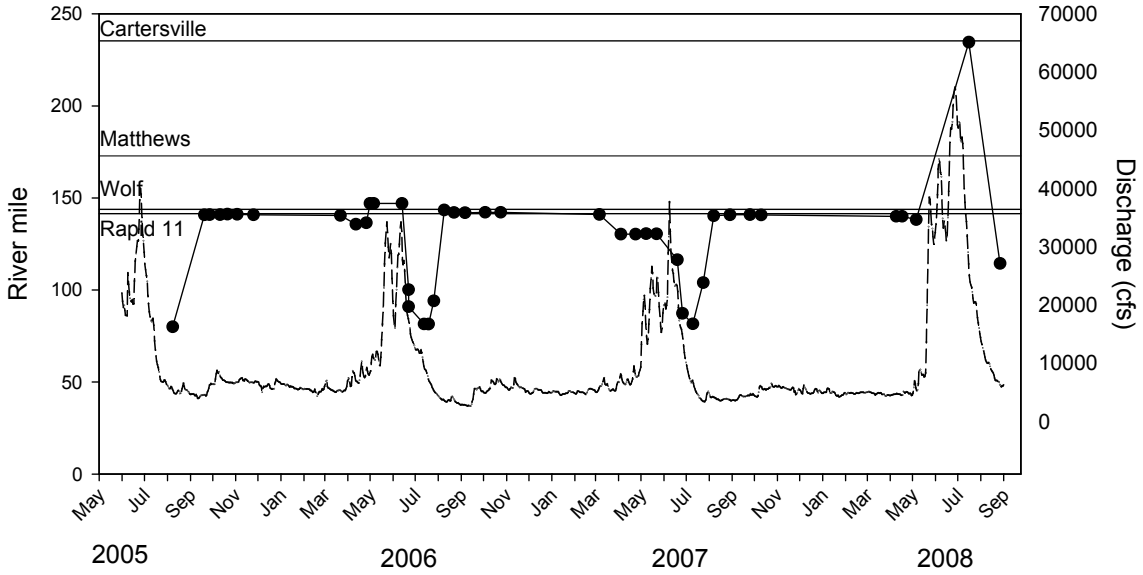

Figure A-1. Movements of shovelnose sturgeon number 420-11 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

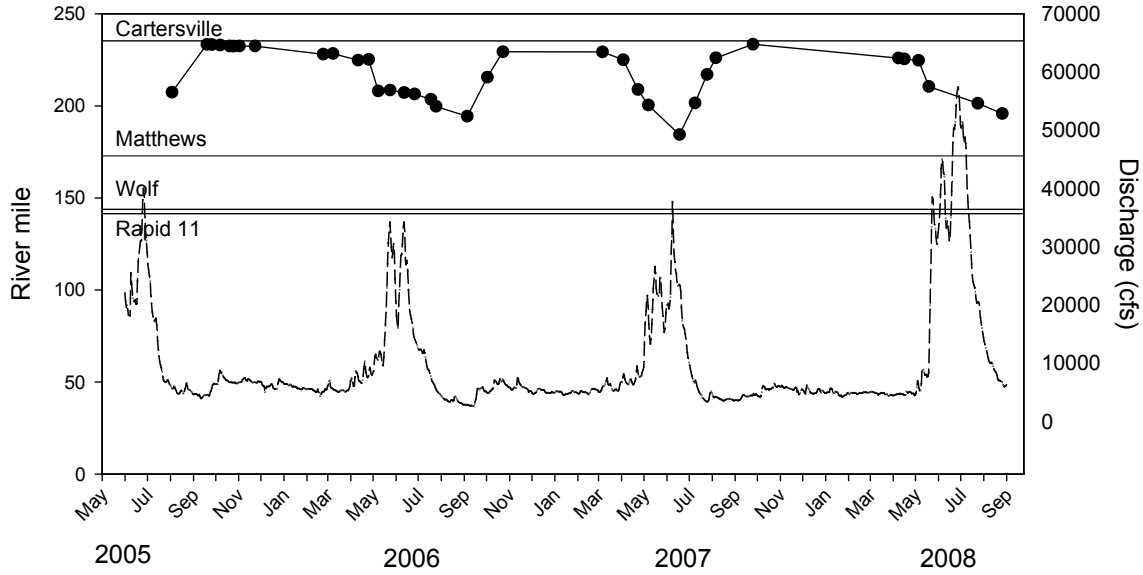

Figure A-2. Movements of shovelnose sturgeon number 420-21 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

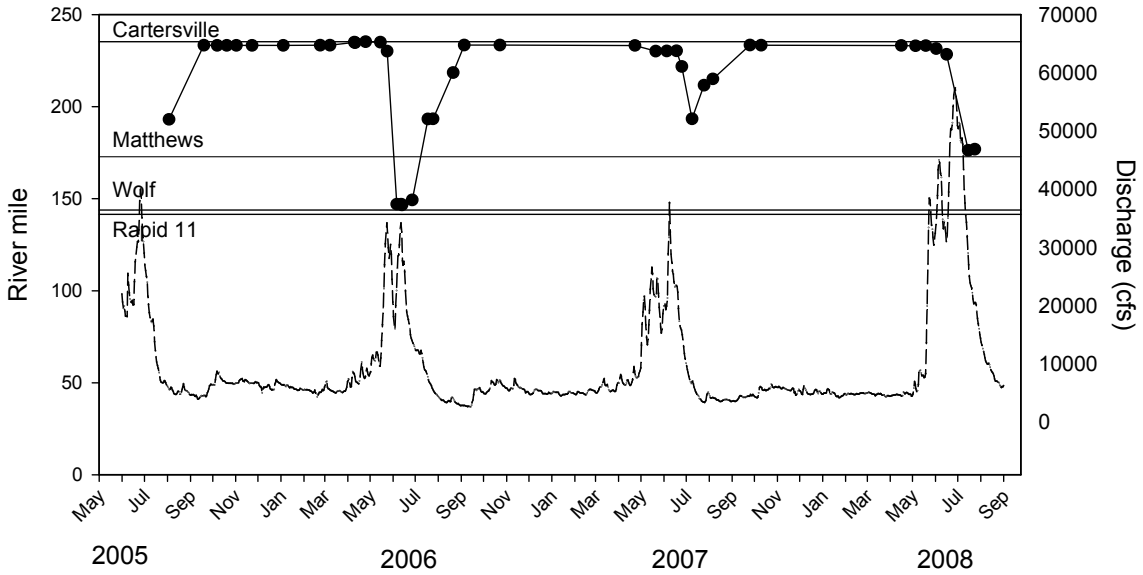

Figure A-3. Movements of shovelnose sturgeon number 420-27 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

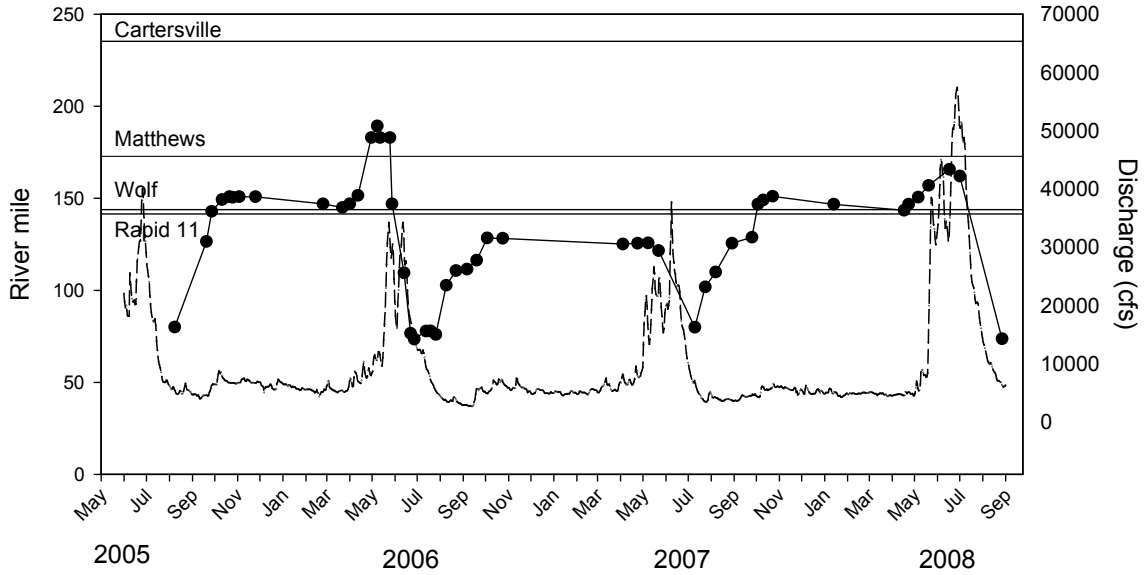

Figure A-4. Movements of shovelnose sturgeon number 420-30 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

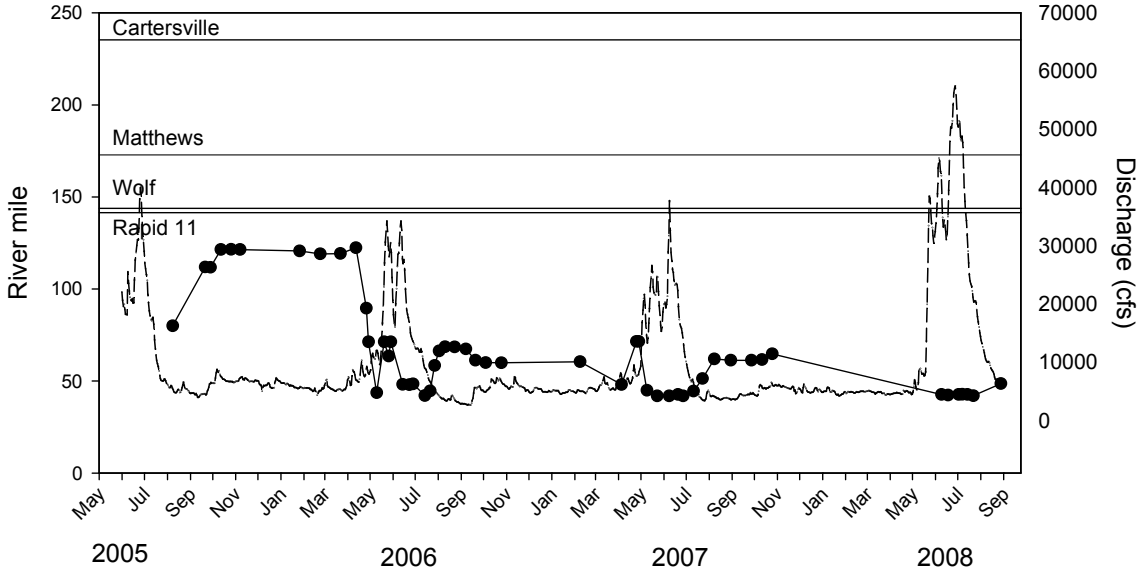

Figure A-5. Movements of shovelnose sturgeon number 420-31 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

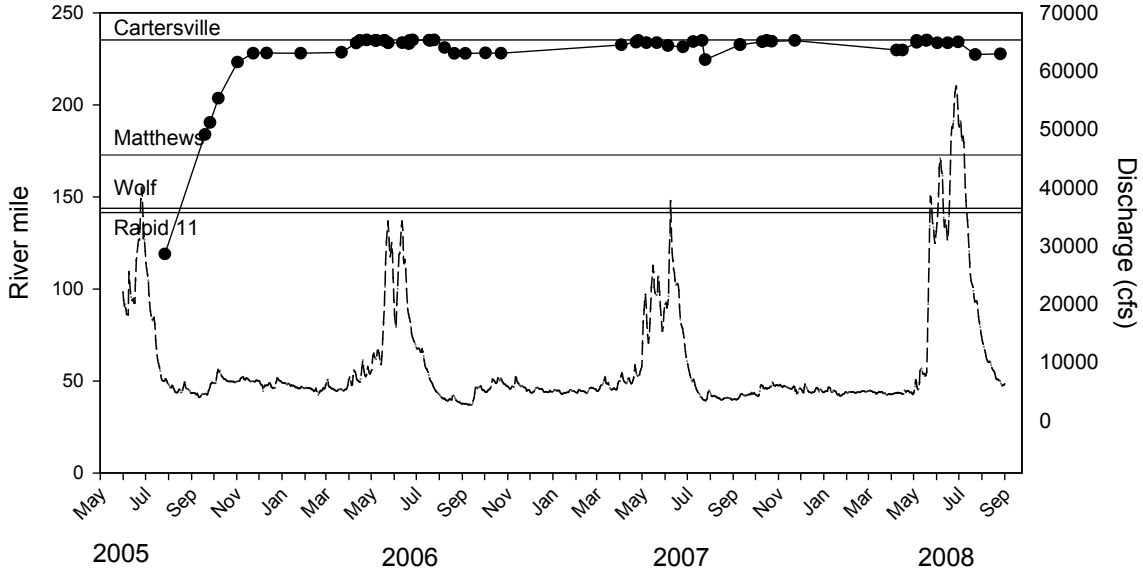

Figure A-6. Movements of shovelnose sturgeon number 420-47 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

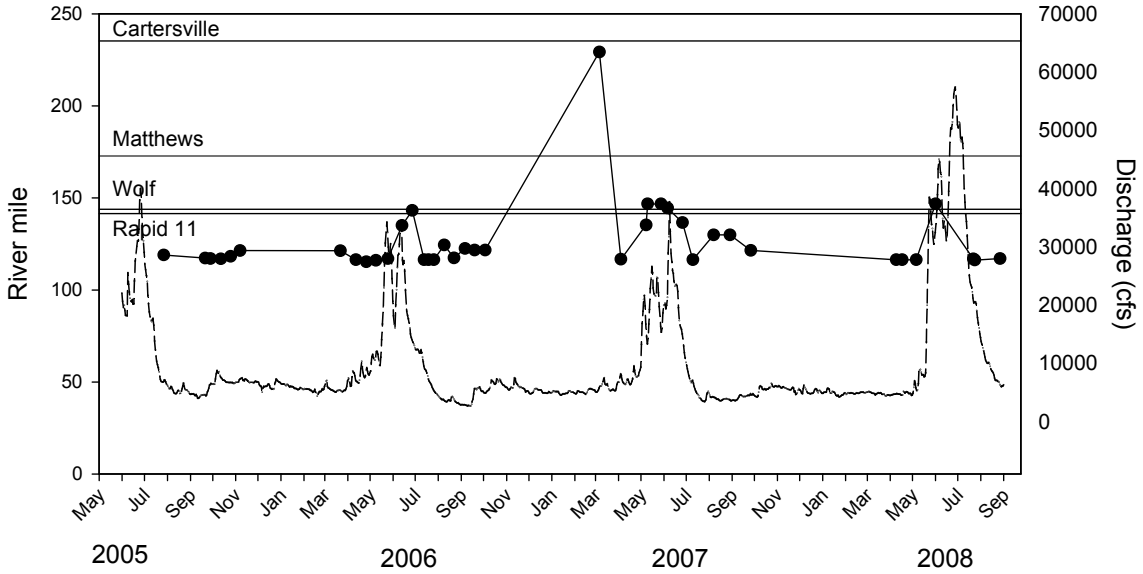

Figure A-7. Movements of shovelnose sturgeon number 420-48 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

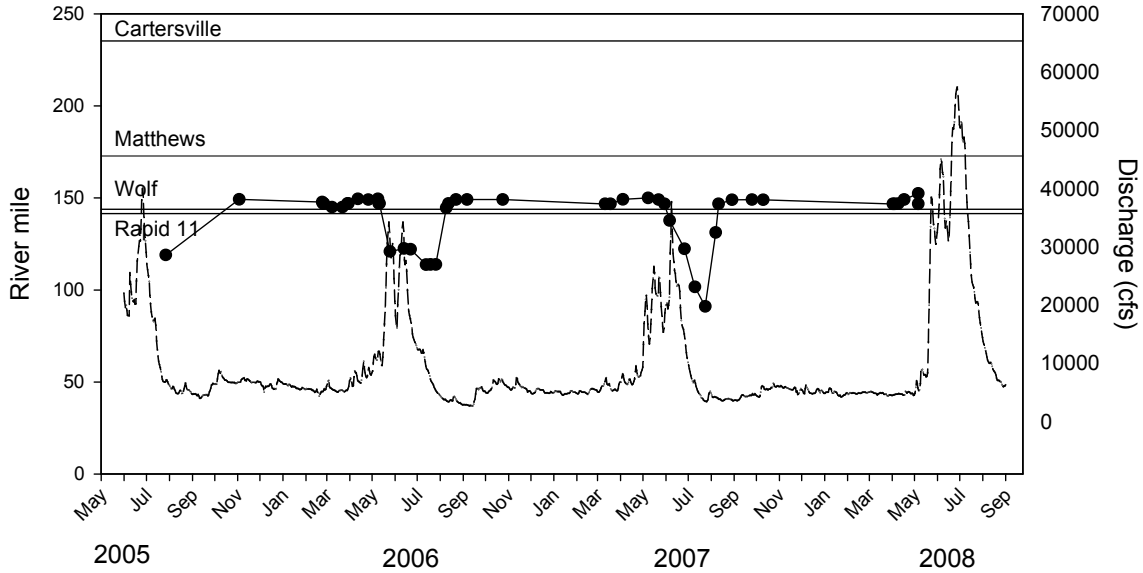

Figure A-8. Movements of shovelnose sturgeon number 420-50 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

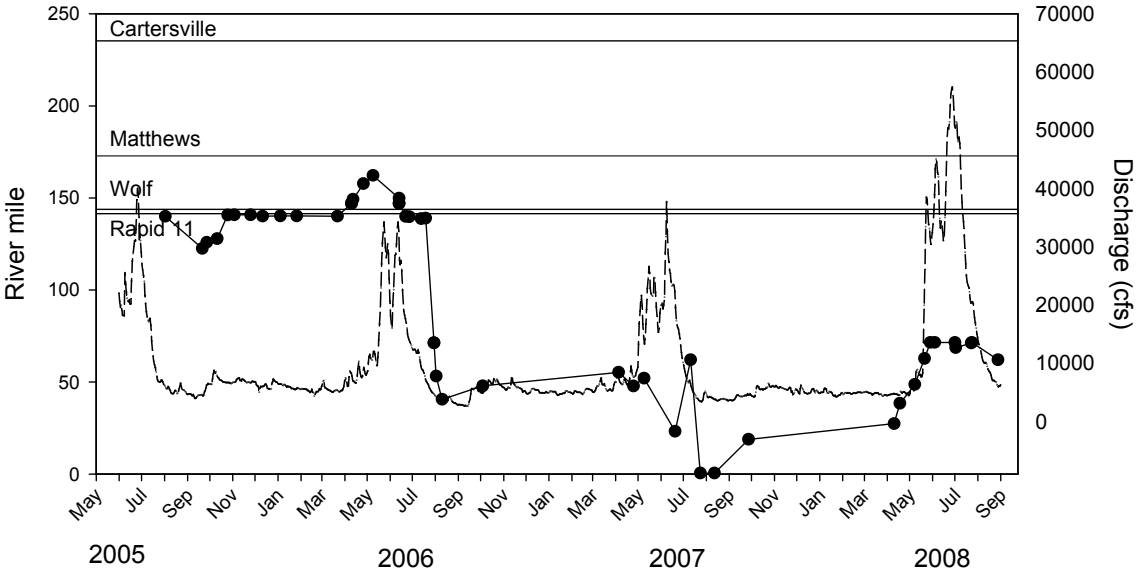

Figure A-9. Movements of shovelnose sturgeon number 420-53 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

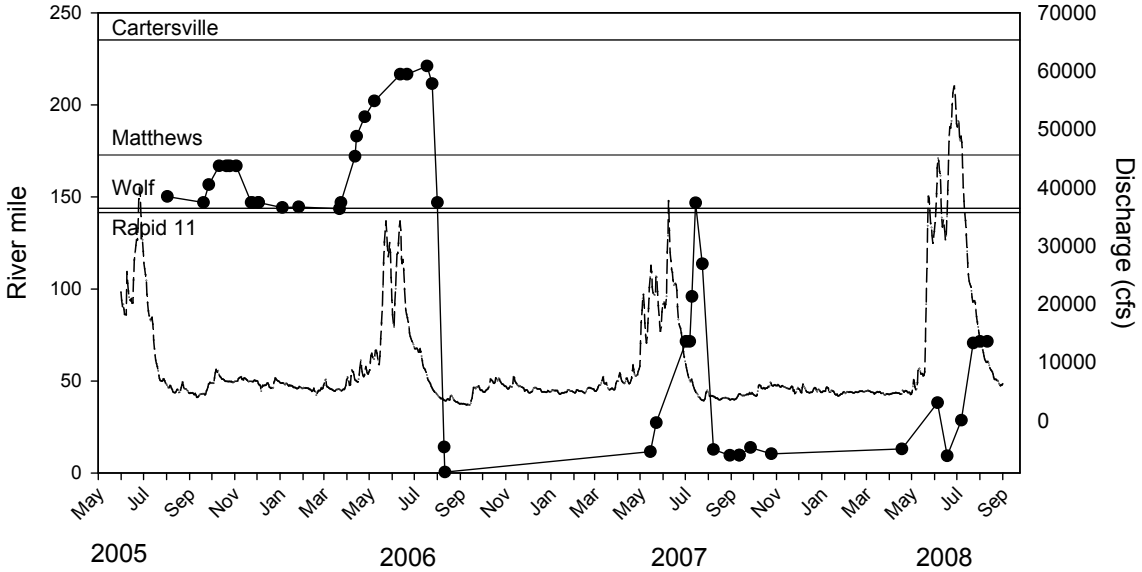

Figure A-10. Movements of shovelnose sturgeon number 420-54 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

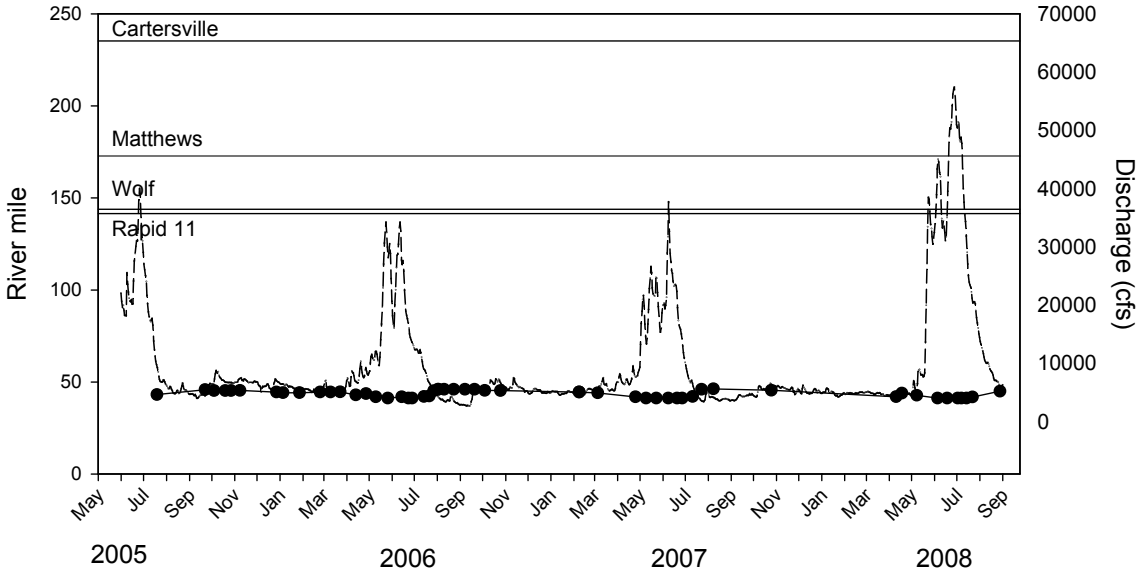

Figure A-11. Movements of shovelnose sturgeon number 420-59 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

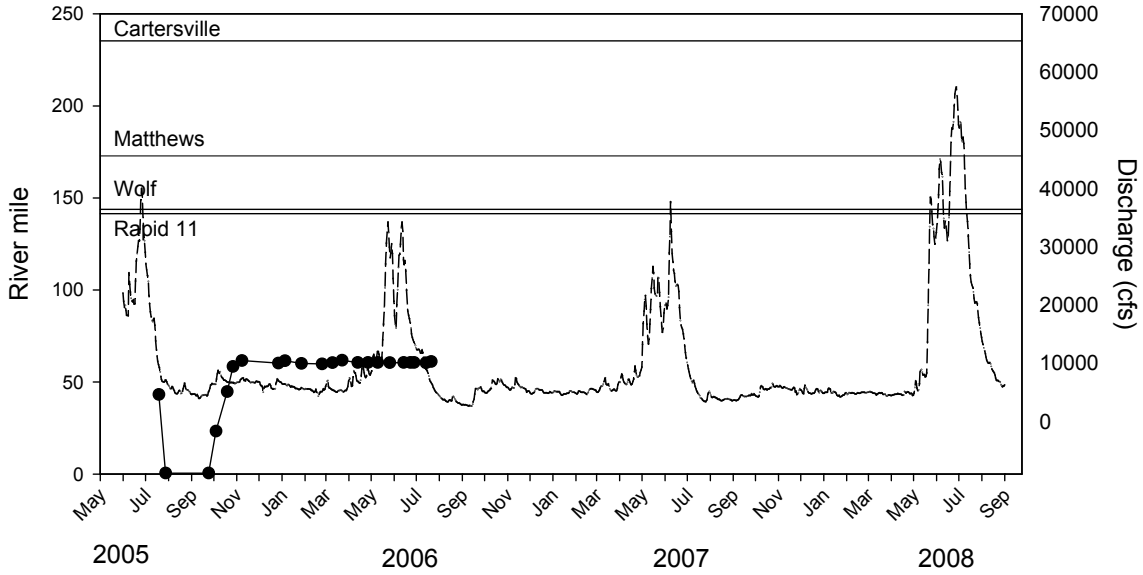

Figure A-12. Movements of shovelnose sturgeon number 420-61 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

