Biological Assessment of the Milltown Reservoir Sediments Operable Unit Revised Proposed Plan and of the Surrender Application for the Milltown Hydroelectric Project (FERC No. 2543)

Prepared for

Environmental Protection Agency
Helena, Montana and the Federal Energy Regulatory Commission

August 2004

Prepared by

CH2M HILL
and
The Clark Fork and Blackfoot, L.L.C.

Biological Assessment
Bull Trout

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CHAPTER 1

Introduction

This Biological Assessment (BA) is intended to satisfy provisions of Section 7 consultation requirements for the Environmental Protection Agency (EPA) and the Federal Energy Regulatory Commission (FERC) with the U. S. Fish and Wildlife Service (FWS) under the Endangered Species Act (ESA). In addition, this BA also is intended to fulfill intra-service FWS consultation requirements on those portions of the Proposed Action planned, administered, or funded by the FWS. This BA evaluates the potential effects on bull trout (*Salvelinus confluentus*), a federally listed threatened species, and on bull trout proposed designated critical habitat from: 1) implementing the selected remedial action and a site restoration plan at the Milltown Reservoir Sediments Operable Unit (actions under EPA and the Natural Resource Damage Trustees authority) and; 2) providing interim fish passage during site remediation, discontinuing certain conservation/enhancement actions once Milltown Dam is removed, and surrendering the Milltown Dam Hydroelectric Project FERC license (actions under FERC's authority). Some major purposes of the remedial action considered for this Operable Unit are to address human health risks and allow the recovery of the contaminated drinking water aquifer, and to reduce the potential impacts on aquatic life in the Clark Fork River downstream of Milltown Dam from the release of disturbed reservoir sediments and associated metals during ice sour events or, potentially, during catastrophic dam failure. The purposes of the site restoration plan are to establish a new natural channel and floodplain for the Clark Fork River within the Operable Unit, and to allow unimpeded fish passage in the Blackfoot River by removing Stimson Dam. The purpose of interim fish passage is to allow upstream movements by bull trout during site remediation, while conservation/enhancement actions are intended to mitigate effects of the Milltown Dam Hydroelectric Project on bull trout. The FERC license would be surrendered by The Clark Fork and Blackfoot, L.L.C. (CFBLLC), owner of Milltown Dam, prior to the removal of Milltown Dam and associated facilities and the completion of site remediation activities.

EPA, in consultation with the Montana Department of Environmental Quality (MDEQ), selected the current proposed remedial action (known as the Revised Proposed Plan) for implementation following public review and comment on the Original Proposed Plan in 2003 and evaluation of an alternative remediation proposal from Atlantic Richfield Company (ARCO) for the Milltown Reservoir Sediments Operable Unit. The alternative proposed removing sediments in the dry using a reservoir drawdown/sediment pre-loading approach (the Revised Proposed Plan) rather than hydraulic dredging under a full reservoir pool approach (the Original Proposed Plan). Previous evaluations conducted by EPA and MDEQ that provided the basis for ultimately selecting the Revised Proposed Plan as the preferred remedial action included the evaluation of 24 alternatives in the original Feasibility Study for groundwater plume cleanup actions (ARCO 1996), 10 alternatives in the Focused Feasibility Study for scour events (ARCO 2000), and 10 alternatives in the Combined Feasibility Study for groundwater cleanup alternatives and scour events (ARCO 2001). The selected proposed remedial action is described in EPA's *Revised Proposed Cleanup Plan* (EPA 2004) and is summarized later in this BA.

Site restoration activities associated with the Proposed Action and described in this BA will be closely coordinated with site remedial activities. All of these activities will occur within the site remediation/restoration area, which is depicted in Figure 1. The site remediation/restoration area includes the Clark Fork River from the Interstate 90 Bridge, located approximately 1 mile downstream of the Milltown Dam site, upstream to near the Turah Bridge, located approximately 5 miles upstream of the Milltown Dam site. The site remediation/restoration area also includes the Blackfoot River from its mouth upstream approximately 1.25 miles to above Stimson Dam (see Figure 1). All of the site remedial activities will occur within the EPA's Milltown Operable Unit boundary (see Figure 2) while some of the restoration activities (Stimson Dam removal, establishing the upstream segment of a new Clark Fork River channel and floodplain) will be outside the Operable Unit boundary but within the site remediation/restoration boundary. The Natural Resource Trustees (FWS, Confederated Salish and Kootenai Tribes, and State of Montana) have developed restoration plans, received public comment, and will be responsible for establishing a new river channel and floodplain through and immediately upstream of the Operable Unit. The Appendix contains the *Draft Conceptual Restoration Plan for the Clark Fork River and Blackfoot River Near Milltown Dam (Water Consulting, Inc., and Rosgen 2003).* The removal of Stimson Dam is being planned as a cooperative effort through the FWS National Fish Passage Program. Site restoration activities are described in EPA's *Revised Proposed Cleanup Plan* (EPA 2004) and are summarized later in this BA.

Information presented in this BA follows the example of a bull trout BA that was described by the FWS (1999) in their "Endangered Species Act Biological Assessment Workshop." *Chapter 1, Introduction*, provides an overview of the area's background and history, and discusses the purpose, need, and scope of this BA. *Chapter 2, Project Description*, describes the Proposed Action (the selected remedial action and site restoration plan). *Chapter 3, Environmental Baseline,* describes baseline conditions, including bull trout distribution, status, proposed designated critical habitat, limiting factors, life history characteristics, and habitat requirements in subbasins and associated drainages in the assessment area for this BA. *Chapter 4, Effects of the Action*, discusses direct, indirect, and cumulative effects on bull trout and their proposed designated critical habitat that could potentially result from implementing the Proposed Action, and describes conservation measures intended to avoid or minimize the potential for adversely affecting bull trout and their habitat. *Chapter 5, Determination of Effects*, discusses whether or not the Proposed Action is likely to adversely affect bull trout, or to destroy or adversely modify bull trout proposed designated critical habitat.

1.1 Background and History

The Milltown Reservoir Sediments Operable Unit is located on the Clark Fork River in western Montana. This Operable Unit extends from Milltown Dam, which is at the confluence of the Clark Fork and Blackfoot Rivers, southeast 1-1/2 miles to the upstream limit of Milltown Reservoir. The City of Missoula is approximately 5 miles west of Milltown Reservoir, and the community of Milltown is immediately east of the reservoir.

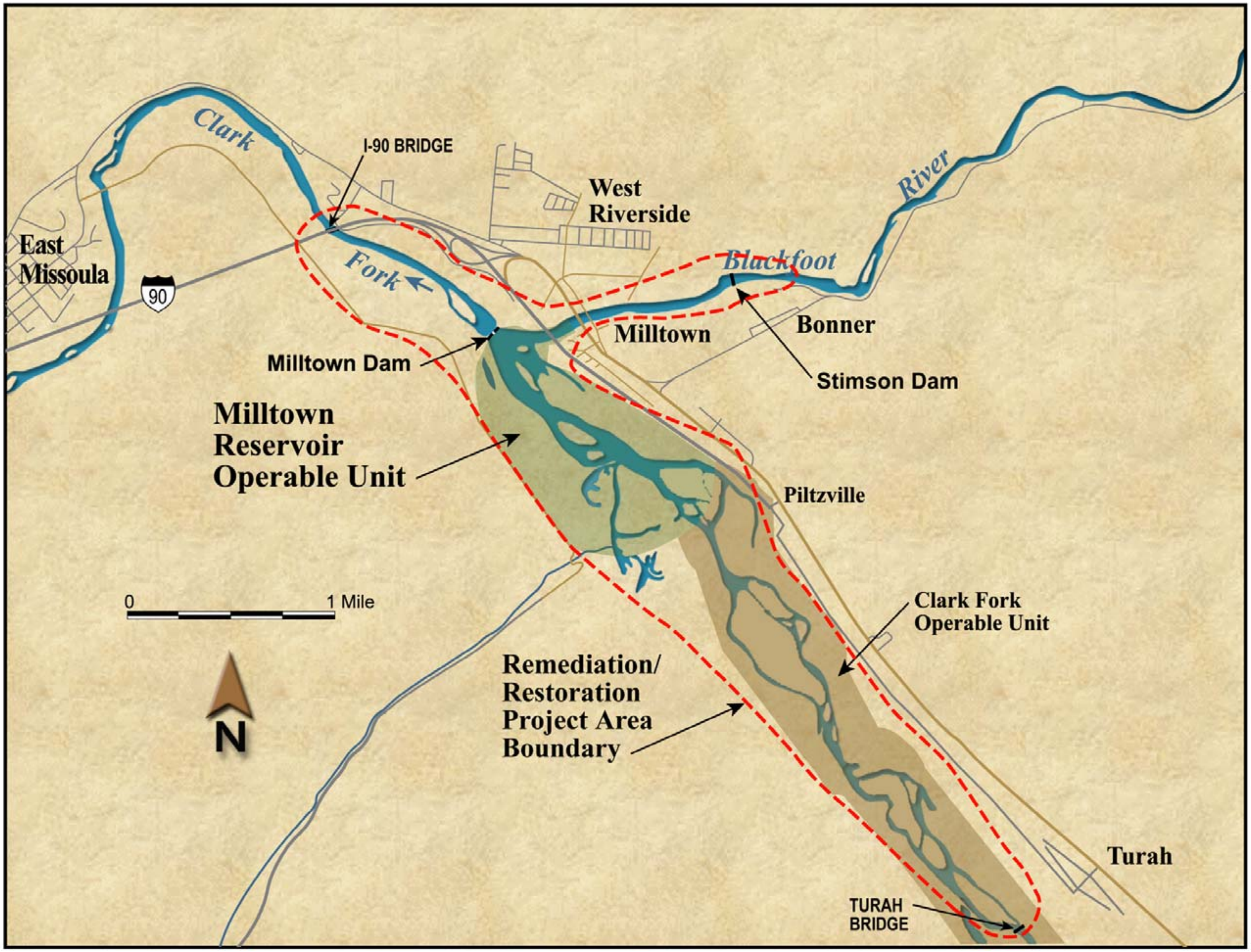


FIGURE 1
Remediation/Restoration
Project Area

Biological Assessment of the Milltown Reservoir
Sediments Operable Unit

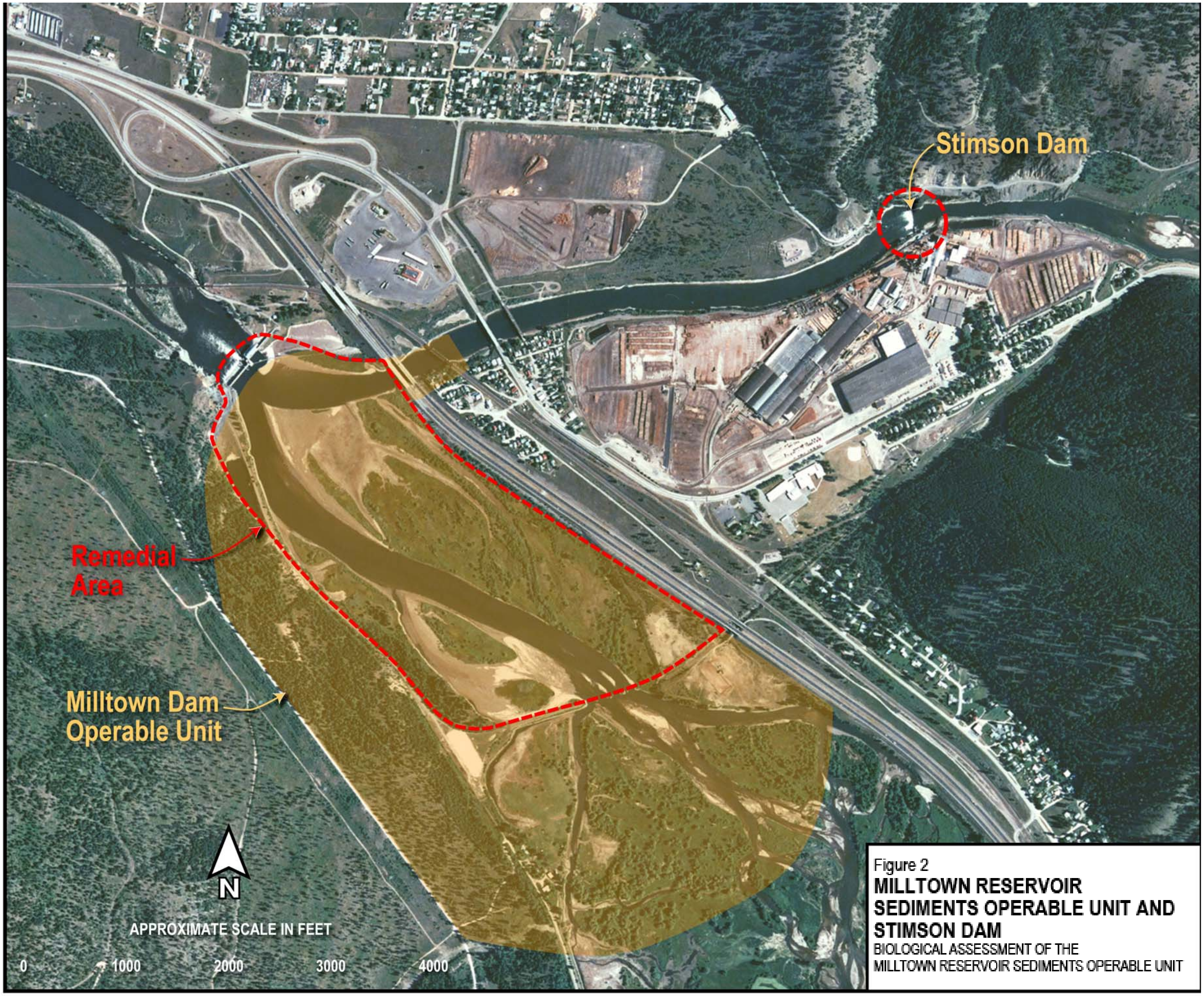


Figure 2
MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT AND STIMSON DAM
BIOLOGICAL ASSESSMENT OF THE MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT

Environmental investigations in 1981 by the Missoula City/County Health Department found levels of arsenic in private drinking water wells in Milltown that exceeded public health standards. It was subsequently determined that sediment from upstream mines that had accumulated in Milltown Reservoir had contributed to the formation of a groundwater arsenic plume that impacted Milltown's drinking water supply (EPA 2002). In 1982, EPA became involved and listed the Milltown Reservoir Site on the National Priorities List (NPL) as a Superfund Site. EPA has the authority to require the implementation of remedial actions to meet requirements, and prevent hazardous sediments from threatening human health and environmental resources at Superfund Sites.

The Milltown Reservoir Clark Fork River Superfund Site consists of the Milltown Reservoir Sediments Operable Unit, which is the subject of this BA, the Milltown Water Supply Operable Unit, and the Clark Fork River Operable Unit. The Milltown Water Supply Operable Unit was addressed in a previous response action to install a new drinking water system for Milltown in 1996. The Clark Fork River Operable Unit is being addressed in a separate cleanup process and in a separate BA of bull trout. The Clark Fork River Operable Unit extends from the upper limit of Milltown Reservoir upstream to Warm Springs Creek on the upper Clark Fork where it abuts the Anaconda Smelter Superfund Site and the Silver Bow Creek/Butte Area Superfund Site.

Milltown Dam was completed in 1907 and acquired by Montana Power Company (MPC) in 1929. Northwestern Energy (NWE) acquired the Milltown Project in December 2001, and transferred ownership to the current owner, The CFBLLC, in December 2002 (CFBLLC 2003a). The dam is approximately 64 feet high, 668 feet long, and produces approximately 3 megawatts of power. Dam components include a right abutment concrete gravity dam (244 feet long), intake and powerhouse (126 feet long), divider block (26 feet wide), radial gate (52 feet wide), and overflow spillway (220 feet long). The powerhouse contains five Francis horizontal-flow turbines, four of which are currently in use. The spillway has 44 fixed wheel panels that maintain the reservoir water surface at a normal operating elevation of 3261.8 feet above mean sea level (amsl), except during periods of high flow. When river flows exceed the turbine capacity of approximately 1,600 cubic feet per second (cfs) (generally during spring runoff from March to July), individual spillway panels are removed to discharge water and regulate reservoir elevations. The radial gate is used to adjust spill during rapidly changing river flows, for emergency drawdown of the reservoir, and to pass debris, trap fish, and maintain reservoir operating elevations during power generation fluctuations (CFBLLC 2003a).

Milltown Dam is operated as a run-of-the-river facility (outflow typically equals inflow). Reservoir water surface elevation is fairly constant (3261.8 amsl), but can be lowered 6 to 12 feet for maintenance and emergency operations. River flows downstream of Milltown Dam are generally stable except for short-term fluctuations, usually of 1 hour or less, caused by electrical generation load fluctuations and radial gate operation. Downstream flows can be greatly affected by changes in generation during low-flow periods, when all river flow passes through the turbines. Rehabilitation of Milltown Dam from 1987 to 1989 and installation of the radial gate spill structure has eliminated the need for an annual 7- to 8-foot (and sometimes up to 22-foot) draw down of Milltown Reservoir (CFBLLC 2003a).

Baseline operating conditions and factors that have the potential to influence bull trout populations or their proposed designated critical habitat downstream of, within, and upstream of the Milltown Reservoir Sediments Operable Unit include upstream and downstream passage of bull trout past Milltown Dam; draw down of Milltown Reservoir; short-duration stream flow fluctuations downstream of Milltown Dam; northern pike *(Esox lucius)* in Milltown Reservoir; metals present in Milltown Reservoir sediments; and ice-flow events. These baseline conditions and factors were discussed by CFBLLC (2003a) in their BA of the Milltown Dam Operations and are summarized below.

Upstream migrations of fluvial and adfluvial stocks of bull trout have been blocked by Milltown Dam since its construction. Permanent upstream fish passage facilities have not been added to the dam. However, MPC began operating a radial gate raceway as a trap and haul facility for upstream migrants in 1998. This trap is operated between March and early November of each year at flows up to about 7,000 cfs. At higher flows the reservoir tailwater floods the radial gate pool (CFBLLC 2003a).

Downstream passage of bull trout past Milltown Dam can occur over the spillway, through the radial gate, or through the turbines. Passage over the spillway is possible when flows exceed approximately 1,600 cfs, which is generally from March to July. Vegetation grates on the turbine intakes prevent the entry and passage of larger adult and subadult fish through the turbines (CFBLLC 2003a).

In the absence of the selected remedy, Milltown Reservoir would probably continue to occasionally be drawn down for inspection and maintenance, and possibly to help control populations of northern pike, which are a threat to bull trout (CFBLLC 2003a). Effects of previous reservoir draw down include the release of reservoir sediments and increased turbidity in downstream areas, and elevated concentrations of metals in the water. The magnitude of these effects is potentially influenced by the rate, method, and duration of draw down, reservoir pool level, river discharge, occurrence of a sediment-disturbing action such as ice flow and scour, and perhaps climatic conditions. CFBLLC (2003a) cited a report by ARCO (1999), which gave examples of elevated turbidity levels that varied from a threefold increase following the slow draw down of Milltown Reservoir to a 25-fold increase following the rapid draw down of the reservoir.

Northern pike, a non-native species that has been illegally introduced into Milltown Reservoir, has the potential to compete with and prey on bull trout. Northern pike have benefited from the reservoir’s shallow, weedy backwaters, which provide good spawning and rearing habitat for this species. The reservoir contributes to a self-sustaining, reproducing population of northern pike, and to the recruitment of northern pike to the Clark Fork and Blackfoot Rivers (CFBLLC 2003a).

Since the construction of Milltown Dam, Milltown Reservoir has acted as a repository for sediment and mining wastes generated by upstream mining activities in the Clark Fork River Basin (EPA 2001). These activities began in 1864 with placer mining in the Butte-Silver Bow Creek area, and were soon followed by mining shallow underground deposits for gold, copper, silver, and other metals. These early mining practices produced the contamination associated with the waste tailings. Subsequent practices included shaft mining and milling of deeper copper sulfide ores in the Butte and Anaconda areas beginning in the late 1880s. Improved milling practices beginning in the early 1900s with the availability of electricity, together with froth flotation and new smelting practices, resulted in increased production rates. Most mine and milling wastes, including contaminated mine and process waters associated with these wastes, were disposed of in Silver Bow Creek and other upper Clark Fork River tributaries well into the 20th century. Aerosols and particulates from smelter smokestacks further contaminated soils in the area (CH2M HILL 2000).

Disposed tailings, mine and milling wastes, and mine and process waters were transported down Silver Bow Creek, Warm Springs Creek, other affected tributaries, and the upper Clark Fork River at varying rates, depending primarily on drainage hydrology and particle size. More wastes were hydraulically transported during snowmelt runoff and major thunderstorms than during drier portions of the weather cycle, because more flow was available for conveying these wastes. Sediment transport in the system also varies with the amounts of contaminated wastes available at any time in the upstream watersheds. Sedimentation ponds built at Warm Springs (two in 1918 and a third in the late 1950s) were all somewhat effective in removing considerable quantities of streambed sediments, which altered the types and amounts of mine wastes reaching the upper Clark Fork River and Milltown Reservoir. In 1994, in a remedial action under a Record of Decision by EPA, the Warm Springs Ponds and the Mill-Willow Bypass were upgraded. Following a second Warm Springs Ponds Record of Decision, water quality from the pond system has been meeting required water discharge standards most of the time (CH2M HILL 2000).

Contaminated sediments transported from upstream areas began to settle in Milltown Reservoir following the completion of Milltown Dam in 1907. In early 1908, the largest flood on record in the Clark Fork River drainage occurred as a result of rain falling on snow and frozen ground. The estimated discharge at Milltown Dam during this flood was 48,000 cfs (CFBLLC 2003a). The 1908 flood is believed to have transported large quantities of contaminated sediments from upstream areas into Milltown Reservoir (CH2M HILL 2000). Later floods, storm events, and normal sediment movement during all flows transported additional quantities of mining and smelting wastes downstream to Milltown Reservoir where much settled as sediment. Today, more than 6 million cubic yards of sediments have been deposited behind Milltown Dam. Mine wastes present in these sediments contain elevated concentrations of metals and arsenic.

Erosion of the banks and bottom of Milltown Reservoir (for example, from ice scour and very high flows) can potentially disturb sediment deposits that contain arsenic, cadmium, lead, copper, and zinc (CFBLLC 2003a). Increased levels of these contaminants in the Clark Fork River downstream of Milltown Dam resulting from the scour and release of disturbed reservoir sediments may occasionally result in increased risks to aquatic life (CH2M HILL 2000). Such an event occurred in February 1996. A combination of unusual meteorological events (rain on snow, ice, and frozen ground and increased river flows) and unusual operation of Milltown Dam to protect the structure caused increased river flows and thick, rafted ice to move down the Blackfoot and Clark Fork Rivers and to scour the accumulated sediments in Milltown Reservoir. This resulted in the release of disturbed sediments and associated metals to the Clark Fork River downstream of Milltown Dam. During late spring of 1997, the melting of a greater than normal snow pack caused high flows (up to 26,700 cfs) below Milltown Dam. This was approximately a 10-year event (CH2M HILL 2000).

Analyses by the U.S. Geological Survey indicated that sediment and metals were released from Milltown Reservoir during the 1996 ice scour event and the 1997 high flow event (CH2M HILL 2000). Subsequent risk assessments performed under the direction of EPA showed that during ice scour events, such as the 1996 event, copper may cause moderate risks to aquatic life from exposure to water below Milltown Dam. Normal high flow events may pose an intermittent low-level chronic risk to fish below Milltown Dam because of the combined impacts of copper and other metals in the water column, and copper in ingested macroinvertebrates. Results of analyses suggest that risks to aquatic life are low except on these types of occasions, such as the 1996 ice scour event, when concentrations of total recoverable metals, particularly copper, are extremely high. Results also indicate that arsenic and cadmium in water pose no significant risks to aquatic life downstream of Milltown Dam, and risks to aquatic life from lead and zinc are absent to low (CH2M HILL 2000). The site also poses a threat to human health because of contaminated groundwater near the reservoir.

Another baseline condition in the remediation/restoration project area reported to affect bull trout that the Proposed Action addresses is the presence of Stimson Dam. This dam is located on the Blackfoot River at the Stimson Lumber Mill approximately 1 mile upstream from Milltown Dam. In the assessment of limiting factors to bull trout, the Bull Trout Draft Recovery Plan (FWS 2002) stated Stimson Dam may be a seasonal fish passage barrier. EPA, MDEQ, and the Natural Resource Trustees' restoration plan subsequently determined that removal of Stimson Dam is necessary to provide fish passage and eliminate physical hazards that would occur from the lower water level once Milltown Dam is removed (EPA 2004).

1.2 Purpose and Need for Biological Assessment

The FWS listed the Columbia River Distinct Population Segment (DPS) of bull trout as a threatened species under the Endangered Species Act (ESA) on June 10, 1998 (Federal Register [FR] 1998). Bull trout occurring in the Clark Fork River and its tributaries are included as subpopulations (now referred to as local populations [FWS 2002]) in the Columbia River DPS. On November 1, 1999, the FWS determined threatened status for all populations of bull trout within the coterminous (lower 48) United States (FR 1999). The FWS proposed the designation of critical habitat and announced the availability of the Bull Trout Draft Recovery Plan for the Columbia River DPS on November 29, 2002 (FR 2002). The remediation/restoration project area for this BA is proposed designated bull trout critical habitat and is located in the Upper Clark Fork Recovery Subunit (FWS 2002).

The purpose of the ESA is to conserve threatened and endangered animal and plant species and their ecosystems. As such, Section 7 of the ESA requires federal agencies to ensure that their actions are not likely either to jeopardize the continued existence of threatened or endangered species, or to destroy or adversely modify designated critical habitat that is essential to listed species. In addition, Section 9 of the ESA prohibits the take of any threatened or endangered species without a special permit. The purpose and need of this BA are to evaluate the potential effects on bull trout and on bull trout proposed designated critical habitat resulting from: 1) implementing the selected remedy and site restoration plan (the Proposed Action) at the Milltown Reservoir Sediments Operable Unit within the site remediation/restoration area (EPA-related actions); 2) providing interim fish passage, discontinuing certain bull trout conservation/enhancement actions, and surrendering the project license (FERC-related actions); and also 3) to satisfy provisions of Section 7 consultation requirements for EPA and FERC with FWS, and FWS intra-service consultation requirements under the ESA.

1.3 Scope of Biological Assessment

This BA focuses on the potential effects on bull trout and their proposed designated critical habitat from implementing the Proposed Action at the Milltown Reservoir Sediments Operable Unit. This BA also considers the potential effects on interim bull trout passage measures during dam and sediment removal activities, and the effects of license surrender and discontinuing certain bull trout conservation/enhancement actions. Discussions of environmental baseline conditions presented in this BA reflect the cumulative effect of all actions that have occurred in the past, plus those actions occurring now or anticipated to occur in the very near future prior to implementing the Proposed Action. These include direct and indirect effects on bull trout and their habitat resulting from the past and present impacts of all federal, state, and private actions and other activities in the geographic action area; anticipated effects of proposed federal projects in the geographic action area for this BA where Section 7 consultation has already occurred; and the effects of concurrent state or private actions.

The geographic action area of this BA extends beyond the boundaries of both the Milltown Reservoir Sediments Operable Unit and the remediation/restoration area for several reasons. First, the remedial benefits and potential short-term negative effects from implementing the Proposed Action would not be limited to just Milltown Reservoir. They would extend to aquatic life in the Clark Fork River downstream of Milltown Dam, which is downstream of the Operable Unit. Second, the migratory nature of bull trout combined with the removal of Milltown Dam and Stimson Dam would allow unimpeded year-round movements of this species among free-flowing river reaches both upstream and downstream of the former Milltown and Stimson Dam sites. Third, because of these interconnected relationships, the potential exists for the Proposed Action to affect the overall abundance and well-being of bull trout and their proposed designated critical habitat in the lower, middle, and upper Clark Fork River drainages. For these reasons, the geographic action area covered by this BA includes mainstem and tributary waters that are presently used by bull trout in the lower, middle, and upper Clark Fork River drainages. These waters include the Clark Fork River and its tributaries downstream of Milltown Dam to Thompson Falls Dam; Milltown Reservoir; the Clark Fork River and its tributaries upstream of Milltown Dam; the Blackfoot River and its tributaries; and Rock Creek and its tributaries. This geographic action area includes all or portions of the Lower, Middle, and Upper Clark Fork Recovery Subunits for bull trout and represents the bull trout assessment area for this BA. Figure 3 depicts the assessment area for this BA.

Figure 3
BULL TROUT ASSESSMENT AREA
BIOLOGICAL ASSESSMENT OF THE
MILLTOWN RESERVOIR SEDIMENTS OPERABLE UNIT

1.4 Methods

Much of the background information presented in this BA is taken from two recent documents that assessed the effects of Milltown Dam and Reservoir on aquatic resources, particularly bull trout and their proposed designated critical habitat. The first document is the *Internal Draft Biological Assessment of the Milltown Dam Operations for the Period 2003 through 2010 FERC No. 2543*. That document was prepared by The CFBLLC as the non-Federal agency representative for FERC, and contains extensive technical information that has been reviewed by FWS. That information constitutes a very important component of the present BA because: 1) it covers the same geographic action area; 2) it provides background information on the status and characteristics of bull trout and their habitat in action area drainages; and 3) it discusses the past, present, and future effects of non-contaminant factors on bull trout populations and habitat upstream, within, and downstream of Milltown Dam and Reservoir, assuming that the dam and reservoir remain in-place. Much of the information from that Internal Draft BA has been summarized in the present BA and is cited as (CFBLLC 2003a) or (in CFBLLC 2003a). As noted previously, this BA covers concurrent consultation being conducted by EPA and FERC with the FWS.

The second document often referenced in the present BA is the *Milltown Reservoir Sediments Operable Unit Ecological Risk Assessment Addendum*. That document was prepared under the direction of the EPA and is cited as (CH2M HILL 2000). The risk assessment addendum evaluates risks to aquatic receptors in the Clark Fork River downstream from Milltown Dam based on data from the February 1996 ice scour event, the late spring 1997 high flow event, and the analysis of the effects of discharges from Milltown Reservoir during these unusual meteorological events.

A third important document cited in this BA is the *Final Technical Memorandum: Milltown Reservoir Scour During Area I Sediment and Dam Removal Evaluation,* which was prepared by Envirocon (2004) at the request of EPA. This document predicts the range of changes in water quality at representative locations in the Clark Fork River from Milltown Dam downstream to Thompson Falls Reservoir during the dredging of contaminated sediments at Milltown Reservoir and during the lowering of the reservoir level, removal of contaminated sediments, and removal of Milltown Dam. Envirocon (2004) analyzed the impacts of reservoir drawdown or early dam removal on reservoir sediment scour during construction by modeling various drawdown and dam breach options under different flow and sediment management operational conditions. Predicted scour depths and volumes and the total mass of sediment released from the reservoir were determined for each option evaluated. Envirocon (2004) estimated concentrations of total suspended solids (TSS) and dissolved metals leaving the dam and compared predicted values to applicable standards and risk-based criteria for the protection of aquatic life. Results of Envirocon's analyses are presented in the effects analysis (*Chapter 4, Effects of the Action*) of this BA.

1.5 Consultation

As noted in *Section 1.2, Purpose and Need for Biological Assessment,* this BA is intended to satisfy provisions of Section 7 consultation requirements for EPA and FERC with the FWS, and FWS intra-service consultation requirements under the ESA. This BA has been jointly prepared by EPA and by CFBLLC as the non-federal agency representative for FERC. CFBLLC is the current owner of the Milltown Dam Hydroelectric Project, which is located within EPA's Milltown Reservoir Sediments Superfund Site. It is anticipated that CFBLLC will submit a license surrender application for the Milltown Project to FERC, and it is anticipated that FERC will act on this license surrender application. As part of the license surrender process, CFBLLC had been preparing a separate BA, concurrent with EPA's preparation of their BA for site remediation/restoration activities. The CFBLLC BA evaluated the potential effects of the operations of the Milltown Project on bull trout and bull trout proposed designated critical habitat for the remaining operational period from 2003 through 2010, including project operations during planning and completion of EPA's Milltown Reservoir remedial action/site restoration plan. The CFBLLC BA also evaluated the effects on bull trout and their proposed critical habitat from activities associated with: 1) existing and new conservation actions (Protection, Mitigation, and Enhancement [PM&E] and Enhanced PM&E, which is referred to in this BA as Bull Trout Conservation Measures); 2) activities associated with the FERC license extensions and the anticipated FERC license surrender; and 3) site restoration activities associated with Milltown Dam removal.

CFBLLC also is preparing an Environmental Report (ER) per FERC requirements as part of a parallel analysis process that addresses impacts to biological resources not covered in this BA. ER elements may include, but are not necessarily limited to, adverse impacts to species and habitats other than federally listed (if not included in the BA), Clean Water Act (CWA) Section 401 certification, and incorporation of Section 10(j) FWS & MTFWP recommendations. ERs may use results of analyses contained in BAs as surrogates for predicting effects on other species with somewhat similar life history requirements (for example, potential effects on bull trout discussed in this BA as a surrogate for potential effects on cutthroat trout and rainbow trout discussed in the ER).

CFBLLC and EPA have jointly prepared this single BA to cover all actions that previously were being separately addressed in CFBLLC's BA and EPA's BA for the following reasons:

- ESA consultation must be completed before CFBLLC can surrender their FERC license.
- The unique and very inter-related nature of EPA and FERC actions proposed and anticipated at the Milltown site.
- To streamline the consultation process among the USFWS, EPA, and CFBLLC/FERC.
- To meet the schedules for the anticipated FERC license surrender application and EPA site remediation/restoration activities.

This consultation represents the initial broad, overarching effects analysis initiated by the EPA for the Proposed Action at the Milltown Reservoir Sediments Operable Unit. The Proposed Action includes the implementation and completion of site remediation and restoration activities within the remediation/restoration area depicted in Figure 1. Other consultations with the FWS regarding Milltown Dam and Reservoir occurring concurrently and covered in this BA and those situations where appending this BA may be appropriate are briefly described in the following text.

Concurrent FERC Consultation. Concurrent with the EPA consultation and in anticipation of the filing of an applications for amendment of license and for surrender of license, this BA will be forwarded to the FWS as part of the consultation process the FERC is completing with the FWS on the effects to bull trout and their proposed designated critical habitat from ongoing operations of Milltown Dam during remedial action, interim fish passage actions, and the required mitigation of the project site after dam removal. This BA is intended to cover both the FERC and the EPA consultation requirements with the FWS.

Concurrent FWS Intra-service Consultation. Concurrent with the EPA consultation, the FWS, in its role as a Natural Resource Trustee, is conducting intra-service consultation on the Stimson Dam removal project and the Natural Resource Trustee restoration plan for the Clark Fork and Blackfoot Rivers in the project area.

Where action-specific updates are necessary, the FWS will reinitiate intra-service consultation on the effects to bull trout and proposed designated critical habitat resulting from restoration activities throughout the design and restoration process.

Future EPA Proposed Action Design Changes. Design details of the remediation and site restoration plan will be better defined during the design stage of EPA's Proposed Action. If substantive changes in the Proposed Action design or effects occur during summer 2004 or thereafter, this BA will be appended with brief action-specific updates. This assumes that actions that differ from what the current perceived Proposed Action is will likely be within (or close to) current sediment/scour predictions. If not, action-specific updates will become increasingly more developed.

Where action-specific updates are necessary, EPA will consult with the FWS on the effects to bull trout and proposed designated critical habitat resulting from site remediation activities throughout the design and construction process. The FWS will determine if re-initiation of formal consultation is necessary on a case-specific basis.

CHAPTER 2

Project Description

This BA evaluates the potential effects of the Proposed Action on bull trout and their proposed designated critical habitat. Figure 3 (See *Chapter 1, Introduction*) depicts the assessment area for this BA. The Proposed Action includes the Revised Proposed Plan, which is a revision of the Original Proposed Plan (*Partial Sediment Removal of the Lower Reservoir, Dam Removal, plus Groundwater Institutional Controls and Natural Attenuation within the Aquifer Plume)* proposed as the preferred action by EPA and MDEQ as the remedial action for implementation at the Milltown Reservoir Sediments Operable Unit. The Proposed Action also includes a site restoration plan, whose implementation, primarily by the State of Montana as lead Natural Resource Damage Trustee, within the Operable Unit and the remediation/ restoration project area would be coordinated with that of the Revised Proposed Plan.

The Original Proposed Plan remedial action was identified in EPA's Proposed Plan (EPA 2002) and was selected as the preferred action from 10 remedial alternatives that were evaluated. During the 90-day public comment period on the April 2003 Original Proposed Plan, EPA received a significant number of comments opposing the local sediment waste repository at Bandman Flats. EPA also received comments and a proposal from ARCO to excavate sediments using conventional mechanical excavation equipment instead of hydraulic cutterhead dredges, and to haul the removed sediments by rail and dispose of them at Opportunity Ponds rather than placing the materials in the Bandman Flats repository. Based on this proposal, evaluation of additional information from ARCO, and results of a national scientific peer review of the Revised Proposed Plan, EPA and MDEQ concluded that the proposed sediment removal methods with disposal at Opportunity Ponds could be done safely and effectively and would address the significant adverse comment on the Bandman Flats disposal area.

Major objectives of the Revised Proposed Plan are to reduce or eliminate the arsenic plume in the groundwater and related human health risks, and to reduce or eliminate the threat of contaminated sediment transport downstream and the potential for impacting the Clark Fork River and aquatic life below Milltown Dam. Major objectives of the site restoration plan are to establish a new natural channel and floodplain for the Clark Fork River through the Operable Unit and upstream in the Clark Fork and Blackfoot Rivers within the remediation/restoration project area, and to allow unimpeded fish passage in the Blackfoot River by removing Stimson Dam.

These objectives will be accomplished in part by removing the primary source sediment area; removing Milltown Dam to reduce the hydraulic head driving contaminants into the adjacent drinking water aquifer and to prevent future impoundment of new sediments; and allowing natural attenuation processes to restore the aquifer over time. Figure 4 presents the Key Sediment Accumulation Areas. The sediments in Sediment Accumulation Area I (SAA 1) (lower reservoir adjacent to Milltown) will be removed, while those in SAA II, III, IV, and V (the upper reservoir) will be left in place and isolated from the Clark Fork River

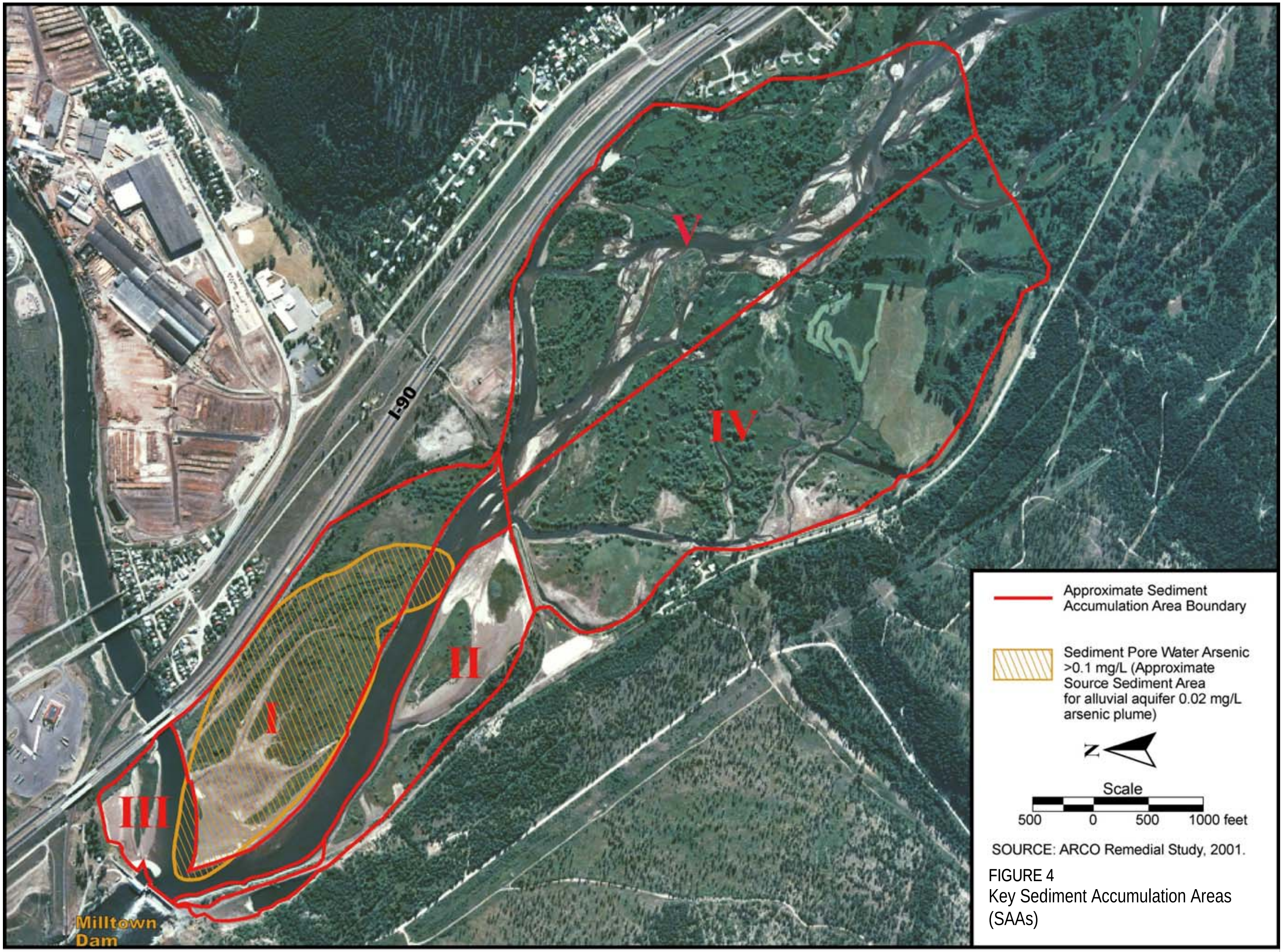


FIGURE 4
Key Sediment Accumulation Areas (SAAs)

channel. In addition, a new, geomorphologically stable river channel with natural floodplains for lateral stability will be designed, constructed, and vegetated to provide adequate stability against erosion. The Proposed Action includes decommissioning Milltown Dam and leaving the river free-flowing. The spillway, radial gate, divider block, powerhouse, and north (right) abutment will be removed. Stimson Dam will also be removed leaving the Blackfoot River free-flowing as well. Approximately 4 years are estimated to complete implementation of the Proposed Action following the Record of Decision and preparation of final designs.

Dam removal with lower reservoir sediment removal and channel reconstruction was selected as the preferred remedy (now termed the Proposed Action) by EPA Region 8 because it offers the best opportunity for long-term protection of human and environmental health. Compared to the Original Proposed Plan, benefits of the Revised Proposed Plan include easier implementibility, shorter construction time, use of an existing waste repository, no loss of undisturbed productive land, better long-term waste management, less risk to the local groundwater supply, fewer impacts to the local community, and stronger public support. Both plans have the potential for negative impacts on downstream aquatic life during sediment and dam removal, but both plans also would benefit bull trout populations and their habitat in the long term. Potential effects of the Revised Proposed Plan are addressed in *Chapter 4, Effects of the Action*, of this BA.

The key components of the Proposed Action and their implementation are briefly described in the following text. Details on these key components will be developed during final design and refined, as needed, during the actual implementation of site remediation and site restoration activities. Refinement will involve information feedback on the effectiveness and effects of different remedial actions, adaptive management to identify methods and modify activities to more efficiently achieve stated project objectives, and a decision-making process that considers and minimizes the potential for adverse effects on the environment while achieving site remediation and restoration goals. These key components include bypass channel construction; dam removal; sediment removal, transportation, and disposal; site restoration/redevelopment; replacement water supply program/temporary groundwater institutional controls; protective measures; and monitoring. This section concludes with discussions of interim fish passage past Milltown Dam and implementation of the Proposed Action. Figure 5 depicts major features of the Proposed Action.

2.1 Key Components of the Proposed Action

2.1.1 Bypass Channel Construction

Prior to sediment and dam removal activities, sediment in SAA-I will be isolated from the active Clark Fork and Blackfoot Rivers by a temporary bypass channel and a wall of interlocking sheet piling or equivalent driven into the underlying alluvium (Figure 6). The conceptual design of the bypass channel shown in Figure 6 is subject to change during the remedial design process. The bypass channel will be constructed adjacent to Interstate 90, with the exact location to be determined during final construction design. Before the construction of the bypass begins, the reservoir water level would be lowered using the existing radial gate. Conventional excavation equipment (excavators and draglines) would be used to excavate the bypass channel. The excavated materials would be stacked on the south side of the channel and allowed to drain. These materials would be loaded into rail cars and hauled to Opportunity Ponds after the bypass and a rail spur are completed. The upstream end of the bypass channel will contain a 5-foot-high fish-passable drop structure to allow upstream and downstream movement of fish past the sediment removal area (Figure 6). The bypass channel and drop structure will be maintained in proper working order throughout this facility's approximately three years of use.

2.1.2 Dam Removal

2.1.2.1 Milltown Dam Removal

Drawdown of the Milltown Reservoir pool level and removal of Milltown Dam would be done in three stages to minimize scouring:

- **Stage 1.** Use the existing radial gate to lower the water level.
- **Stage 2.** Modify the powerhouse inlets to low level outlets by removing the turbines.
- **Stage 3.** Remove the spillway, radial gate, divider block, powerhouse, and north (right) abutment.

Coffer dams will be used to isolate portions of the dam during this removal sequencing.

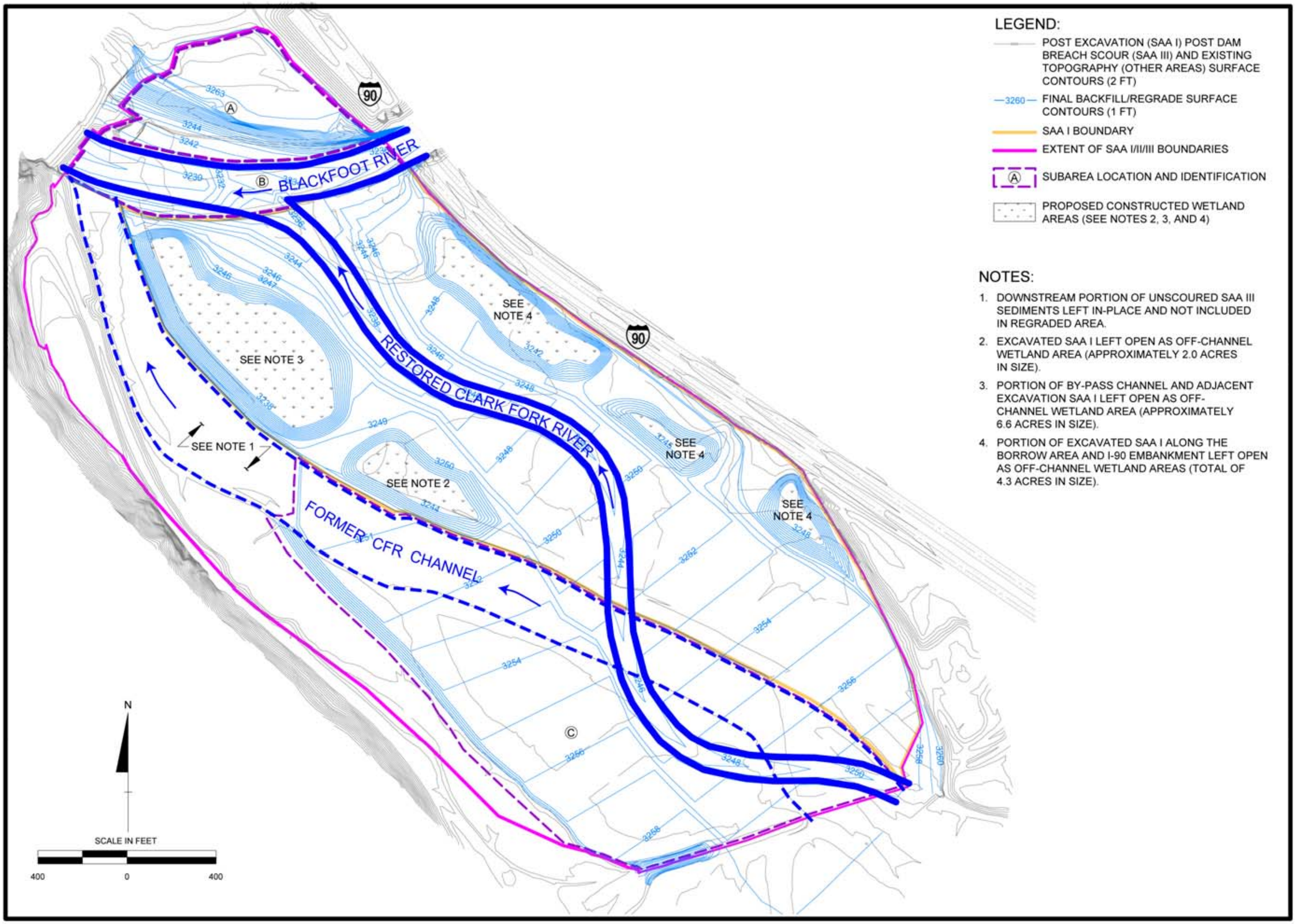
The ongoing operation of the Milltown Project by CFBLLC would include the reservoir drawdown currently scheduled to begin in December 2004. CFBLLC anticipates that this initial action and subsequent actions to be carried out by CFBLLC involving Milltown Dam removal would occur through a FERC license amendment. The "normal operations" of Milltown Dam would essentially cease with the beginning of the Stage 1 drawdown. *Section 2.3, Implementation of the Proposed Action*, lists the anticipated sequencing of tasks associated with remediation/restoration activities and Milltown Dam removal.

2.1.2.2 Timing of Milltown Dam Removal

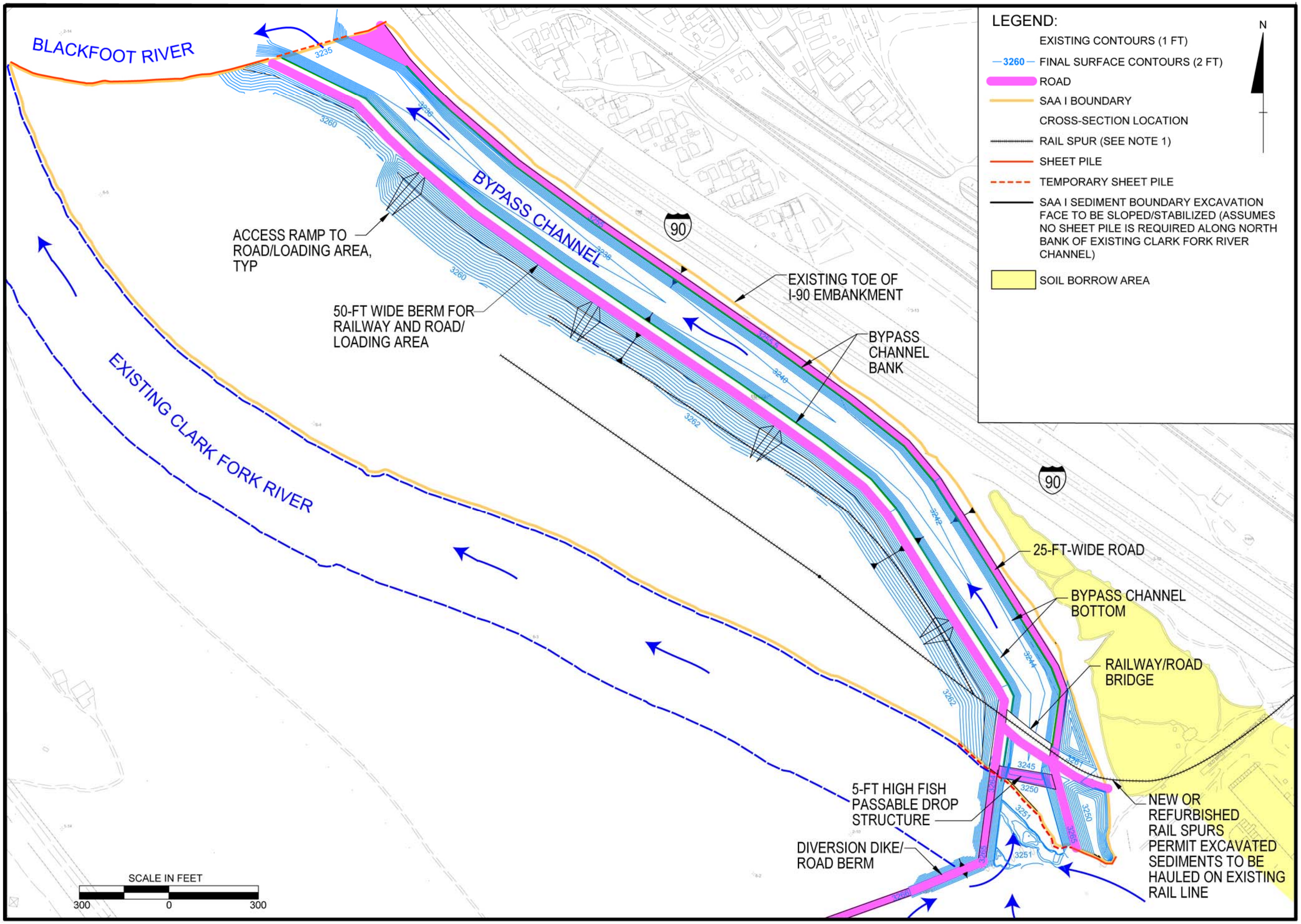
EPA, MDEQ, and the Trustees believe that the timing of the Milltown Dam removal is very important in minimizing the impact to downstream aquatic life and users. To minimize downstream impacts and allow the earliest possible fish passage and recovery from impacts, EPA is proposing removal of the dam during the winter and spring months immediately after the SAA-1 sediments are isolated and the Clark Fork River is routed into the bypass channel. After the dam is removed, the resulting reduction of the river level will facilitate the natural draining of the sediments. Once achieved, this minimum river level will be maintained throughout the construction period.

2.1.2.3 Stimson Dam Removal

Another necessary, coordinated action is the removal of the Stimson Dam located on the Blackfoot River, 1 mile upstream of the Milltown Dam. Although not specifically a remediation element of the project, EPA, MDEQ, and the Trustees have determined that the removal of this dam is necessary to provide fish passage and eliminate physical hazards that would occur from the lower water level once the Milltown Dam is removed. The Stimson Dam would be removed before the Milltown Dam is removed. The removal of the Stimson Dam is not a FERC action.



LEGEND:
POST EXCAVATION (SAA I) POST DAM BREACH SCOUR (SAA III) AND EXISTING TOPOGRAPHY (OTHER AREAS) SURFACE CONTOURS (2 FT)
3260
FINAL BACKFILL/REGRADE SURFACE CONTOURS (1 FT)
SAA I BOUNDARY
EXTENT OF SAA I/II/III BOUNDARIES
A
SUBAREA LOCATION AND IDENTIFICATION
PROPOSED CONSTRUCTED WETLAND AREAS (SEE NOTES 2, 3, AND 4)
NOTES:
1. DOWNSTREAM PORTION OF UNSCOURED SAA III SEDIMENTS LEFT IN-PLACE AND NOT INCLUDED IN REGRADED AREA.
2. EXCAVATED SAA I LEFT OPEN AS OFF-CHANNEL WETLAND AREA (APPROXIMATELY 2.0 ACRES IN SIZE).
3. PORTION OF BY-PASS CHANNEL AND ADJACENT EXCAVATION SAA I LEFT OPEN AS OFF-CHANNEL WETLAND AREA (APPROXIMATELY 6.6 ACRES IN SIZE).
4. PORTION OF EXCAVATED SAA I ALONG THE BORROW AREA AND I-90 EMBANKMENT LEFT OPEN AS OFF-CHANNEL WETLAND AREAS (TOTAL OF 4.3 ACRES IN SIZE).
BLACKFOOT RIVER
RESTORED CLARK FORK RIVER
FORMER CFR CHANNEL
SEE NOTE 1
SEE NOTE 2
SEE NOTE 3
SEE NOTE 4
90
A
B
C
N
SCALE IN FEET
400
0
400


LEGEND:
EXISTING CONTOURS (1 FT)
3260 FINAL SURFACE CONTOURS (2 FT)
ROAD
SAA I BOUNDARY
CROSS-SECTION LOCATION
RAIL SPUR (SEE NOTE 1)
SHEET PILE
TEMPORARY SHEET PILE
SAA I SEDIMENT BOUNDARY EXCAVATION FACE TO BE SLOPED/STABILIZED (ASSUMES NO SHEET PILE IS REQUIRED ALONG NORTH BANK OF EXISTING CLARK FORK RIVER CHANNEL)
SOIL BORROW AREA
N
BLACKFOOT RIVER
BYPASS CHANNEL
EXISTING CLARK FORK RIVER
ACCESS RAMP TO ROAD/LOADING AREA, TYP
50-FT WIDE BERM FOR RAILWAY AND ROAD/ LOADING AREA
EXISTING TOE OF I-90 EMBANKMENT
BYPASS CHANNEL BANK
90
25-FT-WIDE ROAD
BYPASS CHANNEL BOTTOM
RAILWAY/ROAD BRIDGE
5-FT HIGH FISH PASSABLE DROP STRUCTURE
DIVERSION DIKE/ ROAD BERM
NEW OR REFURBISHED RAIL SPURS PERMIT EXCAVATED SEDIMENTS TO BE HAULED ON EXISTING RAIL LINE
SCALE IN FEET
300 0 300

2.1.3 Sediment Removal

Removal of the source sediment is the foundation of the Proposed Action. Sediment residing in Sediment Accumulation Area I (SAA-I, 2.6 million cubic yards) constitutes the target of the removal (ARCO 2002). The sediment deposition area comprising SAA-I is approximately 4,300 feet long by an average of 800 feet wide and forms an elongated wedge of partially submerged land bounded by the Clark Fork River to the southwest, Duck Bridge to the south, Interstate 90 to the east, and the Blackfoot River channel to the north. This area is oriented southeast to northwest (closest to Milltown Dam) within Milltown Reservoir.

Sediment thickness increases in the same orientation from approximately 14 feet in the south, to 20 to 25 feet in the north.

2.1.3.1 Pre-Loading

If required, sediment removal will use an approach called “pre-loading” to facilitate consolidation of existing soft sediments. Pre-loading means importing and placing a layer of clean fill material over the sediments in SAA-I. Alternatively, sufficient consolidation enhancement may be achieved through dewatering of the existing sediments without the need for additional pre-load. The purpose of the pre-load is to force the underlying sediment to consolidate and release excess water to the previously lowered reservoir channel areas. This makes soft material, such as sediment, more stable for the operation of large equipment that will be needed for the excavation. If pre-loading is used, EPA expects the clean fill will come from a local source and will be hauled across the Clark Fork River bypass to the pre-load area via rail car or haul road. Specific pre-load needs will be designated during the design process.

2.1.3.2 Sediment Excavation

The excavation process will use large excavators working a linear face to optimize production and minimize the area of exposed groundwater. The area will be backfilled following excavation. The timing of backfilling will be dependent on many factors, including, but not necessarily limited to, weather, operational considerations, completion of floodplain/channel design, and groundwater inflow. The first excavator will remove the pre-load materials and create blending areas ahead of the sediment excavation operation. Pre-load material described above will also be loaded into trucks and used as backfill in areas where the sediment has been excavated. Concurrently, other excavators will remove the sediment, place it on an adjacent area where the pre-load material has been removed, and let it drain, if necessary. EPA anticipates that, even after spillway and radial gate removal, a small portion of the sediment will remain below the water table. This sediment will be stacked and allowed to drain naturally, mechanically dewatered, or mixed with drier sediment to improve its consistency, and the blended materials will be loaded into trucks and transported to the staging area by the rail spur.

2.1.3.3 Dewatering

Dewatering of the lower sediments within SAA-I may be necessary if the sediments do not free-drain completely. For the proposed cleanup, EPA anticipates that some sediment dewatering will occur. An estimate of sediment pore water quality using sediment drainage test data collected by EPA during the 2002 drawdown indicates that discharge of pore water into the Clark Fork River would not raise the river dissolved arsenic and copper concentrations above EPA's temporary construction standards. However, monitoring will be conducted and, if the impacts of returning excavation water to the river are found to be harmful or temporary standards are expected to be exceeded, the water will be treated before being discharged to the river.

2.1.4 Transportation and Disposal

At a new rail staging and loadout area located between the bypass channel adjacent to Interstate 90 and the Clark Fork River, the sediment will be placed into rail cars. Rail transport will be provided by two trains of 50 to 60 gondola rail cars each. The rail cars will be transported each night to Opportunity Ponds, so a train full of empty cars will be onsite for loading each morning. Figure 6 shows the location of the rail spur near Milltown. Opportunity Ponds are near Anaconda, some 90 miles upstream (south) of the Milltown site.