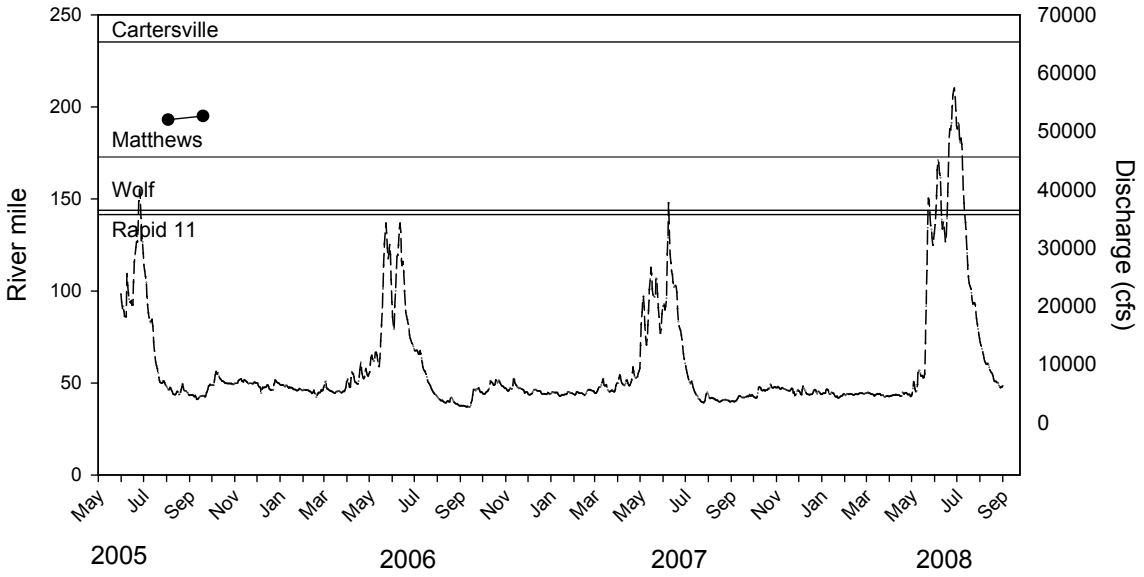

Figure A-13. Movements of shovelnose sturgeon number 420-67 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

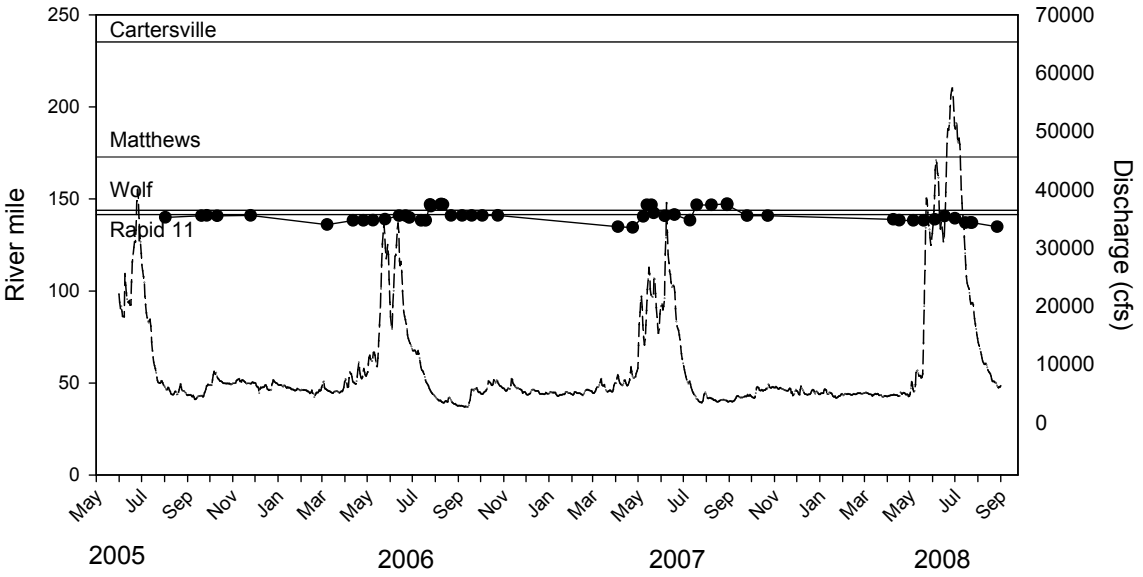

Figure A-14. Movements of shovelnose sturgeon number 420-79 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

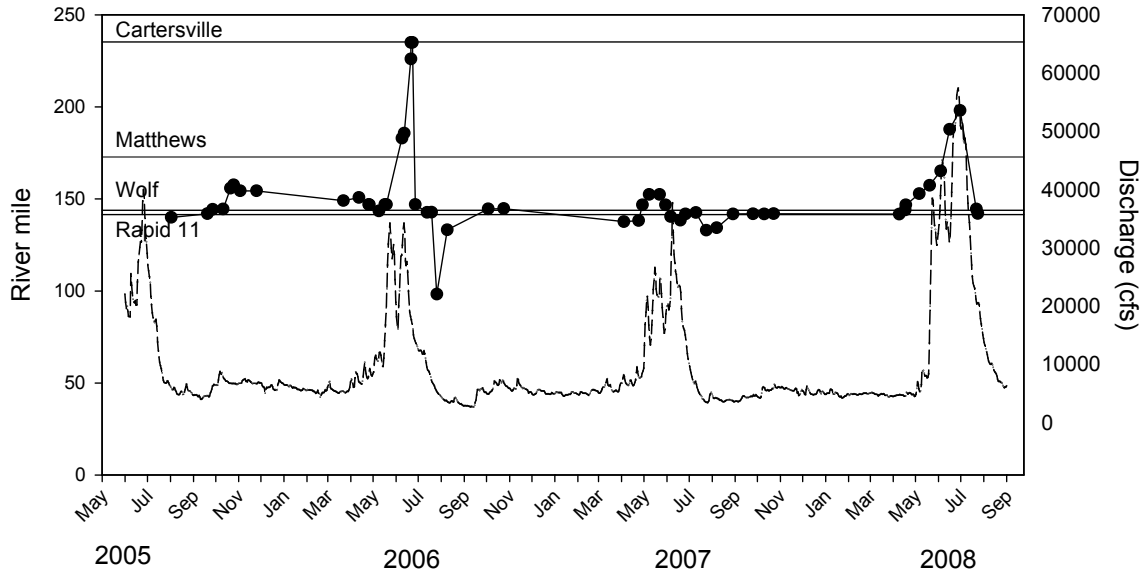

Figure A-15. Movements of shovelnose sturgeon number 420-80 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

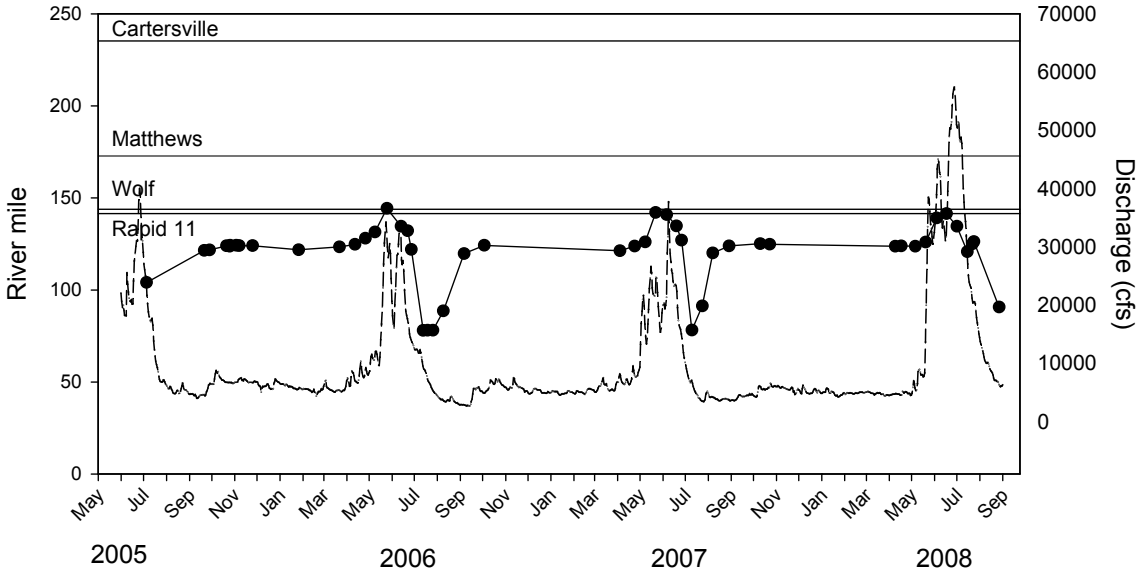

Figure A-16. Movements of shovelnose sturgeon number 480-16 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

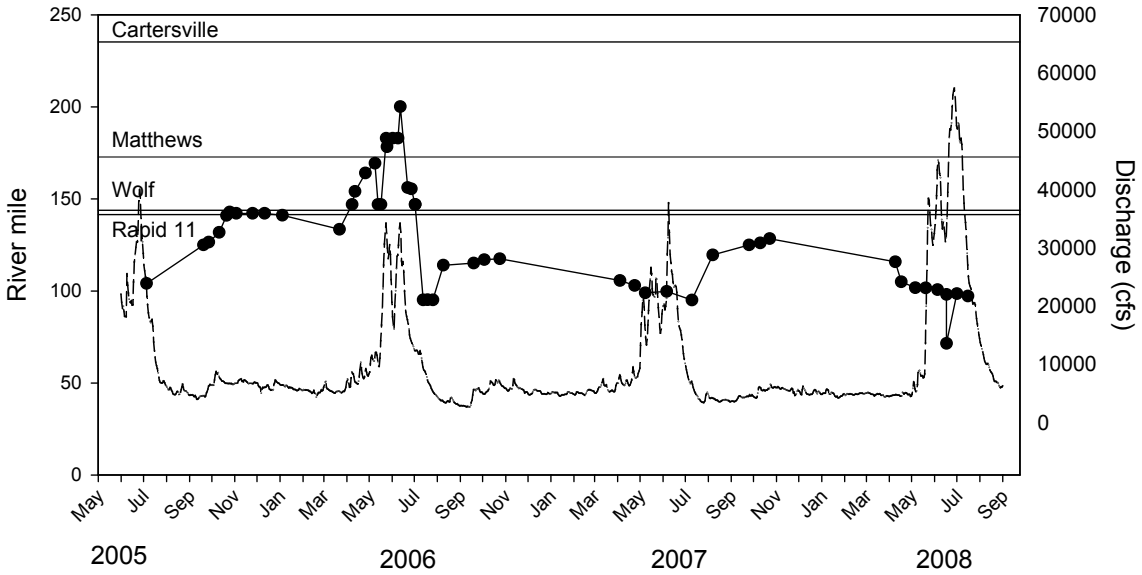

Figure A-17. Movements of shovelnose sturgeon number 480-17 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

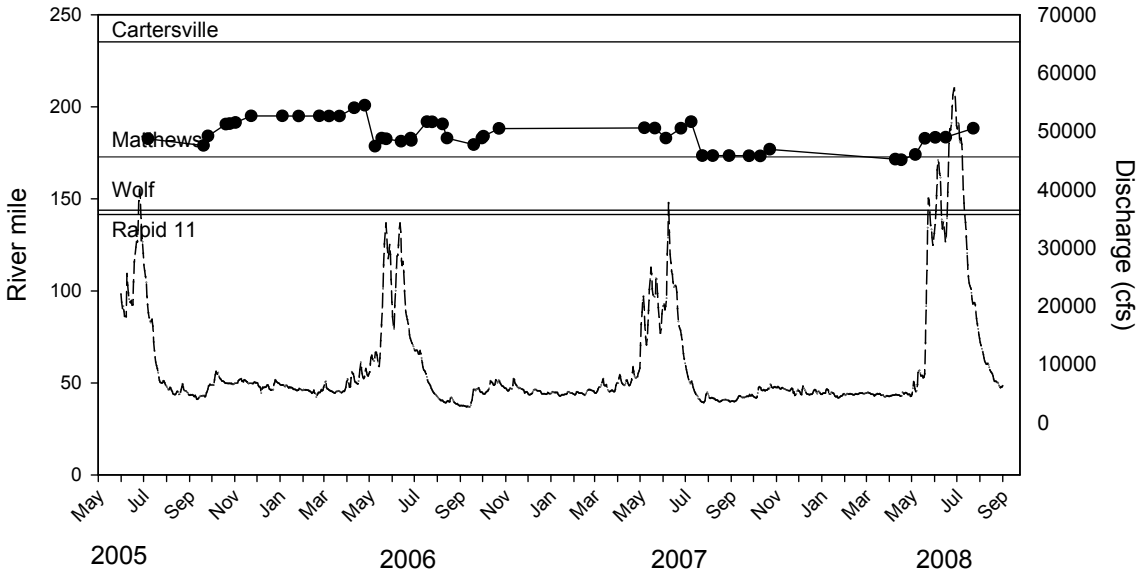

Figure A-18. Movements of shovelnose sturgeon number 480-20 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

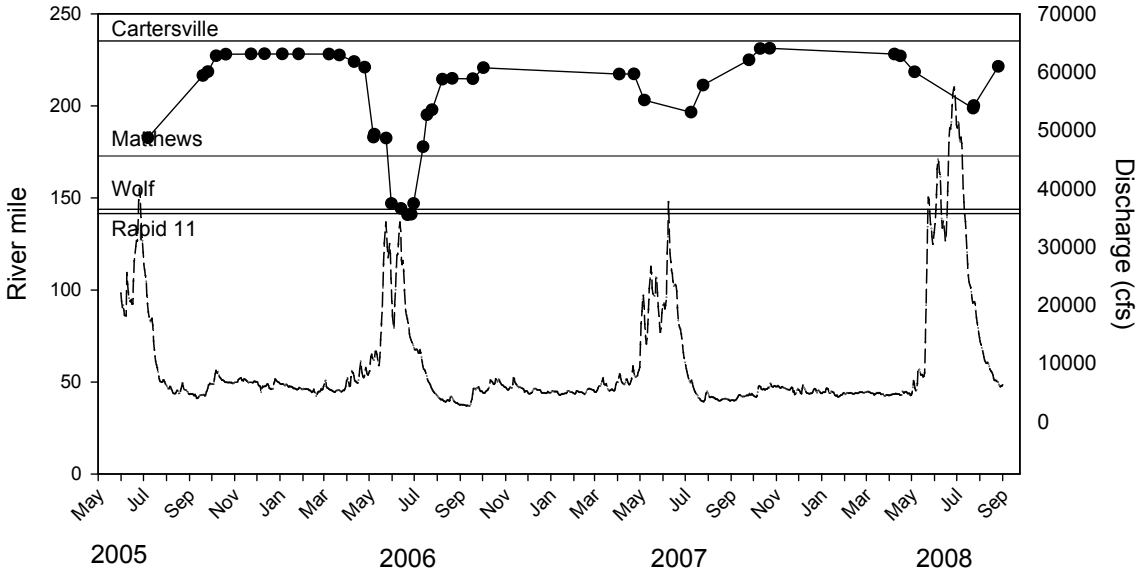

Figure A-19. Movements of shovelnose sturgeon number 480-21 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

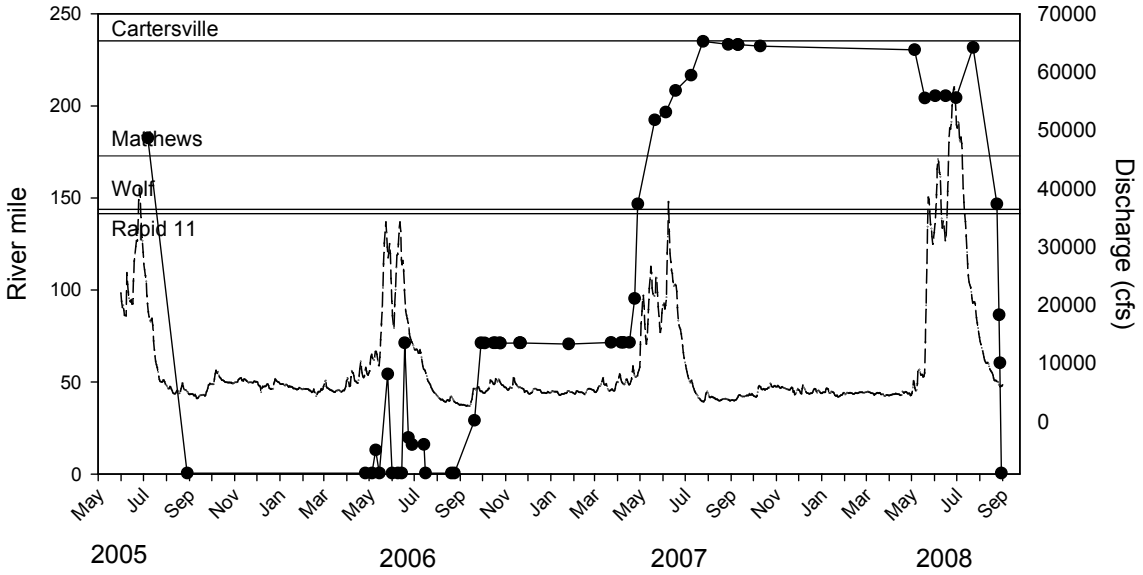

Figure A-20. Movements of shovelnose sturgeon number 480-25 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

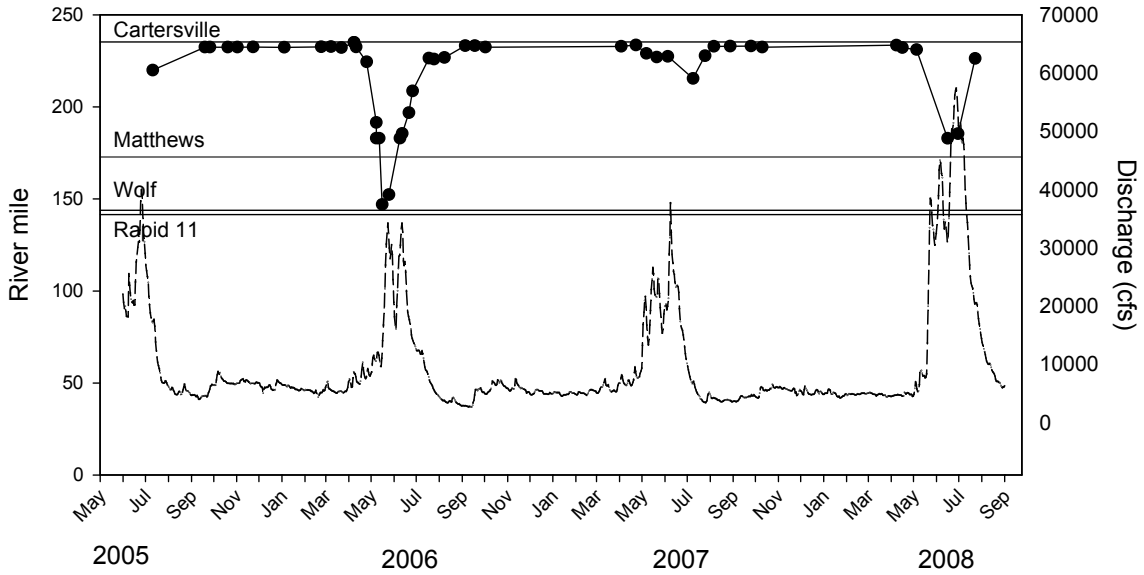

Figure A-21. Movements of shovelnose sturgeon number 480-29 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

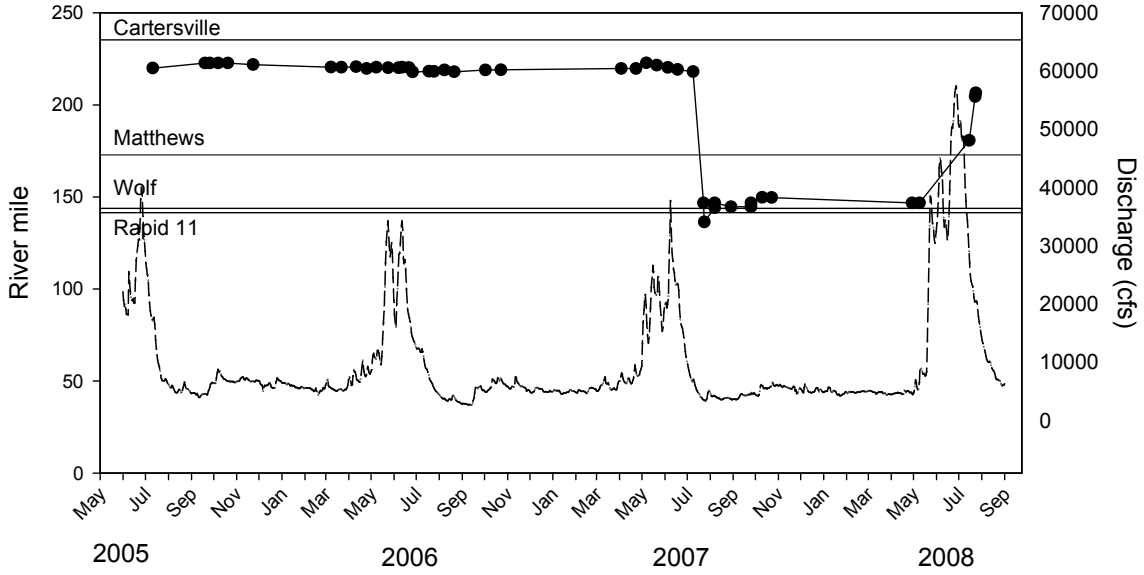

Figure A-22. Movements of shovelnose sturgeon number 480-33 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

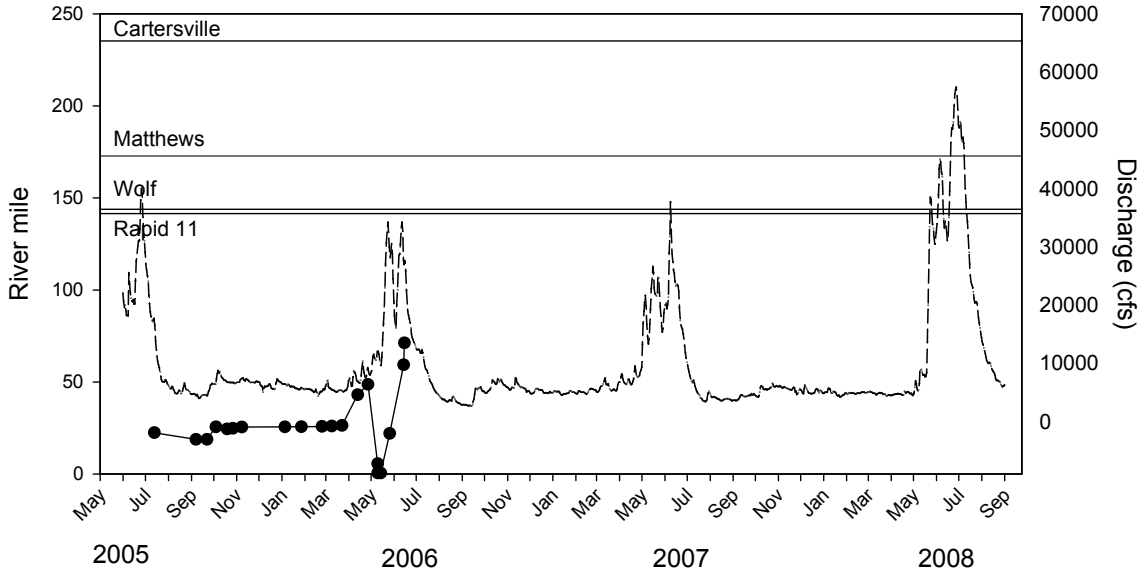

Figure A-23. Movements of shovelnose sturgeon number 480-37 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

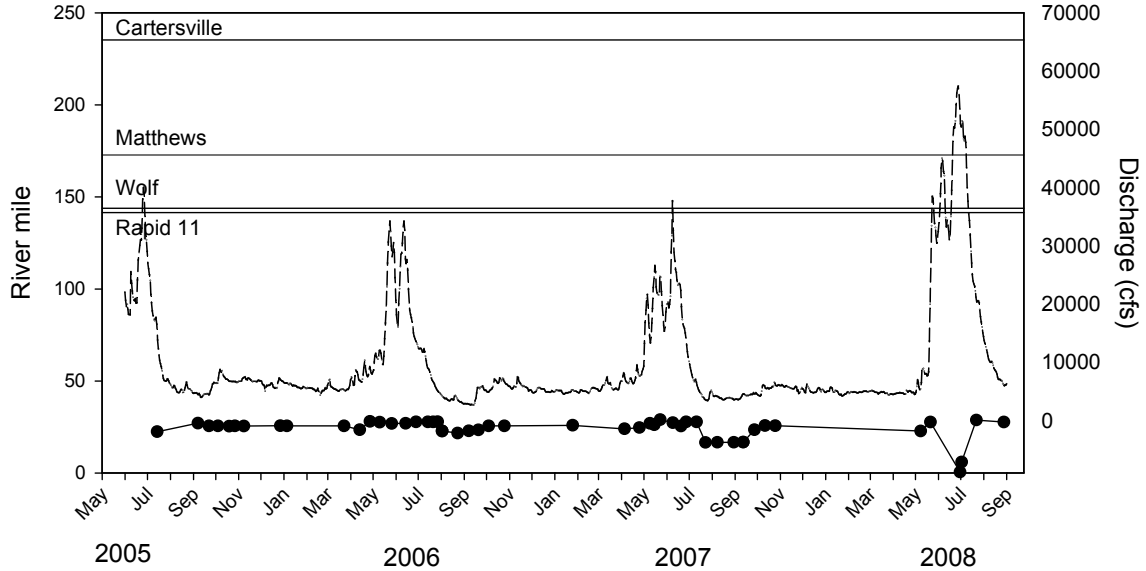

Figure A-24. Movements of shovelnose sturgeon number 480-39 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