At least some (and possibly a large portion) of the large wood and rock encountered during excavation may be stored onsite for use during restoration, provided it is not contaminated. This would not require additional transport. Large or woody debris encountered during excavation that is not used during site restoration may require additional handling and processing to reduce its size so it can be transported by rail to Opportunity Ponds or it may be disposed of in local landfills. Long-term operation and maintenance of the transported materials at Opportunity Ponds will be the responsibility of ARCO as part of its obligations within the Anaconda Smelter Superfund Site.

2.1.5 Restoration

Upon completion of sediment removal, a new floodplain and channel will be constructed. The original channel and floodplain design, which reflected a highly engineered channel with a narrow 100-year floodplain within the remediation/restoration project area, will be replaced with a design consistent with the Trustees Draft Conceptual Restoration Plan (DCRP). The Appendix contains a copy of the DCRP. The DCRP proposes a more natural floodplain and channel design than in the Original Proposed Plan that will benefit fish and wildlife as well as local recreational use. The removal of the entire dam—including the powerhouse, divider block, and right abutment—allows for a wider, more natural channel and floodplain.

The following objectives will be addressed in the Conceptual Restoration Plan (Water Consulting, Inc., and Rosgen 2003):

- Restore the confluence of the Blackfoot and Clark Fork Rivers, the Clark Fork River upstream to Turah Bridge, and the Blackfoot River to upstream of Stimson Dam to a naturally functioning, stable system appropriate for the geomorphic setting.
- Use native materials, to the extent practicable, for stabilizing channel, banks, and floodplains to improve water quality by reducing bank erosion of contaminated sediments.
- Provide adequate channel and floodplain capacity to accommodate sediment transport and channel dynamics appropriate for the geomorphic setting.

- Provide high-quality habitat for fish and wildlife, including continuous upstream and downstream migration for all native and cold water fishes.
- Provide high-quality wetlands and riparian communities, where feasible and appropriate for the proposed stream type.
- Improve visual and aesthetic values through natural channel design, revegetation, and the use of native plants and materials.
- Minimize habitats that will promote non-native, undesirable fish species.
- Supplement revegetation activities proposed by remedy to increase floodplain vegetation diversity.
- Provide increased recreational opportunities compatible with other restoration goals, such as river boating and fishing.

2.1.6 Replacement Water Supply Program/Temporary Groundwater Institutional Controls

Temporary groundwater institutional controls will be necessary during and immediately after construction to address potential human health risks by limiting the use of the groundwater until the aquifer recovers through natural attenuation. Groundwater institutional controls during construction and until the aquifer recovers (4 to 10 years after dam removal) include the following:

- Provide continued funding for maintaining the existing replacement water supply for Milltown residents (this requirement is presently being met through ARCO's settlement with the Milltown Water Users Association)
- Make contingency funds available to reconfigure, expand, or update replacement water supplies (this requirement is presently being met through ARCO's settlement with the Milltown Water Users Association)
- Establish a temporary controlled groundwater area to ban future wells within or immediately adjacent to the arsenic plume, if required
- Continue the ongoing groundwater monitoring program to track changes in groundwater quality as the project is implemented and aquifer recovery occurs

None of these groundwater-related activities will impact bull trout or their proposed designated critical habitat and are not discussed further in this BA.

2.1.7 Protective Measures

2.1.7.1 Control of Sediment Releases

An important factor in EPA's and MDEQ's consideration of whether to issue a Revised Proposed Plan was the evaluation of the potential downstream impact of scoured sediments. Of particular concern was the volume of scoured sediments released and the downstream concentration of metals, arsenic, and TSS; the potential downstream impact of these sediments; methods for controlling and mitigating these potential impacts; and monitoring during and after cleanup activities. Conservative input assumptions were used in sediment scour modeling calculations so the values reported represent the upper range of sediment transport that is expected to occur during construction. The following section briefly describes these issues. For additional details concerning these issues please see *Final Technical Memorandum – Milltown Reservoir Dry Removal Scour Evaluation* (Envirocon 2004) on the EPA Milltown web site or in EPA's Administrative Record. In summary:

- Modeling estimates that approximately 478,000 tons (406,000 cubic yards) of additional sediment will be scoured from the Milltown Reservoir during the 4-year construction period.
- The concentrations of dissolved metals moving downstream during construction are projected to be similar to those seen during normal high flow events.
- EPA expects little or no effect on downstream aquatic life resulting from metals released during construction. The release of high levels of TSS could have a temporary negative impact on aquatic life.
- Sediment releases should not pollute downstream drinking water supplies because of the expected low concentrations of dissolved arsenic being released.
- Deposition of sediment should not cause problems to downstream public infrastructure. There is a potential for some temporary problems at irrigation intakes where coarse particles may settle out and constrict intakes. These areas will be monitored and problems will be corrected. The majority of the sediment will be transported downstream, mixed with other channel sediment, and ultimately deposited in downstream reservoirs. The amount released from Milltown as a result of construction activities is relatively small when compared to the amounts entering downstream reservoirs on a routine basis.
- As further described below under *Controls and Mitigation Measures*, several key engineering controls and best management practices (BMPs) will be used to protect downstream water quality. This will be accomplished by isolating the most highly contaminated sediments with sheet piling and a bypass channel, and carefully planning the timing and sequence of reservoir drawdown and dam removal. Equipment will be available to clean out downstream irrigation intakes to ensure they are not constricted.
- The Clark Fork River downstream of Milltown Dam will be monitored during and after remediation. Monitoring will include daily water quality sampling and possibly caged fish exposure studies, as well as seasonal or annual measurements of fish and benthic (bottom-dwelling) macroinvertebrates communities. Details of the final monitoring program design will be clearly defined prior to implementation of site remediation/restoration activities.

Protective measures to control sediment releases resulting from Clark Fork River and Blackfoot River channel and floodplain restoration as described in the DCRP, and methods to monitor possible effects are also important components of the Proposed Action and include the following:

- The Natural Resource Trustees and specifically the State of Montana have completed restoration projects of this type in the past and will use appropriate BMPs to control sediment delivery and reduce total suspended solids/sediment (TSS) concentrations in the Clark Fork and Blackfoot Rivers during and immediately following completion of construction activities. BMPs that will be employed will be defined in the Final Conceptual Restoration Plan and will include the following: conducting most channel and floodplain reconstruction activities (for example, re-establishing meanders) in the "dry" to the extent possible (outside of the temporary bypass channel); minimizing construction during rainy or wet periods to reduce the potential for soil erosion and runoff to the temporary bypass channel; using sediment barriers and filters to minimize sediment delivery to flowing water; revegetating disturbed areas adjacent to the reconstructed river channels as soon as possible to minimize the potential for soil erosion, sediment delivery, and elevated TSS levels in the new river channels; and using other BMPs as appropriate.

- Restoration plan monitoring would consist primarily of measuring restored channel conditions, including stability and performance, using permanent cross sections, longitudinal profiles, elevation measurements, and photo points in representative habitat types (pools, runs, riffles); measuring vegetation composition, cover, and other parameters (including noxious weed presence) in treated and untreated reaches; and conducting fish population monitoring, possibly including radio-telemetry tracking studies of bull trout. Monitoring will be defined in the Final Conceptual Restoration Plan and will be in addition to monitoring associated with the site remediation activities described above.

2.1.7.2 Controls and Mitigation Measures

Several key engineering controls and construction BMPs will be used to minimize the scour and release of reservoir channel sediment and associated metals during construction activities to protect downstream water quality.

The major planned engineering controls include the isolation of the SAA-1 sediments using a sheet pile and bypass channel system (See Figure 6). This system should be highly effective in reducing the potential for scouring. This system reduces total scouring from about 1.2 million tons of sediment to about 478,000 tons, and reduces the amount of highly contaminated sediment scoured from the reservoir from a projected 400,000 tons to 0 tons. Additional BMPs (such as silt curtains, coffer dams, flood control berms, and grading of stream banks) will also be developed during cleanup design and construction.

Another important aspect of mitigating and reducing potential downstream impacts is the timing and sequencing of reservoir drawdown and dam removal. To minimize downstream impacts and allow the earliest possible fish passage and recovery, EPA and MDEQ propose dam removal during the winter and spring months immediately after the SAA–1 sediments are isolated and the Clark Fork River is routed into the bypass channel. Stimson Dam would be removed first and Milltown Dam would then be removed. By timing the reservoir drawdown and dam removal in late winter/early spring, most sediment would be scoured during spring run-off and before the major irrigation withdrawals and the summer/early fall recreational season. There is also a potential for intake gate elevation control to try to bypass the sand fraction past irrigation intakes. Excavation equipment will also be dedicated to ensure that gates are not constricted by sand deposition. EPA and MDEQ plan to work closely with irrigators to ensure that negative impacts are minimized.

2.1.8 Monitoring

An important part of the cleanup proposal is the monitoring program during and after remediation. Monitoring will be conducted to assess the effectiveness of engineering controls and other BMPs used during remediation activities and site cleanup in preventing exceedences of the temporary construction-related water quality standards. These monitoring results will be used to determine whether or not additional cost-effective controls and mitigation measures can be implemented if the temporary construction-related TSS and metals standards are exceeded. Monitoring also will be conducted to assess remedy effectiveness by comparing monitoring results to historical water quality values and biological conditions prior to the removal of Milltown Dam. In addition, monitoring will provide an opportunity to compare modeled TSS and metals concentrations with actual concentrations as early as possible during site remediation, specifically during the predicted peak concentrations in Stage 1.

A detailed ongoing monitoring program will be developed that includes water quality and biological studies conducted during and after site remediation activities to assess any adverse effects on aquatic habitat and organisms.

The water quality monitoring station will include the following:

- Continuous monitoring of turbidity on the Clark Fork River downstream of the Milltown Dam Site at the Deer Creek Bridge
- Daily sampling of TSS and dissolved and total recoverable metals using standard EPA protocols

In addition, EPA and MDEQ have established temporary construction standards (performance standards) for the river to protect human health and prevent acute impacts to the downstream fishery and bull trout. The Superfund point of compliance for these standards is proposed at Deer Creek Bridge, located about 2.8 miles downstream of Milltown Dam and the site of a current U.S. Geological Survey (USGS) sampling station (Station No. 12340500). This monitoring point will allow direct comparison to historic levels and is downstream far enough to account for the effect of any contaminated groundwater recharge back into the river. Additional BMPs and control actions will be considered if these standards are exceeded.

Seasonal or annual measurements of fish and benthic macroinvertebrate communities will be used to assess longer-term impacts. Results from these monitoring activities will be used to adjust construction activities or BMPs to avoid acute impacts on fish. In addition to the surface water quality monitoring, groundwater quality in the Milltown area and at key downstream locations will be monitored. Although negative impacts to groundwater used for drinking water are not expected, EPA is committed to remedy any problems related to drinking water that might occur.

As discussed previously, restoration plan monitoring would consist primarily of measuring restored channel conditions, including stability and performance, in representative habitat types (pools, runs, riffles); measuring vegetation composition, cover, and other parameters (including noxious weed presence); and conducting fish population monitoring and possibly radio-telemetry tracking of bull trout. Monitoring will be defined in the Final

Conceptual Restoration Plan and will be in addition to monitoring associated with the site remediation activities described above.

2.1.9 Activities of the PM&E Plan and Bull Trout Conservation Measures

2.1.9.1 Activities of the PM&E Plan

In the original FERC order extending the license, MPC was directed to evaluate and implement measures to mitigate impacts to the fishery. The FERC directive resulted in a plan that describes the existing project impacts on the Clark Fork and Blackfoot Rivers fishery, a plan to mitigate those impacts, and a schedule for implementing the mitigation measures (the *Milltown Fisheries Protection, Mitigation, and Enhancement Plan* [Montana Power Company 1993]). In September 1992, MPC convened a Milltown Fisheries Technical Advisory Committee (MTAC) to discuss operations at the Milltown Project, review impact assessment studies, scope issues, and discuss possible protection, mitigation, and enhancement (PM&E) measures for fisheries losses. MPC utilized meetings with MTAC and public meetings to develop the PM&E Plan. MTAC included representation from: Montana Fish, Wildlife, and Parks (MTFWP), West Slope Chapter of Trout Unlimited, FWS, Clark Fork – Pend Oreille Coalition, Confederated Salish and Kootenai Tribes (CSKT), ARCO, MDEQ, University of Montana, Bureau of Land Management, Montana Department of Natural Resources and Conservation, and CFBLLC. A report of PM&E activities is required every 3 years. The last report was completed for the 1999 through 2001 period.

The PM&E Plan includes one operational change and several non-operational activities. The operational change involves limiting necessary reservoir draw down to one foot or less per day and using generation flow instead of spill to lower the reservoir to minimize sediment entrainment. CFBLLC also agreed to monitor turbidity upstream and downstream of the Project during draw down for feedback information in adjusting draw down to meet State turbidity standards.

Non-operational components of the PM&E Plan provide funding for Montana Fish, Wildlife and Parks projects developed for the protection, mitigation, and enhancement of the fishery resources of the project area (MPC 1993). The stated goal for the PM&E Plan is to increase trout populations in the Blackfoot and Clark Fork Rivers impact area.

The non-operational components of the PM&E Plan include funding for: 1) projects involving species of special concern, such as bull trout and westslope cutthroat trout; 2) tributary and mainstem PM&E activities; 3) long-term monitoring of fisheries and PM&E activities; 4) providing field and administrative assistance to implement PM&E activities; 5) modifying Milltown Dam spillway to prevent fish stranding during periods of variable inflows; and 6) construction of an experimental fish capture facility at the dam and assessing its effectiveness.

Projects funded through the PM&E Plan are submitted annually by MTFWP biologists and reviewed by MTAC for approval, modification, or denial. This procedure is intended to provide the best available fisheries information and identification of opportunities for protection, mitigation, and enhancement of fishery resources in the project area. Funding for the PM&E Plan is $91,608 in 2004, including the annual inflation adjustment of 3 percent. Cooperative agreements among agencies, grant sources interested in native fish, and CFBLLC resulted in a 3-to-1 funding match on the PM&E funds.

The Proposed Action discontinues the PM&E funding following license surrender once the dam is removed (currently expected to occur in the Spring 2006). Projects funded through the PM&E Plan can change on an annual basis. The evaluation of potential effects on bull trout and proposed critical habitat of bull trout, resulting from PM&E projects, are addressed through annual reviews. All PM&E projects are coordinated through MTFWP fishery personnel, who annually submit ESA Section 6 documentation of projects in bull trout waters. MTFWP compliance with Section 6 includes anticipated bull trout impacts of restoration and research projects.

Milltown PM&E Plan efforts have focused primarily on gathering information regarding life history of native fish species especially bull trout and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) in the Project assessment area. The mitigation efforts, in cooperation with additional funding sources, have been responsible for radio telemetry studies on bull trout and westslope cutthroat trout in the Blackfoot and Clark Fork Rivers, operation of the radial gate fish trap, genetic evaluations of bull trout and westslope cutthroat trout, stable radio isotope fish stock evaluations, fish passage evaluations for all fish species, Milltown Reservoir northern pike evaluations, westslope cutthroat trout spawning behavior evaluations, fish population evaluations downstream of Milltown Dam, and MTFWP's coordination of the project.

Restoration and rehabilitation projects completed in the Blackfoot and Clark Fork Rivers with the assistance of PM&E funding have significantly improved the available spawning and rearing habitats for all fish species in these systems with special emphasis on bull trout and westslope cutthroat trout. Bull trout and westslope cutthroat populations have significantly increased in the Blackfoot River and Rock Creek over the last decade, but still remain in relatively low densities. Work plans in 2004 expand restoration and rehabilitation activities into several more tributary streams in the Blackfoot and Clark Fork Rivers with high potential for native fish benefits. Projects to improve habitat and migratory fish accessibility on tributary streams within the project area include: Rattlesnake, Grant, and Marshall Creeks.

Milltown PM&E funding, although not significant enough to complete even some of the smaller tributary or mainstem restoration projects, is significant in providing baseline data collection, design, and other pre-construction costs. Most other funding sources limit funding to construction costs that make worthwhile complex projects difficult to develop.

Other PM&E projects have also been funded often as matching funds for a larger project. These include bull trout life history evaluations in Rock Creek using radio telemetry; life history evaluations of largescale sucker in the Clark Fork River; stream restoration projects at Ashby, Rock (Klieschmidt Flat), Wasson, Bear, East Twin, Gold, Primont, Nevada Spring, Turah Spring, McCabe, Dry, Rock, Willow, Lost, Grant, Rattlesnake, Marshall, Racetrack, and O'Brien Creeks, German and Brown's Gulches; and Slemon's pond removal and restoration. A stream and riparian inventories and assessment preceded the restoration efforts. The Little Blackfoot River, a major drainage in the Upper Clark River drainage, was evaluated in 2002. The majority of these projects occur in westslope cutthroat streams and a few in historical bull trout areas. Monitoring and collection of baseline information from restoration streams has been accomplished through partial funding of seasonal employees to assist MTFWP biologists in the project assessment area. The middle Clark Fork River had received very little baseline evaluation of native fish and restoration needs prior to the

PM&E Plan. Several restoration opportunities have been identified and are in various stages of implementation as a result of this PM&E funded activity.

Upstream fish passage evaluations have determined that fish captured in the radial gate fish trap are highly sensitive to the source of water flowing through the radial gate. Normally, water flowing through the radial gate at base flow levels originates from the Clark Fork River. Blackfoot River water flows through the radial gate as the river stage increases in the spring. Clark Fork River water returns to the radial gate as river stage returns to base flow in the summer. The radial gate fish trap is also inoperable at stream discharge exceeding 7,000 cfs. As a result of these factors, limited upstream fish passage for westslope cutthroat trout and bull trout, provided by radial gate trapping and hauling, was initiated in 1999. In 2000 and 2001, 18 bull trout were transported upstream of the dam using the radial gate trap. Two bull trout were transported in 1999. Forty-three to 59 westslope cutthroat trout were captured and transported upstream of the dam in each of the 3 years (1999, 2000, and 2001).

CFBLLC contracts with a fisheries consultant to provide field and administrative assistance on many of the aforementioned activities for 0.20 full-time equivalent employee. The consultant monitors all PM&E activities for CFBLLC as well as assisting in fieldwork and providing project coordination. Other responsibilities include organizing the Milltown Technical Advisory Committee meetings, assembling an annual report of activities, identifying restoration opportunities, and preparing a report of progress every 3 years to FERC.

2.1.9.2 Activities of Bull Trout Conservation Measures

The conservation actions presented in this section, developed in consultation with the FWS, expand the current Milltown Fisheries Protection, Mitigation, and Enhancement (PM&E) Plan through the application of the best available scientific solutions to mitigate the effects of the Project. The expanded elements of the PM&E Plan will be referred to as the Bull Trout Conservation Measures. At the 2002 MTAC meeting, MPC agreed to voluntarily provide an additional $140,000 to the 2003 PM&E funding to address Bull Trout Conservation Measures in the project area related to conservation actions being developed in the ESA consultation. This voluntary advancement of funding provides additional funding of restoration and rehabilitation projects in 2003 in the Blackfoot and Clark Fork Rivers. The Bull Trout Conservation Measures also provide funding for activities funded partially by the PM&E Plan previous to 2003 (the list of items occurs following the next paragraph). The CFBLLC increased contributions to the Bull Trout Conservation Measures to $250,000 in 2004. With the implementation of the Bull Trout Conservation Measures in 2003, all PM&E funding is used for off-site habitat related mitigation projects.

Because the Bull Trout Conservation Measures address issues related to responsibilities of the FWS under the ESA, the FWS maintains the authority to determine compliance with ESA. A subcommittee of MTAC, the Bull Trout Technical Committee, consisting of biologists from CFBLLC, MTFWP, FWS, and CSKT, provides review and recommendations on annual work plans to the FWS and FERC for the Bull Trout Conservation Measures.

The conservation actions in the Bull Trout Conservation Measures addressed to the extent practicable, during the on-going dam operations, the following components (starting in 2003):

- Upstream fish passage
- Downstream fish passage
- Predation and competition by northern pike in Milltown Reservoir
- Education for the public regarding the need for the Bull Trout Mitigation Plan actions and the importance of adherence to fishing regulations in the project area
- An annual fund for off-site habitat mitigation dedicated to proposed designated bull trout critical habitat improvement through FERC license surrender.

The Bull Trout Technical Committee will oversee the annual work plans for the Bull Trout Conservation Measures.

Table 1 provides a summary of bull trout conservation measures and funding levels addressing ongoing operations of the Milltown Dam Project.

TABLE 1
Summary of Bull Trout Conservation Measures and Funding Level *

Item	Description	Cost
Bull Trout Conservation Measures - Habitat	Bull trout off-site mitigation projects in the Blackfoot, Middle, or Upper Clark Fork River drainages	$50,000 annually 2003 to FERC license surrender
Bull Trout Conservation Measures	Radial gate trap/haul migrating fish, Northern Pike control and assessments, Public outreach/education, and other assessments related to project impacts	$200,000 annually 2003 to FERC license surrender

* Addresses on-going operations of the Milltown Dam Project, FERC license No. 2543, for the period 2003 to FERC license surrender

Upstream fish passage at Milltown Dam has been facilitated through the operation of the radial gate raceway as a fish trapping facility. In 1998, MPC in cooperation with MTFWP initiated intermittent operation of a trap and haul facility using the radial gate raceway to collect upstream migrating fish. This system is operated annually between March and early November, but trapping is subject to stream flow conditions. Operation of the radial gate fish trap is ineffective at discharges in excess of approximately 7,000 cfs because tail water elevations flood the radial gate pool area. However, even during optimal flow conditions, the current trap's effectiveness for fish capture is low.

Downstream passage over the dam has been enhanced during the low-flow period by reducing impingement on the spillway panels through sealing of the cracks between the planks in the spillway panels. An additional measure under consideration for implementation included spillway flows from July through March, as long as the reservoir is maintained at a pool elevation suitable for spillway use and air temperatures remain above freezing. The spillway flow using one removed panel or approximately 400 cfs would have provided a potential path for downstream migrating fish other than through the turbines during the low-flow period. Some spillway flows have been practiced intermittently since 2002. The spillway flow was to be evaluated for effectiveness and adjusted accordingly, as data are acquired. Radio tagged fish currently in the system could provide an initial source of data.

Milltown Reservoir provides excellent spawning and rearing opportunities for the recently and illegally introduced, northern pike. The northern pike population in the reservoir has increased to high abundance levels and predation on other fish species has greatly impacted the fish species composition and abundance in the reservoir. In addition, other fish species migrating through the reservoir appear to provide a significant proportion of the food for the northern pike. Species of special concern, bull trout and westslope cutthroat trout, and other game fish, such as rainbow trout, brown trout, and mountain whitefish, have been observed in pike stomachs from Milltown Reservoir.

Northern pike control and evaluation monitoring started in 1999 in the reservoir and downstream of the dam (Schmetterling 2003b). This activity is deemed important to reduce the overall reservoir pike population to prevent excessive northern pike recruitment in the river system and to reduce predation on fish migrating through the reservoir. Two primary methods of population control were applied in Milltown Reservoir since 1999: 1) reservoir draw down of approximately 6 feet in late summer for control of young-of-the-year; and, 2) trap netting of adult northern pike during spawning migrations. In 2002, the use of hoop trap nets proved an effective method for removing adult and sub-adult northern pike. Experimental gill nets are also used in the reservoir fishery investigations for fish population and food habitats monitoring.

Northern pike control actions have reduced older aged northern pike abundance 88 percent from an estimated 2,883 $\pm$ 663 (95 percent C.I.) to 786 $\pm$ 169 from 2002 to 2003 (Schmetterling 2003b). Gill net reservoir fish surveys have also revealed improvements in fish species diversity in the reservoir along with the reduced northern pike population.

Conservation education, information, and enforcement of regulations in the project area are important to improve the public acceptance and adherence to special regulations and conservation action items. MTFWP assisted in the development of an adopt-a-trout program with both a curriculum and other programs in concert with local schools to foster understanding of the mitigation programs and purpose. The program started in 1999 and has continued into 2004. Public education has also been pursued through local printed and visual media focusing on various aspects of the mitigation projects at regular intervals.

The Bull Trout Conservation Measures have provided mitigation funding for proposed designated bull trout critical habitat restoration in the action area to assist bull trout restoration efforts. Several bull trout habitat projects in the Blackfoot River, Middle Clark Fork River, and Rock Creek have been completed in 2003 and more are planned for 2004 (all partially funded through Bull Trout Conservation Measures). The Bull Trout Technical Committee reviews the project proposals with final approval/denial/modifications provided by the FWS.

2.2 Interim Fish Passage

Interim measures for upstream fish passage past Milltown Dam will be provided during dam removal and site restoration activities by CFBLLC as designated and required by the FERC license. Interim fish passage measures will remain in effect until all construction work at the dam has been completed and fish can move unimpeded upstream and downstream past the former Milltown Dam site. EPA anticipates that infrastructure construction at the sediment removal area, including the temporary bypass channel and a 5-foot high fish passable drop structure at the upstream end of the bypass channel, should not affect interim upstream fish passage measures at Milltown Dam. However, under the Proposed Action, fish passage prior to and during the removal of Milltown Dam may not be achievable for approximately 1 year during the initial year of reservoir drawdown. This is discussed further in *Section 4.1.1, Interim Fish Passage* in the analysis of effects of the Proposed Action. EPA will coordinate closely with the MDFWP and FWS in attempts to optimize upstream fish passage prior to the removal of Milltown Dam.

Fish passage scenarios and anticipated courses of action for fish passage from the end of the ongoing Milltown Project operation through the completion of Stage 2, when the entire Milltown Dam structure is removed, will be determined during final construction design. These scenarios and anticipated courses of action are conceptual in nature at present and will be detailed during final design. Fish passage biologists will be involved in the design aspect of the fish bypass structure and the temporary bypass channel. Several possible issues have been identified that should be considered during final design in order to achieve, to the extent possible, a desired success rate of upstream passage by adult and sub-adult bull trout. They include the following:

- Identification of the period of focus for upstream fish passage (April through July for trout)
- Evaluation of the channel and drop structure design using appropriate hydraulic models at a number of cross-sections
- Selection of appropriate river flow ranges for modeling and predicting fish passage success
- Determination of channel bedload transport capacity, ice flow stability, and overall bypass channel stability.

The final design of the temporary bypass channel and fish passage structure will be evaluated during the design process for their ability to pass fish.

2.3 Implementation of the Proposed Action

Table 2 summarizes the basic approach and potential schedule for implementation of the Proposed Action and is immediately followed by a list of the anticipated sequencing of remediation and restoration actions. This schedule reflects the current Envirocon SOW schedule but is subject to change based on public participation activities, final design components and sequencing, and yearly variations in hydrologic conditions.

TABLE 2
Schedule for Implementation of the Proposed Action

Year	Activity
Late 2004	Record of Decision
2004 – 2005	Planning/remedial design, acquire environmental permits
2004 – 2005	Anticipated FERC license surrender regulatory activities
2005	Infrastructure construction (sheet pile, bypass channel, rail spurs, etc.)
Late 2005	Stimson Dam removal
2005 - 2006	Channel stabilization and revegetation activities (restoration): Blackfoot River Reach (lower segment) 1 (dependent on dam removal)
2006	Milltown Dam removal (remediation and restoration elements)
2006 – 2007	Sediment removal, backfilling, regrading
2007 or later	Channel stabilization and revegetation activities (restoration): Clark Fork River Reach 4 and Blackfoot River Reach 2
2007 – 2008	Channel stabilization and revegetation activities (restoration): Clark Fork River Reaches 2 and 3
2009	Channel stabilization and revegetation activities (restoration): Clark Fork River Reach 1 and Blackfoot River Reach (upper segment) 1
2009	Future redevelopment activities
2009	Future operation and maintenance and 5-year reviews

The remediation and restoration actions necessary to construct the Proposed Action are described in *Chapter 2, Section 2.1, Key Components of the Proposed Action,* and summarized according to their anticipated sequencing as follows:

- Initiate the water quality and biological monitoring programs for the Clark Fork River and the water quality monitoring program for the Milltown alluvial aquifer.
- Lower the Milltown Reservoir water level by using the existing radial gate.

Excavate the temporary bypass channel with conventional excavation equipment. Stack excavated materials on the south side of the channel to drain.

- Further isolate SAA-1 sediments through the use of interlocking sheet piling, riprap, or other means.
- Construct a 5-foot-high fish-passable drop structure at the upper end of the bypass channel.
- Construct a rail spur and sediment loading area between the bypass channel and the Clark Fork River.
- Route the Clark Fork River through the temporary bypass channel.

- Further lower Milltown Reservoir water levels by removing turbines and converting powerhouse inlets to low-level outlets.
- Remove Stimson Dam.
- At Milltown Dam, remove the spillway, radial gate, divider block, powerhouse, and north (right) abutment. Use coffer dams to isolate portions of the dam during this removal sequencing.
- Pre-load the sediments in SAA-I with up to 9 feet of clean fill to consolidate the sediments, forcing the release of excess water.
- Excavate the pre-load material and the sediment using large excavators working a linear face to optimize production and minimize the area of exposed groundwater. Pre-load material will also be loaded into trucks and used as backfill in areas where the sediment has been excavated.
- Dewater lower sediments within SAA-I as required.
- At the new rail staging and loadout area located between the temporary bypass channel and the Clark Fork River, place sediment into rail cars. The rail cars will be transported each night to Opportunity Ponds.
- Begin constructing a new floodplain and channel at the confluence of the Clark Fork and Blackfoot Rivers (see the DCRP in the Appendix for a detailed discussion of the river channel and floodplain restoration plan). Continue constructing a new floodplain and channel at and upstream of the confluence of the Clark Fork and Blackfoot Rivers as indicated in Table 2 (see the DCRP in the Appendix for a detailed discussion). Finish constructing a new floodplain and channel at the confluence of the Clark Fork and Blackfoot Rivers and in upstream reaches as indicated in Table 2 (see the DCRP in the Appendix for a detailed discussion). Upon completion, redirect the Clark Fork River from the temporary bypass channel into the new channel.
- Backfill the temporary bypass channel and finish re-contouring, stabilizing, and re-vegetating the new floodplain.

Final designs for these remediation and restoration activities will include detailed work breakdown structures and schedules. Final designs will be prepared following issuance of the Record of Decision and concurrent with the acquisition of required environmental permits. It is assumed that the Proposed Action also may need to include some of the groundwater institutional controls (discussed previously), at least as a temporary measure, during and immediately after construction.

Interim fish passage measures at Milltown Dam are part of the Proposed Action. Accommodations for interim fish passage past Milltown Dam will be provided during dam removal and site restoration activities by CFBLLC as designated and required by the FERC license, and are part of the Section 7 consultation between FERC and FWS being covered in this BA.

A key technical issue in implementing the Proposed Action will be to control, contain, and prevent the transport of sediment during sediment excavation and dam removal activities to protect downstream water quality and aquatic resources. The sediment management program that will be implemented to accomplish this considers OSWER Directive 9285.6-08, *Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites*.

As described in the preceding text, a number of actions intended to minimize or avoid the potential for adversely affecting bull trout, their proposed critical habitat, and water quality will be implemented during sediment isolation/removal/disposal, dam removal, and site restoration activities. These actions include a combination of construction practices, BMPs, and sediment management principles that could be applied during site remediation to control, contain, and prevent the downstream transport of sediment and associated metals. Included in these measures are: 1)isolation of the SAA-1 sediments using a sheet pile and bypass channel system; 2) additional BMPs (such as silt curtains, coffer dams, flood control berms, and grading of stream banks); 3) timing and sequencing of reservoir drawdown and dam removal and other remediation and restoration activities, which were described in *Section 2.1.7.1, Control of Sediment Releases*, to reduce impacts; and 4) production rate controls to reduce sediment and dissolved metals transport if unacceptable impacts are occurring.

An important part of the sediment management program will be to monitor before, during, and after sediment removal to assess and document remedy effectiveness. Pre-remedial monitoring will use results of water quality and biological programs that are currently and regularly being conducted on the Clark Fork River in the vicinity of Milltown Dam and Reservoir to help describe remediation/restoration project area baseline conditions prior to dam removal. These programs include water quality monitoring by the USGS and annual fisheries censuses and routine macroinvertebrate surveys by the State of Montana when flow conditions allow.

To assess and document remedy effectiveness, water quality and biological studies will be conducted during and after site remediation activities to monitor for potential adverse effects on aquatic habitat and organisms. A water quality monitoring station that continuously monitors turbidity will be employed on the Clark Fork River downstream of the Milltown Dam site at the Deer Creek Bridge, while total suspended solids (TSS) and dissolved and total recoverable metals sampling will be conducted on a daily basis. Analytical turnaround time will be minimized to the extent possible. In addition, a predictive relationship between turbidity and TSS will be confirmed early on, if possible, to further expedite data interpretation and identify any potential concerns. Temporary construction standards (performance standards) that EPA believes are protective of human health and acute impacts to the downstream fishery, bull trout, and proposed designated critical habitat have been established and will apply to the river during the construction process. The point of compliance (POC) for these standards would be at the Deer Creek Bridge located about 2.8 miles downstream of Milltown Dam to allow complete mixing of river water before sampling. Additional BMPs and control actions would be considered if these standards were exceeded or if in-situ bioassays (caged fish) indicated the need. Table 3 lists the temporary construction-related water quality standards established for this project during discussions with the State.

TABLE 3
Milltown Reservoir Sediments Site Temporary Construction-Related Water Quality Standards*

Analysis	Standard	Duration
Cadmium—Acute AWQC	2 μg/L	short-term (1 hour)
Copper—80% of the TRV (dissolved) (at hardness of 100 mg/L)	25 μg/L	short-term (1 hour)
Zinc—Acute AWQC (dissolved)	117 μg/L	short-term (1 hour)
Lead—Acute AWQC (dissolved) DWS (dissolved)	65 μg/L 15 μg/L	short-term (1 hour) long-term (30-day average)
Arsenic— Acute AWQC (dissolved) DWS (dissolved)	340 μg/L 10 μg/L	short-term (1 hour) long-term (30-day average)
Iron—AWQC (dissolved)	1,000 μg/L	short-term (1 hour)
Total Suspended Solids (TSS)	550 mg/L 170 mg/L 86 mg/L	short-term (day) mid-term (week) long-term (season)

*All hardness related AWQC values assume a hardness of 100 mg/L
TRV = Toxicity Reference Value, used in Proposed Plan for the Clark Fork River Operable Unit
AWQC = Federal Ambient Water Quality Criteria
DWS = Federal Drinking Water Standard

EPA will attempt to correlate turbidity readings with TSS to allow instantaneous estimation of the TSS level and, potentially, allowing a faster response in mitigating TSS exceedences if exceedences occur.

Biological monitoring programs developed cooperatively and implemented by EPA in consultation with MDFWP and FWS that document the composition and abundance of fish and benthic invertebrate communities will be conducted downstream of Milltown Dam and Reservoir to assess whether or not site remediation activities appear to be affecting these communities. Similar fisheries and benthic invertebrate monitoring programs will be conducted concurrently at control stations to account for any possible background effects on aquatic communities in the Clark Fork River. These control stations may consist of representative stations currently included in the State's basin-wide benthic macroinvertebrate monitoring program.

Another water quality/biological monitoring tool that may be used is live car bioassays. Studies could potentially be conducted in the Clark Fork River upstream and downstream of the Milltown Dam and Reservoir site using juvenile trout as indicators of water quality conditions. Care would have to be exercised when selecting holding locations for the live cars to avoid potential fish stress or mortalities from factors such as excessive water velocity or lack of cover. Details of the final monitoring program design will be clearly defined prior to implementation of site remediation/restoration activities.

To assess and document restoration plan effectiveness, monitoring would include measuring restored channel stability and performance in representative habitat types (pools, runs, riffles); measuring vegetation composition, cover, and other parameters such as noxious weed presence; and investigating fish populations and possibly radio-tracking bull trout. Restoration monitoring will be conducted in addition to site-remedial monitoring described above.

Results of the monitoring programs will be used in an iterative risk assessment-feedback framework to determine if biological resources are being protected, and, if not, what additional management measures or adjustments to construction activities are practical to protect bull trout, their proposed designated critical habitat, and other aquatic resources. It should be noted that specific design of the potential mitigation measures outlined above needs to occur during the design process. EPA plans to consult closely with the FWS and the other Trustees during this design process to finalize an effective and practical mitigation plan.

As discussed previously in this section, details on key components of the Proposed Action will be developed during final design. In addition, key components will be refined, as needed, during the actual implementation of site remediation and site restoration activities by monitoring implementation effectiveness. Refinement will involve information feedback on the effectiveness and effects of different remedial actions, adaptive management to identify methods and modify activities to more efficiently achieve stated project objectives, and a decision-making process that considers and minimizes the potential for adverse effects on the environment while achieving site remediation and restoration goals.

CHAPTER 3

Environmental Baseline

This chapter describes the existing baseline conditions for bull trout and their habitat in the assessment area (the geographic action area) for this BA. These descriptions provide the basis for assessing the potential effects of implementing the Proposed Action in *Chapter 4, Effects of the Action*. The description of existing conditions begins with an overview of the assessment area and bull trout distribution, status, limiting factors, life history characteristics, and habitat requirements. The overview concludes with a summary description of proposed designated critical habitat for bull trout (FR 2002) and the Bull Trout Draft Recovery Plan (FWS 2002) in the assessment area. The overview discussion is followed by more specific discussions of bull trout distribution, status, limiting factors, and life history characteristics in subbasins and associated drainages within the assessment area.

The assessment area subbasins discussed in this BA generally align with the recent proposed designations of critical habitat subunits and bull trout core areas by the FWS (2002, FR 2002). These subbasins correspond to major subpopulations of bull trout within the Columbia River DPS of bull trout previously identified by FWS (FR 1998). They include the upper Clark Fork River, middle Clark Fork River, lower Clark Fork River, and Blackfoot River subbasins. The Blackfoot River subbasin covers the Clearwater River/Chain Lakes watershed, which has recently been identified as a bull trout core area and proposed as a critical habitat subunit separate from the larger Blackfoot River drainage (FWS 2002, FR 2002). Bull trout in the Rock Creek drainage that empties to the Clark Fork River near Clinton are discussed under a separate heading because of their relative abundance in this particular drainage. This drainage also has recently been identified as a separate bull trout core area and proposed as a critical habitat subunit (FWS 2002, FR 2002). Even though it is within the upper Clark Fork River subbasin, conditions affecting bull trout in Milltown Reservoir are discussed under a separate heading because of the prominence of Milltown Reservoir in this BA.

Information on bull trout has been summarized from detailed descriptions presented by CFBLLC (2003a), which were based on locally derived bull trout information gathered and reported by numerous researchers. Many of the references cited in the following text are the same references that are cited by CFBLLC (2003a) in the Milltown Dam Operations Internal Draft BA. Additional information on bull trout in the lower Clark Fork River subbasin has been summarized from discussions contained in the Bull Trout Draft Recovery Plan (FWS 2002). The discussion of Milltown Reservoir summarizes results of previous environmental assessments (CH2M HILL 2000) that evaluated the potential effects of contaminants present in the reservoir on aquatic receptors in and downstream of the reservoir, including bull trout where data are available.

3.1 Bull Trout Overview

3.1.1 Assessment Area Characteristics

The bull trout assessment area is in the east-central headwaters of the Columbia River in the Rocky Mountains. Based on historical and current bull trout use, the assessment area for this BA consists of the Clark Fork River basin upstream of Thompson Falls Dam, not including the Flathead and Bitterroot Rivers. The Montana Bull Trout Recovery Team (MBTRT 2000) reported that historically, bull trout in the Pend Oreille/Clark Fork drainage probably formed a large metapopulation because there were no migratory barriers upstream of Albeni Falls. Milltown Dam, together with other dams on the lower Clark Fork River, such as Thompson Falls Dam, have blocked upstream fish movements and fragmented this historical bull trout range. The Flathead Indians called the area near the confluence of the Clark Fork and Big Blackfoot Rivers "Ai e tem," which roughly translates as, "more bull trout," compared to Rattlesnake Creek, whose name meant "many bull trout" (Taylor and Malouf 1976). The Blackfoot and Clark Fork watersheds, with a combined drainage area of about 8,000 square miles, form the west central region of the state of Montana (Bonneville Power Administration 1965).

Fisheries resources in the assessment area were described by several early investigators (Evermann 1892, Gilbert and Evermann 1895). Nine species of fish were reported in western Montana, including bull trout, westslope cutthroat trout *(Oncorhynchus clarki lewisi),* peamouth (*Mylocheilus caurinus),* mountain whitefish *(Prosopium williamsoni),* redside shiner *(Richardsonius balteatus),* northern pikeminnow (*Ptychocheilus oregonensis*), longnose dace (*Rhinichthys cataractae*), largescale sucker (*Catostomus macrocheilus*), and slimy sculpin (*Cottus cognatus)* (McPhail and Lindsay 1970). Today, species of native salmonids and introduced salmonids co-exist over most of the assessment area, particularly in the larger river systems. The introduced salmonids frequently are the most abundant species among trout populations. Introduced trout species in the assessment area include rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*). In addition, naturally reproducing populations of northern pike, a non-native species illegally introduced into Milltown Reservoir, occur in the assessment area. Combinations of human-caused changes in vegetative cover, land and water use, habitat loss, introduced fish species, angler harvest, and decline in water quality have impacted bull trout abundance in western Montana (CFBLLC 2003a).

3.1.2 Distribution, Status, and Limiting Factors

Bull trout are distributed throughout the Columbia River Basin, including its headwaters in Montana and Canada (FR 1998). This native species is present in northwestern and western Montana within two major drainages of the Columbia River Basin—the Kootenai River drainage and the Clark Fork River drainage (MBTRT 2000). Bull trout in the Clark Fork River drainage have been physically separated from the rest of the Columbia River population for at least 10,000 years by Albeni Falls—and now Albeni Falls Dam in Idaho, which is 26 miles below Lake Pend Oreille. Historically there were no barriers to fish movement above Albeni Falls, thus the Pend Oreille and Clark Fork drainages formed a large metapopulation of bull trout—perhaps the largest in this species' historic range.

Historically, bull trout migrated from Lake Pend Oreille upstream past Missoula, and also probably migrated up the Flathead, Bitterroot, and Blackfoot Rivers (MBTRT 2000).

Bull trout have generally declined in abundance in the Columbia River Basin and currently occupy only about 45 percent of their historical range (FR 1998, Quigley and Arbelbide 1997). Factors contributing to the overall decline of bull trout include habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, and the introduction of non-native species (FR 1998). The Columbia River DPS of bull trout, which is represented by 141 subpopulations—including those in the Clark Fork River and its tributaries, was listed as a threatened species under the ESA in 1998 (FR 1998). The FWS has identified 75 of the 141 bull trout subpopulations in the Columbia River DPS as being at risk of extinction from naturally occurring events because of the currently depressed status of these subpopulations (FWS and National Marine Fisheries Service [NMFS] 2000). Remaining important strongholds of bull trout in the Columbia River Basin are generally found in large areas of adjacent connected habitats. These areas include the upper Clark Fork and Flathead Rivers in Montana, the Snake River Basin in the central Idaho mountains, and the Blue Mountains in Washington and Oregon (FR 1998).

Three subpopulations of the Columbia River DPS of bull trout are present in the bull trout assessment area for the Milltown Reservoir Sediments Operable Unit. They are the middle Clark Fork River subpopulation, the upper Clark Fork River subpopulation, and the Blackfoot River subpopulation (FWS 1998). The middle Clark Fork River subpopulation of bull trout occurs in the mainstem Clark Fork River between Thompson Falls Dam and Milltown Dam, and in tributaries to this reach of the Clark Fork, including the lower Flathead River upstream to Kerr Dam—but excluding the Bitterroot River drainage, which supports a separate bull trout subpopulation. The Thompson Falls, Milltown, and Kerr Dams each block upstream fish passage. FWS (1998) stated that the migratory form of bull trout, which was historically common in the middle Clark Fork River, is now rare because of extreme habitat fragmentation. Remaining resident forms of bull trout are present in various tributaries to this reach of the Clark Fork River (FWS 1998).

The upper Clark Fork River subpopulation of bull trout occurs in the mainstem Clark Fork River and tributaries upstream of Milltown Dam, except for the Blackfoot River. Bull trout present in the Blackfoot River, which empties into the Clark Fork River at Milltown Dam, and in its tributaries are part of the Blackfoot River subpopulation. FWS (1998) stated that the migratory form of bull trout was probably historically distributed throughout the upper Clark Fork River drainage. However, today, bull trout in the upper Clark Fork River subpopulation are primarily restricted to resident forms in the headwaters of relatively pristine tributaries and generally are either rare or extinct, except in the Rock Creek drainage basin (CFBLLC 2003a). Bull trout were historically widely distributed in the Blackfoot River Basin, but are now extinct in a number of this basin's tributaries and are represented by a single subpopulation. The Blackfoot River Basin is one of the few drainages in Montana where fluvial bull trout are the dominant life history form. Bull trout adfluvial migrant and resident forms also are present in the Blackfoot River subpopulation (CFBLLC 2003a). Fluvial bull trout migrate between larger rivers and small streams, while adfluvial bull trout migrate between lakes and tributary streams.

The State of Montana has listed bull trout as a species of concern and, in 1993, initiated a bull trout restoration planning effort. This effort involved a collaborative, interdisciplinary team known as the Montana Bull Trout Restoration Team (MBTRT) with representatives from federal and state agencies, Native American tribes, the private timber industry, and environmental groups; a Montana Bull Trout Scientific Group (MBTSG) to provide technical expertise; and public participation while developing a restoration plan for bull trout in Montana. This planning effort completed status reviews for 12 major conservation areas in Montana, including the middle Clark Fork, upper Clark Fork, and Blackfoot River drainages (MBTSG 1995a, 1995b, and 1996), and a recovery plan titled, *Restoration Plan for Bull Trout in the Clark Fork River Basin and Kootenai River Basin, Montana* (MBTRT 2000). These reports are cited by CFBLLC (2003a) as providing a thorough compendium of bull trout knowledge for the interested reader. As noted previously, the FWS listed the Columbia River DPS of bull trout as a threatened species under the ESA on June 10, 1998 (FR 1998).

3.1.3 Life History Characteristics and Habitat Requirements

Three life history forms of bull trout—fluvial, adfluvial, and resident—occur in the Clark Fork River Basin upstream of Thompson Falls Dam (CFBLLC 2003a). Thompson Falls Dam blocks upstream fish passage and marks the downstream boundary of the bull trout assessment area for this BA. Fluvial (migrate between larger rivers and smaller streams) and adfluvial (migrate between lakes and tributary streams) bull trout generally spawn during early to mid-fall in smaller, low-order tributaries and rear as juveniles for 1 to 4 years before migrating to larger rivers or lakes where they rear to adulthood and overwinter (FR 1998, CFBLLC 2003a). Resident, non-migratory bull trout are generally found in headwater streams; are often isolated from other stocks of bull trout by physical barriers; and typically spawn, rear, and complete their life cycle using a single stream or nearby streams (FR 1998).

Bull trout have relatively narrow, specific habitat requirements compared to many of the other salmonid species. These requirements are referred to generally as the four Cs and include the following:

- **Clean Habitat.** This consists of high-quality water with clean gravel riffles and low levels of fine sediment. Bull trout require clean gravels for spawning, and appear to select areas with groundwater upwelling in which to build their spawning redds (Watson and Hillman 1997). Increased sediment delivery to drainages beyond background levels can adversely affect bull trout habitat and survival of incubating eggs (FR 1998).

- **Cold Habitat.** Bull trout thrive in cold waters and can be harmed by water temperatures above about 61°F (Selong et al. 1998). Optimum or preferred thermal conditions for bull trout vary by life stage, but are within the overall water temperature range of about 39 to 55°F (Rieman and Mcintyre 1993, EPA 1997).

- **Complex Habitat.** This refers to the degree of habitat diversity and amount of high quality cover. It may include all or some of the following components: high levels of shade, undercut banks, a deep boulder-strewn channel, and abundant woody debris in the stream channel (MBTRT 2000, Selong et al. 1998). Bull trout are strongly associated with these components of habitat diversity and abundant cover (FWS and NMFS 2000).

- **Connected Habitat.** Contiguous migratory corridors within and between larger rivers and smaller streams during different seasons and stream flows are necessary to maintain migratory populations of bull trout, and the upstream and downstream routes and movements of adults and juveniles. Migratory corridors also allow for the dispersal of resident bull trout in the recolonization of recovering habitat (FWS and NMFS 2000).

3.1.4 Proposed Designated Critical Habitat and Draft Recovery Plan

The FWS proposed the designation of critical habitat for the Columbia River DPS on November 29, 2002 (FR 2002). The assessment area for this BA is proposed designated bull trout critical habitat. To be proposed as critical habitat, an area had to provide one or more of the following three components (FR 2002):

- Spawning, rearing, foraging, or overwintering habitat to support existing bull trout local populations
- Movement corridors necessary for maintaining migratory life history forms, and/or
- Suitable and historically occupied habitat that is essential for recovering existing local populations that have declined, or that is needed to reestablish local populations required for recovery

The FWS (FR 2002) listed nine physical and biological features essential to the conservation of bull trout that were used in identifying critical habitat areas. These features are known as primary constituent elements (PCEs) and were determined from studies of bull trout habitat requirements, life history characteristics, and population biology. The FWS (2002) stated that an area does not have to include all nine of the PCEs to qualify for designation as critical habitat. The nine PCEs are:

1. Permanent clean water having low levels of contaminants such that normal reproduction, growth, and survival are not inhibited
2. Proper water temperatures ranging from 36 to 59°F. With adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence
3. Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures
4. Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine substrate less than 0.25 inch in diameter and minimal substrate embeddedness are characteristic of these conditions
5. A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, a hydrograph that demonstrates the ability to support bull trout populations
6. Springs, seeps, groundwater sources, and subsurface water connectivity to contribute to water quality and quantity

7. Migratory corridors with minimal physical, biological, or chemical barriers between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows

8. An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish

9. Few or no predatory, interbreeding, or competitive nonnative species present

Subbasin discussions later in this chapter describe instances where PCE conditions are degraded and appear to be limiting bull trout success.

The assessment area for this BA is located in proposed Critical Habitat Unit 2: Clark Fork River Basin (FR 2002). Within this critical habitat unit, portions of the assessment area are located within six smaller critical habitat subunits (CHSUs). The Clark Fork River and its tributary watersheds from Thompson Falls Dam upstream to the confluence with the Flathead River are within the Lower Clark Fork River CHSU. The downstream boundary of this CHSU is Cabinet Gorge Dam in Idaho. A total of 312 miles on 24 streams is proposed for designation as critical habitat within this entire CHSU. The Clark Fork River from Thompson Falls Dam to the confluence with the Flathead River provides foraging, migratory, and overwintering (FMO) habitat for tributary populations of bull trout (FR 2002).

The Clark Fork River and its tributary watersheds from the confluence with the Flathead River upstream to the base of Milltown Dam, except for the Bitterroot River drainage, are in the Middle Clark Fork River CHSU. A total of 386 miles on 28 streams is proposed for designation as critical habitat in this subunit. The mainstem Clark Fork in this CHSU provides historically occupied bull trout foraging, migratory, and overwintering (FMO) habitat that is currently occupied but at very low abundance levels. Mainstem tributaries in the Middle Clark Fork River CHSU provide FMO habitat and/or spawning and rearing habitat for bull trout (FR 2002).

The Upper Clark Fork River CHSU includes the entire Clark Fork River upstream from Milltown Dam except for the Blackfoot River, Clearwater River, and Rock Creek drainages, which are in separate CHSUs. A total of 301 miles on 13 streams is proposed for designation as critical habitat in the Upper Clark Fork River subunit. The mainstem Clark Fork in this CHSU provides FMO habitat for bull trout while tributary watersheds provide FMO habitat and/or spawning and rearing habitat for bull trout. This area is important in providing for the maintenance of existing populations and the migratory life history form essential to the long term conservation of bull trout (FR 2002).

The Blackfoot River CHSU and the Clearwater River and Lake Chain CHSU, which are all within the Blackfoot River Subbasin, provide FMO, spawning, and rearing habitat for bull trout. A total of 270 miles on 12 streams in the Blackfoot River CHSU is proposed as designated critical habitat for bull trout. Totals of 97 miles on 9 streams and 3,608 acres in seven lakes in the Clearwater River and Lake Chain CHSU are proposed for designation as critical habitat (FR 2002).

The Rock Creek CHSU includes the entire Rock Creek watershed. Mainstem Rock Creek provides FMO habitat while its tributaries provide spawning and rearing habitat for bull trout. A total of 302 miles on 28 streams is proposed for designation as critical habitat in this subunit (FR 2002). The Federal Register (2002) provides detailed legal descriptions on the location, reaches, and habitat present in drainages within each of the above CHSUs that have been proposed as bull trout critical habitat.

The FWS also announced the availability of the Bull Trout Draft Recovery Plan for the Columbia River DPS on November 29, 2002 (FR 2002). This plan provides information on local bull trout populations and habitat, and recommends actions for their recovery. The assessment area for this BA is within the Lower, Middle, and Upper Clark Fork Recovery Subunits (FWS 2002). These subunits include the entire Clark Fork River Basin in Montana upstream of Thompson Falls Dam. Within these recovery subunits, portions of the assessment area are located within six smaller bull trout core areas that align with the CHSUs described above. These core areas are Clark Fork River Section 3 (Thompson Falls Dam to Flathead River), Clark Fork River Section 2 (Flathead River to Milltown Dam), Clark Fork River Section 1 (upstream of Milltown Dam), Blackfoot River, Clearwater River/Chain Lakes, and Rock Creek (FWS 2002). These core areas and CHSUs generally align with the subbasins and bull trout subpopulations previously described by the FWS (1998) and discussed in the following text in this BA.

3.2 Upper Clark Fork River and Tributaries

3.2.1 Subbasin Characteristics

The upper Clark Fork River extends from Milltown Dam upstream 120 miles to the confluence of Warm Springs and Silver Bow Creeks. Mean annual flow of the upper Clark Fork River varies from 276 cfs at the City of Deer Lodge to 1,272 cfs at the Turah Bridge, 7 miles above Milltown Dam (USGS 1999). Mean annual flow of the Clark Fork River below Milltown Dam for the period 1929 to 1999 is 2,977 cfs (USGS 1999).

Major tributaries to the upper Clark Fork River are Flint Creek, Warm Springs Creek, and Rock Creek, and the Little Blackfoot and Blackfoot Rivers. Surface flows are used primarily for irrigation, municipal and industrial wastewater dilution, stock watering, light industry, hydroelectric power generation, and habitat for trout fisheries. Major land uses are agriculture/ranching, silviculture, mining, residential development, and recreation. Flows in the lower reaches of tributaries in the upper portion of the upper Clark Fork River (from Drummond upstream) are frequently intermittent during the summer because of water diversion for agricultural use. Human-made physical barriers to fish migration and intermittent flows are common in the lower reaches of tributaries in the lower portion of the upper Clark Fork River (from Drummond downstream) (CFBLLC 2003a).

Fishery resources in the upper Clark Fork River have been severely impacted by extensive poor practices in mining, municipal wastewater treatment, agriculture, transportation systems, and silviculture. An instream flow reservation for maintaining fishery resources in the upper Clark Fork River basin is pending (CFBLLC 2003a). Bull trout are limited to headwater areas of streams and are primarily of the resident life form, except for populations in Rock Creek and the Blackfoot River. Headwater populations of bull trout are isolated from one another because of human-created barriers to fish movement (MBTSG 1995a).

3.2.2 Bull Trout Distribution, Status, and Limiting Factors

Historically, fluvial bull trout probably occurred throughout the upper Clark Fork River subbasin (MBTRT 2000). Currently, however, bull trout populations in this subbasin are highly depressed except in the Blackfoot River and Rock Creek drainages (discussed separately in *Sections 3.4 and 3.5*, respectively; MBTSG 1995a). Radio telemetry data for bull trout trapped below and released above Milltown Dam show they use the mainstem Clark Fork River between the Blackfoot River and Rock Creek (Swanberg 1996, Schmetterling 2000). Bull trout are rare farther upstream in the mainstem Clark Fork River between Rock Creek and Warm Springs Creek. Populations of bull trout identified in tributaries to the upper Clark Fork River include those in the Little Blackfoot River, Rock (Clinton), Harvey, Barker, Cable, Dog, Twin Lakes, Warm Springs, Lost, Foster, Racetrack, Schwartz, Flint, Boulder, South Boulder, and Copper Creeks. Bull trout populations in these tributaries are considered to be stable or declining (MBTSG 1995a, Montana River Information System [MRIS] 2000).

MBTSG evaluated risks to bull trout in the upper Clark Fork River based on the degree a risk factor was presumed to contribute to past and current declines, as well as the future restoration potential of bull trout (CFBLLC 2003a). High risk factors include current and historic water pollution associated with mining; stream dewatering for agriculture; interactions with non-native fish species; degraded stream and riparian habitat from grazing, roads, forestry, municipal wastewater treatment, and highways; high water temperatures from several sources; habitat fragmentation caused by the previously listed risks; and Milltown Dam (MBTSG 1995a, MBTRT 2000). Risk factors are being addressed through regional restoration activities in the upper Clark Fork River basin. These activities include the remedial action (Proposed Action) being addressed in this BA, other Superfund remedial actions that would be implemented in adjacent Operable Units, State Natural Resources Damage Assessment restoration expenditures, and other restoration programs. The goal of these restoration activities is to restore injured resources to a baseline condition. However, the degree of risk reduction to bull trout from completing these restoration activities is unknown (CFBLLC 2003a). It is unknown whether any components of the Milltown Project Fisheries Protection, Mitigation, and Enhancement (PM&E) Plan will be continued once the Proposed Action is implemented.

Re-establishing populations of fluvial bull trout in the upper Clark Fork River subbasin is a key component of restoring the upper Clark Fork River subpopulation of bull trout. Fluvial bull trout use the mainstem of large river systems to over-winter, rear as sub-adults, and migrate, as well as escape from and survive catastrophic events that occur in smaller tributary drainages (MBTSG 1995a, MBTRT 2000).

3.2.3 Bull Trout Life History Characteristics

Currently, bull trout in the upper Clark Fork River subbasin are primarily restricted to tributary streams. Exceptions are Rock Creek (near Clinton) and the Blackfoot River, which are discussed later in this section. “Resident” bull trout spend their lives in the tributary stream. Some migratory bull trout travel through the upper Clark Fork River from Milltown Reservoir to Rock Creek (Swanberg 1996, Schmetterling 2000). However, they are rarely found farther upstream in the mainstem upper Clark Fork River. Juvenile bull trout that were found in stomachs of northern pike in May and June of 2000, together with winter catches of bull trout by anglers in Milltown Reservoir, also indicate use of the reservoir by migratory and over-wintering bull trout. Juvenile bull trout in Milltown Reservoir are probably migrants from the Blackfoot River tributaries and Rock Creek or its tributaries. Radio telemetry tracking of bull trout captured below and released upstream of Milltown Dam during normal spawning migrations showed upstream movements into tributaries of the Blackfoot River and Rock Creek (CFBLLC 2003a).

3.2.4 Summary

Bull trout are rarely observed in the mainstem Clark Fork River upstream of Rock Creek. This river reach has water quality and habitat limitations that currently exceed bull trout tolerances (CFBLLC 2003a). Other populations of bull trout in this subbasin occur in isolated tributaries to the upper Clark Fork River and in the Rock Creek drainage. Preservation and expansion of existing populations, which have been described as stable or declining, are key to restoring the upper Clark Fork River bull trout subpopulation. Bull trout in the upper Clark Fork River subbasin will continue to be vulnerable to further declines caused by random environmental disturbances, reduced genetic integrity, and low population levels (CFBLLC 2003a.

3.3 Middle Clark Fork River and Tributaries

3.3.1 Subbasin Characteristics

The middle Clark Fork River extends from Milltown Dam downstream 119 miles to the Flathead River (BPA 1965). Mean annual flow of the middle Clark Fork River downstream of the St. Regis River (period of record 1930 to present) is 7,253 cfs (USGS 1999). The Bitterroot River, with a mean annual flow of 4,864 cfs, is the largest tributary to the middle Clark Fork River. The Clark Fork River flows through a deeply entrenched channel from Milltown Dam to Missoula. The river channel and floodplain through Missoula have been extensively altered by the Army Corps of Engineers flood control levees that were built in the 1960s. The river braids and accesses its floodplain at the west edge of Missoula, where the Bitterroot River enters the Clark Fork. Surface waters in the middle Clark Fork River basin are used primarily for irrigation, municipal and industrial water discharge dilution, stock watering, hydroelectric power generation, recreational floating, and habitat for trout fisheries. The major land uses are agriculture, silviculture, and municipal and residential development (CFBLLC 2003a).