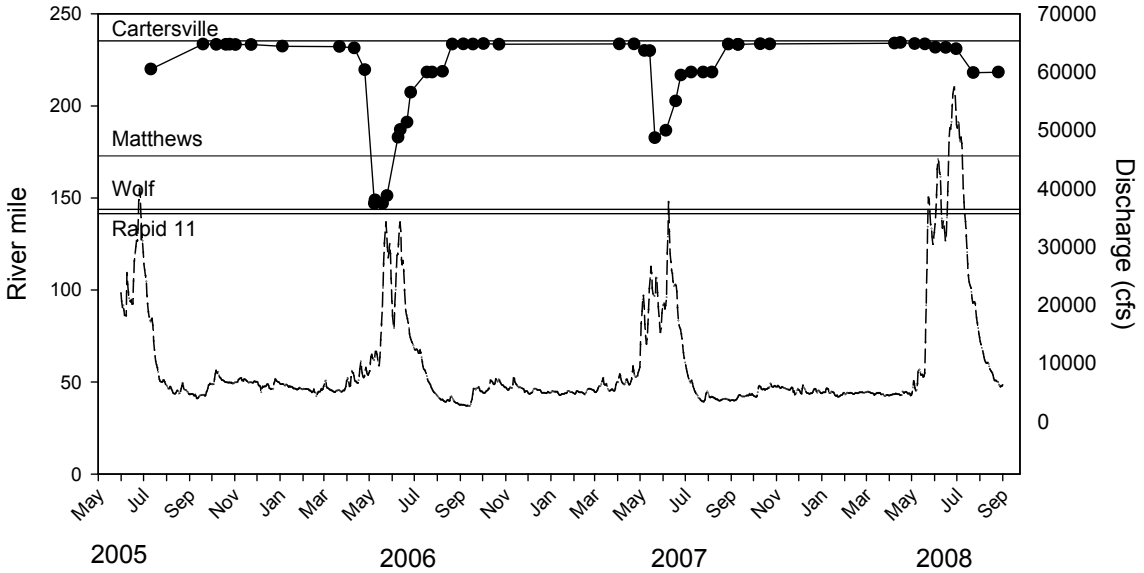

Figure A-25. Movements of shovelnose sturgeon number 480-41 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

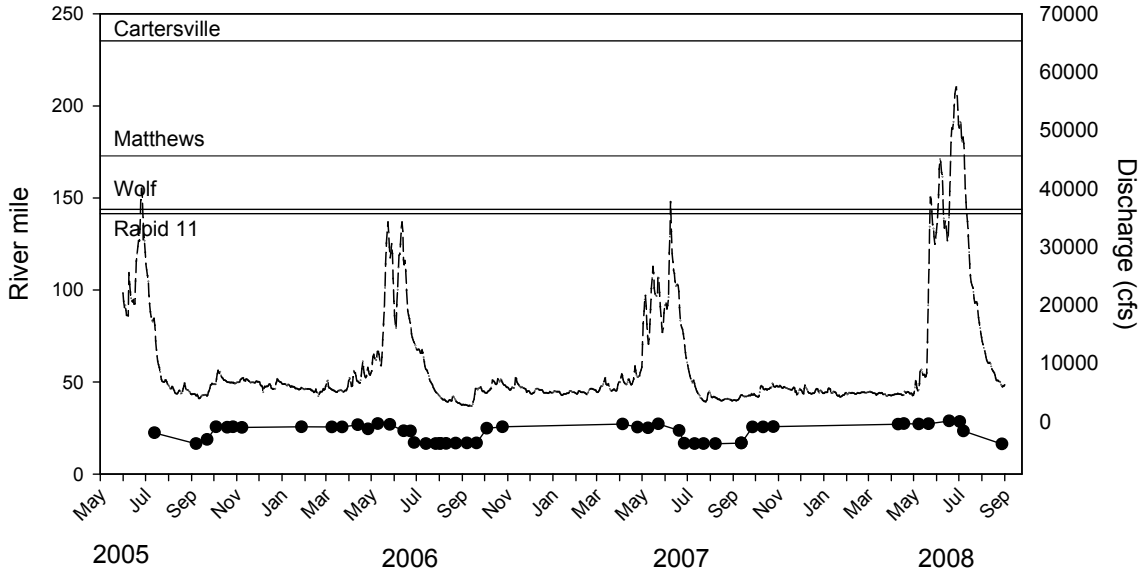

Figure A-26. Movements of shovelnose sturgeon number 480-44 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

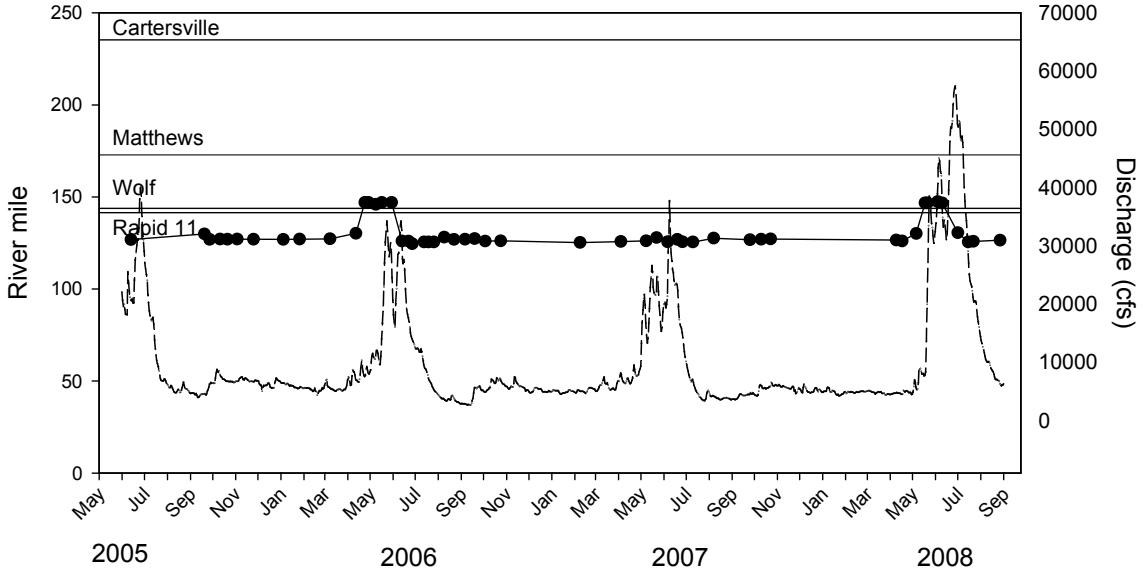

Figure A-27. Movements of shovelnose sturgeon number 480-50 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

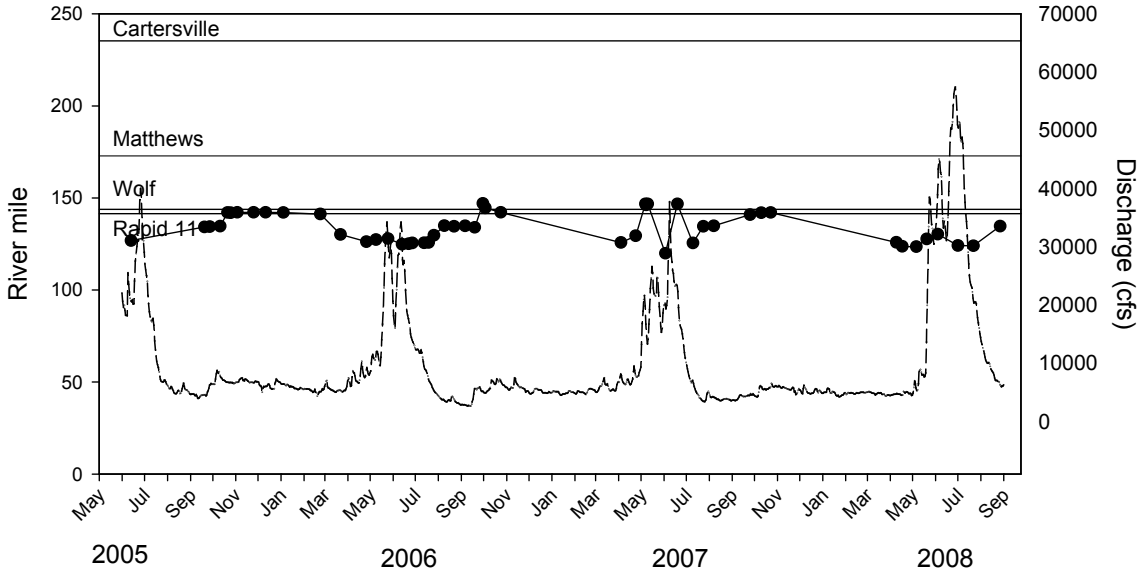

Figure A-28. Movements of shovelnose sturgeon number 480-51 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

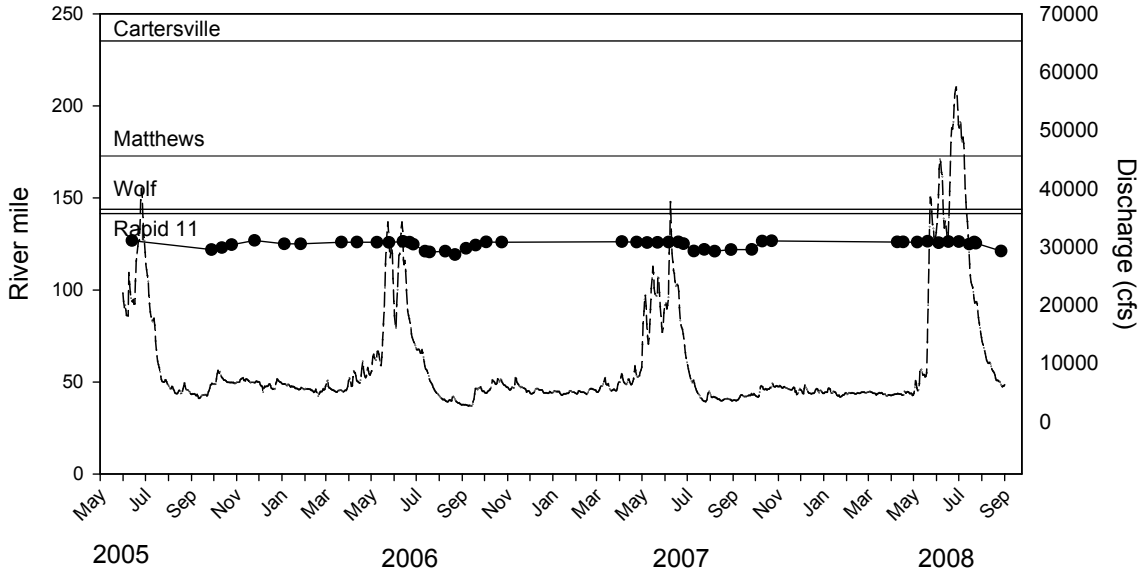

Figure A-29. Movements of shovelnose sturgeon number 480-52 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

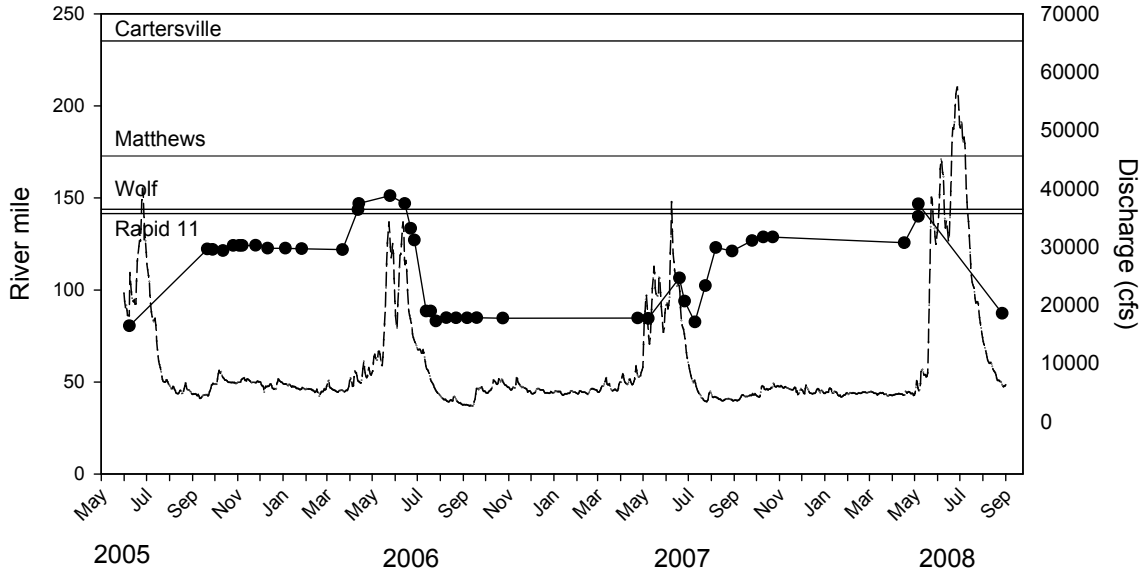

Figure A-30. Movements of shovelnose sturgeon number 75 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

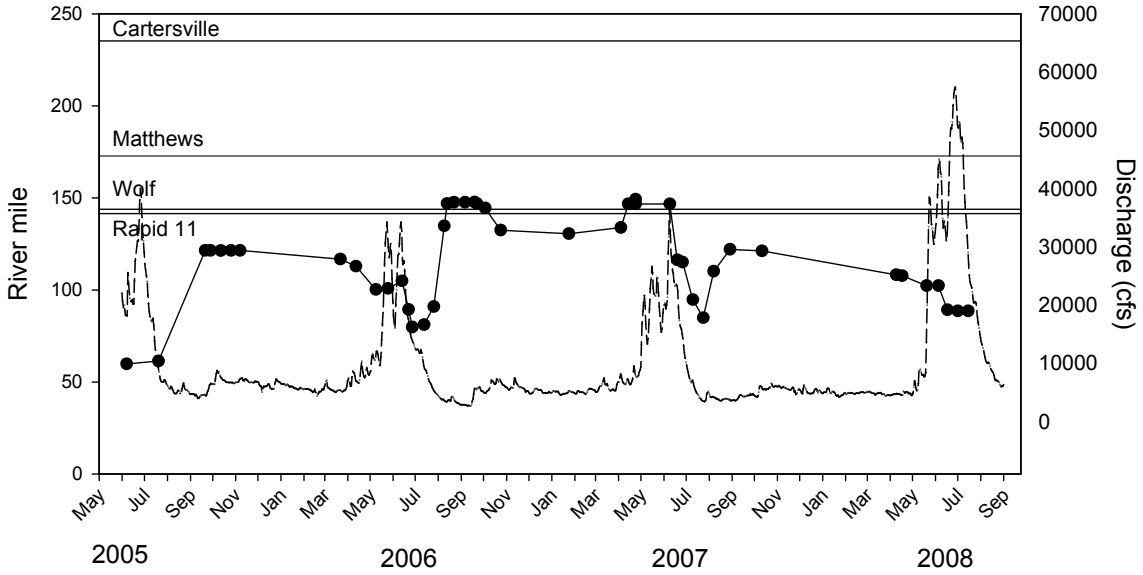

Figure A-31. Movements of shovelnose sturgeon number 480-57 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

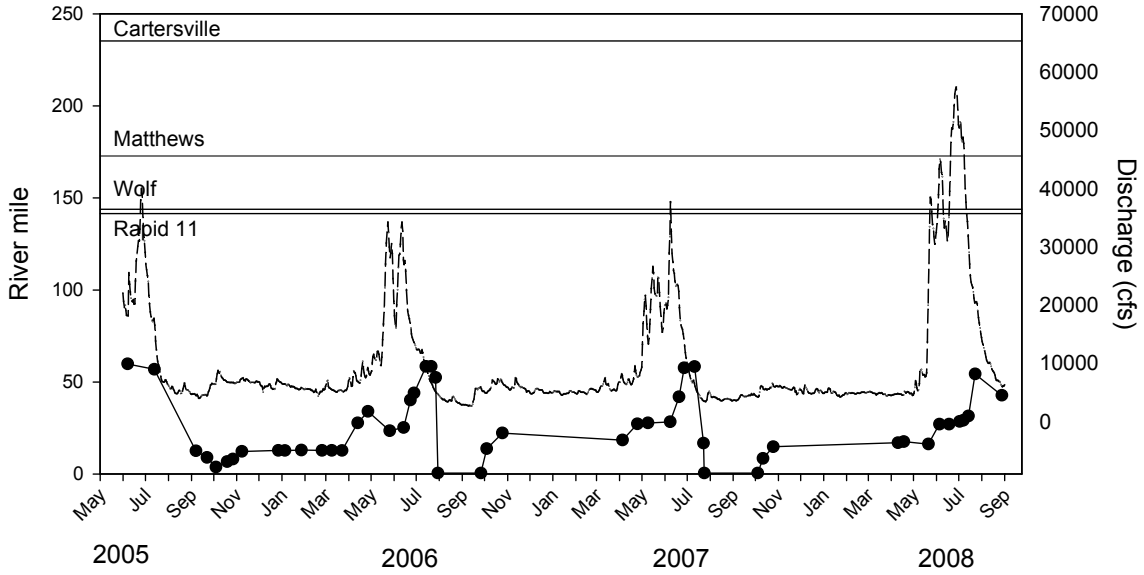

Figure A-32. Movements of shovelnose sturgeon number 480-60 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

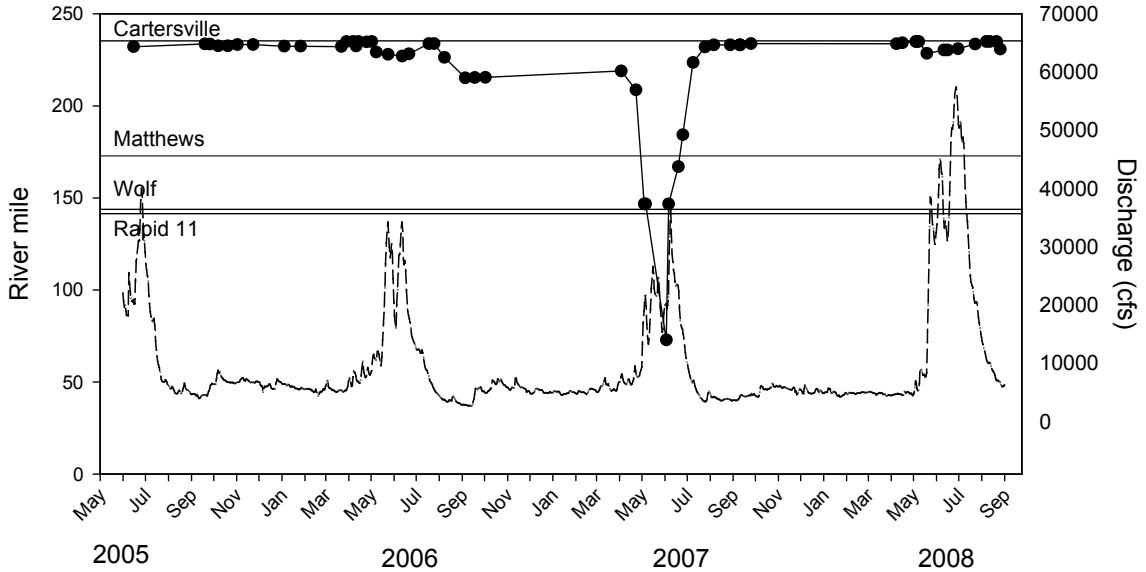

Figure A-33. Movements of shovelnose sturgeon number 480-66 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

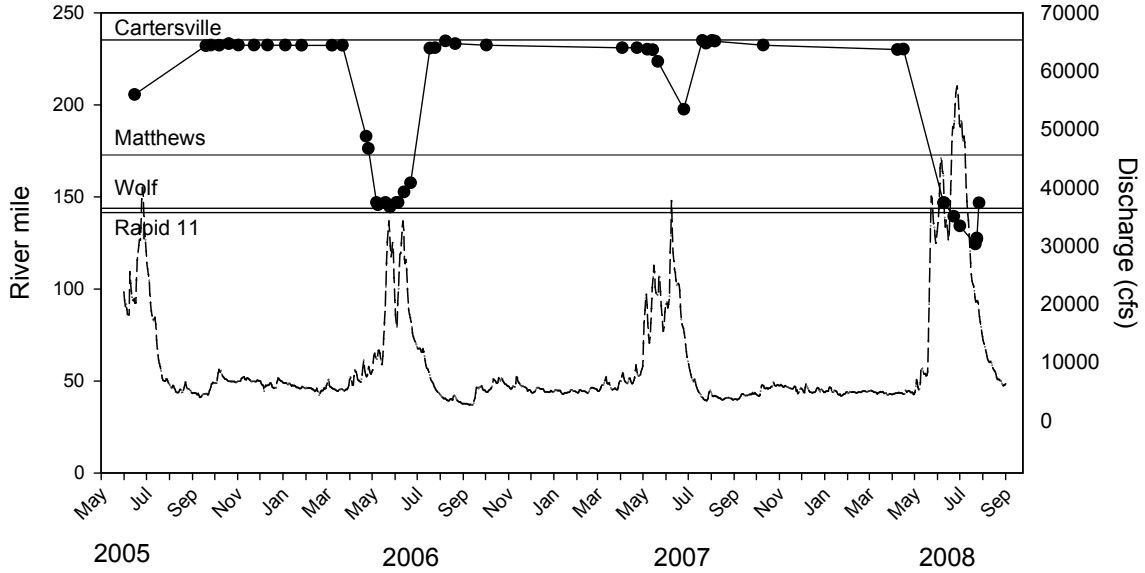

Figure A-34. Movements of shovelnose sturgeon number 480-70 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

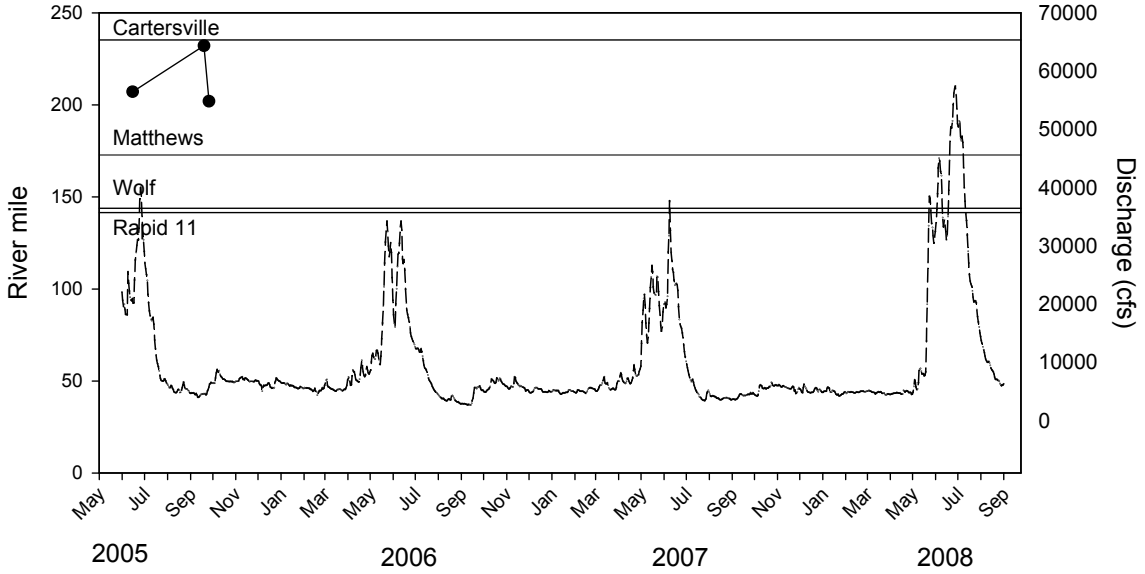

Figure A-35. Movements of shovelnose sturgeon number 480-72 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

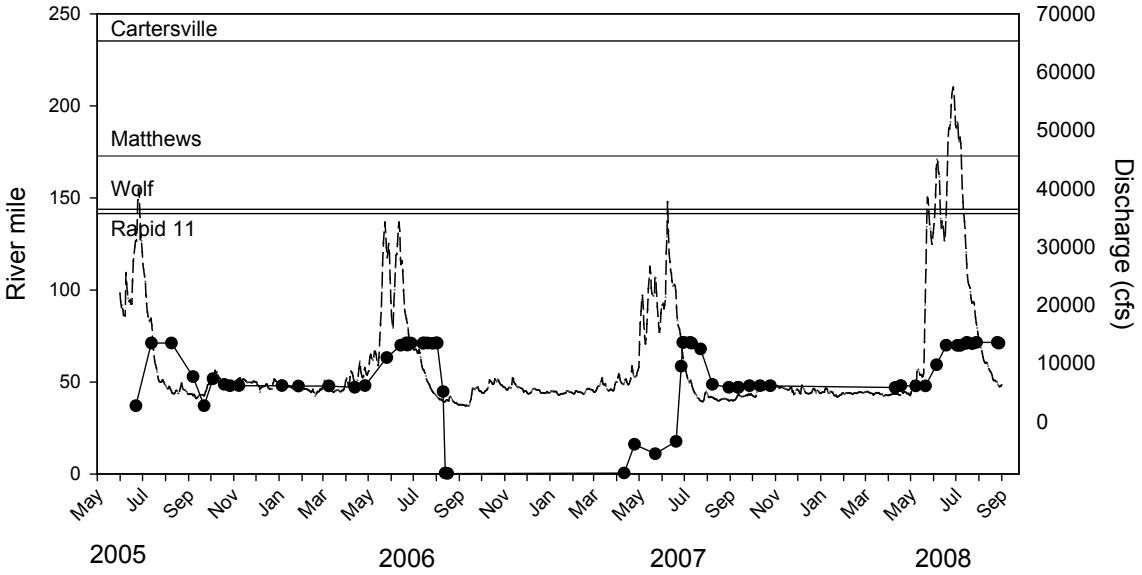

Figure A-36. Movements of shovelnose sturgeon number 480-76 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

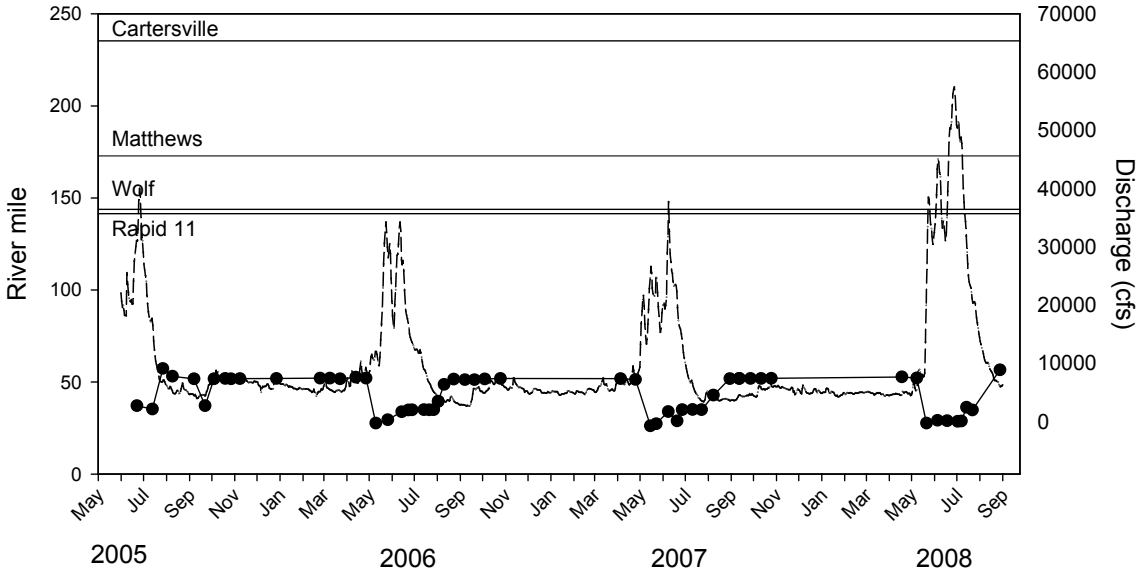

Figure A-37. Movements of shovelnose sturgeon number 480-80 in the Yellowstone River, 2005-2008. Sturgeon locations are indicated with black dots connected by a solid line; discharge at Miles City is displayed as a dashed line. Horizontal reference lines indicate the locations of Cartersville Dam and Matthews Rapid, Wolf Rapid, and Rapid 11.