Rainbow trout are the most abundant salmonid in the middle Clark Fork with fewer numbers of brown trout, westslope cutthroat trout, and bull trout present (Berg 1991). Densities of rainbow trout varied from 170 to 681 catchable fish (greater than 8 inches long) per mile of river (Berg 1992). High growth rates of rainbow trout in the middle Clark Fork River compared to other large streams in western Montana indicate adequate food and space for good growth (Berg 1992, Chapman 1966). Other fish species present in the middle Clark Fork River include brook trout, mountain whitefish, peamouth, northern pikeminnow, longnose dace, redside shiner, longnose sucker *(Catostomus catostomus)*, largescale sucker, and slimy sculpin, as well as the non-native northern pike, largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), yellow perch (*Perca flavescens*), and pumpkinseed (*Lepomis gibbosus*). Westslope cutthroat trout and brook trout were the most widely distributed fish species in 11 of 13 tributaries sampled in the middle Clark Fork River basin during the mid-1980s (Berg 1986). 3.3.2 Bull Trout Distribution, Status, and Limiting Factors

The current distribution of bull trout in the middle Clark Fork River subbasin is greatly reduced from historic levels. Core areas presently supporting key life history functions for bull trout populations in this subbasin are Fish, Trout, Cedar, Petty, Albert, and Rattlesnake Creeks, and the St. Regis River. Areas used seasonally by bull trout for key life history functions include the Thompson (farther downstream), Flathead, and Clark Fork Rivers (CFBLLC 2003a).

Primary risks to the middle Clark Fork River subpopulation of bull trout are mainstem dams, which limit this species' migrations, and historic and potential water quality degradation from agricultural and timber harvest practices (MBTSG 1996). Five hydroelectric dams have fragmented and isolated the Clark Fork and Flathead River systems. Other factors that have contributed to bull trout decline in the middle Clark Fork River subbasin include illegal introductions of non-native fish, fish management, mining, dam operations, transportation systems, and illegal harvest (MBTSG 1996).

Water temperatures in the middle Clark Fork River annually exceed the preferred temperature range for bull trout during portions of July and August. During periods of high water temperatures, bull trout are found in the middle Clark Fork River in thermal plumes of cold water tributaries or groundwater inflow areas (Swanberg 1997, Peters 1983). Natural or irrigation-related intermittent-flow reaches occur in the summer in most of the smaller tributaries to the middle Clark Fork. Physical barriers to fish migration resulting from channel alterations, transportation systems, or irrigation dams also occur in many of the smaller tributaries (CFBLLC 2003a).

In June 1984, the Montana Department of Fish, Wildlife, and Parks (MDFWP) collected 39 bull trout with lengths ranging from 8 to 31 inches in a 13.7-mile-long section of the middle Clark Fork River near Superior, Montana. Bull trout density was 2.8 fish per mile in this river section (CFBLLC 2003a). MDFWP also collected two bull trout downstream of Milltown Dam in June 1984. In 1999, MDFWP estimated that bull trout density downstream of Milltown Dam was two fish per river mile (Schmetterling and Knotek 1999 unpublished data, in CFBLLC 2003a).

Creel census results for the Clark Fork River from Rock Creek to the Flathead River (135.8 miles) during the 1995 fishing season showed that approximately 1 percent (1,477 fish) of the total catch of 147,691 fish were bull trout (Peters and Schmetterling 1996). The density estimate of about 10 bull trout per river mile is high compared to a previous estimate of 1.2 bull trout per river mile (Peters 1985, in CFBLLC 2003a). The catch of 1,477 bull trout and the correspondingly high density estimate may reflect multiple captures of individual fish—possibly because of their relatively high catchability, as well as angler misidentification of bull trout (CFBLLC 2003a).

3.3.2 Bull Trout Life History Characteristics

Fluvial and adfluvial forms of bull trout occur in the middle Clark Fork River from Milltown Dam downstream to the Flathead River (CFBLLC 2003a). Anglers caught large fluvial bull trout near the mouths of Petty, Fish, Rattlesnake, and Trout Creeks during the

1980s, and MDFWP biologists have confirmed migrations of fluvial bull trout into Rattlesnake Creek up to the Mountain Water Supply dam and fish passage barrier (Schmetterling and Swanberg 1998 unpublished data, in CFBLLC 2003a).

Bull trout have been found in 8 of 14 primary tributary streams to the middle Clark Fork River, including Rattlesnake, Petty, Cedar, Albert, Grant, Tamarack, and Fish Creeks and the St. Regis River (CFBLLC 2003a). In addition to these locations, an angler reported catching a subadult bull trout in Ninemile Creek in the mid-1990s, a concentration of spawning bull trout was reported in Cache Creek in the early 1970s, and fluvial bull trout have been observed spawning in Montana Creek and in North Fork of Fish, West Fork of Fish, and Straight Creeks. In 1980, 26 bull trout between 5 and 22 inches long were captured in Fish Creek near Beaver Slough (CFBLLC 2003a).

3.3.3 Summary

Bull trout were historically widely distributed throughout the middle Clark Fork River subbasin via a network of complex and connected habitats that included large streams, Pend Oreille and Flathead Lakes, and numerous tributaries. Monitoring of bull trout populations in the middle Clark Fork River subbasin has been limited; however, MDFWP reassigned a biologist to this segment of the Clark Fork River in 1999, which should improve opportunities for future evaluations. Research by MDFWP in this river reach since 1999 has not revealed any additional decline or improvement in bull trout status (CFBLLC 2003a).

3.4 Lower Clark Fork River and Tributaries

3.4.1 Subbasin Characteristics

The lower Clark Fork River within the assessment area extends from the Flathead River downstream approximately 37 miles to Thompson Falls Dam (FR 2002). This reach of the Clark Fork has been described as basically a single thread channel in a narrow mountain valley confined by Interstate 90 and the Burlington Northern Railroad. The exception to this is the small valley at the town of Plains, about 12 miles downstream of the Flathead River (Envirocon 2004). Average annual flow in the Clark Fork River upstream of Lake Pend Oreille, which includes most of western Montana, is approximately 22,230 cfs (FWS 2002). The Flathead River, with an average annual flow of 11,920 cfs, contributes approximately half of the lower Clark Fork's flow (FWS 2002).

Native and introduced fish species present in the lower Clark Fork River subbasin include many of the same species listed for the middle Clark Fork River subbasin (FWS 2002). Examples of other introduced fish species reported to occur in portions of the lower Clark Fork subbasin include Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri),* black crappie (*Pomoxis nigromaculatus)*, yellow bullhead *(Ictalurus natalis)*, black bullhead (*Ictalurus melas)*, and occasionally walleye (*Sander vitreus*, formerly *Stizostedion vitreum).*

3.4.2 Bull Trout Distribution, Status, and Limiting Factors

Bull trout in the lower Clark Fork River between Thompson Falls Dam and the confluence with the Flathead River are within the Clark Fork River Section 3 Core Area (FWS 2002). Historically, fluvial and adfluvial populations of bull trout probably existed upstream of

Lake Pend Oreille. However, upstream fish passage on the mainstem Clark Fork was blocked in 1916 with the construction of Thompson Falls Dam at Thompson Falls (FWS 1998, 2002). This dam is operated as a run-of-the-river hydroelectric facility. Thompson Falls Dam is reported to have eliminated bull trout migration and spawning access from Lake Pend Oreille to 86 percent of the Clark Fork River Basin (FWS 2002).

Prior to dam construction, the naturally occurring Thompson Falls is reported to not have been a barrier to upstream fish movements (FWS 1998). Historically, migratory bull trout were common in this general reach of the Clark Fork but are now rare because of extreme habitat fragmentation (FWS 2002). With the construction of dams on the mainstem Clark Fork, blockage of upstream fish passage, and habitat alteration, migratory bull trout have generally been replaced by resident fish. Tributary spawning and rearing habitats still exist, although degraded, but foraging, migratory, and overwintering habitats for migratory adult and subadult fish have been lost or modified (FWS 2002).

Additional factors that have contributed to bull trout declines in at least some portions of the lower Clark Fork River subbasin include the same factors listed for the upper and middle subbasins. These include water-quality and habitat related mining, agriculture, grazing, and logging effects, illegal introductions of non-native fish, fish management policies, effects of transportation systems, and illegal harvest of bull trout (FWS 1998, 2002). The FWS (FR 1997) reported that bull trout are uncommon to rare in the mainstem lower Clark Fork River and all remaining populations are considered at moderate to high risk of extinction.

3.4.3 Bull Trout Life History Characteristics

Thirteen local bull trout populations occur in the Lower Clark Fork CHSU. Six of these occur in the watershed upstream of Thompson Falls Dam and include the Fishtrap Creek, West Fork Thompson River, Post Creek, Mission Creek, Dry Creek, and Jocko River populations (FR 2002). The Clark Fork River upstream to the confluence with the Flathead River provides foraging, migratory, and overwintering habitat for tributary populations of bull trout (FR 2002). The FWS (2002) stated that the likelihood of extinction of a given stock of bull trout within this subbasin increased with the shift from larger, more migratory adfluvial populations present historically to smaller, more isolated resident populations of bull trout that are found in this reach of the Clark Fork today (FWS 2002).

3.4.4 Summary

Bull trout were historically widely distributed throughout the lower Clark Fork River subbasin via connected habitats that included large streams, Pend Oreille and Flathead Lakes, and numerous tributaries. Historically abundant fluvial and adfluvial populations of migratory bull trout have generally been replaced by resident fish because of mainstem dam construction that blocked upstream migrations and fragmented habitat. Today, bull trout are considered to be uncommon to rare in the mainstem lower Clark Fork River (FWS 2002, FR 2002).

3.5 Blackfoot River and Tributaries

3.5.1 Subbasin Characteristics

The Blackfoot River flows 132 miles from the Continental Divide near Rogers Pass to its confluence with the upper Clark Fork River immediately upstream of Milltown Dam. Its mean annual flow is 1,598 cfs near Bonner, Montana, for the period of record (1898 to 1999) (USGS 1999). The Blackfoot River subbasin contains 1,900 miles of perennial streams capable of supporting fish (Pierce and Schmetterling 1999).

Tributaries to the Blackfoot River can be grouped as occurring east of the Clearwater River, west of the Clearwater River, or south of the Blackfoot River. Tributaries east of the Clearwater River begin in high alpine basins, flow south through glaciated valleys and vast coniferous forests, then enter prairie and agricultural land. Tributaries west of the Clearwater River have valley and stream types similar to those from the east, but they do not enter glacial outwash or morainal deposits in the Blackfoot Valley and are not greatly influenced by groundwater. South of the Blackfoot River, the Garnet Mountain Range is formed from two mountain blocks divided by the Nevada Creek Valley. This range is much lower in elevation than the northern side of the valley, and its drainages are smaller and yield much less water than streams to the north (Pierce et al. 1997).

Approximately 56 percent of the land in the Blackfoot River subbasin is publicly owned (U.S. Forest Service, Bureau of Land Management, and State of Montana), and 44 percent is privately owned (approximately half of which belongs to Plum Creek Timber Company). Public lands and Plum Creek Timber Company properties account for most of the forested mountainous areas, while the other private ownership occupies the foothills and valleys (CFBLLC 2003a).

Twelve native fish species, 12 introduced fish species, and hybrids of westslope cutthroat x rainbow trout, Yellowstone cutthroat x westslope cutthroat trout, brook x brown trout, and bull x brook trout occur in the Blackfoot River drainage (Pierce et al. 1997). The native species are bull trout, westslope cutthroat trout, mountain whitefish, northern pikeminnow, longnose sucker, largescale sucker, slimy sculpin, mottled sculpin (*Cottus bairdi*), peamouth, pygmy whitefish (*Prosopium coulteri*), redside shiner, and longnose dace. Introduced species include rainbow trout, brown trout, brook trout, Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*), Arctic grayling (*Thymallus arcticus*), kokanee salmon (*Oncorhynchus nerka*), northern pike, pumpkinseed, largemouth bass, walleye (*Stizostedion vitreum*), white sucker (*Catostomus commersoni*), and fathead minnow (*Pimephales promelas*). Depending on the reach of the Blackfoot River, the most abundant trout species are westslope cutthroat trout, brook trout, brown trout, and rainbow trout. Key bull trout habitat present in the Blackfoot River includes year-round rearing habitat for subadult life stages, wintering habitat for subadult and mature life stages, year-round habitat for adults, and a year-round migration corridor (CFBLLC 2003a).

Three major problems were identified in basin-wide fishery evaluations conducted in 1988 and 1989 (Peters 1990). They included tributary stream degradation from numerous causes; mining wastes entering the headwaters; and over-harvest of fish by anglers. Changes in fishing regulations beginning in 1990 by the Montana Fish and Game Commission addressed initial over-harvest concerns. Low numbers of bull trout and westslope cutthroat trout were provided additional protection (prior to bull trout being federally listed as a threatened species) with a no-harvest limit throughout the drainage. Degraded tributary streams were initially addressed through the Blackfoot River Restoration Project, which began in 1990. Restoration activities continue today. The Big Blackfoot Chapter of Trout Unlimited, the Montana Department of Fish, Wildlife, and Parks, FWS-Partners for Fish and Wildlife, and private landowners in the Blackfoot River Valley continue to work cooperatively restoring degraded habitats. These groups are actively involved in river, range, and riparian restoration; wetland conservation; promoting best management practices (BMPs) for all land management activities; conservation easements; and education.

3.5.2 Bull Trout Distribution, Status, and Limiting Factors

Historically, bull trout were probably widely distributed throughout the Blackfoot River subbasin. Evermann (1892) stated that in the 1890s, bull trout were common in most of the larger rivers of the Columbia River drainage in Montana, including the Blackfoot River. Long-distance migrations of bull trout similar to those that would have been necessary to achieve reported historical movements in the Clark Fork River have been documented in the Flathead River, Montana and in the Salmon River, Idaho. In the Middle Fork Salmon River, for example, bull trout migrate up to 201 miles (Bjornn and Mallet 1964, in CFBLLC 2003a).

Today, two apparently geographically separate, but genetically identical populations of bull trout occur in the Blackfoot River subbasin—one in the headwaters from Alice Creek to Nevada Creek, and the other from the North Fork of the Blackfoot River downstream into the Clark Fork River. Poor water quality in the mainstem Blackfoot River from Nevada Creek to the North Fork of the Blackfoot River is the only known potential barrier separating these two populations of bull trout (CFBLLC 2003a).

The Blackfoot River supports one of the better populations of fluvial bull trout within this species' range. However, fisheries investigations over the past two decades have revealed low population densities throughout the drainage and loss of some known spawning populations (Peters 1985, Peters and Spoon 1989, Peters 1990, Pierce et al. 1997, in CFBLLC 2003a). The MBTSG (1995b) status report concluded that bull trout status in the Blackfoot River drainage appears to be "precarious." The MBTSG identified seven core areas in this drainage that provided the best remaining spawning opportunities for bull trout. In 1996, 88 percent of known fluvial bull trout spawning occurred in only three tributary streams: Monture Creek, the North Fork of the Blackfoot River, and Copper Creek. Six additional tributaries provided limited spawning opportunities for fluvial fish (Pierce et al. 1997, Pierce and Podner 2000, in CFBLLC 2003a).

Data suggest a trend of improved bull trout status in several subbasin drainages. From 1989 to 2000, bull trout redd counts increased from 10 to 86 in Monture Creek and from 7 to 123 in the North Fork of the Blackfoot River (Pierce and Podner 2000 and Pierce et al. 2001, in CFBLLC 2003a). Juvenile bull trout populations also have increased substantively in both of these drainages. In Copper Creek, redd counts have remained stable throughout the same time period. Substantive increases in spawning activity have not been observed in secondary spawning streams (CFBLLC 2003a).

Bull trout were found throughout most of the upper Blackfoot River drainage during investigations conducted in 1996, with the highest densities in Copper Creek (Hillman and

Chapman 1996, in CFBLLC 2003a); however, much of the Blackfoot and Landers Fork channel in the area was characterized as unstable, aggraded, and with habitat limitations, including a lack of instream cover. Pierce and Podner (2000, in CFBLLC 2003a) reported that single-pass electrofishing catches of bull trout ranging from 2.4 to 8.5 inches long varied from 21 to 185 fish per river mile in the area.

High risk factors to bull trout sustainability in the Blackfoot River drainage include: mining, introduced fish species, habitat degradation from poor forest practices, poor grazing practices, rural residential development and detrimental water management practices, fish management activities, and habitat fragmentation caused by dams, road-crossing structures (e.g., culverts), and poor water and habitat quality (CFBLLC 2003a). Actual and potential mining risks to bull trout in the Blackfoot River drainage are primarily associated with past mining activities in the basin (MBTSG 1995b).

Key bull trout habitats have been altered by many different activities in the Blackfoot River subbasin (CFBLLC 2003a). Forestry practices have improved greatly over the last several decades. However, historical practices and some current practices interrupted long-term natural cycles key to bull trout habitat requirements. For instance, loss of and reduced recruitment of large woody debris and changes in stream channel morphology can result in increased maximum water temperatures, and the loss of other key habitat features. These conditions do not change immediately in response to a change in management practices, and without intervention may take centuries to recover (CFBLLC 2003a). Poor grazing practices can alter streamside vegetation, stream channel morphology, and many other bull trout habitat requirements for extended recovery periods without intervention. Water management practices may be one of the most underestimated causes of impacts on bull trout in the Blackfoot River subbasin, because of fish entrainment and mortality in irrigation systems and blockage of bull trout movements (Pierce et al. 1997, in CFBLLC 2003a). Residential development can adversely impact bull trout in many ways, including urbanization of stream banks, nutrient loading, altered hydrology, and changing valley and land use patterns.

Widespread forest canopy removal, loss of streamside shading vegetation, widened stream channels, and warm irrigation return flows have altered the historical temperature regimes in the Blackfoot and Clark Fork River drainages (CFBLLC 2003a). The magnitude of temperature increases is unknown because of the lack of historical temperature data, but it is expected at some level to have contributed to temperature regimes in the Blackfoot and Clark Fork rivers that now exceed the preferred temperature range of bull trout. These water temperature alterations may be critical to the persistence of bull trout (Pierce et al. 1997, in CFBLLC 2003a).

Reiman and McIntyre (1993) believe bull trout distribution is limited to areas where water temperatures are maintained at less than 59°F. Daily maximum water temperatures at five monitoring stations in the Blackfoot River exceeded 60°F annually from 1994 through 1996 (CFBLLC 2003a). Water temperatures that exceed the preferred temperature of bull trout may cause high mortality rates (Selong et al. 1998). Crowding of bull trout in thermal refuges also exposes the fish to added competition, stress, predation, and illegal harvest (CFBLLC 2003a).

Man-made structures that impede movements of migratory species pose a significant risk to fluvial bull trout in the Blackfoot River drainage. The Milltown Project, Inez fish barrier, and Rainy Lake fish barrier are three examples of barriers to bull trout movement (CFBLLC 2003a). The Milltown PM&E Plan began trapping and hauling bull trout over Milltown Dam in 1999. However, in most years trapping bull trout during their spawning migrations on the descending limb of the hydrograph is not possible with the existing facility. Improperly designed road-crossing structures, poor water quality, and long sections of poor habitat also have impeded movements of bull trout in the Blackfoot River drainage (CFBLLC 2003a).

The presence of Stimson Dam in the lower Blackfoot River also is reported to affect bull trout movements. This dam is located on the Blackfoot River at the Stimson Lumber Mill approximately 1 mile upstream from Milltown Dam. In the assessment of limiting factors to bull trout, the Bull Trout Draft Recovery Plan (FWS 2002) stated that Stimson Dam may be a seasonal fish passage barrier. EPA, MDEQ, and the Natural Resource Trustees subsequently determined that if Stimson Dam were removed this would allow for year-round upstream fish passage in the lower Blackfoot River and eliminate physical hazards that would otherwise occur from the lower water level once Milltown Dam is removed (EPA 2004).

Introduced fish species (brook, brown, and rainbow trout) represent risks to bull trout through hybridization (brook trout), predation, and competition (CFBLLC 2003a). Fish management activities by MDFWP, including fish stocking and fishing regulations, also may pose a risk to bull trout. Fishing regulations for rainbow and brown trout were designed to meet the goal of maximizing numbers of adult-sized fish. It is unknown whether this action has a positive or negative impact on bull trout (CFBLLC 2003a).

Non-compliance with a no-keep limit and with a no-intentional-fishing regulation for bull trout causes losses of bull trout in the Blackfoot River. A creel census completed in 1999 found that 8.2 percent of bull trout caught by anglers were harvested in the Blackfoot River (Schmetterling and Bohneman 2000). Angler inability to correctly identify bull trout contributes to this illegal harvest. Only 44 percent of anglers surveyed in west-central Montana correctly identified bull trout (Schmetterling and Long 1999).

Many bull trout restoration activities have been implemented in the Blackfoot River subbasin by several government agencies, private organizations, and individual landowners (CFBLLC 2003a). Restoration efforts have occurred in five of the seven core areas in this subbasin and in other streams that historically supported bull trout (Pierce et al. 1997, Pierce and Schmetterling 1999, Pierce and Podner 2000, in CFBLLC 2003a). Restoration activities have included placing fish screens on irrigation canal intakes, modifying riparian livestock management practices, removing barriers to fish movement, restoring habitat and controlling erosion, increasing stream flows, protecting spawning areas, and establishing perpetual conservation easements for managing land surfaces (CFBLLC 2003a).

3.5.3 Bull Trout Life History Characteristics

Bull trout in the Blackfoot River drainage exhibit all three life history forms. Fluvial bull trout are most common, completing their life cycle in the Blackfoot River, Clark Fork River, and second or third order tributaries to the Blackfoot River (Pierce et al. 1997, in CFBLLC 2003a). Bull trout in the upper Blackfoot River begin their upstream spawning migration in late July, later than bull trout in the lower Blackfoot River. Upper Blackfoot River fish migrate a much shorter distance than lower river fish, perhaps explaining the later migratory movements. Both groups of fish use spawning tributaries for approximately 64 to 67 days on average (Swanberg and Burns 1997). Adfluvial bull trout are present in the Clearwater drainage and lakes, and have recently been described as representing a separate core area within the Blackfoot River subbasin (FWS 2002, FR 2002). Bull trout in the Clearwater/Chain Lakes core area spawn and rear in tributaries, otherwise residing as subadults and adults in the lakes (CFBLLC 2003a).

Adult bull trout exhibit two types of downstream migratory behavior following spawning. Bull trout in the North Fork of the Blackfoot move downstream slowly throughout the winter. Fish from other tributary streams return rapidly to the exact location they occupied in the spring prior to their spawning migration. An intermittent river reach downstream of spawning areas in the North Fork of the Blackfoot, together with local adaptation by bull trout, may explain the delayed downstream movements of bull trout adults in the North Fork (CFBLLC 2003a). In addition to these movements, 8 percent of bull trout radio-tagged in the Blackfoot River moved downstream of Milltown Dam during the summer. These fish were larger than the non-migratory fish that remained in the mainstem over the summer. Bull trout that moved over Milltown Dam were probably sexually mature (Swanberg 1997).

Bull trout eggs incubate in stream gravels of spawning redds over the winter. Fry emerge the following spring generally from March to May, depending on local conditions (Weaver and White 1985, Weaver and Fraley 1991, Pierce et al. 1997, in CFBLLC 2003a). Juvenile bull trout appear to have multiple strategies for survival, most commonly dispersing in spawning streams, or moving to non-spawning streams (Peters 1990, Pierce et al. 1997, Pierce and Schmetterling 1999, Pierce and Podner 2000, in CFBLLC 2003a). Juveniles also disperse downstream as young-of-the-year from spawning tributaries into non-spawning tributaries.

3.5.4 Summary

Densities of adult and subadult bull trout in the lower Blackfoot River have been relatively low for the past decade. There have been substantive increases in the numbers of spawning and rearing juvenile bull trout in two key spawning streams—the North Fork of the Blackfoot and Monture Creek. In addition, pioneering of juvenile fish into currently unoccupied but historical spawning streams could eventually result in range expansion. Bull trout are a long-lived species, requiring from 5 to 7 years before females reach sexual maturity. Thus, long time periods are needed to fully understand current bull trout activities and trends. The lower Blackfoot River bull trout population with only two major spawning sites, and the upper Blackfoot River bull trout population with only one major spawning site remain at risk. In addition, bull trout spawning in some of the historically significant spawning streams that are tributary to the Blackfoot River, such as Belmont and Gold Creeks, may be lost because of very low population densities (CFBLLC 2003a). EPA, MDEQ, and the Natural Resource Trustees' restoration plan determined that in the lower Blackfoot River Stimson Dam will prevent upstream fish passage after the Milltown Dam is removed (EPA 2004).

3.6 Rock Creek and Tributaries

3.6.1 Subbasin Characteristics

Rock Creek is 51 miles long and empties into the upper Clark Fork River near the town of Clinton. Mean annual flow of Rock Creek near its mouth is 542 cfs for the period of record (1973 to 1999). The headwater reaches of Rock Creek consist of its four main forks (West, East, Ross, and Middle). The East Fork has an irrigation dam approximately 7 miles upstream of its confluence with the Middle Fork. Land uses important to this subbasin include watershed maintenance, silviculture, livestock forage production, hunting, fishing, hiking, mining, and sightseeing. Land ownership in the Rock Creek subbasin is 83 percent public and 17 percent private (MBTSG 1995a).

3.6.2 Bull Trout Distribution, Status, and Limiting Factors

Bull trout occur in all sections of the Rock Creek drainage, but are more common in the upper portion of the drainage (upstream of Welcome Creek). Tributaries known to contain bull trout include Gilbert, Brewster, Ranch, Spring, Welcome, Butte Cabin, Wahlquist, Cinnamon Bear, Cougar, Hogback, Wyman, Alder, Stoney, Little Stoney, Upper Willow, West Fork, Sand Basin, Boles, Moose Meadow, Middle Fork, Ross Fork, East Fork, Copper, Meadow, Carpp, and Meyers Creeks. The ability of migratory bull trout to access these tributary streams has contributed to the Rock Creek drainage's status as a bull trout stronghold (CFBLLC 2003a).

Annual redd counts in key reference spawning reaches have been used to monitor bull trout populations in the Rock Creek drainage. From 1996 through 1999, the total annual count of bull trout redds in the Rock Creek drainage varied from 363 to 670 redds (CFBLLC 2003a). Total annual redd counts in key reference spawning reaches of mainstem tributaries ranged from 110 to 168 redds during this same time. Wyman Gulch, Welcome, Ranch, Alder, Stony, and Little Stony Creeks consistently had the most redds counted among the mainstem reference tributaries (Reiland and Gerdes 2000 unpublished data, in CFBLLC 2003a). The Middle Fork of Rock Creek and contributing tributary streams, including Carpp, Copper, and Meyers Creeks, consistently had the highest redd counts in the drainage (CFBLLC 2003a).

Water temperatures in mainstem Rock Creek can exceed 70°F during late July or early August (Schmetterling 2000 unpublished data, Carnefix and Reiland 2000, in CFBLLC 2003a). Possible causes of elevated temperatures and potential adverse effects on bull trout are similar to those described for the Blackfoot River drainage. Channel braiding has occurred in significant sections of Rock Creek over the last 30 years and also can contribute to elevated temperatures. Habitat in the Middle and West Forks of Rock Creek is in poor condition, as indicated by few pools (less than 9 percent of the total available channel habitat) and sparse in-channel large woody debris (less than 1.3 pieces per mile) (Carnefix and Reiland 2000).

3.6.3 Bull Trout Life History Characteristics

Bull trout in mainstem Rock Creek exhibit resident, fluvial, and adfluvial life history forms. Adfluvial bull trout occur in East Fork Reservoir on the East Fork of Rock Creek. Fluvial and resident bull trout occur in tributaries to Rock Creek. Fluvial bull trout from Rock Creek enter tributary streams as early as April and as late as July, but for reasons apparently unrelated to spawning—perhaps as refuge from high stream flows (Carnefix and Reiland 2000). These same fish subsequently spawn in tributaries other than where they initially moved. Spawning-related movements appear to begin in mid-June. Bull trout from Rock Creek spawn in tributary streams in early September, then return to their original spring tagging locations in Rock Creek by mid-October.

Adult bull trout from Rock Creek also have been recovered downstream of Milltown Dam, as indicated by radio tracking studies (Swanberg 1996, Schmetterling 2000 unpublished data, in CFBLLC 2003a). From early June to August these bull trout move to spawning areas in Welcome Creek and Copper Creek within the Rock Creek drainage (CFBLLC 2003a).

Eighty percent of radio-tagged bull trout use the same or overlapping over-wintering ranges in successive years (Carnefix and Reiland 2000). Primary over-wintering habitat for bull trout consists of pools with cobble and gravel substrates and cover provided by overhanging vegetation, deep water, undercut banks, and large woody debris (CFBLLC 2003a).

3.6.4 Summary

Rock Creek supports one of the best fluvial bull trout populations in the Clark Fork River basin. Numerous interconnected tributaries and relatively good habitat conditions in several tributaries provide opportunities for spawning, summer thermal refuge, and year-round rearing that contribute to the well-being of bull trout. However, habitat in some sections of Rock Creek and its tributaries is in poor condition. High water temperatures in Rock Creek during July and August limit available habitat for bull trout and also may contribute to high mortality rates subsequently observed for spawning and post-spawning fish (CFBLLC 2003a).

Downstream movement of bull trout over Milltown Dam has been documented for Rock Creek fish. The magnitude of movement is difficult to evaluate because of the physical limitations on sampling fish in a river as large and complex as the Clark Fork. However, possible movements of juveniles over Milltown Dam may be a factor preventing tributaries in lower Rock Creek from showing improving trends similar to upper Rock Creek tributaries. It has not been determined if juvenile bull trout in lower Rock Creek tributaries move downstream as far as upper Rock Creek bull trout. If they do, most of the immigrating juvenile fish from the lower tributaries would travel downstream of Milltown Dam (CFBLLC 2003a).

3.7 Milltown Reservoir

3.7.1 Reservoir Characteristics

Milltown Reservoir was created by the construction of Milltown Dam from 1905 to 1907. The dam is located at the confluence of the Clark Fork and Blackfoot Rivers. Milltown Reservoir has a surface area of 180 acres and an estimated current storage capacity of 820 acre-feet at the normal operating elevation of 3261.8 feet above mean sea level (Curtis 1984). Aquatic habitat in the reservoir consists of extensive areas where water is less than

4 feet deep (WISI 2000). Milltown Dam is managed as a run-of-the-river facility, which maintains a relatively stable water elevation in the reservoir. The estimated water retention time in the reservoir is 3.4 hours. An inflow of only 1,200 cfs during low-flow periods increases the estimated retention time to about 8 hours, which is equivalent to the reservoir refilling three times daily.

Dam rehabilitation work completed from 1986 to 1989 restricts reservoir draw down to about 12 feet below normal operating pool, depending on reservoir inflows. During high water, maintenance, or emergency situations, such as the 1996 ice flow event, stanchions on the spillway can be tripped to increase spill capacity. The reservoir must be drafted at least 6 feet below normal operating elevation to reset the stanchions.

Since the construction of Milltown Dam, sediment transported by the upper Clark Fork River, the Blackfoot River, and their tributaries began settling in Milltown Reservoir. Mining activities in the Butte and Anaconda areas have released an estimated 19 million cubic yards of metals-contaminated tailings and sludge into the Clark Fork River (ARCO 1998). This material has been incorporated into the river bed, floodplain, and Milltown Reservoir (Brook and Moore 1988, and Johnson and Schmidt 1988). Harding Lawson Associates (1987) estimated that 6.6 million cubic yards of sediment have deposited in the reservoir. The concentration of metals in these sediments varies with depth of sediment, size of sediment particles, and location. Over the long term, sediment and metals input to Milltown Reservoir is balanced by output (Lambing 1998).

Bull trout in the BA assessment area are potentially exposed to dissolved and particulate contaminants associated with tailings, mine, and milling wastes that have been transported downstream from the upper Clark Fork River drainage. Bull trout can be exposed to these contaminants in the water column, in reservoir sediments, and in foods they consume (e.g., benthic invertebrates and fish). The EPA defined five contaminants in the Milltown Reservoir area as being ecological chemicals of potential concern (ECOPC) to aquatic receptors in water and sediment. The five ECOPC are arsenic, cadmium, copper, lead, and zinc (CH2M HILL 2000). Results of baseline and addendum ecological risk assessments that evaluated the potential effects of contaminants in Milltown Reservoir on aquatic receptors are summarized below. Other Milltown Dam and Reservoir-related effects on bull trout associated with upstream and downstream fish passage, reservoir habitat and drawdown, and northern pike that were discussed in previous sections of this chapter and/or in *Chapter 1, Section 1.1, Background and History* are noted in the following discussion.

3.7.2 Results of Milltown Reservoir Baseline Ecological Risk Assessment

Previous environmental assessments related to contaminants in Milltown Reservoir indicated low to moderate risks to aquatic receptors in Milltown Reservoir (ETI 1993) and little to no risks to aquatic receptors downstream of Milltown Dam (ETI 1994). The following italicized text, paraphrased from CH2M HILL (2000), summarizes some of the findings of the Milltown Reservoir Baseline Ecological Risk Assessment (ETI 1993) as they relate to aquatic habitat and receptors during typical meteorological conditions and normal operation of Milltown Dam. These findings help define aquatic baseline conditions in the assessment area and are valuable in assessing the potential effects of the Proposed Action on bull trout.

Biological Effects Assessment of Aquatic Habitat

Aquatic habitat in Milltown Reservoir was evaluated by sediment toxicity bioassays and toxicity tests with emergent vegetation and amphibians.

Whole sediment samples were toxic to aquatic species. Sensitivity to sediments was ranked from most to least sensitive as Hyalella azteca > Chironomus riparius > Rainbow trout > Daphnia magna.

Amphipod toxicity tests identified sediment from six of seven reservoir stations as toxic (toxicity expressed as sublethal effects with a shift to metals-tolerant taxa rather than decreased abundance or diversity, and decreased amphipod length and/or sexual maturation compared to controls).

Limited toxicity bioassays on amphibians using reservoir surface waters demonstrated no acute effects on survival or growth. Morphological effects were noted in specimens exposed to samples with elevated concentrations.

Subtle effects such as stimulation of shoot growth and of peroxidase enzyme were observed with emergent aquatic plants exposed to sediments from two of six locations tested.

Ecological Studies of Aquatic Habitat

Ecological studies of the aquatic environment consist of the benthic community structure analysis performed by FWS (Ingersoll, et al. 1993) in conjunction with the sediment toxicity studies, observations of aquatic plants and amphibians from the wildlife survey, and semiquantitative fish population studies for Milltown Reservoir.

Benthic organisms were present at all depositional stations in the reservoir. Total abundance of organisms did not correlate with concentrations of metals in the sediment samples.

Oligochaeta and Chironomidae accounted for over 90 percent of the benthic invertebrate community abundance at all stations in the reservoir. Taxa were primarily pollution tolerant; no intolerant species of Oligochaeta were collected at any stations.

Higher numbers of Chironomidae genera were present at stations with higher concentrations of metals in sediment samples. Scientific literature suggests that the numbers of Chironomidae genera increase in response to metal or organic contamination. (Note, however, that the total number of invertebrate taxa also was higher at more contaminated locations.)

Limited visual observations of aquatic plant communities suggested relatively high biomass and species diversity of emergent plants in the reservoir.

Limited visual observations of amphibians suggested good species abundance.

Fish populations in Milltown Reservoir, especially of trout, are lower than in other sections of the Clark Fork River of comparable length. Population impacts are primarily due to the effect of Milltown Dam on migration and food sources, with some contribution from exposure to metals-contaminated invertebrates as food sources.

Ecological Risks to Aquatic Habitat

Risks to the aquatic environment at Milltown Reservoir for sediment benthos and fish are summarized in the following text. The evaluation of risks to fish is limited to reservoir populations.

Sediment Benthos

Sediment benthos were assessed by evaluating and ranking results of sediment chemistry, benthic community structure, and sediment toxicity.

Samples from two of seven locations in the reservoir were classified as having elevated chemistry, toxicity, and impacted benthos, i.e., evidence of metals-induced degradation. Both these stations were also under oxidizing conditions.

Samples from another location with elevated chemistry were classified as showing no evidence of metals-induced degradation.

Samples from three locations with relatively low metals contamination were classified as toxic, but toxicity may be partially related to something other than metals, such as ammonia concentrations in pore water or the presence of polychlorinated biphenyls (PCBs) or polycyclic aromatic hydrocarbons (PAHs).ETI (1993) reported in the baseline ecological risk assessment (BERA) that the past dumping of chemical wastes into the Blackfoot River may explain a possible source of these chemical contaminants in Blackfoot River sediments.

The sample from the seventh location was classified as having metals concentrations that may be stressing the system.

Since sediment factors affecting bioavailability of metals (i.e., acid volatile sulfide [AVS}, organic carbon) may have differed with seasonal sampling events, a lowering of these factors with a seasonal event may increase bioavailability of metals and potentially their adverse affects.

The overwhelming dominance of sediment benthic communities by Oligochaeta and Chironomidae is not unusual for metals-impacted benthic invertebrate communities. The correlation of a higher number of Chironomidae genera with increasing metals concentrations (i.e., Stations MR-11 and MR-19) may be explained by the intermittent disturbance hypotheses and life-history strategies in Chironomidae.

Fish

Potential factors that may contribute to decreased fish populations in Milltown Reservoir include habitat limitations, such as few riffles and lack of bank cover and woody debris, and the presence of Milltown Dam. The fishery in the Clark Fork River (CFR) upstream and downstream of Milltown Dam is impacted by year-round blockage of migrant trout (bull, cutthroat, rainbow, and brown) resulting in inaccessibility to upstream tributaries for spawning and rearing. (Note: A fish trap and haul program was implemented at Milltown Dam subsequent to the preparation of this baseline risk assessment). The reservoir caused by the dam reduced riverine habitat and may cause increased predation of juvenile trout by northern pike and northern pikeminnow residing in the reservoir, further limiting reproductive and recruitment opportunities for a trout fishery. In addition, some of the juvenile trout that try to migrate below Milltown Dam can be injured or killed when passing through the dam's turbines. The Milltown Fisheries Technical Working Group estimated that the CFR could support 894 trout per mile if river blockage due to the dam and other impacts (e.g., dewatering and blockage of spawning tributaries, streamside degradation due to agriculture, and upstream metal contamination) were removed. Present trout density in the CFR upstream of the dam is estimated at 300 trout per mile. ETI (1993) reported in the BERA that Montana Power Company (MPC) estimated that Milltown Dam is responsible for about 50 percent of the reduced trout production in that portion of the CFR (presumably upstream of Milltown Dam). Factors responsible *for the remaining 50 percent reduction were not identified, but would include contaminant-related impacts.*

Fish in Milltown Reservoir also may be impacted by sediment metals. Early lifestages of fish in the CFR depend on macroinvertebrates as a food source. Studies by the U.S. Fish and Wildlife Service on the CFR, upstream of Milltown Reservoir, have shown that a diet of metals-contaminated invertebrates from the CFR can result in decreased growth and survival of rainbow trout (FWS 1993). Like fish populations in the CFR, fish in the reservoir also may also be exposed to contaminated macroinvertebrate food sources. Thus, the elevated metals in reservoir sediments likely add further stress to the reservoir populations of fish, compounding the habitat impacts from the presence of Milltown Dam.

Summary of Aquatic Risks Characterization

The sediment benthos were the most studied of habitats in Milltown Reservoir. The weight of evidence from chemistry, ecology, and toxicity studies suggests that benthic invertebrate communities in the reservoir are at risk for impacts from metals-contaminated sediments at a range of ratios of simultaneously extracted copper concentrations normalized to AVS concentrations between 0.4 and 3.7, or at a range of extractable copper of 230 to 350 micrograms per gram. An imbalance in benthic invertebrate communities is associated with elevated metals contamination of sediments in oxidizing environments where AVS concentrations are low.

Fish populations in Milltown Reservoir are below the CFR carrying capacity estimated for that river segment in the absence of Milltown Dam. Fish and invertebrates in Milltown Reservoir are contaminated with metals. The consumption of contaminated diet may impart stress to trout populations, in addition to the effects of Milltown Dam on habitat availability.

Ecological Significance of Aquatic Risk Assessment Findings

For aquatic habitat, the chemical exposures in sediments and the factors governing metals bioavailability generally correlated with toxicity to benthic invertebrates and impacted benthic community structure. The correlation of increased number of genera of Chironomidae with increases in extractable metals reflects an imbalance in benthic community structure. Such an imbalance has not been as thoroughly evaluated for its effects to the local ecology. Overt effects such as decreased species diversity in the community are not apparent in Milltown Reservoir sediments.

Although the sediment ecology is imbalanced at those impacted stations, it is unknown whether other ecological parameters, such as predator-prey relationships, may subsequently be affected by this imbalance. The ecological effects of other impacts at the reservoir, such as the presence of Milltown Dam and altered fish migration and recruitment, likely play a major role in regulating the fish populations of Milltown Reservoir. ETI (1993) reported in the BERA that studies by MPC have shown the possible impact of the dam on fish populations of the reservoir, yet a variety of fish species was found in the reservoir during qualitative observations. In addition, the water-fowl survey suggested that the populations of Canada Geese and a variety of ducks are healthy and reproducing. No evidence was observed of impacted sediment invertebrates affecting the health of waterfowl in the reservoir wetland. The ecological significance of impacted benthic invertebrates in the reservoir is likely more important to the fishery population through the potential for trophic transfer of metals to those fish that consume aquatic insects.

3.7.3 Results of Milltown Reservoir Sediments Operable Unit Ecological Risk Assessment Addendum

The baseline ecological risk assessment (ETI 1993) noted that episodic high flows altered the concentrations of metals in waters of the Clark Fork River and Milltown Reservoir because of mobilization of dissolved and particulate metals in bed sediments and mobilization of dissolved metals from upstream tailings-related evaporite deposits. However, subsequent concerns about exceedences of ambient water quality criteria during the very unusual February 1996 ice scour event (when the Milltown Dam spillway was opened to prevent possible structure damage) and the spring 1997 high flow event led EPA to conclude that further evaluation of risks to ecological receptors caused by episodic events of these types was warranted. EPA's goal for the ecological risk assessment addendum (CH2M HILL 2000) was to evaluate the potential for acute and chronic toxic effects on fish and aquatic invertebrates in the Clark Fork River downstream of Milltown Reservoir that could be caused by elevated concentrations of metals being discharged from the reservoir. The addendum noted that risks are probably greatest in the reach of the Clark Fork River immediately downstream of Milltown Dam because of additional dilution by the Bitterroot River just below Missoula.

Four sections of text from the risk assessment addendum (CH2M HILL 2000) are presented verbatim in the following italicized discussion. These sections contribute to an understanding of baseline conditions in the assessment area and are especially valuable in assessing potential effects of the Proposed Action on bull trout. The first section of text lists contaminant-related problems that were identified in the risk assessment addendum. The second section is particularly applicable to this BA because it addresses predicted hazards under baseline conditions to threatened, endangered, and sensitive fish species, including bull trout. The third section of text provides further discussion on the condition of aquatic resources in the assessment area by considering other lines of evidence. The fourth section of text presents the overall risk summary to aquatic receptors for the conditions evaluated in the risk assessment addendum.

Problems

Milltown Reservoir has received and continues to receive inputs of metals from the Clark Fork River.

Metals input varies seasonally and annually and is positively correlated with suspended solids discharge (Hornberger et al. 1997).

Suspended solids input and metals input are both positively correlated with total and peak river discharge (Hornberger et al. 1997).

Most of the metals input (particularly copper) is as total recoverable metal (Hornberger et al. 1997).

During some years there is a net accumulation of sediment measured as suspended solids and metals in Milltown Reservoir (Hornberger et al. 1997); but over the long term, input and output are balanced (Lambing 1998).

Concentrations of metals in sediment of Milltown Reservoir are greater at depth than at the sediment surface (ETI 1993).

During the ice-scour event in February 1996 and spring high flows in 1997, there were net discharges of metals and sediment from Milltown Reservoir (Lambing, 1998,).

Concentrations of metals in fine-grained bed sediment in the Clark Fork River vary somewhat from year to year, but are likely to reflect long-term conditions (Hornberger et al. 1997; Dodge et al. 1997), but fine-grained sediments comprise a small part of the total bed sediments.

Aquatic receptors are exposed to higher metals concentrations in water downstream from Milltown Reservoir during episodic events (Dodge et al. 1997; Lambing 1997).

Predicted Hazard to Threatened, Endangered and Sensitive Fish Species

As noted earlier, two species of fish in the Clark Fork River are of special concern: the bull trout (Salvelinus confluentus), which was listed as threatened by the US Fish and Wildlife Service on June 10, 1998, and the westslope cutthroat trout (Oncorhynchus clarki lewisi), which is of special concern to the State of Montana and has recently been petitioned for listing under the Endangered Species Act. Limited data suggest that bull trout may once have been common in the upper Clark Fork River (Montana Bull Trout Scientific Group 1995). Currently, bull trout densities are low, but large adults still persist (Peters 1985).

Acute toxicities of cadmium and zinc to bull trout were tested in comparison to rainbow trout in side-by-side tests (Stratus Consulting, 1999a, 1999b,). Acute tests indicated that bull trout are similar to, or less sensitive than rainbow trout to cadmium and zinc. Chronic toxicity of cadmium was greater to bull trout at low hardness, and the tests indicated the possibility of some mortality and reduced growth at the national chronic criterion for cadmium at a hardness of 30 mg/L as Ca CO_3. A presentation (poster) of results of acute testing of effects of copper on bull trout (Hansen, et al. 1999) indicated that bull trout are less sensitive to copper than rainbow trout. Results of range-finding tests of acute toxicity of cadmium, lead, and zinc to field-collected westslope cutthroat trout and hatchery-reared westslope cutthroat and rainbow trout were reported by EVS Environmental Consultants, Inc (EVS 1998). Westslope cutthroat trout collected from a stream where some exposure to elevated metals was possible were less sensitive to all three metals than hatchery-reared westslope cutthroat or rainbow trout. Hatchery-reared westslope cutthroat trout were more sensitive to cadmium and lead and less sensitive to zinc than hatchery-reared rainbow trout were.

Based on a review of published studies, Chapman (1999) concluded that most salmonid species tested, including Chinook and coho salmon, brook trout, and brown trout, have an acute sensitivity to copper that is no greater than that of rainbow trout. As a result, it is reasonable to conclude that acute TRVs for the protection of rainbow trout will be protective of bull trout. Thus, the acute HQ and HI values calculated for exposure of rainbow trout to typical concentrations of copper (see Table 6-3, left section of CH2M HILL [2000]) are likely to be applicable to bull trout.

Data on the chronic toxicity of copper on rainbow trout and brook trout are more limited than for acute toxicity, and relative sensitivities are more difficult to judge. Based on the similarity in acute toxicity, it might be postulated that chronic toxicity is also likely to be similar across species. If so, the chronic HQ and HI values calculated for rainbow trout would be applicable to bull trout as well. However, Chapman (1999) noted that limited chronic toxicity tests in brook trout (Sauter et al. 1976) identify chronic toxicity values for copper that are lower than those for rainbow trout. Because brook trout are in the same genus as bull trout (Salvelinus), Chapman concluded that the most appropriate chronic TRV for bull trout (based on an EC2O) was several-fold lower than the estimated value for rainbow trout. Based on this, chronic HQ and HI values for bull trout that would be higher than those shown in Table 6-3 of CH2M HILL (2000) by a factor of about 24 (depending on hardness), and *exceedences of both the acute and the TRVs would occur with increased frequency. However, the tests performed by Sauter et al. (1976) in brook trout were at a pH of 6.6-7.1, which is considerably more acidic than most toxicity tests using rainbow trout (and more acidic that typical values found in the Clark Fork River), and this difference in test condition could account for the apparent difference in toxicity between species. This is supported by the observations of McKim et al. (1978), who performed early life-stage tests for several species of salmonid (two in the genus Salvelinus, one in the genus Salmo, and one in the genus Oncorhynchus), and found that both of the Salvelinus species were less sensitive, not more sensitive, than Oncorhynchus (rainbow trout). This supports the hypothesis that bull trout and rainbow trout are likely to have similar sensitivity to copper under both acute and chronic exposure conditions.*

As noted above, bull trout are currently rare in the Clark Fork River, and their overall abundance in the northwest is tending to decrease as the result of a number of physical and biotic factors (Watson and HilIman 1997, Swanberg 1997). Because of this general population decline, it is important that all individuals in the existing bull trout population be protected from risk of death or toxicity. Therefore, levels of metal exposure that may be acceptable for the protection of rainbow trout and/or brown trout populations may not be acceptable for bull trout or other species of special concern. For acute effects, the acute TRV corresponds to an LCO (ENSR 1999a), so little if any added margin of safety factor is needed here. With respect to chronic toxicity, ENSR (1999b) estimated that a factor of about 1.3-fold was adequate to extrapolate from an IC20 (the basis of the chronic TRV) to an ICO for rainbow trout. Chapman (1999) estimated that a factor of about 2 was appropriate. Based on this, HQ values for individual bull trout based on an ICO would be about 30 to 100 percent higher than those shown in Tables 6-3 and 6-4 of CH2M HILL (2000).

Because the westslope cutthroat is the same genus (Oncorhynchus) as rainbow trout, it is considered likely that the results for rainbow trout are applicable to this species as well. This is supported by the findings of Dwyer et al. (1995), who reported that three other species of listed salmonids (all of the genus Oncorhynchus) are similar in sensitivity to copper exposure as rainbow trout.

Based on these considerations, it is deemed likely that the acute hazards to the bull trout and the westslope cutthroat trout from metals in the Clark Fork River below Milltown Dam are similar to the risks estimated for rainbow trout. That is, typical concentrations are unlikely to be of concern, but both species could be subjected to stress during extraordinary occasions such as the 1996 ice scouring event.

In considering the potential hazard to bull trout from exposures in the Clark Fork River, it is important to note that this species spawns in tributaries, and most reports indicate that fish do not generally migrate from the natal stream into the mainstem until they are several years old (e.g., Fraley and Shepard 1989, Pratt 1992). The potential significance of this behavior is that, because older (migratory) fish are less sensitive to the toxic effects of metals than are fry (see TRV discussion, above), the hazard of injury or death may be overestimated by calculations based on toxicity tests in 0.4 g fry. Fish below Milltown Dam are recruited from tributaries downstream because upstream access is blocked by the dam. McPhail and Murray (1979) noted circumstantial evidence for annual out-migration of bull trout fry, and direct evidence of this phenomenon has recently been reported by Reiser et al. (1997). Thus, at least some fraction of the young-of-the-year probably do enter the mainstem, so HQ values calculated using TRVs for fry are likely to be applicable to this subpopulation. With respect to fish that do not migrate until they are older (and less sensitive), it is important to recognize that there is still a risk of some stress associated with ice-scour events. Moreover, repeated loss of migratory individuals from historic or current pulse events could ultimately result in a diminution or loss of this phenotypic behavior in the population.

An additional issue of potential concern is that bull trout, like rainbow and brown trout, are likely to have a preference for avoiding water that contains levels of metals similar to those found in the Clark Fork River (Woodward, et al. 1995). If so, this avoidance response could interfere with the normal migratory behavior of this species as individuals seek to move from tributaries into the mainstem of the Clark Fork River. (Note: The Milltown Dam Operations Internal Draft BA also noted that bull trout would probably bioaccumulate some metals more than other Clark Fork River salmonids because of their longer life expectancy (greater exposure) and piscivorous feeding habits (food chain bioaccumulation) (Moore et al. 1990, in CFBLLC 2003a).

Other Lines of Evidence

Fish kills like those noted in previous years on the upper Clark Fork have not been observed below Milltown Dam. However, high flows and associated turbidity could make fish kills difficult to observe. Data from the State of Montana (Berg 1996), indicate decreases in densities of both brown and rainbow trout below Milltown Dam between 1995 and 1996. Total catchable trout (>8 inches) decreased from 425 to 162 per mile, while the declines of juvenile brown and rainbow trout (<8 inches) were 70 and 85 percent, respectively. Several possible causes for the observed declines have been noted including, metals, sampling conditions, and physical effects of ice and sediment (R2 Resource Consultants Inc. 1998). Unpublished data provided by the State of Montana (Don Skaar, November and December 1999) indicate some recovery of trout populations in subsequent years. It should be noted that trout populations in tributaries to the Clark Fork, including the Blackfoot River and Rock Creek were also lower in 1996. The size-distribution of fish collected in 1999 shows that while the juvenile fish numbers had rebounded to 1995 levels, the adult numbers were still reduced. This may be a reflection of the reductions to juvenile fish numbers in 1996 (unpublished data from MDFWP).

During the 1997 high spring flows MDFWP exposed caged rainbow trout above and below Milltown Dam and at reference locations (Skaar and Hill, 1999 draft). During the 40-day exposure, survival, growth, and some physiological indicators were measured in the trout, and total and dissolved metals measured in the water. The results provided no clear indication that exposure to the metals had an effect on survival, growth or health of the fish. The authors suggested that effects may have been seen if smaller fry had been used, if the exposure had been longer, or if the exposure had included a dietary source of metals.

Aquatic resources in the Clark Fork River below Milltown Dam include periphyton and benthic invertebrates. The benthic invertebrates are well represented in the toxicity data base used to develop the national criteria, and are also discussed above with respect to risks from bed sediment; but plants, and periphyton in particular, are less represented in the data used to develop the national criteria. A pollution index used as part of long-term monitoring of periphyton in the Clark Fork River indicates that in the reach below Milltown Dam, periphyton are unimpaired by pollution, but showed some impairment by siltation, as did the Blackfoot River and the Clark Fork above Milltown Dam (Weber 1998). The lack of significant impairment caused by metals below Milltown Dam has been consistent from 1989 to 1998 (Weber 1999).

Long-term monitoring of benthic macro-invertebrates in the Clark Fork also suggests little to no adverse effects of metals below Milltown Dam. In August 1996 the monitoring of biotic integrity of benthic invertebrates showed no impairment by metals below Milltown Dam (McGuire 1998),or at Turah Bridge indicating that metals effects on biota living on riffles was not evident at these locations six months after the ice-scour event. A similar absence of impairment by metals was observed in 1997 and 1998, except for slight metals impairment at Turah Bridge in 1997 (McGuire 1999).

Risk Summary

During rare events, such as the 1996 ice scour event, copper may cause low to moderate risks to aquatic life from exposure to water below Milltown Dam. Normal high flow events may pose an intermittent low level chronic risk to fish due to the combined impacts of copper and other metals in the water column, and copper in ingested macroinvertebrates. Any chronic effects would be less than those that occur at Turah Bridge because of the dilution of metals by the Blackfoot River during normal high flow events. It is not known whether the slight chronic effects below the dam are sufficient to contribute to the reduced populations of trout, which may be significantly impacted by other factors including degraded habitat and the lack of passage upstream at Milltown Dam. State standards for total recoverable metals were exceeded frequently, but site-specific evidence such as macroinvertebrate population indices, levels of metals fine-grained bed sediment, absence of observable effects of metals in caged fish studies, and general trends in trout populations suggest that risks are actually low except on rare occasions when total recoverable metals concentrations, particularly copper, are extremely high.

Arsenic and cadmium in water pose no significant risks, and risks from lead and zinc are absent to low.

There were no significant risks to benthic invertebrates from exposure to metals in sediment downstream from Milltown Dam.

Some metals, such as cadmium and lead, may potentially bioaccumulate in trout. However, the hazard quotients (HQs) calculated from metals concentrations in invertebrates below Milltown dam divided by the lowest-observed-adverse-effects concentrations (LOAECs) of metals in the diet of fish were below one. (HQs below one indicate the measured concentrations were less than the LOAEC values). Concentrations of metals in invertebrates in 1996 (used to calculate the HQs) were somewhat higher than long-term trends for the Clark Fork River below Milltown Dam, possibly reflecting the greater fluxes of metals during 1996.

Hazard indices (HIs) calculated by combining the HQs from chronic exposure to water combined with exposure to contaminated food were slightly larger than the HQs for exposure to water only, but were still in a low to moderate risk range.

It should be noted that the analysis and risk assessment results presented for the ice scour event in February 1996 may not represent worst-case conditions, because sampling did not occur at the peak of the event.

3.7.4 Effects of Suspended Sediment on Aquatic Resources

Results of ecological risk assessments discussed in the preceding text indicate that risks to aquatic resources within and downstream of Milltown Reservoir are typically low. Exceptions can occur during rare, high-flow events when increased concentrations of copper can cause low to moderate risks to aquatic life from exposure to water below Milltown Dam and during normal high-flow events when increased metals levels may pose an intermittent, low-level chronic risk to fish. The risk assessments did not specifically identify increased concentrations of suspended sediment or total suspended solids (TSS) during normal high-flow or rare-flow events as independently posing a risk to aquatic resources. However, it has been reported widely in the literature that increased suspended sediment concentrations can have adverse effects on aquatic organisms and result in the degradation or loss of aquatic habitat.

These possible effects are described in two subsections in the following text, primarily for use in *Chapter 4, Effects of the Action,* to assess the potential effects of the Proposed Action on bull trout and on their proposed designated critical habitat. The first subsection is a literature review prepared by CH2M HILL on suspended sediment effects on fish. The literature review is presented verbatim from CH2M HILL in the following italicized text. The second subsection discusses predictive models available for assessing effects of suspended sediment on aquatic resources.

Suspended Sediment Effects on Fish: A Literature Review

This literature review was conducted to gain pertinent literature information regarding the potential effects of suspended sediments on fish, primarily salmonids. Effects of suspended sediments on fish include effects on fish behavior, effects on fish physiology, and effects on fish habitat.

Suspended sediments are usually silt and clay particles that are between 2 and 60 micrometers (µm) in diameter. Suspended sediments can be directly measured as total suspended sediment (TSS) in milligrams per liter (mg/L) but are frequently measured indirectly as turbidity. Turbidity is the optical property of water resulting in a loss of light transmission caused by absorption and scattering. Turbidity is typically measured in Nephlometric Turbidity Units (NTUs). Regression equations correlating turbidity and TSS (Sigler et al., 1984; Lloyd et al., 1987, and Scannell, 1988) have been published, but these correlation's are typically site-specific (Rowe et al., 2003; Duchrow and Everhardt, 1971; Kunkle and Comer, 1971). While suspended sediments are often the main contributors to turbidity, other nonsediment sources that affect light transmission (that is, natural tannins and algae) can also influence turbidity. Most recent literature studies on suspended sediment effects report TSS.

The scientific data regarding the effects of suspended sediments on fish have been derived from laboratory experiments (for example, artificial channels with variable TSS conditions); observations of natural systems (for example, population comparisons between habitats differentially influenced by TSS); and in situ experiments (for example, caged fish exposed to variable TSS conditions). Because of the variable approaches and methods used in these studies, generalization and extrapolation of their results to specific areas of concern must be made with caution.

Influences on individual fish, fish populations, and fish communities have been associated with stream TSS loads and turbidities. The TSS influences on fish reported in the literature range from beneficial to detrimental. Elevated TSS conditions have been reported to enhance cover conditions and reduce piscivorous fish and bird predation risks. Elevated TSS conditions have also been reported to cause physiological stresses, reduce growth, and adversely affect survival. Significant suspended sediment levels have been observed to alter fish community composition from salmonid to nonsalmonid fish (for example, creek chub), which better tolerate or prefer more turbid water (Gradall and Swenson, 1992).

Of key importance in considering the effects of TSS on fish are the frequency and the duration of the exposure (not just the TSS concentration) (Newcombe and Jensen, 1996). Adverse effects can become more pronounced with increased TSS concentrations and longer exposure durations in aquatic systems where elevated TSS conditions occur infrequently. In systems where elevated TSS conditions occur more frequently, fish can become acclimated to increased TSS levels and adverse affects can be less pronounced or nullified. Newcombe (2003) created a model that takes into account duration of exposure and suspended sediment concentration to project possible effects on fish. The model is

$$SEV = -4.49+0.92(\log_e x)-2.59(\log_e y)$$

where SEV is severity of ill effect, x is duration of exposure (hours), and y is black disk sighting range (meters), a vertical measure of optical water quality. SEV is ranked 0 to 14 on a 15 step scale, where 0 represents nil effect and 14 represents 100 percent mortality (Newcombe and Jensen, 1996). Table 2 describes the SEV scale and corresponding effects.

Table 2. Severity of Ill Effects Scale and Corresponding Effects on Salmonids.

SEV	*Description of Effect*
	Nil effect
0	*No behavioral effects*
	Behavioral effects
1	*Alarm reaction*
2	*Abandonment of cover*
3	*Avoidance response*
	Sublethal effects
4	*Short-term reduction in feeding rates; short-term reduction in feeding success*
5	*Minor physiological stress; increase in rate of coughing; increased respiration rate*
6	*Moderate physiological stress*
7	*Moderate habitat degradation; impaired homing*
8	*Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition*
	Lethal and paralethal effects
9	*Reduced growth rate; delayed hatching; reduced fish density*
10	*1-20% mortality; increased predation; moderate to severe habitat degradation*
11	*>20-40%mortality*
12	*>40-60% mortality*
13	*>60-80% mortality*
14	*>80-100% mortality*

The size and type of suspended particles can also influence the degree of effects on fish (e.g., larger particles [>75 µm] can be more abrasive and have more adverse effects). Interpretations of TSS influence on aquatic organisms can also be confounded if the suspended sediments contain toxins (e.g., metals or pesticides).