Appendix B
Correspondence

Public Information Meeting
July 28, 2009

Cartersville Diversion Dam Public Information Meeting

The Montana Department of Fish, Wildlife and Parks has contracted with DOWL HKM to prepare a feasibility analysis and environmental assessment (EA) for fish passage alternatives at Cartersville Diversion Dam. **A public information meeting will be held at the Rosebud County Library meeting room at 7:00 p.m. on Tuesday, July 28, 2009.**

Cartersville Diversion Dam Public Information Meeting

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M E M O R A N D U M

TO: Jim Darling (jdarling@mt.gov)

FROM: Gary Elwell

CC: Pam Ash (pamkashp@aol.com)
Brad Schmitz (brschmitz@mt.gov)
Don Youngbauer (dyoungbauer@yahoo.com)

RE: Cartersville Irrigation Dam
Fish Passage Alternative Analysis and EA
Public Information Meeting 7/28/09

DATE: July 30, 2009
h:\26\10216\memotojimdarling.docx

A public information meeting was held in the Rosebud County Library in Forsyth, Montana on July 28, 2009 at 7:00 p.m. An attendance list is attached. Jim Darling, FWP, presented the project history. Gary provided a power point presentation describing DOWL HKM and the feasibility/environment assessment tasks to be completed. Forms were provided for comments relative to the proposed project. No written comments were submitted during the meeting. Discussion during the meeting included the following:

- Will the selected fish passage project be built for sure?
- Where will the money come from?
- Will existing fishing sites be impacted?
- Will trees hang up on a rock ramp?
- If the Cartersville Irrigation District (CID) approves a fish passage plan, will it make it easier to get funding for other projects (e.g. canal lining in the future)?
- The CID generally is satisfied with the operation of the diversion dam as is, but would like new headgates and a strengthen dam
- Would a rock ramp be built all the way across the river?
- The diversion dam is an important asset to the community.

Public Information Meeting
Cartersville Diversion Dam
July 28, 2009
Signup Sheet

Name:	Jack N. Clifford
Representing:	
Address:	P.O. 28 Forsyth, MT 59327
Email:	jclifford@rangeweb.net
Phone:	346-2648
Name:	Steve Seleg
Representing:	CID
Address:	1523 Cartersville Road Rosebud, MT 59347
Email:	
Phone:	347-5249
Name:	Mark Holmes
Representing:	Holmes Ranch
Address:	157 Thurlow Road Rosebud, MT 59347
Email:	
Phone:	347-5376
Name:	Bud Biery & Sean Zepeda
Representing:	Biery Ranch
Address:	3 Sand Creek Road W Rosebud, MT 59347
Email:	
Phone:	351-1486
Name:	Pat Freed
Representing:	
Address:	Forsyth, MT 59327
Email:	
Phone:	346-7575

Name:	Burt Williams
Representing:	Nature Conservancy
Address:	Fishtail, MT
Email:	
Phone:	
Name:	Don Youngbauer
Representing:	YRCDC
Address:	P.O. Box 68 Forsyth, MT 59327
Email:	
Phone:	346-2131
Name:	Jack Ferguson
Representing:	CID
Address:	120 RT 446 Rosebud, MT 59347
Email:	
Phone:	347-5334
Name:	Pam Ash
Representing:	CID
Address:	Box 668 Forsyth, MT 59327
Email:	pamkashp@aol.com
Phone:	346-1600
Name:	Kirk Montgomery
Representing:	CID
Address:	92 Route 446 Rosebud, MT 59347
Email:	
Phone:	

Name:	Sonja Crocker
Representing:	Crocker Ranch
Address:	50 Thurlow Road Rosebud, MT 59347
Email:	srcrocker@rangeweb.net
Phone:	347-5520
Name:	Cray Weight
Representing:	XH Cattle
Address:	P.O. Box 503 Forsyth, MT 59327
Email:	xhcattle@rangeweb.net
Phone:	351-1191
Name:	Joseph Schiffer
Representing:	Schiffer Ranch Co.
Address:	106 Sand Creek Road E Rosebud, MT 59347
Email:	rsranch@rangeweb.net
Phone:	347-5421 or 951-1458
Name:	Randy Kraus
Representing:	Kraus Ranch
Address:	45 Sand Creek Road Rosebud, MT 59347
Email:	rdkraus84@hotmail.com
Phone:	347-5427
Name:	Jack Crocker
Representing:	Crocker Ranch
Address:	44 Thurlow Road W Rosebud, MT 59347
Email:	
Phone:	347-5276
Name:	Gary E. Elwell, P.E.
Representing:	DOWL HKM
Address:	222 N 32nd Street, Ste. 700 PO Box31318 Billings, MT 59107-1318
Email:	gewell@hkminc.com
Phone:	869-6310

Public Information Meeting
Cartersville Diversion Dam
November 3, 2009
C o m m e n t s

Name:		
Representing:		
Address:		
Email:		
Phone:		
Contacts:	Gary Elwell, P.E. DOWL HKM P.O. Box 31318 Billings, MT 59107-1318 Ph: 406.656.6399 Fax: 406.656.6398 gelwell@hkminc.com	Jim Darling MT Fish, Wildlife & Parks 1420 East Sixth Avenue Helena, MT 59601 Ph: 406.444.5334 jdarling@mt.gov
Comments		

PUBLIC INFORMATION MEETING

CARTERSVILLE IRRIGATION DAM
FISH PASSAGE ALTERNATIVE ANALYSIS AND ENVIRONMENTAL ASSESSMENT

Montana Fish Wildlife and Parks

JULY 28, 2009

Team: DOWL HKM, WHPacific, CONFLUENCE consulting incorporated, KOZMO, Applied Geomorphology, Inc., MONTANA STATE UNIVERSITY

Montana Historical Society
State Historic Preservation Office
September 11, 2009

Rux, Julie

From: Murdo, Damon [dmurdo@mt.gov]
Sent: Friday, September 11, 2009 3:06 PM
To: Elwell, Gary
Subject: RE: Catersville Irrigation Dam Fish Passage Project

Big Sky. Big Land. Big History.
Montana
Historical Society
State Historic Preservation Office • 1410 Eighth Ave • P.O. Box 201202
Helena, MT 59620-1201 • 406-444-7715

September 11, 2009

Gary Elwell
DOWL HKM
222 North 32nd Street, Suite 700
Billings MT 59101

RE: CARTERSVILLE IRRIGATION DAM FISH PASSAGE PROJECT. SHP Project #: 2009091108

Dear Mr. Elwell:

I have conducted a cultural resource file search for the above-cited project located in Section 14, T6N R40E. According to our records there have been a few previously recorded sites within the designated search locale. Site 24RB1000 is the Cartersville Irrigation system which is eligible for listing on the National Register of Historic Places. In addition to the site there have been a few previously conducted cultural resource inventories done in the area. If you would like any further information regarding the site or reports you may contact me at the number listed below.

It is SHPO's position that any structure over fifty years of age is considered historic and is potentially eligible for listing on the National Register of Historic Places. If any structures are to be altered and are over fifty years old we would recommend that they be recorded and a determination of their eligibility be made.

Based on the potential disturbance to the diversion dam required by this undertaking we feel that this project has the potential to impact cultural properties. We, therefore, recommend that a cultural resource inventory be conducted in order to determine whether or not sites exist and if they will be impacted.

If you have any further questions or comments you may contact me at (406) 444-7767 or by e-mail at dmurdo@mt.gov. Thank you for consulting with us.

Sincerely,

Damon Murdo
Cultural Records Manager
State Historic Preservation Office

File: MISC/CONSULTANTS/2009

STATE HISTORIC PRESERVATION OFFICE

1410 8th Ave., P.O. Box 201202, Helena, MT 59620-1202
Phone: (406)-444-7767
Email: dmurdo@mt.gov
Attn: Damon Murdo

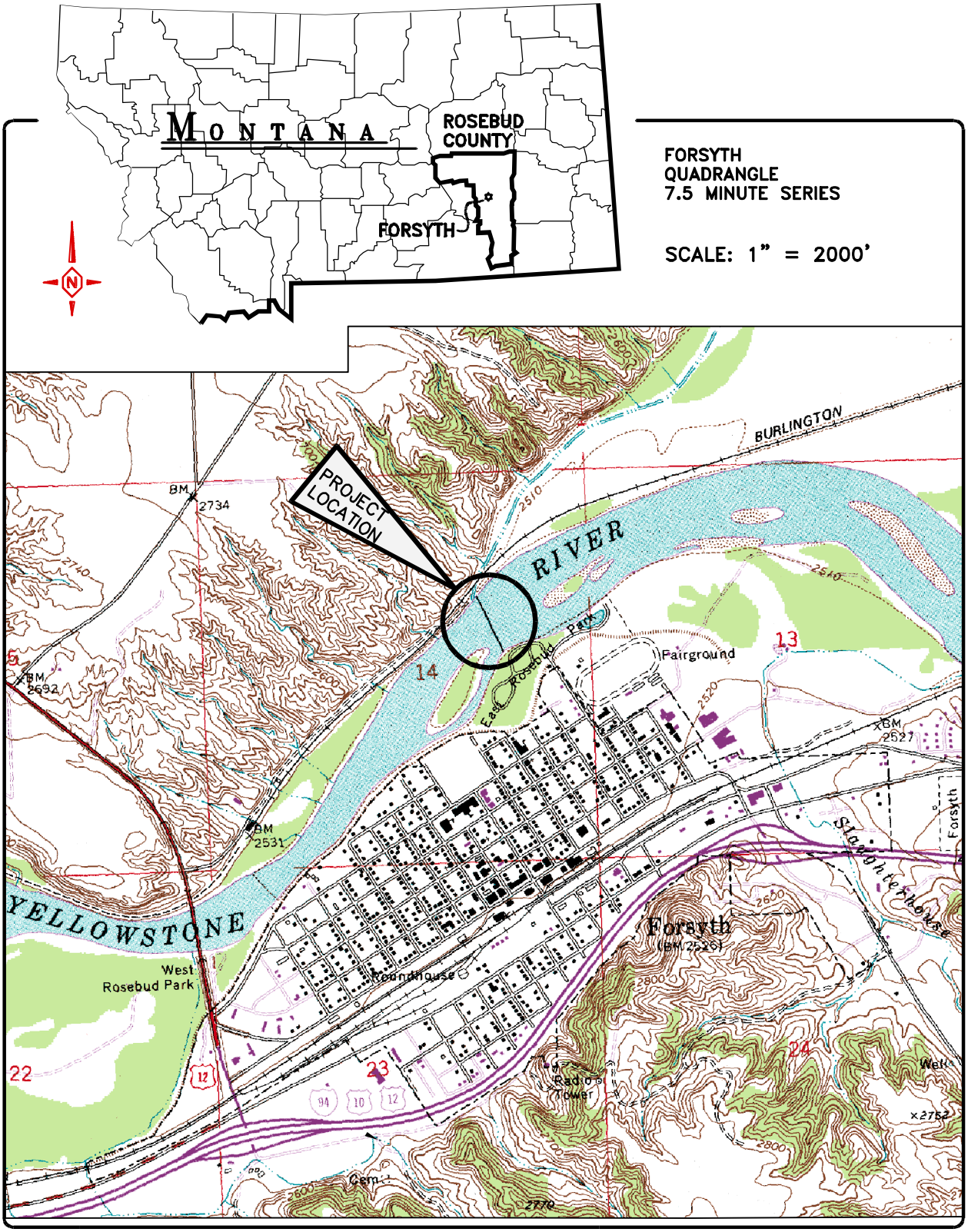
File Search Request Form

Please complete this form and attach a copy of the appropriate USGS Quad map showing the project location. All fields must be completed in order for your file search request to be processed. The form and accompanying map can be returned to the address above, emailed, or brought directly to the office.

Individuals Name	**Gary Elwell, PE**		
Organization (Agency/Company)	**DOWL HKM**		
Street	**222 North 32nd Street, Suite 700**		
City	**Billings**	**State: MT**	**Zip:59101**
Telephone #	**406-869-6310**	**Fax: 406-656-6398**	
Project Name	**Cartersville Irrigation Dam Fish Passage Project**		
Government Agency Involved	**Project being performed under contract with Montana Fish, Wildlife & Parks**		
Describe the project. Please identify any work that will involve ground disturbance, or the demolition and modification of existing buildings. If none of these are to occur, please indicate.	**Preparing a feasibility study and environmental assessment (EA) to identify preferred plan for modifying the Cartersville Irrigation Diversion Dam to allow for fish passage. The dam is owned and operated by the Cartersville Irrigation District.**		
Describe any previous disturbance and the current land use.	**The diversion dam was constructed in the early 1930's and consists of rock riprap capped with concrete. The dam requires annual maintenance including placement of additional rock.**		
Approximate date of proposed project initiation.	**Construction date unknown. Funds for construction have not yet been obtained.**		
Land Ownership (Private, State, Federal, etc.)	**Stream bottom owned by State of Montana**		
Remarks/ Special Requests			

Project Area Location Information (add on if necessary) Projects in cities also require TRS.

TOWNSHIP	RANGE	SECTION	COUNTY
T6N	R40E	14	Rosebud



LOCATION AND VICINITY MAP

CARTERSVILLE IRRIGATION DAM FISH PASSAGE PROJECT

FORSYTH, MONTANA

FIGURE #1

DOWL HKM

26.10216.01	Sept. 2009

H:\26\10216\Mapping\Forsyth_vic-loc.dwg 9/11/2009 9:54:37 AM MDT

Solicitation of Comments
Invitation to Act as Cooperating Agency on EA
Montana Department of Natural Resources and Conservation
September 25, 2009

Montana Fish, Wildlife & Parks
P.O. Box 200701
Helena, MT 59620-0701
(406) 444-3186
FAX: 406-444-4952
Ref: DO386-09
September 25, 2009

Mary Sexton, Director
Montana Department of Natural Resources and Conservation
1625 Eleventh Avenue
Helena, MT 59620

Re: Cartersville Irrigation Dam Fish Passage Project
Solicitation of Comments - Invitation to Act as Cooperating Agency on the Environmental Assessment

Dear Ms. Sexton:

Montana Fish, Wildlife & Parks (FWP) is in the process of evaluating the feasibility and cost of rehabilitating the Cartersville irrigation dam to provide fish passage to the upstream reaches of the Yellowstone River. DOWL HKM has been contracted by FWP to prepare a Feasibility Study and an Environmental Assessment (EA). The FWP is the lead state agency responsible for the preparation of the Montana Environmental Policy Act (MEPA) Environmental Assessment, which is required prior to any state action that may affect the human or physical environment. The FWP would like to invite the Department of Natural Resources and Conservation (DNRC) to act as a Cooperating Agency on this MEPA/National Environmental Policy Act (NEPA) document, due to your agency's permitting jurisdiction over this project. Please indicate whether this seems like a reasonable approach to streamline the environmental process for this project, by marking the appropriate line at the end of this letter, and returning it to our office.

No federal funds will be used for this study, however, a U.S. Army Corps of Engineers (USACE) Section 404 Permit will be required if the selected alternative requires placement of fill in the river. As such, the USACE will be the lead federal agency on this project. FWP has invited the USACE to act as a Cooperating Agency on this MEPA/NEPA document, in order to streamline their federal NEPA requirements associated with the permitting under Section 404 of the Clean Water Act.

Project Overview

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Project Purpose and Need

This dam has likely impeded the upstream migration of the shovelnose sturgeon and other fish species native to the Yellowstone River, since it was built in the early 1930s. (Bob Bramblett) There is another fish passage barrier approximately 135 miles downstream of the Cartersville dam (near Intake in Dawson County, Montana), however, the USACE is currently working on a project that will provide fish passage through that section of the river. Once that project is complete, the Cartersville dam will be the next barrier that precludes the upstream movement of the pallid sturgeon and other native fish species.

The overall intent of the project is to rehabilitate the dam to improve fish passage through this section of the Yellowstone River, while continuing to provide the water needed for the adjacent irrigation ditch.

The primary project objectives are:
1. Maintain the ability of the irrigation district to divert water at all water levels;
2. Allow upstream passage of native fishes, particularly sturgeon;
3. Provide minimal maintenance requirements;
4. Increase public safety, and
5. Maintain recreation opportunities at the adjacent city park.

Alternatives under Consideration
Initial alternatives were developed for this project as part of a two-day inter-agency planning process that was held February 25-26, 2009, resulting in a summary report called the "Cartersville Diversion Dam Project Study". The purpose of the study was to expand the existing list of project alternatives and prioritize them. Agencies and stakeholders represented at this two-day meeting included:

U.S. Fish and Wildlife Service (USFWS)
U.S. Army Corp of Engineers (USACE)
Montana Fish, Wildlife & Parks (FWP)
Montana Department of Environmental Quality (DEQ)
Natural Resource Conservation Service (NRCS)
Yellowstone River Conservation District
Cartersville Irrigation District
Nature Conservancy

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4. Bypass channel; circumvent obstacles
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These alternatives, plus others developed during the feasibility study, will be addressed in the EA.

Request for Comments
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Please submit written comments to our consultant, DOWL HKM, at 222 N 32nd Avenue, Suite 700, Billings, MT 59101 (Attn: Gary Elwell, PE), or by e-mail (gelwell@hkminc.com). Please provide any initial written comments within thirty (30) calendar days from receipt of this letter.

If you have any questions regarding the project, you may contact Gary Elwell, PE of DOWL HKM at (406) 869-6310.

Sincerely,

for

Joe Maurier
Director

Attachment: Figure 1

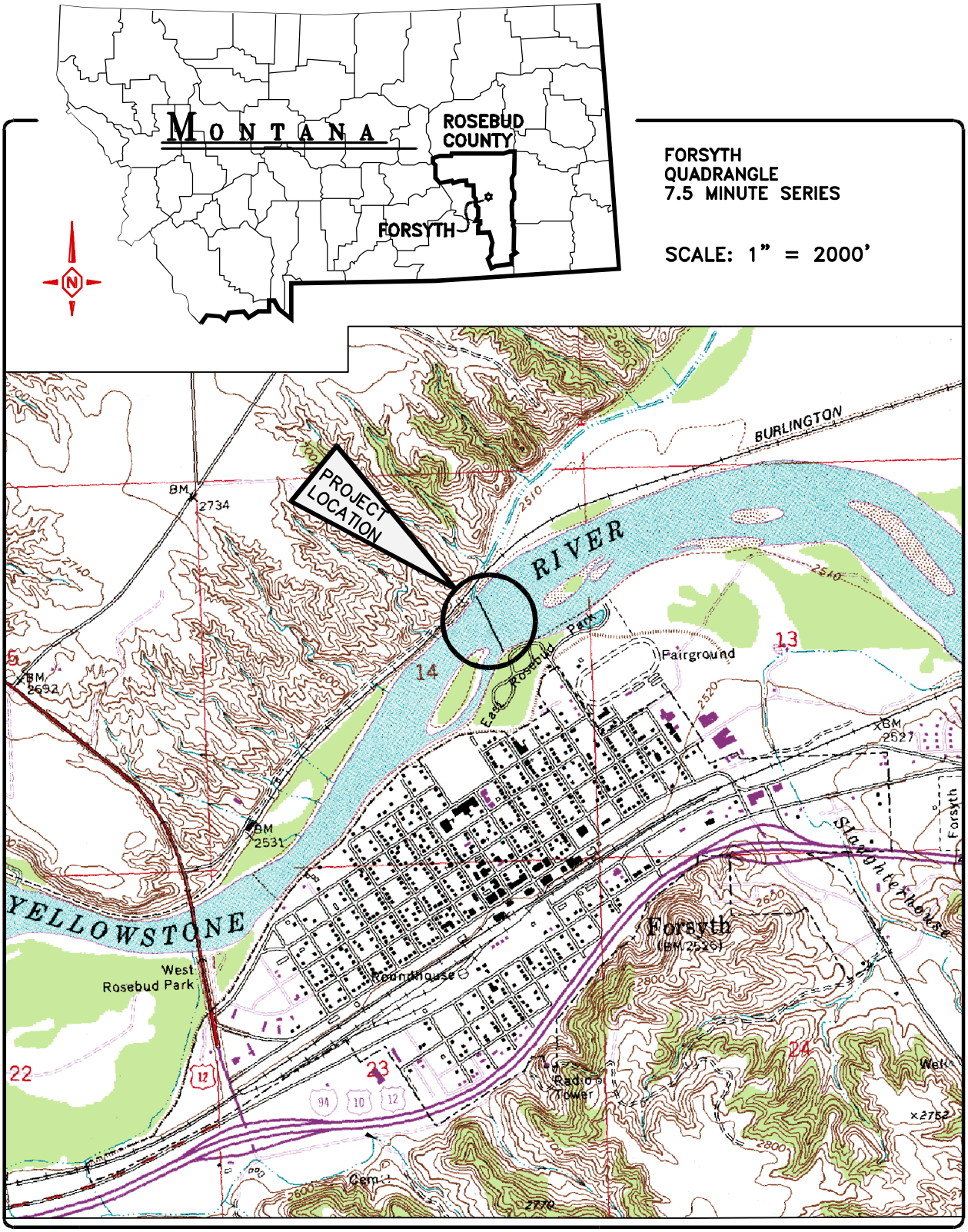
c: Pam Ash, Cartersville Irrigation District
Brad Schmitz, Montana, Fish Wildlife & Parks
Burt Williams, Nature Conservancy
Gary Elwell, PE, DOWL HKM

Please indicate the DNRC's response to the invitation to act as a Cooperating Agency on this EA, and return this page to: Montana Fish, Wildlife & Parks
Attn: Jim Darling
P O Box 200701
Helena MT 59620-0701

___ The DNRC would like to act as a Cooperating Agency on this EA.

___ The DNRC declines to act as a Cooperating Agency on this EA.

_____ _____
Montana Department of Natural Resources and Conservation Date



LOCATION AND VICINITY MAP

CARTERSVILLE IRRIGATION DAM FISH PASSAGE PROJECT

FORSYTH, MONTANA

FIGURE #1

DOWL HKM

26.10216.01	Sept. 2009

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Solicitation of Comments
Invitation to Act as Cooperating Agency on EA
Montana Department of Environmental Quality
September 25, 2009

Montana Fish, Wildlife & Parks
P.O. Box 200701
Helena, MT 59620-0701
(406) 444-3186
FAX: 406-444-4952
Ref: DO38509
September 25, 2009

Richard Opper, Director
Montana Department of Environmental Quality
P O Box 200901Avenue
Helena, MT 59620-0901

Re: Cartersville Irrigation Dam Fish Passage Project
Solicitation of Comments - Invitation to Act as Cooperating Agency on the Environmental Assessment

Dear Mr. Opper:

Montana Fish, Wildlife & Parks (FWP) is in the process of evaluating the feasibility and cost of rehabilitating the Cartersville irrigation dam to provide fish passage to the upstream reaches of the Yellowstone River. DOWL HKM has been contracted by FWP to prepare a Feasibility Study and an Environmental Assessment (EA). The FWP is the lead state agency responsible for the preparation of the Montana Environmental Policy Act (MEPA) Environmental Assessment, which is required prior to any state action that may affect the human or physical environment. The FWP would like to invite the Department of Environmental Quality (DEQ) to act as a Cooperating Agency on this MEPA/National Environmental Policy Act (NEPA) document, due to your agency's permitting jurisdiction over this project. Please indicate whether this seems like a reasonable approach to streamline the environmental process for this project, by marking the appropriate line at the end of this letter, and returning it to our office.

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Project Overview

The Cartersville irrigation dam is located on the Yellowstone River at the town of Forsyth in Rosebud County, Montana (Figure 1). The legal description of the site is Sec 14, T 6N, R 40E. The dam is owned and operated by the Cartersville Irrigation District, which has associated water rights dating to the late 1800s. The condition of the dam has deteriorated since it was constructed in the early 1930s, and has required ongoing annual maintenance in recent years. The dam is made of rock-rubble riprap capped with concrete, and spans the entire channel of the Yellowstone River, over 800-ft in length. Currently, the dam acts as a fish passage barrier, particularly during periods of lower flows. (US Fish Wildlife Service (USFWS), Yellowstone River Coordinator's Office, Montana – Prairie Region)

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through that section of the river. Once that project is complete, the Cartersville dam will be the next barrier that precludes the upstream movement of the pallid sturgeon and other native fish species.

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Yellowstone River Conservation District
Cartersville Irrigation District
Nature Conservancy

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If you have any questions regarding the project, you may contact Gary Elwell, PE of DOWL HKM at (406) 869-6310.