In general, elevated TSS conditions can influence fish in the following ways:

- *Behavioral effects: avoidance (holding or migration changes), attraction (TSS as cover; reduced predation risk), reduced feeding success, increased "coughing" or "gill flaring"*
- *Physical effects: stress, tissue damage, reduced growth, mortality*
- *Habitat effects: increased sedimentation, fill gravel interstitial spaces, decrease intergravel dissolved oxygen concentrations, decrease residual pool volumes, decrease spawning and emergence success*

Behavioral Effects

High levels of sediment can reduce light penetration and inhibit primary production, abrade and clog fish gills, prevent feeding by sight feeders, stop migration, and cause fish to avoid the use of turbid reaches. Increased turbidity generally reduces visibility and decreases the ability of sight-feeding fish to obtain food (Berg and Northcoat, 1985) and thus reduces feeding habitat.

Avoidance is the primary fish behavioral response to locally turbid water. Avoiding areas with elevated TSS or turbidity may lead to fishless reaches in natural systems (DeVore et al., 1980; Birtwell et al., 1984; and Scannell, 1988). All life stages of salmonids have been observed to prefer clear water when given the option of clear or turbid water (Bisson and Bilby, 1982). Salmonids move laterally (Servizi and Martens, 1992) and/or downstream to avoid turbid areas (McLeay et al., 1984, 1987). Avoidance of turbid water may begin as turbidities approach 30 NTU (Sigler et al., 1984; Lloyd, 1987). Servizi and Martens (1992) noted a threshold for the onset of avoidance at 37 NTU (300 mg/L TSS). However, Berg and Northcoat (1985) provide evidence that juvenile coho salmon did not avoid moderate turbidity increases when background levels were low, but exhibited significant avoidance when turbidity exceeded a threshold that was relatively high (>70 NTU). At turbidities of between 10 and 30 NTUs there is generally altered behavior, avoidance and a reduction in feeding rates over the course of 24 hours (Rowe et al., 2003). At chronic (continuous) exposures as low as 15 NTUs survival rates of some species have been effected. Other species have experienced reduced growth rates at chronic exposures of 22 NTUs (Rowe et al., 2003).

Salmonids experience a loss of habitat by avoiding turbid water. High turbidity levels may cause abandonment of traditional spawning habitat, displacement from current habitat, and underutilization or avoidance of available habitat. Salmonid migration may be interrupted or blocked in the fish's attempt to avoid turbid water (Newcombe and Jensen, 1996).

Turbid water can be beneficial in somewhat low concentrations and act as cover to protect fish from predation. Fish that remain in turbid water experience a reduction in predation from piscivorous fish and birds (Gregory and Levings, 1988). In systems with intense predation pressure, this provides a beneficial trade-off (e.g., enhanced survival) to the cost of potential physical effects (e.g., reduced growth). A study done regarding the effects of turbidity on predation showed that prey are more active in turbid water and utilize areas in the turbid water column that would otherwise be unsafe in clear water. The results of this study show that turbid water acts as protective cover and allows fish to exist in otherwise more "riskier" habitat (Gregory, 1993). Turbidity levels of about 23 NTU have been found to minimize bird and fish predation risks (Gregory, 1993).

Other effects of turbidity on the predator-prey relationship are reaction distance and prey recognition (Rowe et al., 2003). Reaction distance is a negative linear function of turbidity, decreasing 2-2.3 percent for each increase in turbidity unit (Barrett, 1992). Turbidities greater than 25 NTU or suspended sediment concentrations from 2,000 to 3,000 mg/L can decrease the visual acuity of *predatory fish, leading to reduced feeding rates (McLeay et al., 1984, 1987; Redding et al., 1987; and Reynolds et al., 1989) and reduced growth (Sigler, 1984). Researchers hypothesized that turbidity lowers prey-background contrast so predators cannot see prey as well (Rowe et al., 2003; Miner and Stien, 1993). Perceived lack of recognition may be attributed to feeding desperation. Due to lower encounter rates, and consequently lower predator feeding rates, predators may be more desperate for food and pursue anything that resembles prey (Crowl, 1989).*

Turbid water may also have indirect effects on salmonid feeding rates. Cloudy water diminishes the extent to which light can penetrate and decreases the volume of the photic zone (Rowe et al., 2003; Lloyd, 1987). Decreased light penetration reduces local primary production, which can trigger a cascade of impacts from one trophic level to the next, involving phytoplankton, zooplankton, insects, freshwater mollusks, and fishes (Rowe et al., 2003; Newcombe, 2003). Furthermore, Rowe et al. (2003) state that in slow moving waters suspended materials can increase absorption of solar energy near the surface causing the heated upper layers to stratify reducing the dispersion of dissolved oxygen and nutrients to lower depths. A study of the effect of clay on a New Zealand stream it was suggested that restriction in light penetration may be an important mechanism by which fine inorganic solids damage streams (Rowe et al., 2003).

Additional behavioral effects include "gill flaring" and "coughing" responses. These responses increase in frequency at higher suspended sediment concentrations (30 to 60 NTU, Berg and Northcote, 1985; and at 230 mg/L TSS, Servizi and Martens, 1992). It is not clear whether these responses affect long-term salmonid health. It is important to note that while the effects of chronic exposures to increased turbidity are evident – avoidance, reduced feeding resulting in reduced growth, and potentially reduced survival there is evidence that short exposures to very high turbidities (100,000 ppm) have no lasting effect (Rowe et al., 2003). Tolerance to brief periods of high sediment is a trait essential to survival of fish in environments with spring freshets and flood events. (Rowe et al., 2003). Rowe et al., (2003) also state that instream construction activities cause short-term spikes in turbidities while construction is occurring but levels generally return to background levels after cessation of work activities and that brief spikes in turbidity may be benign however, frequent or long episodes may not.

Physical Effects

TSS exposure frequency, duration, particle size, particle type, and fish life stage are critical in determining the magnitude of physical effects on fish. Research has found that duration of exposure plays a more dominant role than TSS concentration (Anderson et al. 1996). Long-term exposure to elevated TSS conditions may cause endocrine stress responses (elevated plasma cortisol, glucose, and hematocrits), suggesting an increased physiological burden that could influence growth, fecundity and longevity (Redding et al., 1987; Lloyd, 1987; and Servizi and Martens, 1992). In addition, Servizi and Martens (1992) found that blood sugar levels which are a secondary indicator of stress, increased at all levels tested. Fish growth is also inhibited by reduced feeding rates due to the behavioral effects mentioned previously. Elevated TSS concentrations can decrease salmonid fitness by thickening the gill epithelium and reducing respiratory efficiency (Bell, 1973, as cited in Waters, 1995).

The mechanisms of TSS-related mortality are not well understood. Acute TSS-related mortality has been demonstrated in laboratory or controlled in situ exposures where the fish were unable to avoid the elevated TSS conditions (i.e., the fish were in artificial streams or caged in natural streams). Elevated TSS concentrations alone have not been shown to cause mortality (McLeay et al., 1987; Redding et al., 1987; and Reynolds et al., 1989). It has been shown that juvenile salmon and steelhead trout can adapt when exposed to short term increased TSS concentrations. In a laboratory *experiment, juvenile coho salmon and steelhead were subjected to 2000-4000mg/L of suspended sediment for several days, showing an immediate increase in stress, then within 5 days of initial exposure, returning to control stress levels (Reeding and Schreck, 1987). Elevated suspended sediment concentrations appear to have a synergistic effect with other causes of mortality. For example, salmonids appear to be more prone to bacterial- and viral-induced mortality when exposed to TSS concentrations of 2,000 to 3,000 mg/L for 7 or 8 days (Redding et al., 1987).*

TSS-related mortality in salmonids depends on several factors, such as life stage, particle size, and water temperature. Significant mortality (>50 percent) usually occurs at suspended sediment concentrations in the range of 500 to 6,000 mg/L (Lloyd, 1987; Sigler et al., 1984). Older, larger salmonids are generally more tolerant of high suspended sediment concentrations (200 to 20,000 mg/L) than juvenile salmonids, eggs, and larvae (Sigler et al., 1984). Particle size affects mortality, with decreases in lethal tolerance as particle size increases (Servizi and Martens, 1987). Finer particles tend to clog gillrakers, erode gill filaments, and reduces growth (Sigler, 1984). Tolerance is also temperature related. Survivorship is optimal at about 7 degrees C (44.6 degrees Fahrenheit (F)), with reduced survivorship at higher (18 degrees C [64.4 degrees F]) and lower (2 degrees C [35.6 degrees F]) temperatures (Servizi and Martens, 1991).

Habitat Effects

Increased turbidity in streams can lead to an increase in sedimentation. The primary concern of increased sedimentation on fisheries resources is the potential for degrading and/or decreasing spawning habitat (Shirazi et al., 1979). Although, rearing habitat can also be degraded and/or decreased by increased sedimentation such as a decrease in residual pool volumes.

A basic necessity for quality fish habitat is freedom from excessive sediment and turbidity (Everest, 1987) and retention of desirable channel morphology and stability (Bisson et al. 1987; Sullivan et al. 1987). Persistent long term sediment sources are the most detrimental to fish and fish habitat with low gradient streams being more vulnerable to irreversible clogging than high gradient streams (Chamberlin, 1982). Pool volumes may be decreased, resulting in direct loss of living space (Reiser and Bjornn 1979; Toews and Brownlee 1981).

There is considerable literature concerning sedimentation effects on fish. A general conclusion reached by a review of literature is that the greatest adverse impact of sedimentation is on incubating embryos and larval fish. Sedimentation can cause high losses of incubating eggs and fry in redds (nests), particularly by interfering with oxygen exchange. Fine sediment deposits may also seal rubble and gravel substrates, decreasing spawning area, egg survival, emergence of fry, and hiding cover for fingerlings (Hall and Lantz 1969; Satterlund and Adams 1992). Sand, silt, and fines in the makeup of the substrate can reduce intergravel water flow, decrease intergravel dissolved oxygen concentrations, and result in high Biological Oxygen Demand (BOD) over long periods (Chamberlin, 1982). A dissolved oxygen concentration of at least 11.0 mg/l is needed in the water column to maintain an intergravel dissolved oxygen concentration of at least 8.0 mg/l (EPA, 1987). This is the minimum level required as to not cause a production impairment of salmonid embryos or larvae (EPA, 1987). These minimum dissolved oxygen requirements assume a minimum embeddedness. Sedimentation without cleansing and scouring flows can result in permanent rearing and spawning habitat changes (Platts et al., 1989).

Aquatic invertebrates can also be affected by sedimentation resulting in a change of community composition and prey species for fish. Benthic macroinvertebrates tend to drift as turbidity and TSS levels rise. As the duration of the increased turbidity or TSS concentration lengthens and when particles are smaller, macroinvertebrates become especially prone to drift (Rowe et al., 2003).

Sensitive benthic herbivores abundances can be reduced when sediment accumulation occurs in algal mats (Rowe et al., 2003). Salmonids do not benefit from increased drift because turbidity reduces sight distances as well as capture rates (Rowe et al., 2003).

Summary

The TSS influences on fish reported in the literature range from beneficial to detrimental. Elevated TSS conditions have been reported to enhance cover conditions, reduce piscivorous fish/bird predation rates, and improve survival. Elevated TSS conditions have also been reported to cause physiological stress, reduce growth, decrease feeding rates, and adversely affect survival. Of key importance in considering the detrimental effects of TSS on fish are the frequency and the duration of the exposure (not just the TSS concentration). Most western United States salmonids have evolved in systems that periodically experience short-term (days to weeks) elevated TSS/turbidity events (winter runoff, spring storms and floods) and are adapted to periodically elevated TSS exposures without adverse effects.

Suspended sediments can have behavioral and physical effects on salmonids. Avoidance is the primary fish behavioral response to locally turbid water. Other behavioral responses include attraction (TSS as cover, and enhanced survival because of reduced fish and bird predation); reduced feeding success; and increased "coughing" or "gill flaring." TSS exposure frequency, duration, particle size, and particle type are critical in determining the magnitude of physical effects. Long-term exposure to elevated TSS conditions may cause endocrine stress responses, decrease the visual acuity of predatory fish (leading to reduced feeding rates and reduced growth), and decrease salmonid fitness.

The mechanisms of TSS-related mortality are not well understood. Acute TSS-related mortality has been demonstrated in laboratory or controlled in situ exposures where the fish were unable to avoid the elevated TSS conditions. TSS-related mortality in salmonids depends on several factors, such as life stage, particle size, and water temperature. Mortality usually occurs at suspended sediment concentrations in the range of 500 to 6,000 mg/L.

Suspended sediments can also reduce fisheries habitat by increasing sedimentation. Sedimentation can decrease or reduce spawning habitat as well as rearing habitat. Increased sedimentation, especially in low valley streams, can smother incubating embryos and emergent fry. Increased sedimentation can seal gravel and decrease intergravel water flow reducing intergravel dissolved oxygen concentrations and result in high BOD. Increased turbidity, especially caused by fine inorganic particles, increase drift of macroinvertebrates. Aquatic invertebrate communities may change as a result of sedimentation or turbidity, which in turn could affect salmonid prey items. In addition, suspended materials in slow moving waters can increase absorption of solar energy near the surface causing the heated upper layers to stratify reducing the dispersion of dissolved oxygen and nutrients to lower depths.

The scientific data regarding the effects of suspended sediments on fish have been derived from laboratory experiments, observations of natural systems, and in situ experiments. Because of the variable approaches and methods used in these studies, the generalization and extrapolation of their results to specific areas of concern must be made with caution.

Suggested or existing TSS standards typically range from 25-80 mg/L. The higher end of this range seems to have been derived from the impacts of TSS on adult fish, whereas the low-end concentrations seem to have come from the impacts and protection of juveniles, larvae, and eggs. Again, suspended sediment concentrations must be considered in conjunction with frequency and duration of exposure to predict effects on fish. Short-term spikes in turbidities may be benign however, frequent or long *episodes may not. Tolerance to brief periods of high sediment is a trait essential to survival of fish in environments with spring freshets and flood events.*

3.7.4.1 Predictive Models for Assessing Suspended Sediment on Aquatic Resources

Development of a stress index for predicting suspended sediment effects on fish has been described and reviewed in the literature over the past decade. Newcombe and MacDonald (1991) described a concentration-duration response model as a tool for assessing environmental effects caused by suspended sediment on salmonid fishes. Gregory et al. (1993) commented on the utility and limitations of this particular model for predicting suspended sediment effects. Newcombe and MacDonald (1993) responded to these comments, defending their stress index but acknowledging its limitations as a predictor of general effects and the need for additional data to more precisely predict suspended sediment effects on fishes. This predictive tool was subsequently refined by Newcombe and Jensen (1996) who developed a quantitative approach for assessing the acute and chronic effects of channel suspended sediment on a variety of fish species. This predictive model is discussed further below.

Newcombe (2003) recently described an impact assessment model for clear water fishes exposed to excessively cloudy water, which was described above in the literature review. This model is optimized for sediment pollution events where loss of visual clarity is the primary mode of harmful effect in systems that are relatively clear and free of excessive suspended sediment most of the year. Newcombe (2003) stated that this model is suitable for determining the impact status of a sediment pollution event in relation to the threshold of ill effects, but requires black disk measurements at the time of the event to predict magnitude of effect. He also noted that the model requires further testing and refinement of postulated scores aided by data yet to be generated and published in peer reviewed sources. For these reasons, the quantitative model described by Newcombe and Jensen (1996) and discussed below is used to assess potential project-related TSS effects on fish.

Newcombe and Jensen (1996) summarized the acute and chronic effects of channel suspended sediment on a variety of fish species, and used these data in developing a method for synthesizing and quantitatively assessing the resulting degree of risk and impact to fish. In determining the severity of ill effect to fish, the authors stressed the importance of considering both the duration of exposure and the concentration of suspended sediment (the sediment dose). Newcombe and Jensen (1996) described four categories of severity of ill effects associated with excess suspended sediment, beginning with no effects and progressively worsening through behavioral effects, sublethal effects, and paralethal and lethal effects (see Table 1). Behavioral effects include alarm reaction, abandonment of cover, and avoidance response, while sublethal effects include short-term to long-term reduction in feeding rate and success, increased rate of coughing and respiration, impaired homing, poor condition, and moderate habitat degradation. Paralethal and lethal effects include reduced fish growth rate and density, delayed hatching, increased predation, moderate to severe habitat degradation, and stepwise incremental rates of mortality increasing from 0 to 20 percent to 80 to 100 percent.

Newcombe and Jensen (1996) used results of previous suspended sediment studies on fish to predict the severity of effect for different species' groups and life stages of fish. Because of the wide range of results of these previous studies, the predicted thresholds for different levels of severity of effect vary widely over a range of suspended sediment concentrations and durations of exposure. For example, Newcombe and Jensen's (1996) model for juvenile and adult salmonids predicts that paralethal effects will begin at the following suspended sediment concentrations (mg/L) and durations of exposure: 59,874 mg/L for 1 hour; 8,103 mg/L for 7 hours; 2,981 mg/L for 1 day; 403 mg/L from 6 days to 2 weeks; 148 mg/L for 7 weeks; 55 mg/L for 4 months; and 20 mg/L for 11 months. Lethal effects at a mortality rate of 0 to 20 percent for these same durations of exposure are predicted to occur at the following suspended sediment concentrations: 162,755 mg/L for 1 hour; 22,026 mg/L for 7 hours; 8,103 mg/L for 1 day; 2,981 mg/L for 6 days; 1,097 mg/L for 2 weeks; 403 mg/L for 7 weeks; and 148 mg/L for 4 months and 11 months. Mortality rates are predicted to increase as suspended sediment concentrations increase for the same durations of exposure (Newcombe and Jensen 1996). The predicted threshold for sublethal effects to juvenile and adult salmonids consists of the following suspended sediment/exposure duration relationships: 55 mg/L for 1 hour; 7 mg/L for 7 hours; 3 mg/L for 1 day and 2 days; and 1 mg/L for exposures of 6 days or longer. In discussing different possible applications of their dose-response models, Newcombe and Jensen (1996) observed that the models are only a beginning, that thresholds of sublethal and lethal effects must be known more precisely, and that research is needed on the effects of sediment particle quality, particle toxicity, and water temperature.

Newcombe and Jensen's predictive models were developed using regression equations and empirical data that are more conservative than predicted values in estimating the severity of TSS threshold effects to juvenile and adult salmonids. Newcombe and Jensen (1996) noted that the empirical data can be used to estimate (infer) the minimum concentrations and durations that trigger sublethal and lethal effects in salmonids. They define the category of lethal effects as including paralethal effects (reduced fish growth, delayed hatching, and reduced fish density) as well as lethal effects (incremental mortality rates to 100 percent). Newcombe and Jensen (1996) noted that thresholds estimated from empirical data often are lower than thresholds predicted by regressions fit to meta-analytical data, and stated that they viewed empirical thresholds as "an approximated response of the more 'sensitive' individuals within a species group." For purposes of comparison to predictive values listed above and for later reference in the effects analysis section of this BA, empirical TSS lethal (paralethal/lethal) thresholds presented by Newcombe and Jensen (1996) for the most sensitive juvenile and adult salmonids include the following: 22,026 mg/L for 1 hour; 2,981 mg/L for 3 hours; 1,097 mg/L for 7 hours; 148 mg/L for 1 day and 2 days; 55 mg/L for 6 days; 7 mg/L for 2 weeks; and 3 mg/L for 7 weeks to 11 months. Most of these empirical thresholds for paralethal/lethal effects are considerably lower (TSS concentrations are lower and/or durations are shorter) than listed above for predicted paralethal and lethal thresholds.

3.8 Milltown Dam

The height and structure of Milltown Dam prevent upstream migrating fish from moving over the structure, thereby blocking access to key spawning sites in areas upstream of the dam and interrupting migration corridors for accessing other habitat not associated with spawning, such as thermal refugia and seasonal feeding areas. Therefore, the Proposed

Action has the potential to affect bull trout and proposed designated bull trout critical habitat.

Hill et al. (1993) evaluated upstream and downstream fish passage in 1993 for MPC and the MTAC. Using the data existing in 1993, the researchers could not conclude that providing fish passage would have a beneficial effect on fish densities throughout the middle Clark Fork River basin. However, they recognized the importance of adult fish accessing natal streams as a critical link in the life cycles of trout using the middle Clark Fork River. Hill et al. (1993) identified empirical data necessary to improve the evaluation of the potential effect of providing fish passage at Milltown including: species of fish migrating to the dam, life stage of fish, abundance, and timing of passage. These data and other related data have been collected since 1993.

Data have been collected at the Milltown Project using the radial gate raceway as an upstream fish trap. From 1998 through 2003, fish attempting to move upstream at Milltown Dam were trapped, counted, marked, and numbers estimated for the 9 to 13 fish species captured (Schmetterling and McEvoy 2000, Schmetterling 2000). In 1999, 33,800 fish representing eight species were captured from March 10 to May 21. The native catastomid, the largescale sucker, accounted for 97 percent of the captured fish. High water conditions stopped trapping in the radial gate raceway from May 21 to June 30, 1999. Two bull trout were captured after June 30. Other species captured during the spring and summer trapping included westslope cutthroat trout, longnose sucker, northern pike minnow, redside shiner, peamouth, longnose dace, mountain whitefish, brown trout, and rainbow trout.

Stream discharge followed an average volume and pattern in 1999. In 2000, low run-off conditions allowed for trapping through the entire run-off period. The Milltown trap was operated intermittently from March 6 to November 3, 2000, representing 78 days of trapping. The trap captured 48,000 fish representing 12 species during the entire period. From March 6 to June 15, 2000, spring migrations of spawning rainbow trout, westslope cutthroat trout, longnose suckers, largescale suckers, and northern pikeminnow were captured. Westslope cutthroat trout abundance (n = 43, mean length 14.8 inches, range 13.0 to 17.3 inches) peaked at the radial gate raceway from mid-April to mid-May, which corresponds with known spawning migration periods. Trapping operations captured approximately 7,156 fish representing nine species from June 16 to November 3, 2000, through 36 days of trapping. Nine bull trout (mean length 25.2 inches, range 19.2 to 31.9 inches) were also captured during the fall sampling period.

The majority of the bull trout were captured from June to July as discharges declined after peak runoff. This period corresponds with the onset of known bull trout spawning migration periods. One 26.4-inch-long bull trout was also captured on September 15. Fish remaining at the dam for extended periods were exposed to high water temperatures and often developed injuries from trying to ascend the dam (Schmetterling 2000b).

The radial gate fish trap captured 13,378 fish in 40 days of operation from March 15 to October 25, 2002. Eight species of fish were captured, including: rainbow trout (608), largescale sucker (12,131), brown trout (228), and bull trout (4) (McFee and Schmetterling 2003a). In 2003, the radial gate fish trap was operated from March 19 to August, 2003, and captured 23,523 fish representing 9 species in 25 days of trapping (Schmetterling 2003a).

Most fish captured at the Milltown Dam radial gate trap are released back into the tail water pool downstream of the dam after collection of capture data. All bull trout and westslope cutthroat trout captured in the radial gate from 1998 to present have been transported upstream of the dam and released.

Numbers of bull trout captured in the radial gate pool at Milltown Dam do not reflect potential run sizes because of the long-term impacts of this migration barrier. The capture efficiency of the radial gate trap is not known because alternative counting measures are not available for corroborative efforts during high run-off periods. Water flowing through the radial gate can originate from either the Clark Fork River or Blackfoot River, depending upon the river stage (Schmetterling 2002a). Radial gate water flow is dominated by Blackfoot River water during low-low periods, and Clark Fork River water dominates during higher-low periods. Rainbow trout migrating to the Milltown Dam tailrace oriented with high fidelity to their respective source water of spawning location (Schmetterling 2002c). Accordingly, fish capture numbers from the radial gate trap at Milltown Dam should be considered as conservative estimates of sizes of fish runs. In addition, the radial gate fish trap cannot be operated when stream flows exceed approximately 7,000 cfs because the tail water elevations flood the radial gate pool area. These flow conditions commonly occur during the peak of bull trout spawning migrations. Thus, fish capture numbers from the radial gate trap at Milltown Dam should be considered qualitative and not representative of actual fish runs.

Bull trout spawning migrations occur on the descending limb of the hydrograph in the Blackfoot River and Rock Creek usually from June into July (Swanberg 1997, Carnefix et al. 2000, Schmetterling et al. 2000, Schmetterling 2000b). Bull trout moved a mean distance of 39 miles in the Blackfoot River and ranged from 25 to 81 miles in Rock Creek (Swanberg 1997, Schmetterling 2000b). Bull trout in Rock Creek, the Blackfoot River, and the Clark Fork River utilize aquatic resources on a large spatial scale; much larger than previously expected (Hill et al. 1993, Swanberg 1997, Schmetterling 2000c, Carnefix et. al. 2000). Long-term fragmentation of bull trout habitat possibly limits observed movements in the Clark Fork River. Shepard et al. (1984) reported movements greater than 124 miles in the upper Flathead River system. Bjornn et al. (1964) reported movements of bull trout up to 201 miles in the Middle Fork Salmon River.

Small populations of bull trout in individual tributary streams are at risk of loss in genetic variation that may eventually reduce productivity (Leary et al. 1985). Loss of genetic variation important to the survival of local populations could result in the loss of the local populations (Leary et al. 1992). Although not comprehensive, radio telemetry studies identified some distinctive behavioral adaptations of Clark Fork River-Blackfoot River system bull trout that are not found in most other bull trout populations in Montana. Mature and sub-adult spawning and non-spawning bull trout migrate long distances, ascending immediately into spawning streams 1 to 2 months prior to spawning (Swanberg 1996). The spawning fish move near spawning sites and stage at these locations until spawning commences. Sub-adult fish stay in lower stream reaches and generally return to the Blackfoot prior to the beginning of spawning. In most years, some of the bull trout spawning streams in the middle reaches of the Blackfoot River system, including the Blackfoot River's largest spawning stream, the North Fork of the Blackfoot River, have intermittent reaches that would block upstream migrations if the fish staged at the mouth of the tributary rather than move directly to the spawning areas. Also, large beaver populations throughout the drainage historically, may have required spawning bull trout to move around or through these barriers, which would also be accomplished easier during high flow conditions.

Small population sizes of bull trout in tributaries to Rock Creek and the Blackfoot River including Gold, Belmont, Cottonwood, Gilbert, Ranch, Spring, and Welcome Creeks and others make identification of important local adaptations difficult and risky to attempt to detect through studies requiring capture, handling, and other intrusions on the fish.

Significant improvements in bull trout populations have occurred in a small number of spawning streams in both Rock Creek and the Blackfoot River over the last decade. However, recovery of bull trout in Rock Creek, the Clark Fork, and the Blackfoot Rivers hinges upon the improvement of numbers of spawning fish in more tributaries with broader geographical representation (MTBRT 2000).

The lack of upstream fish passage may also impact overall productivity of the Blackfoot and Clark Fork Rivers and Rock Creek. Annual spawning runs of largescale suckers captured attempting to ascend Milltown Dam were estimated at 44,000 in 1998 and 33,800 adult fish in 1999 (McEvoy 1998, Schmetterling et al. 2000). These large numbers of spawning suckers have the potential to deliver a relatively large volume of eggs and they are a potential source of increased productivity to upstream areas. The potential contribution of spawn (approximately 100,000 eggs per female), juvenile fish abundance of prey species for bull trout, and the food resources these spawning suckers could provide to upstream areas is likely very large. Radio telemetry studies initiated in the summer of 2002 on largescale suckers, captured downstream of Milltown Dam and released upstream of the dam, have revealed long upstream movements in the Clark Fork River (Schmetterling 2002b). This limited information suggests largescale suckers use stream habitat on a large geographic scale.

The Montana Bull Trout Restoration Team (MBTRT 2000) completed work on a restoration plan for bull trout in the Clark Fork and Kootenai River basins with four primary objectives:

- Protect existing populations within all core areas and maintain genetic diversity represented by those remaining populations.
- Maintenance and restoration of connectivity among historically connected core areas.
- Restoration and maintenance of connectivity between historically connected restoration conservation areas.
- Development and implementation of a statistically valid monitoring program for bull trout.

Passage at Milltown Dam was specifically addressed as important for the desired future condition of restored bull trout habitat (MBTRT 2000). Three of the objectives listed above directly relate to risk posed by the blockage of upstream fish passage.

The proposed plan for remedial action by EPA requires dam removal. CFBLLC has agreed to surrender the FERC license to allow dam removal and site restoration. Those actions will result in the long-term solution for fish passage at the site.

The lack of upstream fish passage annually prevents mature bull trout, over-wintering downstream of Milltown Dam, from spawning in tributaries of Rock Creek, the Blackfoot River, and the Clark Fork River. Therefore, the progeny of these bull trout cannot potentially contribute to bull trout populations downstream of dam. These bull trout have the behavioral traits most likely to establish an enhanced Clark Fork River bull trout population. In addition, continuing losses of individual bull trout from specific small populations with unique genetic\behavioral traits, through the movement of these emigrating bull trout downstream of Milltown Dam with no passage available to return for spawning, could result in the loss of these populations. Enhancing these small populations of bull trout (individual spawning stream populations) is considered a key to establishing secure drainage basin bull trout populations and preservation of genetic diversity in Rock Creek, the Blackfoot, and Clark Fork Rivers. Although numerical losses of bull trout associated with both effects are likely relatively small compared to overall bull trout populations in Rock Creek and the Blackfoot River, the losses compounded over years, contribute significantly to poor bull trout populations downstream of Milltown Dam.

Chapter 4, Effects of the Action, and specifically *Section 4.1.2.5, Effects of Discontinuing the PM&E Plan and Bull Trout Conservation Measures,* discuss effects to bull trout and bull trout proposed critical habitat associated with Milltown Dam and the upstream migratory corridor that would result from implementing the following Proposed Action components: Milltown project operations from 2003 through 2010, activities of the Plan, activities of the Bull Trout PM&E Plan (Conservation Measures), surrender of the FERC license, and post-dam removal restoration of the site. These effects are listed below and discussed further in various sections of Chapter 4.

3.8.1 Effects to Bull Trout

- Limiting access of bull trout to upstream spawning habitat
- Limiting the connectivity between groups of bull trout
- Potentially reducing genetic variability from loss of small populations
- Reducing overall fishery productivity and forage base
- Limiting access of bull trout to upstream thermal refugia
- Limiting access of bull trout to upstream foraging areas

3.8.2 Effects to Bull Trout Proposed Critical Habitat

- Blocking the migratory corridor (PCE #7)
- Blocking access to thermal refugia (PCE #2)
- Blocking access to upstream rearing and feeding areas (PCE #8)
- Blocking bull trout prey species from upstream spawning and rearing areas (PCE #8)

CHAPTER 4

Effects of the Action

This chapter assesses the potential direct, indirect, and cumulative effects on bull trout and on the primary constituent elements (PCEs) of their proposed designated critical habitat that would result from implementing the Proposed Action. The nine PCEs were defined in Section 3.1.4 of this BA. Both short-term and long-term direct and indirect effects are described. Short-term effects are those effects expected during, and as a result of, the site remediation and restoration activities within the remediation/restoration project area described in *Chapter 2, Project Description*, and discussed in the following text. Long-term effects are those effects expected following the completion of site remediation and restoration activities within the remediation/restoration project area. Short-term effects would be temporary while long-term effects would extend indefinitely into the future. Evaluation of the effects of the removal of Stimson Dam is also considered in this chapter because of its inclusion as a restoration activity associated with the Milltown Remedial Action. In addition, effects of discontinuing certain bull trout conservation/enhancement actions with the surrender of the FERC license are discussed in this chapter to satisfy Section 7 consultation requirements of FERC with FWS. This chapter concludes with a discussion of conservation actions that would be implemented to minimize or avoid the potential for adversely affecting bull trout or their habitat. The following analysis assumes that the Proposed Action is implemented as described and will effectively remediate and restore site conditions, as intended and described in Chapter 2.