Sincerely,

for

Joe Maurier
Director

Attachment: Figure 1

c: Pam Ash, Cartersville Irrigation District
Brad Schmitz, Montana, Fish Wildlife & Parks
Burt Williams, Nature Conservancy
Gary Elwell, PE, DOWL HKM

Please indicate the DEQ's response to the invitation to act as a Cooperating Agency on this EA, and return this page to:

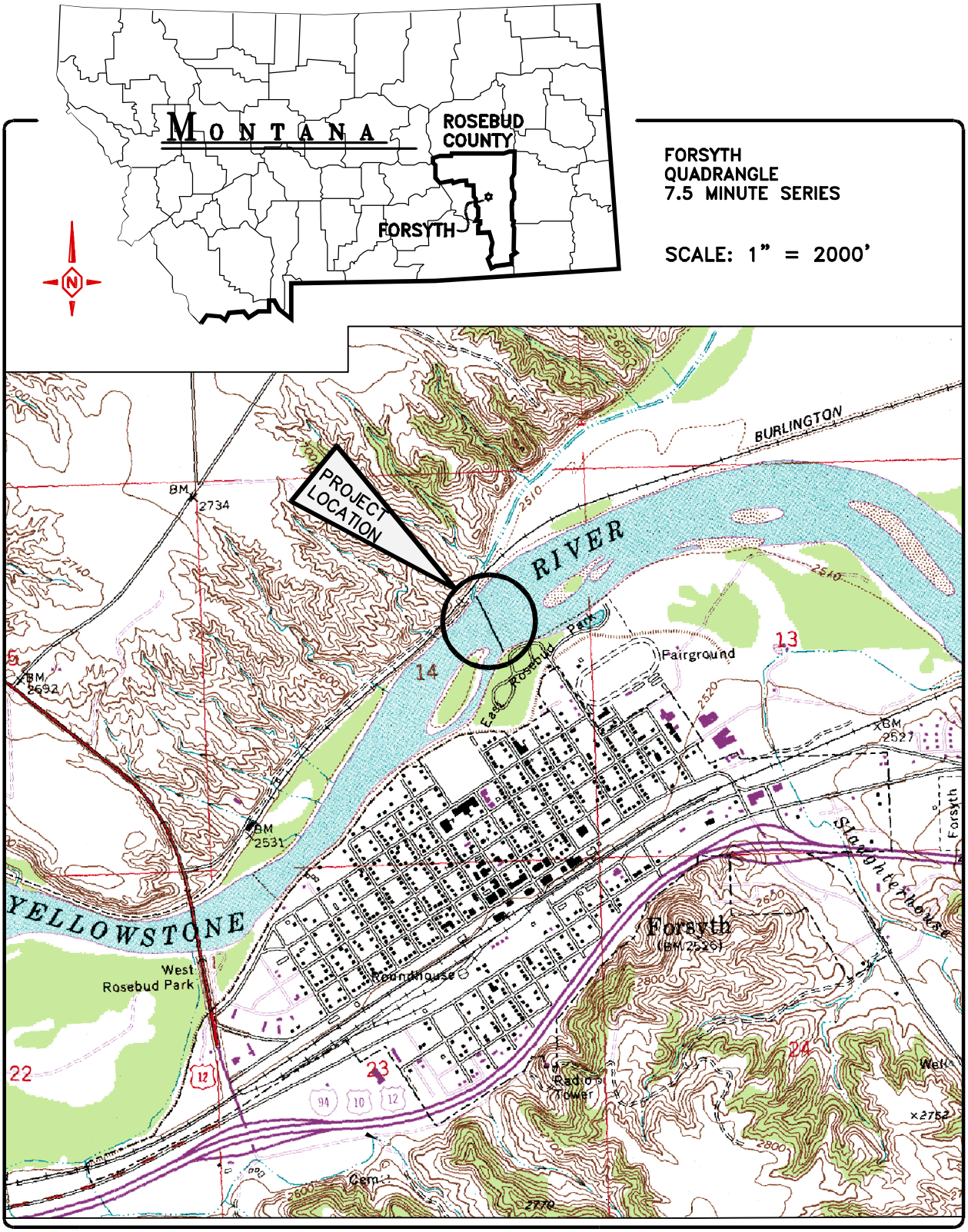
Montana Fish, Wildlife & Parks
Attn: Jim Darling
P O Box 200701
Helena MT 59620-0701

___ The DEQ would like to act as a Cooperating Agency on this EA.

___ The DEQ declines to act as a Cooperating Agency on this EA.

_____ _____

Montana Department of Environmental Quality Date



LOCATION AND VICINITY MAP

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FORSYTH, MONTANA

FIGURE #1

DOWL HKM

26.10216.01	Sept. 2009

H:\26\10216\Mapping\Forsyth_vic-loc.dwg 9/11/2009 9:54:37 AM MDT

Elwell, Gary

From: Elwell, Gary
Sent: Wednesday, September 30, 2009 11:15 AM
To: 'tellerhoff@mt.gov'
Subject: Cartersville
Attachments: deq cartersville_20090930110538.pdf

Tom

Attached is a scan of the letter from FWP you requested.

Gary Elwell ,PE

DOWL HKM
406-656-6399
222 N 32nd Street
Suite 700
Billings, MT 59101-1911
Fax 406-656-6398
DID 406-869-6310
www.dowlhkm.com

IMPORTANT INFORMATION ABOUT THIS COMMUNICATION: This electronic communication (including any appended material) is intended solely for the use of the person or entity to which it is addressed. Because the communication may contain information that is confidential, privileged, or legally exempt from disclosure, you are prohibited from reading, disclosing, reproducing, distributing, disseminating, or otherwise using the communication if you are not its intended recipient. Accordingly, if you have received this communication because of an error or inadvertence on our part or on the part of one of the recipients, we ask that you please, for your own protection, immediately notify the sender by electronic communication and immediately delete this message from your system. DO NOT RELY on professional recommendations, professional opinions, plans, specifications, or other instruments of professional service that are delivered electronically. Any such material may have been corrupted by electronic delivery. RELY ONLY on the hard copy that we will issue to you by mail or delivery service.

Solicitation of Comments
Invitation to Act as Cooperating Agency on EA
U.S. Army Corps of Engineers
September 25, 2009

Montana Fish, Wildlife & Parks

P.O. Box 200701
Helena, MT 59620-0701
(406) 444-3186
FAX: 406-444-4952
Ref: DO387-09
September 25, 2009

Todd Tillinger
U.S. Army Corps of Engineers
10 West 15th Street
Suite 220
Helena, MT 59626

Re: Cartersville Irrigation Dam Fish Passage Project
Solicitation of Comments - Invitation to Act as Cooperating Agency on the Environmental Assessment

Dear Mr. Tillinger:

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If you have any questions regarding the project, you may contact Gary Elwell, PE of DOWL HKM at (406) 869-6310.

Sincerely,

Joe Maurier for
Director

Attachment: Figure 1

c: Greg Johnson, COE, Omaha
Pam Ash, Cartersville Irrigation District
Brad Schmitz, Montana Fish, Wildlife & Parks
Burt Williams, Nature Conservancy
Gary Elwell, PE, DOWL HKM

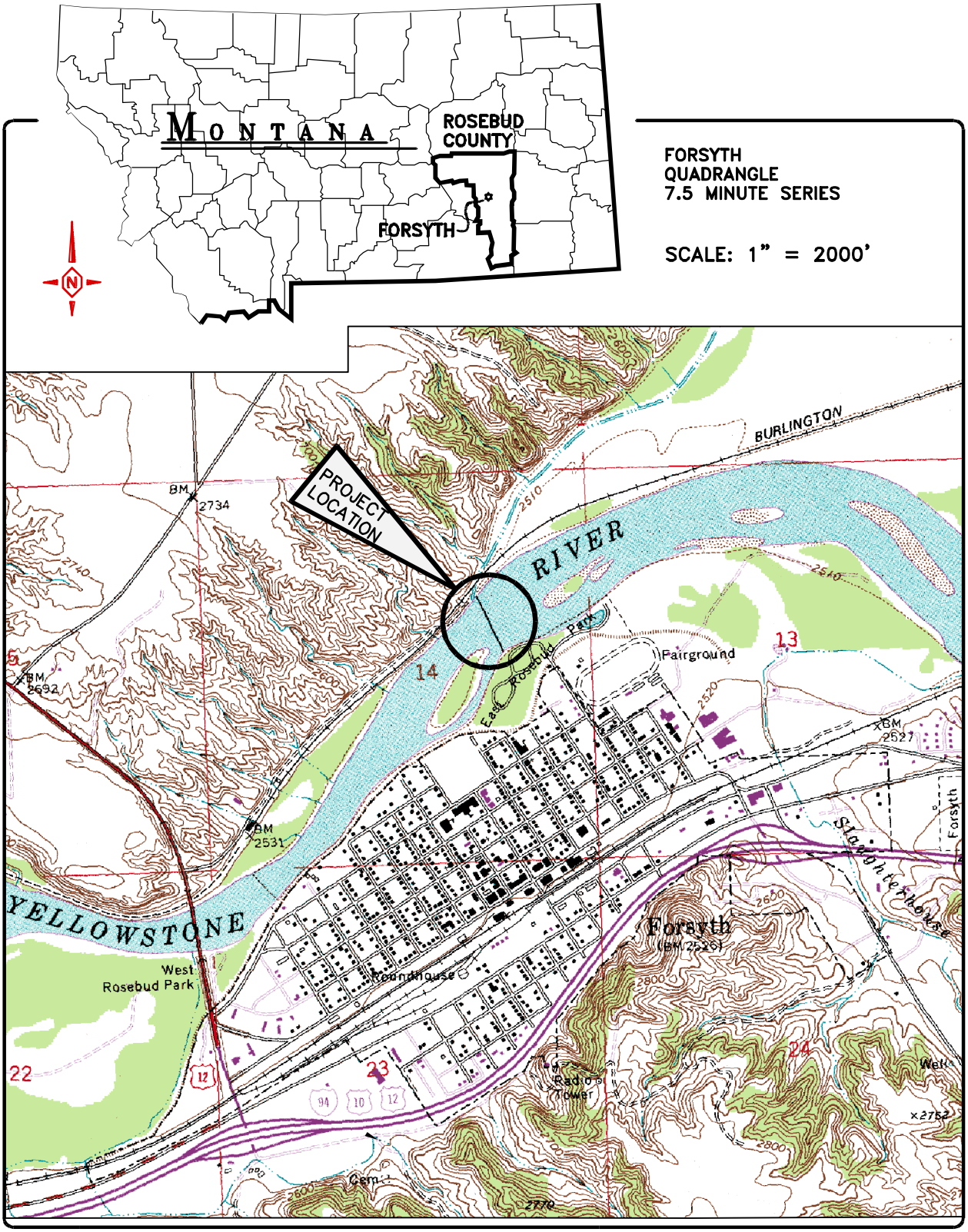
Please indicate the USACE's response to the invitation to act as a Cooperating Agency on this EA, and return this page to:

MT Fish, Wildlife & Parks
Attn: Jim Darling
P. O. Box 200701
Helena MT 59620-0701

___ The USACE would like to act as a Cooperating Agency on this EA.

___ The USACE declines to act as a Cooperating Agency on this EA.

_____ _____
U.S. Army Corps of Engineers Date



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CARTERSVILLE IRRIGATION DAM FISH PASSAGE PROJECT

FORSYTH, MONTANA

FIGURE #1

DOWL HKM

26.10216.01	Sept. 2009

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Letters to Cartersville Irrigation District
September 28, 2009

DOWL HKM

September 28, 2009
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Ms. Pam Ash
Cartersville Irrigation District
P.O. Box 668
Forsyth, MT 59327

RE: Cartersville Irrigation Dam

Dear Pam:

We have not received any comments from the irrigators except those received during our meeting in Forsyth on July 28, 2009. Attached is a copy of the attendance list and comments received at that meeting. We are well into our study; however, we would still appreciate any additional comments from the irrigators and/or other interested parties regarding this study.

We have completed our underwater surveys at the dam site and I have included a copy for your use in deciding what immediate action you feel is necessary to protect the dam. Notice that a significant hole has developed immediately below the dam.

If you have any questions, please call.

Sincerely,

DOWL HKM

Gary Elwell

Gary E. Elwell, P.E.

Enclosures

cc: Jack Ferguson, CID, 120 Route 446, Rosebud, MT 59347
Kirk Montgomery, CID, 92 Route 446, Rosebud, MT 59347
Jim Darling, MT FWP, 1420 East Sixth Avenue, Helena, MT 59601
Brad Schmitz, MT FWP, P.O. Box 1630, Miles City, MT 59301
Burt Williams, Nature Conservancy, 2721 2nd Avenue N. #310, Billings, MT 59101
Don Youngbauer, Yellowstone R. Conservation District Council, P.O. Box 68, Forsyth, MT 59327

Department of Environmental Quality
October 7, 2009

Montana Department of
ENVIRONMENTAL QUALITY

Brian Schweitzer, Governor

P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • www.deq.mt.gov

RECEIVED
OCT 09 2009

October 7, 2009

Joe Maurier, Director
Montana Fish, Wildlife and Parks
P.O. Box 200701
Helena, MT 59620-0701

Re: Cartersville Irrigation Dam Fish Passage Project

Dear Mr. ~~Maurier~~ Joe:

The Department of Environmental Quality (DEQ) is part of the interagency group working on the Intake fish passage project, and will be more than happy to participate in the process of evaluating the feasibility and cost of rehabilitating the Cartersville irrigation dam on the Yellowstone River at Forsyth, MT, for fish passage to the upper reaches of the river.

DEQ's primary concerns involve the possible need for a 318 Authorization for short-term water quality standards for turbidity, a 401 Certification for a federal 404 Permit from the Corps of Engineers, and a possible Storm Water Discharge Permit for construction activity.

Please direct future requests for DEQ participation to Jeff Ryan, Water Protection Bureau (406-444-4626 or jeryan@mt.gov) and Greg Hallsten, DEQ Montana Environmental Policy Act Unit (406-444-3276 or ghallsten@mt.gov).

Sincerely,

Richard H. Opper
Director

c: G. Elwell, PE, DOWL HKM
Judy Hanson, DEQ
Jenny Chambers, DEQ

Department of the Army
Corps of Engineers, Omaha District
October 19, 2009

HKM ENGINEERING
OCT 20 2009
RECEIVED

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
BILLINGS REGULATORY OFFICE
2602 FIRST AVENUE NORTH, SUITE 309
POST OFFICE BOX 2256
BILLINGS, MONTANA 59103-2256

REPLY TO
ATTENTION OF

October 19, 2009

Regulatory Branch
Montana State Program
Corps No. **NWO-2009-02424-MTB**

Subject: Cartersville Irrigation Dam Fish Passage Project

DOWL HKM
Attn: Gary Elwell, PE
222 North 32nd Avenue, Suite 700
Billings, Montana 59101

Dear Mr. Elwell:

Reference is made to your letter requesting comments on behalf of Montana Fish, Wildlife, & Parks regarding the proposed project to improve fish passage at the Cartersville Irrigation Dam located in Sections 26 and 35, Township 36 North, Range 32 East; Section 14, Township 6 North, Range 40 East, in Rosebud County, Montana.

Under the authority of Section 404 of the Clean Water Act, Department of the Army permits are required for the discharge of fill material into waters of the United States. Waters of the United States include the area below the ordinary high water mark of stream channels and lakes or ponds connected to the tributary system, and wetlands adjacent to these waters. Isolated waters and wetlands, as well as man-made channels and ditches, may be waters of the United States, which must be determined on a case-by-case basis. Under the authority of Section 10 of the Rivers and Harbors Act, Department of the Army permits are required for structures or work in, over, under or affecting navigable waters of the United States.

This office agrees to be a Cooperating Agency on the Environmental Assessment for this project. If you have any questions, please call me at (406) 657-5910, or Todd Tillinger at (406) 441-1375 and reference File No. **NWO-2009-02424-MTB.**

A copy of this letter will be sent to Jim Darling, MT Fish, Wildlife, & Parks, PO Box 200701, Helena, MT 59620-0701.

Sincerely,

Cathy Juhas

Cathy Juhas
Project Manager

Enclosure

Printed on Recycled Paper

Please indicate the USACE's response to the invitation to act as a Cooperating Agency on this EA, and return this page to:

MT Fish, Wildlife & Parks
Attn: Jim Darling
P. O. Box 200701
Helena MT 59620-0701

✓ The USACE would like to act as a Cooperating Agency on this EA.

___ The USACE declines to act as a Cooperating Agency on this EA.

U.S. Army Corps of Engineers

01 Oct 2009
Date

TODD N. TILLINGER

Public Information Meeting
November 3, 2009

PUBLIC INFORMATION MEETING

CARTERSVILLE IRRIGATION DAM
FISH PASSAGE ALTERNATIVE ANALYSIS AND ENVIRONMENTAL ASSESSMENT

Montana Fish Wildlife and Parks

NOVEMBER 3, 2009

Team: DOWL HKM, WHPacific, CONFLUENCE consulting incorporated, KOZMO, Applied Geomorphology, Inc., MONTANA STATE UNIVERSITY

DOWL HKM

Public Information Meeting
Cartersville Diversion Dam
November 3, 2009
Comments

Name:	PAULA A. SELISKI
Representing:	ROSEBUD TREASURE WILDLIFE ASSOC
Address:	P.O. BOX 1491 FORSYTH, MT 59327-1491
Email:	
Phone:	(406) 356-7398 HM or 346-7555 WK
Contacts:	Gary Elwell, P.E. DOWL HKM P.O. Box 31318 Billings, MT 59107-1318 Ph: 406.656.6399 Fax: 406.656.6398 gelwell@hkminc.com Jim Darling MT Fish, Wildlife & Parks 1420 East Sixth Avenue Helena, MT 59601 Ph: 406.444.5334 jdarling@mt.gov

Comments

Thank you for coming a long way to visit with us. It was a very good explanation of what is proposed. (It did open a few eyes and I believe dispelled the "rumors"!!) If done correctly I personally see it as a win-win for all. Change is never easy.

Sincerely,

Paula A. Seliski

RECEIVED

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FISH, WILDLIFE & PARKS

Rosebud Treasure Wildlife Assoc. Nov. 3, 2009 monthly meeting

Sign in Please

Paula A. Seliski	Forsyth - (P.O. Box 1491 Forsyth, Mt. 59327) 406-356-7398
Bobbi L Vannatter (Nathaway)	Forsyth (P.O. Box 488 Forsyth, Mt. 59327) 406-749-0442
Bob Vannatter	"
Gary Campbell	Forsyth - (Box 22, Forsyth, MT 59327) 406 351-1199
Penny Leong	" - (NW of Forsyth, Mt. 59327) 406-356-2411
Ken Reiger	Forsyth - (309 S. 9th Forsyth, Mt. 59327) 406 346-2523
Bob Chanay	Forsyth - (280 S 11th Forsyth, Mt. 59327) 406 346-2681
JoAnn Brewer	Forsyth (2158 old Highway 10 Forsyth, Mt. 59327) 406 356-2468
Roger Brewer	Hysham (1586 Sarpy Rd Hysham, Mt. 59038) 406 342-5503
[illegible]	Forsyth - (410 So. 6th Forsyth, Mt. 59327) 406 346-7575
Stan Watson	Forsyth - (1206 OLD HIGHWAY 10 FORSYTH MT.) 356-2820
Lyle D Tompkins	Forsyth. NA - 346-9340
John Shepard	Forsyth
Mack Sell	Hysham 7 Cole LANE FORSYTH, MT. 59327
Dwayne Andrus	Miles City FWP
Brad Schmitz	" " "
Ric Riggs	" " " Fish Manager R7
Dan Kennedy	Forsyth (P.O. Box 666 Forsyth, Mt. 59327) 346-7211

Rosebud Treasure Wildlife Assoc. Nov. 3, 2009

Sign in Please

Charlie Brown 406 346-9316 547 7th 3rd Forsyth, Mt 59327 Forsyth, MT

husband also Jerry Linda Wolf-Bowen 406 346-7014 341 So 3 Forsyth, Mt. 59327 Forsyth MT

Paul A. Pifford 406 346-2648 1347 Cedar Forsyth, Mt. 59327

Matt Abrahamson FWP Fisheries Biologist Miles City

MATT HAGEDORN P.O. 337 FORSYTH, MT. 59327 (406) 346-1677

Jimmy Schroeder 406 346-2974 Forsyth (14 Schiffer Rd Forsyth Mt. 59327) 356-7164

Val S. Bell 241 N. 7th Forsyth, Mt 59327 406 356-2761 Forsyth

Gene Bell NA Forsyth.

Jack Ferguson Rosebud, Mt. 59347

Steve Seeg Rosebud, mt. 59347

Kirk Montgomery Rosebud, mt. 59347

Eli Fennema (406) 346-7978 7 Poplar Forsyth, Mt 59327 Forsyth.

Dave Martin NA (406) 346-1412 "

Pam Ash Mgr. C.I.D, Forsyth

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K. J. M Colstrip

Billings Gazette
November 8, 2009

Preliminary work advances on fish passage

By BRETT FRENCH
Of The Gazette Staff

The work may be years off, but state and federal governments are looking into ways to create fish passage at Cartersville Diversion Dam on the Yellowstone River near Forsyth.

"The goal is to have a report and draft environmental assessment by January and then we'll move ahead," said Jim Darling, fisheries habitat section supervisor for Montana Fish, Wildlife and Parks.

FWP is partnering with the U.S. Fish and Wildlife Service's Yellowstone River coordinator and the U.S. Army Corps of Engineers. The Corps is already at work on a similar project downstream from Forsyth to rebuild the Intake Dam to allow fish passage.

The push for passage

The push to create fish passage is largely driven by the fact that pallid sturgeon, an endangered species, is believed to need more upstream access for its offspring to live. After pallid sturgeon eggs hatch, the larvae drift downstream anywhere from 150 to 300 miles.

Right now, the theory is that the tiny pallids are floating into Lake Sakakawea in North Dakota and being eaten by other fish or dying in the stagnant waters. As a result, wild hatches of pallid sturgeon have not been documented on the Yellowstone River. Estimates put the number of wild pallid sturgeon in the Yellowstone and the upper Missouri River at only 150 fish. Without successful reproduction, wild pallids in the Yellowstone and Missouri between Garrison and Fort Peck dams may be extinct by 2017, although hatchery-raised fish have been released.

Opening up the Intake Diversion Dam to fish passage would allow the sturgeon another 165 miles of upstream access. That's where they'd hit the Cartersville Diversion Dam. If the Cartersville Dam is fish-friendly, fish could move another 40 miles upstream before reaching the Yellowstone Diversion Dam. In all, there are six diversion dams between Billings and Glendive. Of the four above Cartersville, only Huntley has a side channel for fish passage.

"The intent of constructing this rock ramp structure is to resemble areas where fish have been able to pass in the past. We'd get rid of the steep drop at the existing diversion dam and replace it with a gradual slope."

— Gary Elwell
Dowl HKM water resource engineer

The three others, since they are low, may be navigable to fish in high water.

"From a pallid standpoint, our real priorities are Intake and Cartersville," said George Jordan, Yellowstone River coordinator for the U.S. Fish and Wildlife Service. "I think cumulatively the two would then open up the historic range of pallids on the Yellowstone River."

Making the dams fish-friendly would also aid six Montana species of special concern, including the shovelnose sturgeon, blue sucker and sicklefin chub.

Preliminary design

FWP hired Dowl HKM engineers in Billings to draw up options for creating fish passage at Cartersville. The project was funded with a $110,000 appropriation from the Legislature. Dowl HKM water resource engineer Gary Elwell is leading the project's preliminary design.

Elwell and Darling said the Cartersville project would be able to draw upon the engineering work at Intake Diversion Dam, with the preference being a gradual rock ramp that resembles a natural river riffle.

"The intent of constructing this rock ramp structure is to resemble areas where fish have been able to pass in the past," Elwell said. "We'd get rid of the steep drop at the existing diversion dam and replace it with a gradual slope."

That slope could extend as much as 1,000 feet downstream, he said. But it wouldn't alter the flow of water to the southern side channel that feeds the fishing access site at Forsyth. The river is 800 feet wide at the dam site with the northern channel carrying more water.

The dam, owned by the Cartersville Irrigation District, was built during the early 1930s with rock capped by concrete. The dam spans the entire river. Irrigation district members met with FWP and the U.S. Fish and Wildlife Service earlier in the spring to hammer out concerns and agree on design possibilities, Jordan said.

Calming fears

Elwell spoke to a crowd of about 40 Forsyth-area folks on Tuesday outlining the scenarios. Some Forsyth residents got nervous when rumor circulated that FWP would close the area below the dam to fishing if a bypass channel is created. There is a popular fishing access site at a park just below the dam on the south side of the river, which includes a boat ramp. But Darling said closing that portion of the river to fishing is not the agency's intent.

"Well, I feel a little better and we got to voice our concerns and fears," said Robert Vannattan, of Forsyth, who attended the meeting. "We all came to the same agreement that a (rock) ramp or something may work."

It could take years for any recommendation to wind through the state and federal bureaucracy, and then funding would have to be acquired. So any deal is a long way from being done.

However, Sen. Jon Tester has requested $3 million for the dam project in the Energy and Water Development Subcommittee. Darling and Jordan said some of the money could also come from the Water Resources Development Act.

"If and when both projects are designed, funded and implemented, it will be a large benefit to fish species on the lower Yellowstone," Jordan said.

Contact Brett French at french@billingsgazette.com or at 657-1387.

Response from
Montana Department of Natural Resources and Conservation
November 13, 2009

Rux, Julie

From: Dalby, Chuck [cdalby@mt.gov]
Sent: Tuesday, November 17, 2009 11:08 AM
To: Schultz, Tom (DNR); Siroky, Laurence; McLaughlin, Terri
Cc: Azevedo, Paul; Kerbel, Keith; Darling, Jim; Elwell, Gary
Subject: FW: Invitation to act as a Cooperating Agency
Attachments: DNRC ltr.PDF

Hello,

DNRC is participating in a Feasibility Study/Environmental Assessment of the Cartersville Irrigation Dam/Fish Passage Project near Forsyth. DFWP is the lead state agency responsible for preparation of the MEPA-EA. At this point I am seeking comments on DNRC's jurisdiction, permitting authority, and issues specific to our regulatory role in the project.

I sincerely appreciate your forwarding this email and the attached memo, which describes the project, to appropriate staff for their insights
and recommendations on permitting actions/issues as may be required by:

1. Montana Water Use Act (Water Rights/Change Authorization—my impression is that no permits will be required ?);

2. Montana Land-Use License or Easement on Navigable Waters (permits required ?);

3. Dam Safety and/or Floodplain and Floodway Management (permits required ?).

Because we have engaged in this process somewhat late, and the anticipated completion date for the draft Feasibility Study/EA is December 31, 2010, I would appreciate a response by the end of this week (Nov. 20) if possible.

Please contact me if you have any questions about the project.

Thanks,
Chuck

Chuck Dalby
Hydrologist
DNRC-WRD
1424 9th Ave, PO 201601
Helena, MT 59620-1601
(406-444-6644)

From: Sexton, Mary
Sent: Friday, November 13, 2009 13:39
To: Darling, Jim
Cc: Zackheim, Karen; Elwell Gary (E-mail); Dalby, Chuck; Azevedo, Paul; Schultz, Tom (DNR)
Subject: RE: Invitation to act as a Cooperating Agency

Jim,

Chuck Dalby will be taking the lead. He'll be contacting you regarding process and needed documents. Thanks for the reminder!

Mary

Mary Sexton

Billings Gazette
December 15, 2009

Billings Gazette

Intake Dam plan would affect water, livelihoods

Posted: Tuesday, December 15, 2009 12:00 am

Plans for Intake Dam should be a concern for all of us who live in Dawson and Richland counties. The deadline has been extended to Dec. 31 to call or write letters to the Corps of Engineers, P.O. Box 2256, Billings, MT 59103, or call Cathy Juhas at 406-657-5910 with your concerns and objections in regards to reconstruction of the Intake Dam pertaining to the proposal of installing a rock ramp at the dam site for a passageway for the pallid sturgeon.

An article appeared in the Nov. 15 Ranger Review stating that the state and federal officials are considering ways to create a fish passage at the Carterville diversion dam on the Yellowstone River near Forsyth to help the pallid sturgeon fish. This will have a great impact on agriculture (irrigation), recreation, historical tourism and the Yellowstone Caviar Program that provides grants for many community projects from the paddlefish that are snagged at the Intake Dam. Are they perhaps destroying this program with the paddlefish in order to save the pallid sturgeon? We at least eat the paddlefish, but the pallid sturgeon is useless.

We are in danger of losing our water and livelihoods if this takes place, plus all the money that will be wasted. This money could be spent in a more reasonable way — like improving health care! George and I have lived on an irrigated farm for 50-plus years. The dam has served the community well for over 100 years, and it doesn't have to be messed with because of a fish.

Jenny Rice

Glendive

Solicitation of Comments for MEPA/NEPA Document
Informal Endangered Species Act Section 7 Consultation
December 21, 2009

DOWL HKM

December 21, 2009
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Lou Hanebury
U.S. Fish and Wildlife Service
2900 4th Avenue N, Room 301
Billings, MT 59101

Re: Cartersville Irrigation Dam Fish Passage Improvements Project

Subject: Solicitation of Comments for MEPA / NEPA document
Informal Endangered Species Act Section 7 Consultation

Dear Mr. Hanebury:

The Montana Department of Fish, Wildlife and Parks (DFWP) is in the process of evaluating the feasibility and cost of rehabilitating the Cartersville irrigation dam to provide fish passage to the upstream reaches of the Yellowstone River. DOWL HKM has been contracted by DFWP to prepare a Feasibility Study, including a more detailed alternatives analysis, including cost for each alternative, and the Environmental Assessment. The DFWP is the lead state agency responsible for the preparation of the Montana Environmental Policy Act (MEPA) Environmental Assessment, which is required prior to any state action that may affect the human or physical environment. No federal funds have been designated for this project, although a U.S. Army Corps of Engineers (USACE) Section 404 Permit will be required for placement of fill in the river. The USACE is a cooperating agency on this project.

The Cartersville irrigation dam is located on the Yellowstone River at the town of Forsyth in Rosebud County, Montana (Figure 1). The legal description of the site is Sec 14, T 67N, R 40E. The dam is owned and operated by the Cartersville Irrigation District, which has associated water rights dating to the late 1800's. The condition of the dam has deteriorated since it was constructed in the early 1930's, and has required ongoing annual maintenance in recent years. The dam is made of rock-rubble riprap capped with concrete, and spans the entire channel of the Yellowstone River, over 800-ft in length. Currently, the dam acts as a fish passage barrier, particularly during periods of lower flows.

Project Purpose and Need

This dam has likely impeded the upstream migration of the Pallid Sturgeon *(Scaphirhynchus albus)*, an endangered species, and other fish species native to the Yellowstone River, since it was built in the early 1930's. There is another fish passage downstream of the Cartersville dam (near Intake in Dawson County, Montana), however, the U.S. Army Corps of Engineers is currently working on a project that will provide fish passage through that section of the river. Once that project is complete, the Cartersville dam will be the next barrier that precludes the upstream movement of the Pallid Sturgeon and other native fish species.

The overall intent of the project is to rehabilitate the dam to improve fish passage through this section of the Yellowstone River, while continuing to provide the water needed for the adjacent irrigation ditch.

The primary project objectives are:

1. Maintain the ability of the irrigation district to divert water at all water levels
2. Allow upstream passage of native fishes, particularly sturgeon
3. Provide minimal maintenance requirements
4. Increase public safety
5. Maintain recreation opportunities at adjacent City park

Alternatives Under Consideration

Initial alternatives were developed for this project as part of a 2-day inter-agency planning process that was held February 25-26, 2009, resulting in a summary report called the "Cartersville Diversion Dam Project Study". The purpose of the study was to expand the existing list of project alternatives and prioritize them. Agencies and stakeholders represented at this 2-day meeting included:

U.S. Fish and Wildlife Service (USFWS)
U.S. Army Corp of Engineers (USACE)
Montana Department of Fish, Wildlife, and Parks (DFWP)
Montana Department of Environmental Quality (DEQ)
Natural Resource Conservation Service (NRCS)
Yellowstone River Conservation District
Cartersville Irrigation District
Nature Conservancy

Through this process, several alternatives were chosen and prioritized as follows:

1. Notch in Concrete Dam Controlled by Inflatable Bladder

A natural channel exists to the south of a large, well-established island that extends approximately 2,000 feet upstream from the dam. Lateral channel migration is prohibited by a large earthen dike to the south and the island bank to the north.

This alternative would construct a 200-ft long notch in the crest of dam with an inflatable bladder dam to create head for diverting water into the slough to allow fish passage most of year and intermittently at lowest flow conditions.

2. **Engineered Fishway Bypass Channel**

This alternative would open the south channel to fish passage by connecting the east end of the island to the existing dam, and removing a section of the dam at the southern terminus, to allow a natural gradient channel through that area.

3. **Rock Ramp**

Under this alternative, the streambed would be reconfigured through either a U-shaped configuration or a boulder weir to reduce the channel gradient downstream from the existing diversion dam.

4. **Partial Diversion Dam**

This alternative would replace the existing diversion structure with a partial span diversion dam, creating a relatively natural gradient open channel on the southern side of the river.

5. **Island – South Channel Passage**

This alternative would open up the south channel to fish passage by connecting the east end of the island wall to the existing dam, and removing the southernmost portion of the dam.

6. **Raceway Notch Fish Passage**

This alternative would construct a passage channel through the dam with continuous gradient that meets minimum swim criteria, and allows control of flow through the notch.

A copy of the report containing more detailed information about each of these alternatives can be sent to you, upon request.

An additional alternative would be to remove the dam and either move the intake for the irrigation ditch further upstream and use pumps to get the water to the ditch, or buy out the irrigators. This alternative involves some rather complicated issues, and is unlikely to be carried forward, however, it will likely be covered in the EA as an alternative that was considered for this project.

Request for Comments and Information re: Threatened and Endangered Species

Your organization has been identified as an agency that may have an interest in the project due to potential permitting involvement or other agency jurisdiction. With this letter, we are requesting comments and information relative to the permitting requirements and MEPA/NEPA documentation for this project, as well as information regarding known threatened or endangered species that may occur in the project area. In addition, please identify any issues of concern regarding the alternatives that we intend on evaluating, or the potential environmental or socioeconomic impacts that could substantially delay any necessary Section 7 Consultation that is needed for the project. We currently plan to have a Draft EA for public and agency review by January 2010.

Please submit written comments to our consultant, DOWL HKM, at 222 N 32nd Avenue, Suite 700, Billings, MT 59101 (Attn: Gary Elwell), or by e-mail (gelwell@hkminc.com). Please provide any initial written comments within thirty (30) calendar days from receipt of this letter.

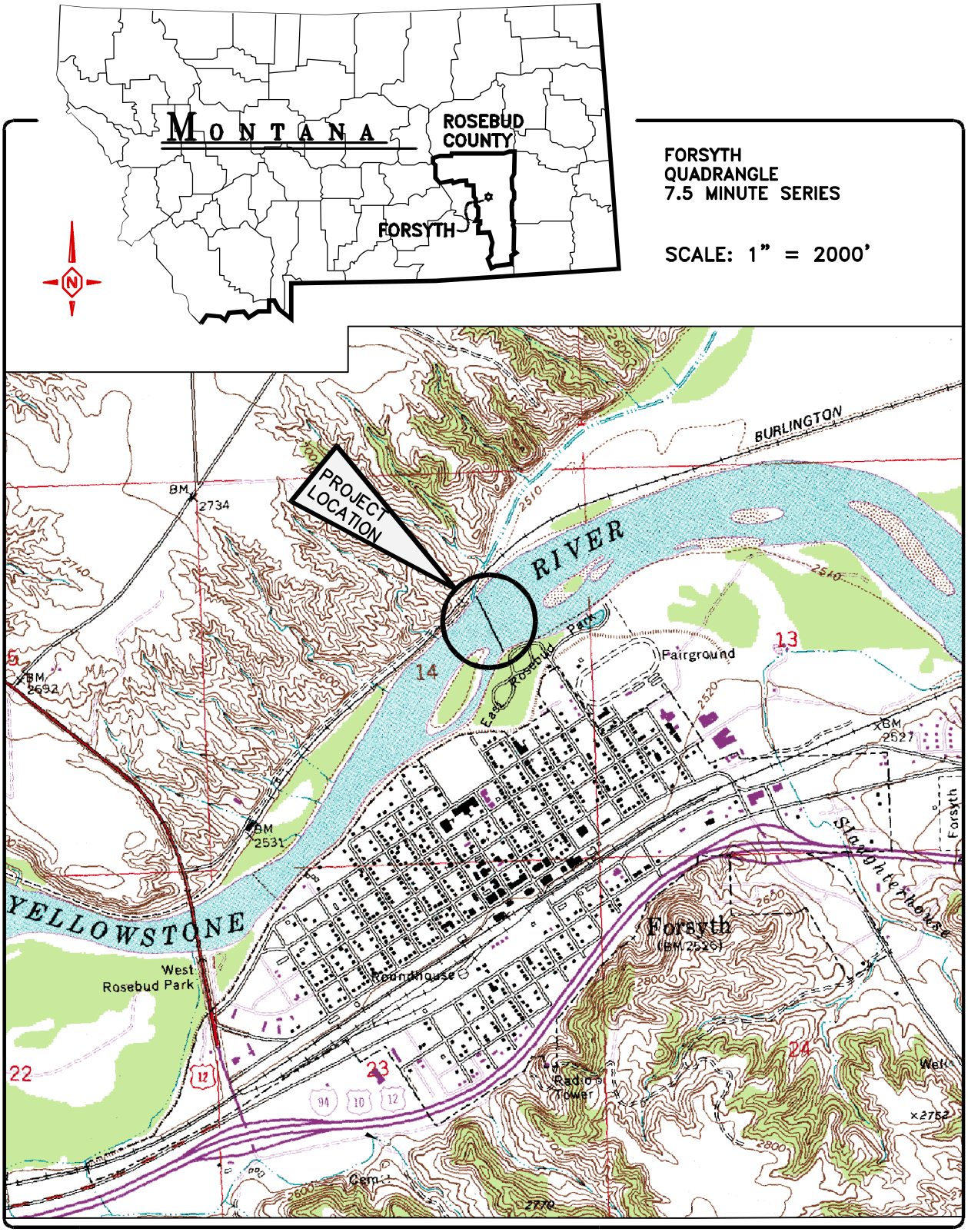
If you have any questions regarding the project, you may contact Gary Elwell of DOWL HKM at (406) 656-6399.

Sincerely,

Gary Elwell, P.E.
DOWL HKM Project Manager

Attachment: Figures 1 – Location and Vicinity Map

cc: Jim Darling, FWP, Helena, MT



LOCATION AND VICINITY MAP

CARTERSVILLE IRRIGATION DAM FISH PASSAGE PROJECT

FORSYTH, MONTANA

FIGURE #1

DOWL HKM

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Yellowstone River Conservation District Council
December 22, 2009

For Immediate Release
Contact information: Nicole McClain – 406-223-5702
yellowstoneriver@aol.com
December 22, 2009

Diversion Dams along the Yellowstone River Can Be Fish Friendly

Don Youngbauer, Chairman of the Yellowstone River Conservation District Council, (YRCDC), announced today that the full Council has come forth with a position statement to encourage cooperation between irrigators along the river basin and those concerned with the overall health and viability of the river.

Don Youngbauer, YRCDC Chairman, 2009

"In most all cases, Youngbauer points out, the diversion dams and intakes along the river are aging and in need of repair. The repairs can be made so not to entrain (trap) fish. Many of the intakes and diversions were created when such issues were of little or no concern," Youngbauer concluded.

Warren Kellogg, YRCDC Technical Advisory Committee Chairman

Warren Kellogg, who serves on the Council's Technical Advisory Committee, helped draft the position statement approved by the Council, which is shown here in part:

The Yellowstone River Conservation District Council support and encourages efforts within the Yellowstone River Basin to seek and develop mutually agreeable solutions in order to provide fish passage and prevent entrainment into water intake or diversion points while maintaining water supplies for irrigation.

Kellogg points out that researchers have suggested that blockage of seasonal migrations for spawning and feeding may be a leading cause of the decline in fishes native to large river systems like the 500 plus mile long Yellowstone River.

Those seeking more information or having questions should contact the YRCDC's Coordinator Ms. Nicole McClain at YellowstoneRiver@aol.com.

The full position statement by the YRCDC is shown below.

Version: August 21, 2009
Fish Passage Position Statement

Position Statement: The Yellowstone River Conservation District Council (YRCDC) supports and encourages efforts within the Yellowstone River Basin to seek and develop mutually agreeable solutions in order to provide fish passage and prevent entrainment into water intake or diversion points while maintaining water supplies for irrigation.

Introduction
Fish passage and agricultural irrigation are two resource issues intertwined along the Yellowstone River. Free flowing river water is needed for either or both to occur and prosper. Where irrigation water is derived by diversion structures spanning the entire river channel it can affect movements or migrations of various fish species. Where water is withdrawn from the river either via gravity diversions or pumps, there is a risk of entraining fish. Data have established that the distributions and movements of many species of Yellowstone River fishes, one of which is the federally endangered pallid sturgeon, are affected by low-head diversion dams. In addition, studies for some unscreened diversions indicate that substantial numbers of fish can be entrained at water diversion points annually. Across the United States and locally, fish passage and entrainment protection measures have been utilized effectively to prevent loss of fish, restore connectivity with habitat, and increase fish abundance without negatively affecting agricultural practices.

Background
Researchers have suggested that blockage of seasonal migrations for spawning and feeding may be a leading cause of the decline in fishes native to large river systems (Trenka 2000, Helfrich et al. 1999, Elser et al. 1977). Along with fish passage, entrainment is an issue that needs to be assessed at each diversion point or intake structure. For example, Heibert et al. (2000) conducted an entrainment study on Intake Diversion Dam and found 36 species of fish passed into the irrigation canal during their sample years (1996, 1997, and 1998). Additionally, 14 species of fish were found entrained behind the Shirley Pumping Plant of the Buffalo Rapids Project (Montana Fish Wildlife and Park, unpublished data).

Because numerous barriers and points of entrainment exist in the Yellowstone River basin, it is necessary to evaluate each project on an individual basis in order to identify the best options for fish passage and entrainment protection that are mutually agreeable to both the land owners/irrigators and funding agencies.

The following list provides a few examples of the types of projects this position statement supports:

- The recently completed T and Y dam bypass project and SH dam removal on the Tongue River;
- Efforts at Intake and Cartersville Dams on the Yellowstone River;
- Pryor Creek and the Yellowstone River confluence area;
- Chadbourne Dam on the Shields River;
- Fish screening efforts at Buffalo Rapids Irrigation District's Shirley Pumping Plant.

Agencies involved with Yellowstone River Basin fish passage projects are; Montana Fish Wildlife and Parks, U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, and U. S. Army Corps of Engineers, and the Natural Resources Conservation Service. Non-government entities include The Nature Conservancy and Trout Unlimited.

Role of the YRCDC

The governor, state government agencies, and regional citizens are looking to the YRCDC for leadership in managing the Yellowstone River. YRCDC, made up of a coalition of conservation districts, has both resource management and producers' well-being as goals. The position taken by the YRCDC is based on recent science findings and past collaborative efforts between agency personnel and private land owners/irrigators. This position seeks to eliminate conflict between economic and conservation interests and supports the YRCDC's role as a grass roots supporter of wise use of resources.

References

Heibert, S., R. Wydoski, and T. Parks. 2000. Fish entrainment at the Lower Yellowstone Diversion Dam, Intake Canal, Montana 1996-1998. Bureau of Reclamation, Denver and Montana Area Offices.

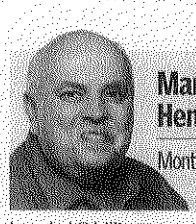
Elser, A. A., R. C. McFarland, D. Schwehr. 1977. The Effects of altered streamflow on fish of the Yellowstone and Tongue Rivers, Montana. Technical report No. 8. Yellowstone Impact Study. Montana Department of Natural Resources, Helena.

Helfrich, L. A., C. Liston, S. Hiebert, M. Albers, and K. Frazer. 1999. Influence of low-head dams on fish passage, community composition, and abundance in the Yellowstone River, Montana. Rivers 7 (1):21-32.

Trenka, R. 2000. Community Structures and Habitat Associations of Fishes of the Lower Tongue and Powder Rivers. Master's Thesis. Montana State University, Bozeman.

Billings Gazette
March 18, 2010

Biologists launch hunt for sage grouse grounds



Mark Henckel
Montana outdoors
henckel@billingsgazette.com

Sage grouse have begun to strut on their spring dancing grounds on the Montana prairies. For Bernie Hildebrand, that means it's time to take to the air and prowl the backroads before dawn to check on the status of the biggest member of the grouse family.

This year, the importance of that quest for the Miles City-based wildlife biologist for Montana Fish, Wildlife and Parks has taken on new meaning and new urgency.

Recently, the U.S. Interior Department announced that while it won't list the sage grouse as an endangered or threatened species, it will classify the bird among species that are candidates for federal protection.

Interior Secretary Ken Salazar announced in a news release that listing is warranted but precluded by higher priorities — other species that are in greater danger.

"The sage grouse's decline reflects the extent to which open land in the West has been developed in the last century," Salazar said. "This development has provided important benefits, but we must find common sense ways of protecting, restoring, and reconnecting the Western lands that are most important to the species' survival."

Southeastern Montana provides a giant land mass that includes some of the best sage grouse habitat and populations in the state.

But according to Hildebrand, it's not just enough to show the habitat and say that you have good populations of birds. You have to be able to prove it. One way to do that is with lek (dancing or strutting ground) counts done in spring.

"We want to provide the feds with all the data we can," he said. "We've got GPS coordinates on about 900 different leks that we've found over the years in FWP Region 7. But we don't visit them all every year to generate our trend counts.

"We have somewhere over 300 that are confirmed. We've got around 500 more that are what they term unconfirmed," Hildebrand said.

"To be a confirmed lek, we don't have to have an actual count of the number of birds there," he continued. "We can either see birds there or find other evidence that the ground is being used — walk out on the leks, see where the grass is all stomped down and droppings and a bunch of scattered feathers. The first time you'd have counted birds. The second time, you may not have birds actually on the ground, but you see evidence that they've been there."

For Hildebrand and other wildlife biologists, that's not necessarily an easy task, in part because of the way that sage grouse use leks.

Birds will gather in the predawn darkness and only remain on the grounds into the first hour or two of daylight before moving off to feed and rest during the remainder of the day. If you don't get them spotted at first light, they're gone.

Some leks are checked on driving routes on the backroads and ranch trails. Others are so remote

Please see Henckel, 5C

THE PALLID PROBLEM

Dam removal no sure cure for survival of sturgeon

National Archives; Fish, Wildlife and Parks

This undated photo shows the Ma...n Canal's headworks being constructed in the early 1900s as part of the construction of the Intake Diversion Dam. Inset, biologist Dave Yerk holds a pallid sturgeon that was netted during fish surveys. Only about 4,000 of the fish are estimated to live in all U.S. waterways.

But scientists know this much: Without a change, the species has no shot at reproducing

By BRETT FRENCH
Of The Gazette Staff

As the project to remove Intake Diversion Dam on the Yellowstone River and rebuild it moves forward, there are a couple of unsettling possibilities lurking.

The $36.5 million project is designed to ensure the survival of pallid sturgeon, an endangered species that no longer naturally reproduces in the upper Missouri and Yellowstone rivers. Only 125 of the nature-spawned, older native fish are found in the drainages, while others have been stocked.

Only 4,000 pallid sturgeon are estimated to live in all U.S. waterways. Since the Intake Dam removal project is the first of its kind dealing with pallids, there are no guarantees that removing the dam will lead to pallid reproduction.

"Really, with these sorts of projects, the only way to know is to do them," said Matt Jaeger, a fisheries biologist with the Montana Department of Fish, Wildlife and Parks.

To read the Bureau of Reclamation's draft environmental assessment on the Intake Diversion Dam, click the link in this story at billingsgazette.com

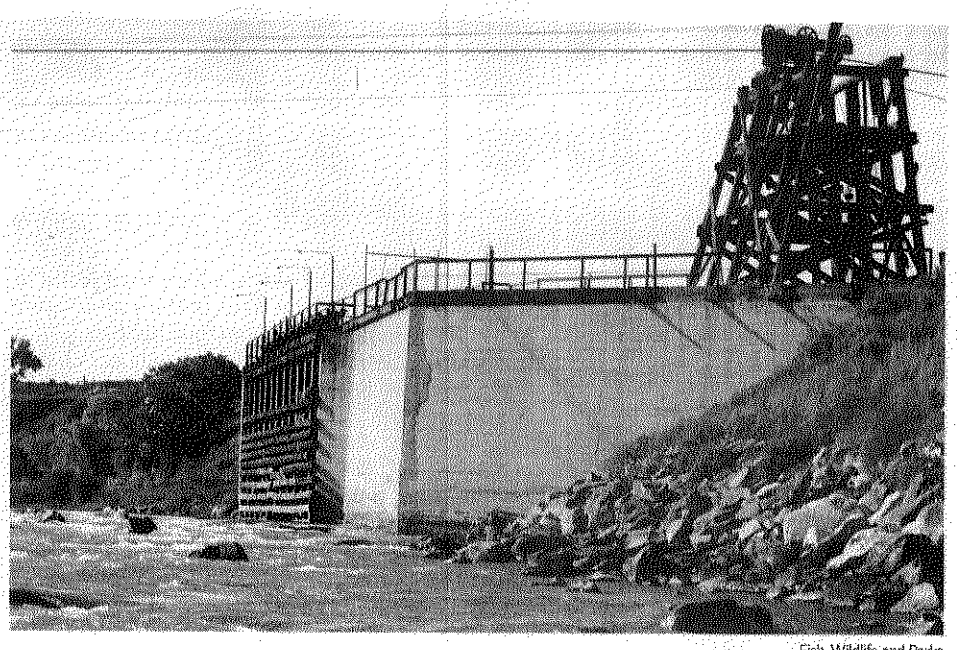
Questionable outcome

Two large unknowns loom.

First, there is no guarantee that after replacing the dam that adult pallid sturgeon will make use of the extra 165 upstream river miles. Second, if adult fish do move upstream and spawn, there's no assurance that newly hatched pallid sturgeon will have enough drift distance downstream to survive.

"The best scientific data available right now says they would be able to pass, but since it's unproven, there's no guarantee," said Jeff Baumberger, head of the resource management division of the Montana area office of the Bureau of Reclamation. "But everyone says this will give you the best chance of success."

Please see Dam, 2C



Fish, Wildlife and Parks

The $36.5 million project to remove and rebuild the Intake Diversion Dam on the Yellowstone River is expected to also aid in the passage of other native fish, such as sauger and paddlefish. The loss of an estimated 577,000 fish into the canal each year could be reduced.

"We need to take this larger-ecosystem approach. In combining these events, we're creating a situation where the overall health of the ecosystem helps natural regeneration."

— Matt Jaeger
fisheries biologist with the Montana Department of Fish, Wildlife and Parks

offers a five-week fly-fishing course designed specifically for teenagers. Any teenager enrolled in one of the area's middle schools or high schools may apply for the course. No fly-fishing experience is necessary.

Classes start May 15, with succeeding sessions May 22, May 29, July 15 (Boulder River) and culminating in mid-August with a trip to Cooke City and Yellowstone Park.

The course will include instruction on fly-casting techniques, entomology, knot tying, conservation, safety and on-stream coaching from two of the area's most experienced fly fishing instructors: Ron Hildebrand and Ron Fisher. Most fly-fishing equipment is furnished by the club including a rod, reel, line and flies.

The course costs $50, with scholarships available to any student unable to pay. Students or parents of students interested may sign up by calling the Community Ed office at 281-5010 or by e-mailing one of the instructors at ronchar-maine@msn.com.

Pictograph Cave sets summer hours

Hours at Pictograph Cave State Park will change, effective April 1. Park hours during the month of April will be 9 a.m. to 7 p.m., seven days a week. The visitor center will be open 10 a.m. to 6 p.m. every day.

Admission to Pictograph Cave State Park is free for Montana residents; however, park fees apply to nonresidents. For more information, call Pictograph Cave State Park at 254-7342 or the Region 5 Fish, Wildlife and Parks office in Billings at 247-2940.

can bring their calls and questions.

Bowhunting legend Chuck Adams will also be at the store signing autographs and talking one on one with customers from 9 a.m. to 4 p.m. Saturday and 10 a.m. to 4 p.m. on Sunday.

Great Falls couple honored by RMEF

Walker S. "Buddy" Smith, Jr. and wife, Tammie Lynne Smith, of Great Falls, have received the highest honor given by the Rocky Mountain Elk Foundation.

The Wallace Fennell Pate Wildlife Conservation Award honors contributions of lasting significance to the benefit of elk, other wildlife and their habitat across North America. The award was presented to the Smiths during the 26th annual RMEF convention, which concluded March 7 in Reno, Nev.

The Smiths have been avid RMEF supporters since the organization was founded in 1984.

Yellowstone Bowmen planning fun shoot

Laurel's Yellowstone Bowmen will hold an archery fun shoot Sunday, Mar. 28, at the club's range between Laurel and Park City, north of old Highway 10.

Registration is from 8 to 10 a.m., with archers taking aim at a minimum of 20 targets.

Fees for the event cost $10 for adults 18-over, $8 for young adults age 15-17, and $5 for youths age 12-14, with cubs and chicks shooting for free.

For more information, contact Irv Wilke at 670-6268 or Flo Milliron at 628-4727.

Gear Junkie

Stephen Regenold

Stephen Regenold writes a blog on outdoors gear at ww.gearjunkie.com

haps somewhere a few days down a trail on a backpacking trip, I gave up on the food category known as "energy bars." After years of eating bars from a dozen different companies, something clicked.

All of a sudden, bars — calorie-rich and oh-so-convenient in the outdoors — started to seem too sweet, too chewy and too "fake" a food to want to eat anymore.

But then Clif Bar & Co. did something different. The Mojo bar, marketed as a "sweet and salty trail mix bar," debuted a couple years back. It has steadily grown on me ever since.

The "salty" part of the equation is key. So much packaged food for athletics and outdoors pursuits hinges on a sugary taste. With the Mojo bars, which come in various flavors, a nutty, salty taste is the prime influence.

Mojo bars cost about $1.50 each, comparable with the competition.

Flavors available are chocolate peanut, dipped fruit nut, honey-roasted peanut, mixed nut and a couple other options.

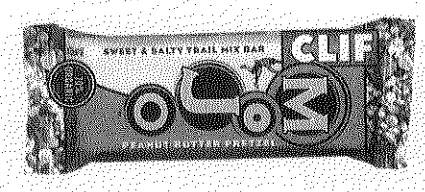
The peanut butter pretzel is my latest obsession. This bar mixes peanut-butter-filled pretzel chunks with nuts, rice crisps, sunflower oil and other ingredients. On a long hike, the taste can be sublime.

Clif Bar & Co. (www.clifbar.com) markets the Mojo as made with 70 percent organic ingredients. They do not contain bioengineered (GMO) ingredients. The bars are even a vegan food except for the honey-roasted peanut and chocolate peanut flavors, which contain organic honey (a product of bees).

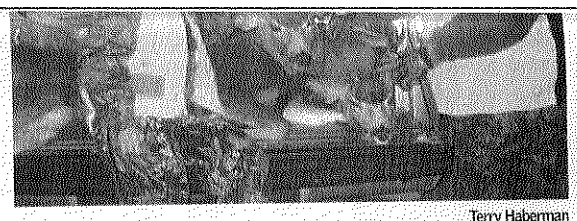
Nutritionally, each bar has about eight to 10 grams of protein, around eight grams of fat and around 180 calories, depending on the flavor.

For me, the bars provide a good caloric and nutrient mix for about one hour's worth of activity. (I aim to eat 200 to 300 calories of "energy food" per hour when active.)

Mojo bars are by no means a niche product. They have hit the mainstream. Indeed, the company sells its bars now at places like Safeway, Target, REI and Walmart. If you're tired of traditional energy bars — or want a saltier side to your grab-and-go food for a trip — I recommend giving the Mojo a try.

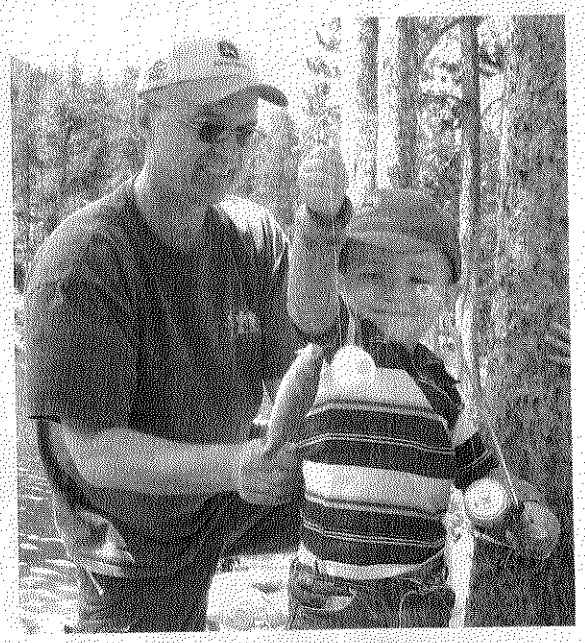


The Clif Mojo bar makes an nice alternative to the same old energy sources.



Terry Haberman

Terry Haberman and his son, Allen, shot these two deer 20 minutes apart while hunting south of Harlem on Thanksgiving weekend.



TJ Wierenga photos

Mark Wierenga sent in these photos of his kids, Colton, 3, and Casey, 2, having fun catching trout at Wild Bill Lake, near Red Lodge.

To share your outdoor photo with Gazette readers, send a copy in an e-mail to henckel@billingsgazette.com and include your name, phone number, when the photo was taken, the photographer's name, where the photo subject is from and the general area where the photo was taken.

Dam

Continued from 1C

Baumberger also said the project has other, ancillary benefits, including passage of other native fish like sauger and paddlefish. Replacing the headgate on the irrigation canal will also reduce the loss of an estimated 577,000 fish into the canal each year.

Viewed from another angle, without removal of the dam, there is no hope that the fish will naturally reproduce in the Yellowstone River, so the government's options are limited.

"We need to take this larger-ecosystem approach," Jaeger said. "In combining these events, we're creating a situation where the overall health of the ecosystem helps natural regeneration. Intake is the first thing that needs to happen."

Caught in the flow

It was once believed that the stretches of the Yellowstone River above Intake didn't contain the type of habitat that pallids prefer — wide valleys, low gradient flows and sand bottoms. But further examination has shown that pallid sturgeon have currently and historically inhabited streams that have narrow valleys, high gradient and cobble bottoms, as well.

Pallid sturgeon are also known to move great distances, and to move great distances upstream to spawn. So it seems reasonable that pallids would explore the area above Intake Dam if they had reasonable passage.

To try to ensure that the new design would allow pallid sturgeon upstream, the Bureau of Reclamation has built a 1/20th-scale model of the dam in its Denver lab to test different flow models.

"So we're doing some things to minimize some of the uncertainty," Baumberger said.

Dialing in drift

The uncertainty about newly hatched pallid sturgeons' survival comes down to one factor: drift. After pallid sturgeon hatch, they bob along in the river current. The current theory among scientists is that there's not enough distance for the larval fish to drift in the Yellowstone River before they hit Lake Sakakawea in North Dakota, where they settle to the mud bottom and die or are eaten by other fish.

If fish spawn and hatch above Intake Dam, it would add to a larval pallid's drifting distance. But will the additional distance be enough? The answer seems to be yes — but only sometimes.

"If passage is only provided at Intake Diversion, successful drift periods may occur in 9.4 percent of the time for the slowest drifting larvae," wrote environmental consultant Jim Parham in an addendum to the Intake Dam draft environmental assessment.

"Some people construe that as a poor situation," Parham said. "Others say it is good that it can happen at all."

Aligning the stars

Pallid sturgeon, because they live for decades, don't breed annually. When they do spawn, they can produce thousands of eggs. Scientists believe that if the fish are able to exploit those few good years with low, slow river flows, the larval pallids have a good chance to survive.

"They evolved this way because conditions aren't right all the time," Jaeger said. "They do this because when all the stars do align, they can pull off a big year class."

But what if removing and remodeling Intake Dam isn't enough to ensure natural regeneration? What then?

Parham's figure for larvae survival doubles to 19 percent if Cartersville Dam, the next impasse above Intake, is also removed. The U.S. Fish and Wildlife Service is examining that scenario.

"This (Intake) project is right on the edge," Parham said. "Especially with passage at Cartersville, the project seems to be much more successful."

Baumberger said the Bureau of Reclamation will be monitoring to ensure that pallid sturgeon are able to move upstream after the new dam is constructed. If it's not working, he said, the agency will try to correct the situation.

"If it was a species that lived only five years, we'd be in trouble," Jaeger said. "Because they live 60 years, we don't need to be right every single year."

Contact Brett French at french@billingsgazette.com or at 657-1387.

MOUNTAIN SNOWPACK

River basin data for percent of average snow water equivalent as of March 15:

Missouri Headwaters: 68
Jefferson River: 68
Madison River: 64
Gallatin River: 76
Headwaters Missouri Mainstem: 76
Smith, Judith and Musselshell rivers: 91
Sun, Teton and Marias rivers: 55
Missouri Mainstem River Basin: 73
St. Mary and Milk rivers: 67
Upper Yellowstone River: 66
Wind River: 67
Shoshone River: 55
Bighorn Basin: 65
Tongue River: 68
Powder River: 80
Lower Yellowstone River: 67
Kootenai River: 65
Flathead River: 68
Upper Clark Fork River: 68
Bitterroot River: 51

Source: U.S. Department of Agriculture Natural Resource Conservation Service

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Public Comment Period
April 19, 2010 to May 18, 2010

***** AFFIDAVIT OF PUBLICATION *****

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Ad Number: 3849049

NOTICE OF AVAILABILITY DRAFT CARTERSVILLE IRRIGATION DAM FISH PASSAGE ALTERNATIVE ANALYSIS, ENVIRONMENTAL ASSESSMENT, AND FINDING OF NO SIGNIFICANT IMPACT

The Montana Department of Fish, Wildlife, and Parks (FWP) announces the availability of, and invites public comment on, the Draft Cartersville Irrigation Dam Fish Passage Alternative Analysis, Environmental Assessment (EA), and Finding of No Significant Impact (FONSI). The EA and FONSI are published in accordance with the National Environmental Policy Act (NEPA), Montana Environmental Policy Act (MEPA), Endangered Species Act (ESA), the National Historic Preservation Act (NHPA), as amended, regulations of the Council on Environmental Quality, and U.S. Army Corps of Engineers' NEPA regulations (33 CFR 230).

FWP proposes to construct a rock ramp with a slope of 0.5% in the north channel of the Yellowstone River below Cartersville Dam, near Forsyth, Montana. The rock ramp would buttress the downstream face of the dam, reducing the risk of failure, while providing fish passage and continued water supplies for the Cartersville Irrigation District and City of Forsyth.

For a 30-day period from April 19, 2010 to May 18, 2010, the Draft Alternative Analysis, EA and FONSI will be available for public review at the Rosebud County Library, 201 North 9th Avenue, Forsyth, Montana 59327; and on the Internet on the FWP website: http://fwp.mt.gov.

Questions may be addressed to Jim Darling, FWP, by telephone at (406) 444-5334 or to Gary Elwell, P.E., DOWL HKM, by telephone at (406) 869-6310 or via e-mail to GElwell@dowlhkm.com. Comments should be submitted to Gary Elwell, P.E., DOWL HKM, PO Box 31318, Billings, MT 59107 or sent via e-mail to GElwell@dowlhkm.com by May 18, 2010.

April 20, May 4, 2010

Tammy Haar, being first duly sworn, deposes and says: That she is the principal clerk of The Billings Gazette, a newspaper of general circulation published daily in the City of Billings, in the County of Yellowstone, State of Montana, and has charge of the Advertisements thereof.

That the: 55 Lines legal regarding:

Notice of Availability

a true copy of which is hereto annexed, was published in said newspaper on the following dates: via:

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Making all 2 publication(s)

Mark below if certificatation for the State of Montana.

_____ I hereby certify that I have read sec. 18-7-204 and 18-7-205, MCA, and subsequent revisions, and declare that the price or rate charged the State of Montana for the publication for which claim is made in the attached papers in the amount of $ 275.10 is not in excess of the minimum rate charged any other advertiser for publication of advertisement, set in the same size type and published for the same number of insertions. I further certify that this claim is correct and just in all respects, and that payment or credit has not been received.

STATE OF MONTANA
County of Yellowstone

On this day of May 5, 2010, before me, the undersigned, a Notary Public for the State of Montana, personally appeared Tammy Haar, known to me to be the person whose name is subscribed to the within instrument and acknowledged to me that he/she executed same. IN WITNESS WHEREOF, I have hereunto set my hand and affixed my notarial seal the day and year first above written.

NOTARY PUBLIC for the State of Montana
Residing at Billings, MT
My commission expires: 8/31/2013

TERESA A COX NOTARIAL SEAL STATE OF MONTANA

TERESA A COX
NOTARY PUBLIC for the
State of Montana
Residing at Billings, Montana
My Commission Expires
August 31, 2013

4026.10216

AFFIDAVIT OF PUBLICATION

No. 2435

STATE OF MONTANA)
)
County of Rosebud)

Shirley Bertin being first sworn, deposes and says: That she is and during the time hereinafter mentioned, has been ASSISTANT Bookkeeper of the Independent Press, a weekly newspaper of general circulation, printed and published at Forsyth, in the said County and State.

That the

NOTICE OF AVAILABILITY
DRAFT CARTERSVILLE IRRIGATION DAM FISH PASSAGE ALTERNATIVE ANALYSIS, ENVIRONMENTAL ASSESSMENT, AND FINDING OF NO SIGNIFICANT IMPACT

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Questions may be addressed to Jim Darling, FWP, by telephone at (406) 444-5334 or to Gary Elwell, P.E., DOWL HKM, by telephone at (406) 869-6310 or via e-mail to GElwell@dowlhkm.com. Comments should be submitted to Gary Elwell, P.E., DOWL HKM, PO Box 31318, Billings, MT 59107 or sent via e-mail to GElwell@dowlhkm.com by May 18, 2010.

Published April 15th 2010

a printed and true copy, cut from the columns of said newspaper, of which is hereunto annexed, was printed and published in the regular and entire issue of the weekly edition of said newspaper for 1 issues, commencing on the 15th day of April and ending on the 15th day of April, on the following dates, to wit:

April 15, 2010

The legal rate charged for the printing does not exceed the minimum going rate charged to any other advertiser for the same publication, set in the same size type and published of the same number of insertions.

Shirley F. Bertin

Subscribed and sworn to before me this 16th day of April, 20 10

C L Stirling

Notary public in and for the State of Montana, residing in Forsyth, Montana

My commission expires August 14, 2010

CHAUN M. STIRLING
NOTARIAL SEAL
STATE OF MONTANA

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #1	Response #1
Rosebud Conservation District 270 S. Prospect, P.O. Box 1200 Forsyth, MT 59327 Phone/fax: 406-346-7479 bobbi.vannattan@mt.usda.gov Phone: 406-346-7333 ext. 101 May 18, 2010 Mr. Gary Elwell Dowell HKM Box 31318 Billings, MT 59107 RE: Draft Cartersville Irrigation Dam Fish Passage Alternative Analysis and Environmental Assessment Dear Mr. Elwell, The Rosebud Conservation District would like to convey its support on the proposed project for the Carterville Irrigation Dam, located in Forsyth Montana. Although the main scope of the project is to improve fish passage for the pallid sturgeon, the modification of the diversion dam to the rock ramp appears to be a tolerable solution for the Irrigators and will improve the failing structure dramatically. We would like to make you aware that we are the permitting agency for the Montana Natural Streambed and Land Preservation Act or the 310 permit. Any private, nongovernmental individual or entity that proposes to work in or near a stream on public land and any activity that physically alters or modifies the bed or immediate banks of a perennial-flowing stream is required to apply. We are concerned that you have not listed this permit in your assessment. Information regarding the 310 permitting process is available on the Montana Department of Natural Resources web site: www.dnrc.mt.gov/permits/default.asp. Thank you, Doug McRae Rosebud Conservation District Chair Montana CDs: *Local Common Sense Conservation*	Thank you for your comments. Your support for the project is appreciated. All required permits will be obtained before construction begins.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #2	Response #2
DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION BRIAN SCHWEITZER GOVERNOR DIRECTOR'S OFFICE (406) 444 TELEFAX NUMBER (406) 444 STATE OF MONTANA WATER RESOURCES DIVISION (406) 444-6601 TELEFAX NUMBERS (406) 444-0533 / (406) 444-5918 http://www.dnrc.mt.gov 1424 9TH AVE PO BOX 2(HELENA, MONTANA 59620 May 14, 2010 Mr. Gary Elwell, P.E. DOWL HKM P.O. Box 31318 Billings, Montana 59107 Re: Comments on Draft Cartersville Irrigation Dam Fish Passage Alternative Analysis, Environmental Assessment, and Finding of No Significant Impact Dear Mr. Elwell: As a cooperating agency on the Cartersville Irrigation Dam Fish Passage Project, the Department of Natural Resources and Conservation is pleased to comment on the Draft Environmental Assessment and Finding of No Significant Impact. Our review of the Draft EA indicates that DOWL HKM, and partners in the effort, have done a thorough and commendable job of analyzing potential effects of dam re-placement and fish passage alternatives. The Department appreciates efforts by you, and the Department of Fish Wildlife and Parks, to coordinate with regulatory agencies, concerned public and the Cartersville Irrigation District. This coordination and careful analysis of alternatives, has resulted in the selection of a preferred alternative that meets the needs of the water users and allows for fish passage. The preferred alternative, replacement of an old, high maintenance, diversion dam that is a safety hazard, with a sloping rock ramp, provides for: 1. Continued performance of the Cartersville Diversion with minimal maintenance costs to the water users; 2. Passage of shovelnose and pallid sturgeon – the latter being an Endangered Species; 3. Removal of safety hazard to floaters; and 4. Maintenance of local recreational opportunities on the Yellowstone River. STATE WATER PROJECTS BUREAU (406) 444-6646 WATER MANAGEMENT BUREAU (406) 444-6637 WATER OPERATIONS BUREAU (406) 444-0860 WATER RIGHTS BUREAU (406) 444-6610	Thank you for your comments. Support of the Montana DNRC for this project is appreciated.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #2 (continued)	Response #2 (continued)
The Department agrees with the Finding of No Significant Impact and supports the implementation of the preferred alternative. Sincerely, Thomas M. Schultz, Jr. Division Administrator Water Resources Division Montana Department of Natural Resources and Conservation 1424 9th Ave—P.O. 201601 Helena, Montana 59620 c.c. Mary Sexton Chuck Dalby Marc Aberg Keith Kerbel Jim Robinson	Thank you for your comments. Support of the Montana DNRC for this project is appreciated.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #3	Response #3
From: Bruce Shaver, Forsyth, MT 307.660.5228 To: Pleased to pass fish. Would like to remove the dam and pump. When you make a mess, you clean it up.	Thank you for your comments. Your support for allowing fish passage is appreciated. Removal of the dam and conversion to pumping was considered as a part of the 2-day "Cartersville Diversion Dam Project Study" conducted February 25-26, 2009. This was one of 60 ideas considered, but not one of the seven selected for further development. This alternative is not acceptable to the Cartersville Irrigation District.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #4	Response #4
BILLINGS ROD & GUN CLUB, INC. P. O. BOX 33 BILLINGS, MONTANA 59103 406-259-0006 April 26, 2010 RECEIVED APR 30 2010 DOWL HKM Mr. Gary Elwell Box 31318 Billings, Mt. 59107 Dear Mr. Gary Elwell The Billings Rod and Gun Club would like to comment on the draft Environmental Assessment for the Cartersville Dam modification. We are a Club of 2000 families who use the hunting and fishing resources of Montana, many of our members use the Yellowstone River for these activities and we are intensely interested in any activity that affects these uses. The modification of this dam to allow fish to pass upstream is a great improvement to the fishery and therefore to our use of the river. We are very pleased that this action is being undertaken. We are, however, completely baffled by the lack of a provision to allow boats to pass through this structure. Why would this opportunity be passed up while the other modifications are being done? This structure is an existing impediment to watercraft, recognized in your EA, it is unsafe to boaters and floaters, restricts recreation users, and prevents passage by rescue and emergency craft. Please modify your proposal to include a provision for the passage of watercraft of all types. Irv Wilke President BRGC	Thank you for your comments. Your support for the project is appreciated. The final design will incorporate features to maximize passage to upstream habitat and reduce hazards to swimmers and boaters. It will also consider methods to ensure passage of watercraft.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #5	Response #5
From: John Moorhouse, 123 Norris Court, Billings, MT To: Gary Elwell **From:** Elwell, Gary **To:** Rux, Julie **Subject:** FW: Comment on Cartersville Dam **Date:** Tuesday, November 02, 2010 10:10:57 AM **From:** JOHN MOORHOUSE [mailto:pandjmoor@msn.com] **Sent:** Tuesday, April 27, 2010 8:11 AM **To:** Elwell, Gary **Subject:** Comment on Cartersville Dam Mr. Elwell, I do not have substantive comments on the analysis of either the no action or preferred action alternative. I believe your analysis of these alternatives is adequate for as far as you went. However, I am extremly disappointed that the opportunity to modify this structure to allow for the safe passage of watercraft was not a part of the actions considered. There is a wonderful opportunity to make this modification while the other construction activities are ongoing. Your document identified that the existing structure is an impediment to river use, yet no mention is made of the fact that the opportunity to remedy this situation is being foregone. Please refer to the attached position paper by the Yellowstone River Conservation District Council that encourages taking advantage of just this type of action. This is an organization that represents all 13 of the County Conservation Districts that abut the river from Livingston to North Dakota a very significant number of constituents. I am disappointed that you have chosen not to respond to this position by at least addressing the possibility of allowing watercraft to safely pass through the structure. Pleae consider modifying the proposed action to analyze this additional modification. John Moorhouse 123 Norris Court Billings, MT 59105	Thank you for your comments. Your support for the project is appreciated. The final design will incorporate features to maximize passage to upstream habitat and reduce hazards to swimmers and boaters. It will also consider methods to ensure passage of watercraft.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #6	Response #6
From: Leonard Colvin, Forsyth, MT To: Gary Elwell **Elwell, Gary** **From:** slcolvin@rangeweb.net **Sent:** Saturday, May 15, 2010 9:56 PM **To:** Elwell, Gary **Subject:** forsyth fish later the new fish later at forsyth . would be a wast of money . at this time fisherman enjoy fishing the face if the dam in boats .to put all the rocks in for a fish later will put a stop to fishing from a boat . right now river is low for a spring run off . the olny way to take boat down river is by way of the north side . right were you want to put your rocks . this will put a stop to boat fishing east of the dam . the dept of fish gets talk into this type of wasting money .a fine example is the rosebud boat ramp in the last 8 or 10 years water dose not come aneywere near it . thank you leonard colvin forsyth mt,	Thank you for your comments. The proposed action was identified as having the best opportunity to achieve the objectives for this project. The final design will take into consideration maintaining/improving fishing opportunities to the extent possible.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #7	Response #7
From: Robert Vannattan, PO Box 835, Forsyth, MT To: Gary Elwell Mr. G. Elwell Box 31318 Billings, MT 59107 RE: Carterville Irrigation Dam Project Dear Mr. Elwell; I would like to comment on the Carterville Dam Project, I agree that the dam is failing and something needs to be done to prevent the structure from failing. I understand that the only structure that the irrigation district is willing to consider is the rock ramp, however I would like to see the ramp installed and engineered to continue to meet the needs of the irrigators as well as the recreationist that frequent the area. Although the Cartersville Irrigation District owns the dam, they do not own the adjacent state park and recreation area, or the land that the rock embankment proposed will cover. I have great concern about who will be funding the project, it is mentions several times that the Army Core "MAY" provide some of the funding. When will funding be secured and the funding sources identified? I also understand that the cost of the Glendive project has increased several million and the users cost is going up to cover that increase, who will ultimately pay for this project? The Cartersville Irrigation Dam is vital part of the Forsyth community. People gather in the mornings to drink coffee, read the paper and watch the water go by. Many BBQ's and picnics occur at the site every day. Wildlife is abundant in the area; there are some eagles that gather here to fish. There is a nesting pair of falcons on the old bridge a half mile up-stream that fish below the dam. White pelicans also fish here. Many birds of all kinds can be seen throughout the year. The first time they did a repair on the dam there was a family of mink on the south corner of the dam. When the front end loader came and removed part of the rock covert bank to get out onto the dam, that family of mink was destroyed. I don't know if they were killed or the runoff. I do know they were never seen again. Presently there is a family of mink on the north shore; I am concerned as to their fait when the bank armor work is done. I have been utilizing the site for well over 30 years, I am an avid fisherman and sportsman. I have seen many fish cross over the dam. There is a wide variety of aquatic life as well, I have seen turtles, bass, catfish, northern pike, sauger, walleye and thousands of minnows crossing over the dam at anytime of the regardless of whether the water was high or low. I realize that the main scope of the project is to allow pallid sturgeon passing, I would like to see more sturgeon in the area as well.	Thank you for your comments. Neither the timing or the source of funding for this project has been identified. During final design, opportunities for new boater access points will be explored. The final design will be configured to maximize fish passage while minimizing the potential for debris collection. Section 5.4.8.1.1 states "The excavated bed material will be used to fill the scour hole at the toe of the existing dam, with any remaining material used to fill voids within the riprap rock ramp". It further states "The south channel will be left intact based on the desires of the Cartersville Irrigation District and the community". The intent is to pass the same amount of water through the south channel as passes now. Roads used to move equipment and materials to the project site will require strengthening prior to construction or will be repaired after construction if necessary. Every attempt will be made to meet the needs of those who use and enjoy the facility. An additional public meeting was held on June 9, 2010 in Forsyth, Montana.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #7 (continued)	Response #7 (continued)
From: Robert Vannattan, PO Box 835, Forsyth, MT To: Gary Elwell As far as fish concentrating on the dam, they already do. It is a very popular fishing spot. The blue herons one already there feeding daily. I feel that the new boat ramp downstream as indicated will not work, the reason is there is no water for a boat ramp at low flows. As for being able to travel upstream over the dam by boat or launch a boat for upstream travel, there is already a very nice boat ramp up stream where no camping is allowed. I do not agree that the fishery will benefit at all from this proposed project, if anything I believe it would suffer. I am also concerned with the design of the proposed ramp that the placement of large rocks to create resting place for the fish. It will create a problem during high water when there is a lot of large trees and debris coming down the river. It may create a fence to catch the debris and form a high stick dam of sorts and cause major flooding and destruction. The removal of the river depth, of four feet, also concerns me what will be done with the gravel. It will also kill a very large amount of aquatic life in the area of the ramp and who knows how far downstream. The decision to not put passage on the south side is a good one, I have not seen anything about the channel on the south side about the dam being necessary to back the water up so the Forsyth water plant can get water out of the river. There is no way a fishing whole can be put on the south side channel. All of the charts and aerial photos show the river at high water. During most of the year there is no water in the south channel. Figures 7-2 page 7-18 locating at new boat ramp shows the river at high water, the new boat ramp will be high and dry at low water and the water depth at this location, if any is usually around 6 inches. My main concern is how much this will change the use of this area of the river. I attended a meeting with Don Youngbauer and a Representative of Denny Reburges office on Friday, May 14, 2010. They would like an extension on the comment time and a town hall meeting on this project. I have also spoken with the mayor and a major concern is who will be responsible for repairing the streets that will be use to haul the material and equipment to the dam site.	

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #7 (continued)	Response #7 (continued)
From: Robert Vannattan, PO Box 835, Forsyth, MT To: Gary Elwell Thank you very much and please keep me informed on this project. As a sportsman and a conservationist, I agree in preserving a dying species, but feel that this can be accomplished and the needs of all interested parties can be met without destroying a valuable asset to the community and the many visitors that come to the site every year with family and friends to fish and camp. Sincerely, Robert Vannattan Sr. 406-749-0442 PO Box 835 Forsyth MT, 59327 Email gelwell@hkminc.com Gary Elwell, PE PO box 31318 Billings MT 59107-1318 PH. 406-656-6399 Fax: 406-656-6398 Jim Darling MT FWP 1420 East 6th Avenue Helena, MT 59601 Phone: 406-444-5334	

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #8	Response #8
From: Cartersville Irrigation District Will the Cartersville Irrigation headgate on the Yellowstone River be rebuilt as a part of this project?	The proposed design does not require reconstruction of the headgate to allow for upstream passage of shovelnose sturgeon. However, screening of the intake may be beneficial to prevent entrainment of young sturgeon when drifting downstream. A report entitled "Yellowstone River Fish Passage – BOR" published by the MT FWP in February 2010 addresses studies on the Yellowstone River between Billings and Terry. The study included entrainment measurements in the Cartersville Irrigation ditch. The report indicates the presence of shovelnose sturgeon upstream of Cartersville Dam, but does not indicate any shovelnose sturgeon in the ditch. Once shovelnose sturgeon pass upstream of the Cartersville Dam, entrainment in the ditch may become an issue. The report recommends modification to a second headgate located approximately 2 miles downstream of the river headgate that diverts water from Anchor Island Slough to the irrigation canal. During final design, consideration will be given to the need to reconstruct the Yellowstone River headgate to prevent entrainment.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #9	Response #9
Yellowstone River Conservation District Council 1371 Rimtop Drive Billings, MT 59105 Nicole McClain, Coordinator Phone: 406-223-5702 Fax: 406-247-4429 Email: yellowstoneriver@aol.com Don Youngbauer Chairman P.O. Box 68 Forsyth, MT 59327 Phone: 406-346-2935 don@rosebudcd.org Bob Hector Vice-Chairman 4912 Pryor Road Billings, MT 59101 406-252-4332 Bhector4912@hotmail.com Council Conservation District Members: Carbon County Will Alexander Custer County Walter Rolf Dawson County Kenny Nemitz Park County Jerry O'Hair Prairie County Dave Schwarz Richland County Tony Barone Rosebud County Don Youngbauer Stillwater County Steve Story Sweet Grass County Paul Gilbert Treasure County Phil Fox Yellowstone County Bob Hector McKenzie County, ND Orvin Finsaas RAC Chair John Moorhouse May 17, 2010 Mr. Gary Elwell Box 31318 Billings, MT 59107 Dear Mr. Elwell, The Yellowstone River Conservation District Council (YRCDC) would like to comment on the draft Environmental Assessment for the Cartersville Dam modification. The modification of this dam to allow fish to pass upstream is a great improvement to the fishery and therefore to the overall health of the river. It appears that you can accomplish this without having a negative impact on the water supply for either the irrigation users or the City of Forsyth. We are very pleased that this action is being undertaken. We are; however, concerned by the lack of analysis and follow up on a provision to allow boats to pass through this structure. The EA documents that this structure is an existing impediment to watercraft and is a safety hazard. It is unsafe to boaters and floaters, restricts recreation users, and prevents passage by rescue and emergency craft. The Purpose and Need section of the document notes that improving public safety is one of the purposes of the proposal. The proposal description mentions that some watercraft might pass through under some conditions. Other than these brief notes, there is no further analysis of how the structure will accomplish the purpose of allowing passage of watercraft. In fact, there is no documentation of what the effect on boating might be. The YRCDC represents thirteen county Conservation Districts that abut the Yellowstone from Livingston to North Dakota that are very concerned about the health of the river and about ensuring that the river is available to all users. In support of this concern the YRCDC adopted a Position Paper on Watercraft Passage (attached) that addresses just the situation that exists here as illustrated by the following excerpts from that paper: • **When existing structures are modified or maintained, design changes that would provide for passage of watercraft should be evaluated and incorporated when feasible.** • (Role of the YRCDC) **Reviewing plans for dam construction and re-construction and insisting that provisions for safe watercraft passage are considered as part of the design**. . . . Please modify your analysis to fully address whether a provision for the passage of watercraft of all types is a part of the final proposal, how it would be accomplished, what the cost might be and what the effect on this use might be. We look forward to your response. Don Youngbauer Chairman cc: Mr. Jim Darling, MT Dept Fish Wildlife and Parks Attachment: Watercraft Position Paper	Thank you for your comments. Your support for the project is appreciated. The final design will incorporate features to maximize passage to upstream habitat and reduce hazards to swimmers and boaters. It will also consider methods to ensure passage of watercraft.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #9 (continued)	Response #9 (continued)

Yellowstone River Conservation District Council

POSITION STATEMENT

Watercraft Passage

Adopted 2/18/2010

Position Statement: The Yellowstone River Conservation District Council (YRCDC) encourages the development of mutually agreeable solutions that provide for the safe passage of small watercraft through or around irrigation diversion structures in the Yellowstone River.

Introduction:

Recreational use of the Yellowstone River by watercraft, both powered and unpowered, is an increasingly important component of the many legitimate, but sometimes competing, uses of the river resources. Power boaters, canoeists, rafters and float tubers ply the waters the length of the river to fish, hunt, bird watch, or just to enjoy the scenery and tranquility the river has to offer. Six major irrigation diversion structures downriver from the City of Billings span the width of the river and effectively stop the movement of watercraft (Huntley, Waco-Custer, Rancher Ditch, Yellowstone, Cartersville and Intake). There are an additional 12 minor irrigation structures downstream from Gardiner that partially block the river or block one channel of the river and that may affect the movement of watercraft.

Public access points that allow the launching of boats are often separated by these irrigation structures. Floaters cannot launch at one access and take out at the next downriver because an irrigation structure prevents their safe passage. This restricts the use of the river and may contribute to trespass issues by boaters wanting to use the river but unable to access it. These structures also pose a very real danger to anyone who might go over them and into the turbulent pool below. In addition, most of these structures do not a have adequate warning signs on the riverbank to let boaters know they are approaching a dam and which side of the river is most appropriate for portaging.

Proposed Solutions:

Following are some actions that would alleviate the issues created by the existence of irrigation structures that span the river.

- Any new structures that would impede the movement of watercraft should contain design provisions that allow reasonable passage through or around the structure by small watercraft.
- When existing structures are modified or maintained, design changes that would provide for passage of watercraft should be evaluated and incorporated when feasible.

CONSERVATION DISTRICT COUNCIL MEMBERS: Carbon – Custer – Dawson – Park – Prairie – Richland – Rosebud – Stillwater, Sweet Grass – Treasure – Yellowstone – McKenzie County, North Dakota – MACD – RAC Chair

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http://dnrc.mt.gov/cardd/yellowstonerivercouncil/default.asp

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #9 (continued)	Response #9 (continued)
Yellowstone River Conservation District Council ***POSITION STATEMENT*** Watercraft Passage • Every structure that impedes passage of watercraft must have warning signs on the riverbank at appropriate distances above the structure to alert boaters of the existence of the structure and the appropriate bank to use to portage or float around the structure. • Public river access points should have signs warning boaters of the existence of structures below and above and the proper avoidance techniques. **Role of the YRCDC:** Because it is an organization that spans more than 500 miles of the river, the YRCDC is in a position to take a leadership role in assisting river users to avoid conflicts and minimize dangers. Actions taken by the YRCDC should include: • Reviewing plans for dam construction and re-construction and insisting that provisions for safe watercraft passage are considered as part of the design. Encouraging discussions between irrigation and recreation user groups and agencies to find reasonable solutions to conflicts. • Encouraging the erection and maintenance of warning signs above structures through agreements between irrigation and recreation user groups, the owner/operator of the structure and riverbank landowners and by assisting these groups to find funding sources for signage. • Encouraging discussions between user groups and landowners to provide easements for portage routes around dams if necessary. • Encouraging the inclusion of dam warning information at river access points, in floater's guide maps and other information that is made available to river users. **References:** Final Report, Historic Events Timeline, November 17, 2008, prepared for Yellowstone River Conservation District Council by Tony Thatcher, DTM Consulting and Karin Boyd, Applied Geomorphology Inc. **CONSERVATION DISTRICT COUNCIL MEMBERS:** Carbon – Custer – Dawson – Park – Prairie – Richland – Rosebud – Stillwater, Sweet Grass – Treasure – Yellowstone – McKenzie County, North Dakota – MACD – RAC Chair 1371 Rimtop Drive • Billings, MT 59105 (406) 247-4412 http://dnrc.mt.gov/cardd/yellowstonerivercouncil/default.asp	

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #10	Response #10
Montana Department of ENVIRONMENTAL QUALITY Brian Schweitzer, Governor P.O. Box 200901 • Helena, MT 59620-0901 • (406) 444-2544 • www.deq.mt.gov Gary Elwell DOWL HKM 222 N 32nd Avenue, Suite 700 Billings, Montana 59107-0137 Re: Cartersville Irrigation Dam Fish Passage Alternative Analysis and Environmental Assessment Dear Mr. Elwell: We appreciate the substantial efforts of Montana Fish, Wildlife and Parks (FWP) to prepare this draft environmental assessment (EA) to evaluate a proposal to improve passage for endangered pallid sturgeon and other native fish at Cartersville Irrigation Dam. The Rock Ramp Alternative is identified as the preferred alternative. We support the purpose of this proposed project to improve fish passage, which supports in part our main focus of maintaining or improving beneficial uses in state waters. However, we believes opportunities to further support beneficial uses for the proposed project and more fully mitigate adverse impacts to the overall aquatic habitat should be considered. We are concerned that anthropogenic alterations of the Yellowstone River and riparian areas by structures including riprap, diversions, closing side channels, and clearing banks are contributing to loss of beneficial uses. Natural channel migration and the ability of the river to access its floodplain at Cartersville are critically important to overall river health. The current diversion at Cartersville does not allow these important functions to occur and the proposed rock ramp will perpetuate those concerns The draft EA suggests no mitigation is currently proposed for overall aquatic ecosystem impacts because of the overall benefits to fish passage. However, the EA does suggest mitigation for wetland impacts will be required. That appears to be inconsistent with not requiring mitigation for the stream impacts. We concur that the proposed rock ramp may result in net benefits to fisheries from improved fish passage and increased access to available habitats on the Yellowstone River and major tributaries. We support attainment of such beneficial uses. However, we do not believe that these benefits should preclude addressing the loss of other riverine functions and values, and the need to mitigate for other aquatic impacts. A reasonable means of providing compensation for loss of natural channel migration and floodplain access may be available by making contributions to the Montana Channel Migration Zone Program being developed by FWP in cooperation with DEQ. This program promotes maintenance of natural channel migration processes by compensating land owners for easements along the river to allow natural bank erosion and channel migration processes to take place. Purchase of sloughing easements for an equivalent 1	Thank you for your comments. The Montana DEQ support for this project is appreciated. The Montana Department of FWP will consider these comments when funding is secured and final designs are being prepared.

The following comments were submitted during the formal public comment period (April 19, 2010–May 18, 2010)

Comment #10 (continued)	Response #10 (continued)
nearby floodplain area to preserve other natural channel migration opportunities nearby could compensate for loss of natural channel migration at Intake. Efforts to compensate for loss of natural channel migration and floodplain access would make the proposed project more of an ecosystem restoration project rather than just a fish passage improvement project and lend itself to our focus of maintaining or improving beneficial uses. Another suggestion to consider is using the Montana Stream Mitigation Process being developed by the Montana Regulatory Office of the Corps of Engineers as a means of evaluating and addressing river/stream mitigation needs at Intake. DEQ worked collaboratively with the Corps during the early stages of development of the process and it appears to be a useful tool in evaluating credits and debits associated with proposed river/stream projects. Lastly, we share the concerns of all the resource folks involved in these efforts that timely implementation of modifications at Cartersville Irrigation Dam are critical to avoid potential extirpation of the endangered pallid sturgeon. To avoid delays in project implementation, we suggest that our recommendations about compensating for loss of natural channel migration and river floodplain access and any impacts to wetlands be addressed collaboratively by simply including these impacts among the environmental impacts to be evaluated and mitigated with an Adaptive Management Strategy and evaluated by an interagency Environmental Review Team - similar to that which is being done on the proposed Intake fish passage project. The details regarding compensation for aquatic impacts can be worked out while the project design details are being finalized. DEQ's participation in the Adaptive Management Strategy as a member of the interagency Environmental Review Team should enhance those efforts and would complement our decisions relative to mitigation issues involving our 401 Water Quality Certification of the Corps 404 permit for the project. We appreciate the opportunity to review and provide comments on the draft EA. If you have any questions regarding our comments please call Jeff Ryan at 406-444-4626. Sincerely, Greg Hallsten Director's Office/MEPA Unit Cc: Mr. Jeff Ryan, Montana DEQ, Helena 2	

Billings Gazette
April 27, 2010

RULING EXPLAINED: Flaws in bid to build courthouse noted Page 2

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Dam plan envisions added rock ramp

Fish, Wildlife and Parks

The Carterville Dam across the Yellowstone River, viewed from the south shore at Forsyth, creates a 6-foot drop during low flows in the river.

By BRETT FRENCH
Of The Gazette Staff

Under a recently unveiled $15 million proposal, boulders would be added to create a more gradual fish- and boater-friendly passage at Cartersville Dam on the Yellowstone River at Forsyth.

The dam, built in the 1930s of timber and rock capped with concrete, blocks upstream fish passage as well as boaters with its 6-foot drop. The structure stretches across the entire river for 800 feet.

Please see Dam, 8C

4026.10216.01
Cartersville Irrigation Dam

Dam

Continued from 1C

Under the Montana Fish, Wildlife and Parks proposal contained in a draft environmental assessment, boulders would be used to fill in the slope below the dam to create a .5 percent grade in the river's north channel. The rocks would also strengthen the dam to prevent it from failing.

DowlHKM, a Billings engineering firm, designed the plans for the work.

It's estimated that 200,000 tons of boulders stretching up to 1,500 feet downstream would be needed to create the rock ramp. Under ideal conditions, the work would be completed in one construction season beginning after spring runoff. Construction is not expected to affect water flows to the city or irrigators.

The draft EA states: "The rock ramp would be designed to lower velocities and turbulence, so that migrating fish could easily make their way past the dam. The boulder weir design is used quite extensively in Europe, and has also been successfully implemented to pass lake sturgeon in Minnesota and Wisconsin.

"The design uses a 3 percent slope and 1-ft drops between the boulder weirs."

FWP is accepting comments on the draft environmental assessment through May 18. The document is available at the Rosebud County Library in Forsyth as well as on the FWP website.

The dam provides water to the Cartersville Irrigation District and to the city of Forsyth for its municipal system.

Just downstream of the dam is a popular fishing access site and boat launch. Under the proposed plan, a new boat launch would have to be constructed.

The rock ramp proposed for construction is similar to what's being pursued by the Bureau of Reclamation downstream at the Intake Diversion Dam between Glendive and Sidney. One of the main drivers behind that project is to allow passage of endangered pallid sturgeon in hopes that access to the river upstream of the dam will enhance their chances of successful reproduction.

Making the Intake dam passable to fish would add another 165 navigable miles. If the work at Cartersville is also completed, an additional 56 miles of river would be opened to native fish before they hit the Yellowstone Diversion Dam.

According to the draft EA, the fragmentation of the river's habitat isolates fish populations, limits genetic diversity and limits the long-term viability of fish and other water organisms.

Initially, 60 ideas to address the problems were considered. The list was narrowed to seven before the rock ramp was chosen. After the comment period ends and the environmental assessment is made final this summer, FWP will complete detailed designs, get the necessary permits and seek funding.

Questions about the project may be addressed to Jim Darling, FWP chief of fisheries habitat, at 406-444-5334, or to Gary Elwell, senior water resource engineer for DowlHKM, at 869-6310.

E-mailed comments should go to Elwell at gelwell@dowlhkm.com. Written comments should go to Elwell at P.O. Box 31318, Billings, MT 59107. All comments are due by May 18.

Public Information Meeting
June 9, 2010

CARTERSVILLE IRRIGATION DAM
FISH PASSAGE ALTERNATIVE ANALYSIS AND ENVIRONMENTAL ASSESSMENT
FACT SHEET
JUNE 9, 2010

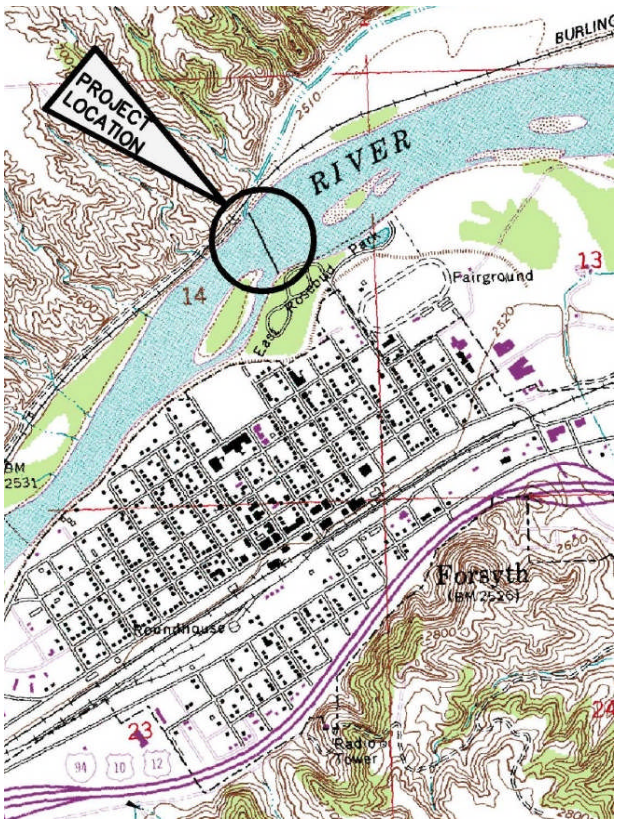
- Cartersville Irrigation Dam is located on the Yellowstone River at the town of Forsyth in Rosebud County, Montana.

- The Cartersville Irrigation Dam has required ongoing maintenance.

- Impediment to fish passage created by Cartersville Dam impacts shovelnose sturgeon and other migratory fish species.

- When Intake Dam, downstream in Dawson County, is repaired, Cartersville Dam will be the next barrier to upstream movement of pallid sturgeon, a threatened and endangered species.

- Previous studies include a 2-day "Cartersville Diversion Dam Project Study" conducted February 25-26, 2009 which generated 60 alternatives.



- The Cartersville Irrigation District, owner of the dam, supported three alternatives: two rock ramp options and a controlled notch (inflatable bladder).

- DOWL HKM prepared the draft "Cartersville Irrigation Dam Fish Passage Alternative Analysis and Environmental Assessment" dated April 16, 2010 under contract with the Montana Department of Fish, Wildlife and Parks dated June 26, 2009.

- Public meetings for this study were held in Forsyth on July 28, 2009 and November 3, 2009.

shovelnose sturgeon
(IN Dept. of Natural Resources)

- The Draft "Cartersville Irrigation Dam Fish Passage Alternative Analysis and Environmental Assessment" report was made available for a 30-day comment period which ended on May 18, 2010.

- Notice of availability of the draft was published in the Forsyth and Billings papers, a copy was made available at the Rosebud County Library, and copies were sent to those who requested one.

Cartersville Irrigation Dam

- The study followed instructions from the U.S. Army Corps of Engineering (USACE) "Planning Guidance Notebook" which categorizes this fish passage project as an "ecosystem restoration" project.

- Cooperative agencies in this study include the U.S. Army Corps of Engineers, the Montana Department of Natural Resources and Conservation, and the Montana Department of Environmental Quality.

- The overall intent of the project is to modify the dam to improve fish passage while continuing to provide water needed for the Cartersville Irrigation District.

- Primary objectives are to:

    - maintain the ability of the irrigation district to divert water at all flow levels;
    - allow upstream passage of native fishes, particularly sturgeon;
    - provide minimal maintenance requirements;
    - increase public safety; and
    - maintain recreation opportunity at the adjacent city park.

- This study resulted in identification of the preferred alternative consisting of a 0.5% slope rock ramp in the north channel while leaving the south channel as is.

- Final configuration of the rock ramp for fish and boater passage will be determined during final design.

- The estimated project cost is $15,000,000.

- USACE funding would require a significant non-federal cost share.

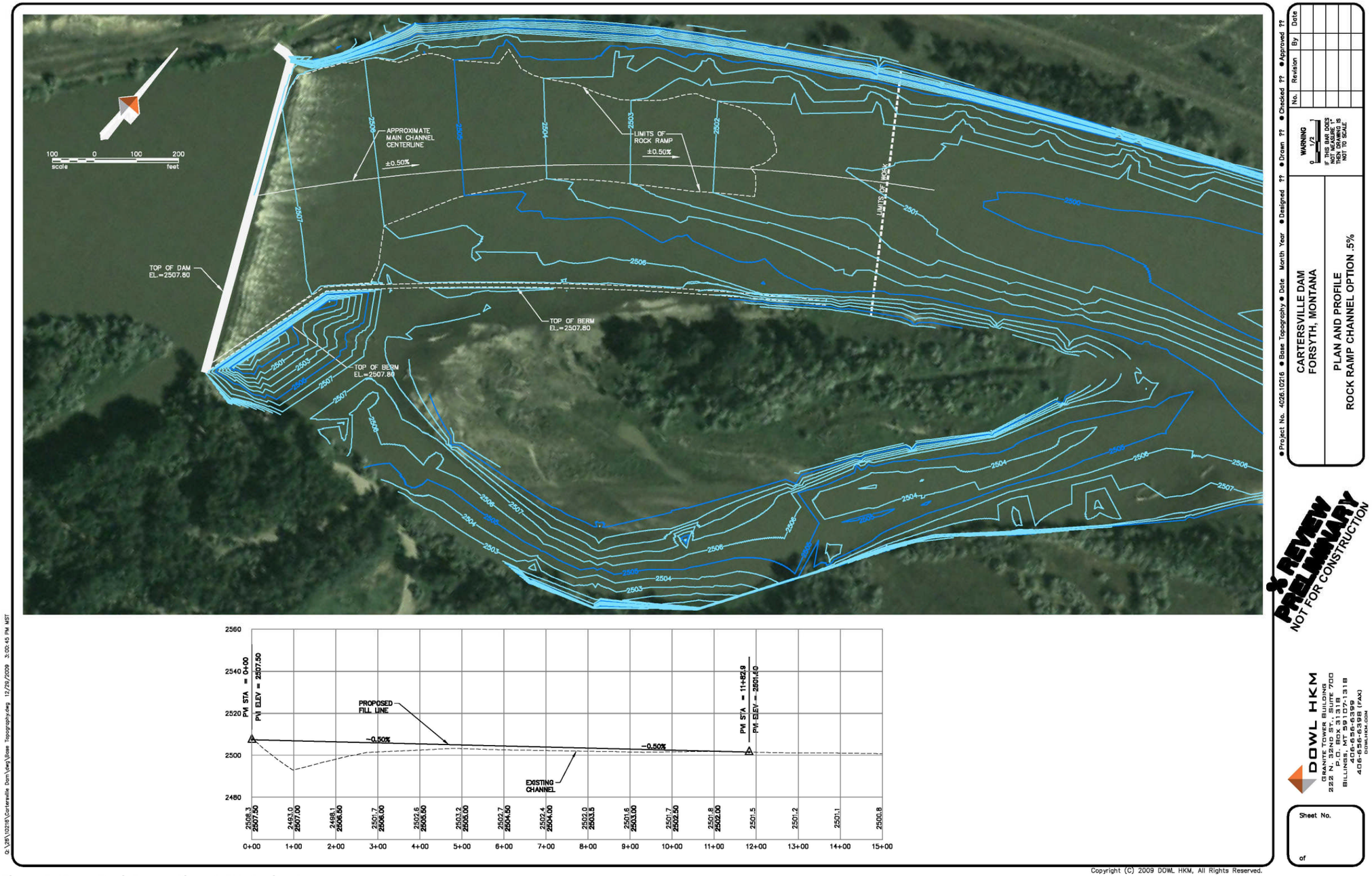


Figure 5-42 Rock Ramp, Slope 0.5%, Option 2

Feasibility Study, Environmental Analysis, Fish Passage, Public Safety, Recreation Opportunities, Streambed Gradient,

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