4.1 Short-Term Direct and Indirect Effects

Remediation and restoration activities are expected to last approximately 6 years (from late 2004 through 2010). Potential short-term adverse effects that could result from remediation and restoration activities within the remediation/restoration project area include increased turbidity, TSS, and metals levels downstream of Milltown Dam, disruption of the current fish trap and haul program being operated at Milltown Dam, disruption of the current northern pike management program, and discontinuation of certain FERC-related conservation/enhancement actions intended to mitigate effects of the Milltown Dam Hydroelectric Project on bull trout and other aquatic resources. Various measures will be implemented as an integral part of the Proposed Action to reduce the potential for downstream water quality and habitat degradation during site remediation and restoration activities, to provide upstream fish passage past the sediment removal area via the temporary bypass channel, and also to provide interim upstream fish passage past Milltown Dam prior to dam removal. Expected resultant effects are discussed below.

4.1.1 Interim Fish Passage

Interim upstream fish passage measures prior to the removal of Milltown Dam will be provided by CFBLLC as designated and required by the FERC license. Specific interim fish passage measures discussed in *Section 2.2, Interim Fish Passage* will be implemented once they have been approved through the ESA consultation process with the FWS. The former owner of the facility, The Montana Power Company, initiated the present fish passage program in 1998. It is operated from approximately March through November each year, flow conditions permitting. The radial gate raceway currently captures about 12 percent of the trout attempting to pass Milltown Dam (Schmetterling 2002d). As is presently the case, it is assumed that not all bull trout congregating at the base of Milltown Dam will be captured and passed around the dam. However, unlike existing conditions, this adverse effect would be short-term in nature and eliminated once the bypass channel is installed and Milltown Dam is removed. This dam is scheduled for removal in early 2006.

EPA anticipates that infrastructure construction at the sediment removal area, including the temporary bypass channel around SAA-I and a 5-foot high fish passable drop structure at the upstream end of the bypass channel, may affect interim upstream fish passage measures at Milltown Dam for approximately 1 year (March through November) during the first full year of the early construction period (Stage 1) as the reservoir pool is drawn down for construction of the bypass channel. Section 2.2 discusses potential fish passage issues associated with the temporary bypass channel and drop structure that should be considered to conform with fish passage standards.

The current Envirocon SOW schedule calls for Stage 1 drawdown to begin December 1, 2004, and last through December 22, 2005. At that time, river water will be directed through the radial gate of the dam. Discharge through the radial gate prevents use of the downstream discharge pool (the normal fish trapping location) as a safe and viable trapping site. The resulting potential worst-case effect for approximately 1 year is that none, rather than 12 percent (present passage rate), of the trout congregating at the dam base would be able to pass upstream. The resultant adverse effect from the interruption of upstream fish passage is that the 2006 year class would be reduced. As discussed above, this adverse impact would be short term in nature and eliminated once Milltown Dam is removed. EPA will coordinate and consult closely with MDFWP and FWS in attempts to optimize upstream fish passage prior to and after the removal of Milltown Dam. Downstream fish passage is not anticipated to be a problem during site remediation and restoration, and will be monitored. The resultant long-term benefits to bull trout from dam removal and 100 percent upstream passage, as well as the avoidance of potential increases in TSS and metals concentrations associated with the reservoir, are described below in the discussion of long-term effects**.**

4.1.2 Water Quality, Habitat, and Fisheries

4.1.2.1 Background

Chapter 3, Environmental Baseline, of this BA describes potential adverse effects that elevated concentrations of TSS and some metals may have on biological resources and their habitat. A number of measures (conservation actions) will be implemented as part of the Proposed Action to avoid or minimize the potential for these kinds of impacts to occur. These conservation actions are described in Section 4.4 of this chapter. Potential water quality, habitat, and fisheries effects are discussed in the following text.

The EPA requested that ARCO generate predictions of the range of change in water quality in the Clark Fork River at the Milltown Dam site and downstream during Milltown site remediation and restoration activities. In response to this request, Envirocon (2004) conducted modeling to estimate the volume of materials that would be scoured during site remediation and restoration activities and the resultant downstream TSS, copper, and arsenic concentrations. Envirocon (2004) explained the reasons for analyzing TSS, copper, and arsenic as follows: "Based on the available water quality sample results data base for the site and the results of previous modeling runs, compliance with water quality standards for constituents other than TSS, dissolved copper, and dissolved arsenic were not considered to be of potential concern. Therefore, the comparison to Temporary Construction-related Water Quality Standards focuses on TSS, dissolved copper, and dissolved arsenic concentrations." Table 2 lists the temporary water quality standards. Envirocon (2004) selected the U.S. Army Corps of Engineers computational model "HEC-6, Scour and Deposition in Rivers and Reservoirs" to analyze sediment transport resulting from the removal of Milltown Dam and associated remediation/restoration activities. Envirocon (2004) described in detail the nature and suitability of the HEC-6 model, as well as model development, calibration, and sensitivity analysis, for predicting water quality effects from implementing the Proposed Action. The scenario analyzed by Envirocon (2004) models a dry sediment removal action using mechanical excavation equipment under staged early Milltown Dam removal (the Revised Proposed Plan). The model assumes, as described in Chapter 2, that a temporary bypass channel would be constructed and used to divert Clark Fork River flows around the SAA III sediments prior to dam removal.

The modeled time period begins on October 1, 2004, and runs for 4.3 years (1,582 days) through December 31, 2008. This time period was modeled in three stages to represent the approximate lengths of time required to dewater, pre-load, and excavate the SAA I sediments. Modeled Stage 1 extends from October 1, 2004, to November 1, 2005, and includes the gradual drawdown of Milltown Reservoir (December 2004 to November 2005) to the spillway crest by opening the radial gate. All Stage 1 flows would be through the existing Clark Fork River and Blackfoot River channels. Modeled Stage 2 extends from November 1, 2005, to March 15, 2006. During Stage 2, Clark Fork River flow would be routed through the temporary bypass channel, then through the powerhouse with the inlets converted to low-level outlets. Modeled Stage 3 extends from March 15, 2006, through December 31, 2008. During this final stage, the dam would be fully breached and flow would be routed through the temporary bypass channel and the removed spillway (Envirocon's current SOW schedule, discussed below, calls for fully breaching the dam and diverting flow through the temporary bypass channel in late Stage 2). At the completion of site remediation and restoration activities at the end of Stage 3, flow would be routed through the new, natural restored Clark Fork River channel.

For purposes of clarification, Envirocon's current SOW schedule for the three stages differs from the modeled time periods, although major activities such as Milltown Dam breaching and removal would occur at about the same points in time. The current SOW shows activities associated with the three stages occurring in the following time periods: Stage 1 - December 1, 2004 to December 22, 2005; Stage 2 - December 1, 2005 to March 16, 2006; Stage 3 - December 22, 2005 to May 21, 2008. As noted in *Section 2.3, Implementation of the Proposed Action*, the current Envirocon SOW schedule is subject to change based on public participation activities, final design components and sequencing, and yearly variations in hydrologic conditions.

Envirocon's modeling analysis predicted water quality effects under three different flow regimes during the 4.3-year period. These flow regimes include: 1) a series of average annual flows during the 4.3-year period; 2) a 25-year flow event hydrograph (based on the 1975 hydrograph) during post-dam removal in 2007 and average annual flows in other years; and 3) low-flow conditions (based on the 1992 hydrograph) in 2007 and average annual flows in other years.

EPA and MDEQ brought in scientific peer reviewers from across the country to examine and evaluate Envirocon's modeling results. Based on these peer reviews, Envirocon's revisions to draft versions of their technical memorandum, and Envirocon's (2004) *Final Technical Memorandum: Milltown Reservoir Dry Removal Scour Evaluation*, EPA (2004) and MDEQ concluded the Revised Proposed Plan can be done safely and effectively. EPA (2004) stated that strong support exists for the Revised Proposed Plan from the Natural Resource Trustees (State of Montana, the Confederated Salish and Kootenai Tribe, and FWS).

Potential effects of several activities could not be addressed in the HEC-6 model because of a lack of quantitative data, and are discussed separately in the following text. Information on the volume of sediment that would be released with the removal of Stimson Dam, which is outside the Milltown OU boundary, was not available at the time of modeling. Since then, data have been collected and will be used to predict potential downstream TSS effects resulting from Stimson Dam removal. In addition, potential effects on water quality from remediation activities in the Clark Fork River Operable Unit (CFROU) some 80 to 100 miles upstream of the Milltown Dam site could not be modeled because of their qualitative descriptions and are discussed below. Finally, as discussed here, there is the potential for the inadvertent delivery of sediment to the Clark Fork River temporary bypass channel while hauling clean fill from a local source to the pre-load area via rail car or haul road, or while loading and hauling pre-load material to be used as backfill where sediment has been excavated. Effects of accidental sediment delivery to the Clark Fork bypass channel resulting from a spill of pre-load or backfill material would be expected to be temporary, and to be well within the predicted levels of TSS effects described in the following text for site remediation activities. BMPs and other measures described in *Section 2.1.7, Protective Measures* will be in place during pre-loading and backfilling activities and are designed to prevent or minimize the potential for sediment delivery to the Clark Fork River. Except for these instances, site remediation and restoration activities described in Chapter 2 of this BA are considered in the HEC-6 model.

4.1.2.2 Milltown Remediation and Restoration Effects (excluding Stimson Dam Removal and Clark Fork River Operable Unit Remediation Effects)

Envirocon's (2004) modeling results are summarized in the following text. They include comparisons of estimated concentrations of TSS, dissolved copper, and dissolved arsenic in downstream surface waters against federal and state acute and chronic water quality criteria for the protection of aquatic life, and also against the site-specific trout toxicity reference value (TRV) for dissolved copper in the Clark Fork River. Table 2 lists these criteria. Comparison of projected contaminant concentrations during site remediation against a site-specific TRV for dissolved copper is appropriate given results of previous investigations at the project site. Previous analyses suggest that risks to trout populations in the Clark Fork River downstream of Milltown Dam from elevated metals levels are low except on rare occasions, such as the 1996 ice scour event, when total recoverable metals concentrations, particularly copper, are extremely high (CH2M HILL 2000). Those previous analyses also concluded that on these rare occasions arsenic and cadmium in water pose no significant ecological risk, and risks from lead and zinc are absent to low. The EPA has determined that metals toxicity to aquatic life is caused primarily by dissolved metals and has developed site-specific trout TRVs based on toxicity tests using Clark Fork River water (CH2M HILL 2000). The site-specific trout toxicity reference value for dissolved copper in the Clark Fork River is 37 µg/L at an assumed hardness of 100 mg/L. Dissolved copper concentrations less than this in the vicinity of the Milltown Dam site are regarded as not being toxic to trout. The proposed temporary construction-related water quality standard for dissolved copper is 80 percent of the TRV at a hardness of 100 mg/L, which is equivalent to 25 µg/L. The following text discusses predicted TSS concentrations and effects first, and then predicted concentrations and effects for dissolved copper and dissolved arsenic.

Envirocon (2004) predicted that the total amount of sediment scoured from above Milltown Dam during the 4.3-year simulation period under average flows is 478,000 tons (406,000 cubic yards). As a comparison, this would be in addition to about 148,000 tons of sediment that move through Milltown Reservoir and continue downstream each year. Envirocon (2004) observed that the predicted amount of scour over 4.3 years is considerably less than the 762,000 tons of total sediment measured in the Clark Fork River at the USGS gage above Missoula in 2 recent high-flow years (317,000 tons in 1996 and 445,000 tons in 1997). Envirocon (2004) stated that 29 percent of the sediment scoured comes from the Clark Fork River between Milltown Dam and Duck Bridge, about 20 percent comes from the upper Clark Fork River, and slightly over 50 percent comes from the Blackfoot River. EPA (2004) stated sediments in the Blackfoot River are uncontaminated.

The HEC-6 model predicts three distinct TSS peaks resulting from the three staged drawdown events at the current location of Milltown Dam. These peaks are nearly identical for the average, high-flow, and low-flow regimes that Envirocon (2004) modeled. The first drawdown event (during Stage 1) would produce a predicted TSS peak of 1,049 mg/L, the second drawdown event (during Stage 2) a predicted TSS peak of 1,219 mg/L, and the third drawdown event (during early Stage 3 – late Stage 2 in the current Envirocon schedule) a predicted TSS peak of 1,854 mg/L. Peak TSS concentrations would exceed the 550 mg/L short-term (day) TSS standard for a total of 12 days in 4.3 years, including 3 days following radial gate drawdown in Stage 1, 4 days following powerhouse inlet conversion drawdown in Stage 2, and 5 days following Milltown Dam removal in early Stage 3 (late Stage 2 in the current Envirocon schedule).

Envirocon (2004) reported that the three predicted peak TSS concentrations would decrease to below the 170 mg/L mid-term (week) TSS standard within 1 to 2 weeks of each drawdown event and below the 86 mg/L long-term (season) TSS standard within 1 to 3 months of each drawdown. The only noticeable difference in TSS concentrations among the three flow regimes modeled was during runoff in 2007 when predicted peak TSS is about 400 mg/L under the 25-year high-flow regime and less than 200 mg/L under the average flow and low-flow regimes. Modeling results indicated that during most of the 4.3-year construction period, TSS concentrations immediately downstream of the Milltown Dam site would be on the order of 50 mg/L or less, which would meet all temporary construction-related TSS standards.

Envirocon (2004) stated the predicted peak TSS concentrations are considered conservative given the various assumptions built into the HEC-6 model regarding staging of drawdown, mathematical equations used, and alluvial grain-size gradation and transport properties. Envirocon (2004) concluded that because of these conservative input assumptions, predicted TSS concentrations listed above could represent over-predictions by about 33 percent or more.

TSS concentrations would be expected to decline proceeding downstream from the Milltown Dam site as some of the larger, coarser material settles and river flows are diluted by major tributaries: the Bitterroot River (a major sediment source), and the Flathead River (a limited sediment supply). Envirocon (2004) estimated that under average flow conditions it may take up to 1 year for coarse sands to move through the Clark Fork reach below Milltown Dam to the Bitterroot River, and as long as 10 to 11 years to travel approximately 150 miles from the Milltown Dam site to Thompson Falls Reservoir. However, Envirocon (2004) also predicted that the strategic timing of the three drawdown events with high flow periods will help minimize the amount of sediment deposition in the downstream Clark Fork River reach between Milltown Dam and the Bitterroot River. The HEC-6 model predicted that fine material (clays and silts) would travel through this river reach as wash load in 1 day or less with little to no dilution. The sediment modeling effort indicated that these fine materials (about 50 percent of the total release) will move through the system very quickly (EPA 2004). Envirocon (2004) estimated the wash load travel time of fines from the Milltown Dam site to Thompson Falls Dam would be approximately 44.5 hours.

Maximum TSS concentrations will occur from immediately below Milltown Dam to the junction of the Clark Fork and Bitterroot Rivers. Effects of sand and fine material moving downstream will become less and less as more water enters the river. The flow of the Clark Fork River below the Bitterroot River is twice as great as the flow of the Clark Fork River leaving Milltown Reservoir and seven times greater by the time the Clark Fork River reaches Thompson Falls Reservoir (EPA 2004). Modeling results indicate that because of the high river velocity between Milltown Dam and Thompson Falls Reservoir, most of the fine sediments and sand will be transported downstream, mixed with other channel sediment, and accumulate in Thompson Falls Reservoir. Some fines may go through Thompson Falls Reservoir into Noxon Reservoir (EPA 2004).

The amount of sediment transported to downstream reservoirs because of construction activities at the Milltown site will be relatively small compared to the amount routinely transported. An estimated 478,000 tons of sediment will be transported from Milltown Reservoir during the 4-year construction period compared to an estimated 2,200,000 tons of sediment transported from upstream to Thompson Falls Reservoir during a series of average flow years over a 4-year period (EPA 2004). EPA (2004) concluded that given the large amounts of sediment routinely deposited in downstream reservoirs, there should be little to no impact on Thompson Falls Reservoir storage capacity because of Milltown remediation and restoration activities.

As described in *Chapter 3, Section 3.7.4, Effects of Suspended Sediment on Aquatic Resources*, potential effects on fish resulting from elevated TSS concentrations can vary from behavioral and sublethal effects at relatively low TSS levels to paralethal and lethal effects at considerably higher TSS levels (Newcomb and Jensen 1996). Temporary construction-related TSS standards for the Proposed Action (550 mg/L for 1 day, 170 mg/L for 1 week, 86 mg/L for 1 season) are more conservative (protective) than concentrations identified by Newcomb and Jensen (1996) in their predictive model at which paralethal and lethal effects to fish are predicted to occur. While TSS concentrations for the construction standards would not be expected to result in lethal or paralethal effects to fish using these predictive model criteria, TSS concentrations predicted by Envirocon (2004) using the HEC-6 model could be associated with behavioral, sublethal, and some paralethal effects to fish based on Newcombe and Jensen's (1996) predictive model. Behavioral effects include alarm reaction, abandonment of cover, and avoidance response. Sublethal effects include short-term to long-term reduction in feeding rate and success, increased rate of coughing and respiration, impaired homing, poor condition, and moderate habitat degradation. Paralethal effects include reduced growth rate, delayed hatching, reduced fish density, and moderate habitat degradation (Newcomb and Jensen 1996).

It is expected that any resultant TSS effects to bull trout and their proposed critical habitat during the 4.3-year site remediation and restoration period would be manifested at behavioral, sublethal, and paralethal effects levels based on Newcombe and Jensen's (1996) predictive model, and perhaps at lethal effects levels for the more sensitive individuals based on Newcombe and Jensen's (1996) empirical TSS model for lethal effects thresholds (discussed below). TSS concentrations would be highest at the Milltown Dam site and decrease proceeding downriver as more water enters the Clark Fork. Envirocon's (2004) predictive model indicates the following peak TSS concentrations and durations of exposure would occur:

- Three days in October or November 2004 (modeled Stage 1) when peak TSS values would vary between approximately 700 and 1,049 mg/L
- Four days in November 2005 (modeled Stage 2) when peak TSS values would vary between approximately 550 and 1,219 mg/L
- Five days in March or April 2006 (modeled Stage 3; late Stage 2 in the current Envirocon schedule) when peak TSS values would vary between approximately 700 and 1,854 mg/L

It is important to note that Newcombe and Jensen (1996) also used the empirical data from their model to predict "thresholds of ill effect" for lethal effects. As discussed in Chapter 3, Newcombe and Jensen (1996) interpreted these thresholds to be "an approximated response of the more 'sensitive' individuals within a species group." The empirical lethal effect threshold at one day of exposure to suspended sediment ranges between 148 and 1,097 mg/L TSS, and the threshold at 6 days of exposure ranges between 55 and 403 mg/L TSS (Newcombe and Jensen 1996). The ranges bracketed by these thresholds reflect, in part, the variability of responses reported in different studies that were used in their model. The source of this variability is probably related to the fact that the studies did not all use the same salmonid species, and also to the differences among studies in water temperature, particle size, particle angularity, and interactions between TSS and metals. These threshold ranges are at TSS levels that are lower than the peak levels predicted by Envirocon (2004) to occur during the three stages of dam and sediment removal at Milltown Dam. Because of this and the fact that many of the variables that contribute to the lethal response to TSS were not addressed in the model, it is clear that there is considerable uncertainty in applying this model to predict the TSS thresholds of lethal effects on bull trout in the Clark Fork River.

Therefore, it cannot be stated with a high level of confidence that there will be no mortality of bull trout during site remediation/restoration activities.

Predicted peak TSS concentrations would decrease to below the 170 mg/L mid-term (week) TSS standard within 1 to 2 weeks of each drawdown event, and below the 86 mg/L long-term (season) TSS standard within 1 to 3 months of each drawdown event (Envirocon 2004). These TSS concentrations and durations of exposure (between 170 and 550 mg/L TSS for 1 to 2 weeks and between 86 and 170 mg/L for 1 to 3 months) could result in some paralethal effects to salmonids and perhaps some lethal effects to the more sensitive individuals. Sublethal and behavioral effects to salmonids also would be anticipated during those times TSS values exceed temporary construction-related daily, weekly, and seasonal TSS standards, based on Newcombe and Jensen's (1996) criteria. During most of the 4.3-year construction period, TSS concentrations would be on the order of 50 mg/L or less, which would meet all temporary construction-related TSS standards.

Envirocon (2004) predicted total copper and total arsenic concentrations in surface waters downstream of the Milltown Dam site using results of HEC-6 modeling and linear regressions with strong correlations between total copper and total arsenic concentrations and TSS concentrations. Envirocon (2004) reported that the highest total metals concentrations would be presumed to occur just downstream of the Milltown Dam site. At the predicted peak TSS concentration of 1,854 mg/L (during modeled Stage 3; late Stage 2 in the current Envirocon schedule), the predicted peak downstream total copper and total arsenic concentrations are estimated to be approximately 550 μg/L and 90 μg/L, respectively. The predicted range of total copper during the duration of the project is 7 to 550 μg/L, averaging 22 μg/L. The predicted range of total arsenic during the duration of the project is 4 to 90 μg/L, averaging 6 μg/L. Envirocon (2004) reported that for comparison purposes, maximum total copper and arsenic concentrations in the Clark Fork River at the USGS gage above Missoula during the 1996 ice scour event were 400 μg/L and 69 μg/L, respectively.

As discussed previously, the EPA has determined that metals toxicity to aquatic life is caused primarily by dissolved metals. Regression analysis, HEC-6 model TSS predictions, and various partitioning coefficients were used by Envirocon (2004) to estimate concentrations of dissolved copper and dissolved arsenic in surface waters. Locations considered were at the Milltown Dam site and 2.8 miles below the dam site at the USGS gage above Missoula (Envirocon 2004).

Envirocon (2004) stated that predicted dissolved copper concentrations are generally elevated during powerhouse routing and Milltown dam removal. Dissolved copper concentration peaked at approximately 23 μg/L immediately following dam removal, then rapidly declined to baseline levels of approximately 3 μg/L shortly after dam removal. Envirocon (2004) reported that HEC-6 modeling runs estimated that dissolved copper concentrations downstream of the Milltown Dam site would not exceed the temporary construction-related dissolved copper standard of 25 μg/L. Dissolved copper concentrations would be expected to decline proceeding downriver with dilution flows from tributaries.

A similar pattern was observed for predicted dissolved arsenic concentrations. A predicted peak of approximately 12 μg/L dissolved arsenic, which exceeds the 10 μg/L drinking water standard but only for 3 days would occur immediately after powerhouse routing and

Milltown Dam removal (Envirocon 2004). Predicted dissolved arsenic concentrations would then decline rapidly to a baseline level of approximately 4 µg/L. Envirocon (2004) reported that the modeling predicted there would be no exceedences of either the 340 µg/L short-term (1-hour) or the 10 µg/L long-term (30-day average) dissolved arsenic temporary construction standards downstream of the Milltown Dam site.

The restoration actions proposed in the DCRP for the Clark Fork and Blackfoot Rivers upstream of the remediation area have the potential to temporarily affect downstream water quality through the suspension and transport of sediments (total suspended sediments or TSS) caused by disturbing stream banks and channel sediments. In the long term, restoration actions are intended to reduce erosion by establishing soil binding vegetation and constructing river channels and floodplains that limit streambed and bank erosion. The floodplain and channel sediments outside the remediation area on the Clark Fork and Blackfoot Rivers contain lower levels of contamination than sediments within the remediation area. Therefore, these upstream sediments should not cause exceedences of temporary construction-related water quality standards for contaminants (see Table 2) because the more highly contaminated sediments downstream were determined to not exceed standards. The TSS caused by the restoration work will be limited to concentrated work areas, and the highest TSS levels will occur when water first re-enters the restored river channel. The State of Montana has completed projects of this type in the past, and will use appropriate BMPs (see examples in *Section 2.1.7.1, Control of Sediment Releases*) to control sediment delivery and reduce TSS during and following completion of construction activities.

It is anticipated that the restoration actions will not cause exceedences of temporary construction-related TSS standards established for this project (see Table 2). In addition, these restoration actions will need to comply with specific water quality permit requirements needed for these activities (318 permitting from MDEQ). The quantity of sediment transported will be much less than that caused by removal of Milltown Dam and cleanup of sediments under remediation. The levels of TSS caused by the restoration actions are not anticipated to be lethal to bull trout, except possibly the more sensitive individuals, and will not permanently decrease bull trout habitat in the Clark Fork or Blackfoot Rivers, which is consistent with the findings discussed previously for remediation-generated TSS using Newcombe and Jensen's (1996) predictive and empirical criteria for predicting TSS effects on salmonids. The fate and transport of TSS caused by the restoration actions will be similar to the modeled fate and transport of TSS caused by dam removal and other remedial actions.

4.1.2.3 Stimson Dam Removal Effects

The removal of Stimson Dam under the Proposed Action has the potential to temporarily affect downstream water quality through the suspension and transport of sediments (TSS) that have accumulated behind the dam. EPA (2004) stated that sediments in the Blackfoot River are uncontaminated. CH2M HILL (2004) prepared a preliminary estimate of the volume of sediment deposition upstream of Stimson Dam based on results of a channel bathymetry survey, tile probe measurements, and Side Scan Sonar imaging conducted during April 2004. Sediment was defined as particles in the clay, silt, and sand size range (less than 2.0 mm) that are transported as TSS within the water column (CH2M HILL 2004).

Study results indicate that approximately 14,000 cubic yards of coarse sediments (gravels to large cobbles) have accumulated behind Stimson Dam, and that approximately 4,000 cubic yards of suspendable sediments (fine sand and smaller) are present within pore spaces among the gravels and cobbles (CH2M HILL 2004). The study concluded with the following:

> *Depending on how Stimson Dam is removed it is unlikely this entrained fine-grained material will be mobilized all at one time. Its movement will be dependent on the movement of the bedload matrix within which it is trapped. As the wedge of alluvial material (cobble, gravels, etc.) is redistributed by the post dam velocity regimes, periodically a portion of the sediment may be exposed to sufficient velocity to be mobilized.* (CH2M HILL 2004).

It is anticipated that Stimson Dam would be removed during Stage 2, and perhaps no later than Fall 2005, prior to the removal of Milltown Dam. Mean monthly flow in the Blackfoot River (at the USGS gage near Bonner) during this time is anticipated to be approximately 600 cfs. Assuming a residual pool level retained behind the Milltown Dam and this discharge rate, only minor scour of upstream sediment is expected, with most of the initial sediment originating from disturbance created from removal of the dam structure itself. As a check on this assumption, Envirocon will enter the Stimson Dam information into their HEC 6 scour model and generate an incremental TSS prediction. This information will be added as an addendum to the Biological Assessment in the near future. The incremental prediction is not expected to demonstrate a significant impact on aquatic life. The sediment anticipated to be released by the Stimson Dam removal represents only 1 percent of the total sediment load (4,000 tons versus 480,000 tons) predicted to move through the Clark Fork and Blackfoot Rivers during the course of the remedial construction period.

4.1.2.4 Clark Fork River Operable Unit Remediation Effects

EPA's Cleanup Proposal for the Clark Fork River Operable Unit (CFROU) evaluated the ability to reduce contaminant loads in the upper Clark Fork River. The Record of Decision for the Cleanup Proposal concluded that it is likely to be technically impracticable during cleanup to consistently achieve surface water standards in the Clark Fork River upstream of the Milltown OU during construction of the proposed CFROU remedial action. However, the BA that was prepared for the CFROU proposed remedial action identified a number of beneficial long-term impacts to the aquatic ecosystem (and bull trout) in the upper Clark Fork River that would result from implementing the proposed remedial action (EPA and Syracuse Research Corporation 2002). These benefits include: 1) treating or removing slickens areas, thereby decreasing the probability and magnitude of "pulses" of highly toxic materials (metals) entering the river during late summer thunderstorm runoff events; 2) improved ground and riparian cover resulting in reduced sediment delivery and lower TSS concentrations in the river; and 3) increased bank stability and decreased tailings deposits (removal/treatment) resulting in stable and complex aquatic habitat. These long-term benefits would eventually be manifested downstream and contribute to improved water quality within the Milltown OU.

The BA for the CFROU also identified the potential for temporary adverse effects associated with remedial actions (EPA and Syracuse Research Corporation 2002). These included inadvertent sediment delivery, possibly accompanied by increases in levels of copper and other potentially toxic inorganic contaminants, while using heavy equipment to reconstruct and stabilize stream banks. Because the CFROU remedial actions would occur some 80 to 100 miles upstream of Milltown Reservoir and inflowing tributaries between the upper Clark Fork and the Milltown OU dilute river flows, it is unlikely that any temporary increases in TSS or metals levels resulting from CFROU construction activities would be readily apparent at the Milltown Dam site. The period of time when remedial activities at both Operable Units would overlap is estimated to be approximately during 2007 and 2008. Predicted peak TSS values at the Milltown Dam site would have occurred 1 to 3 years earlier, prior to when the CFROU remediation is anticipated to begin.

4.1.2.5 Effects of Discontinuing the PM&E Plan and Bull Trout Conservation Measures

The Milltown PM&E Plan and Bull Trout Conservation Measures, developed in concert with FERC, CFBLLC, MTFWP, FWS, and other conservation organizations, for mitigation of the impacts of Milltown Dam operations have been very successful programs.

Adaptive management of the PM&E Plan and Bull Trout Conservation Measures has provided the means to develop critical fisheries information on the fishery impacts of Milltown Dam, broadly expanded the overall understanding of native and non-native fish species life history and behavior, and contributed to the restoration and protection of the Clark Fork and Blackfoot Rivers and tributaries in the impact area. PM&E Plan and Bull Trout Conservation Measures used as matching funds in the applications for other private, state, and federal funding have significantly benefited fishery investigations and restoration work in the Project impact area. PM&E Plan and Bull Trout Conservation Measures provided an estimated 25 percent of the funds required to complete all the projects undertaken with the two programs. The loss of the PM&E Plan and Bull Trout Conservation Measures is likely to significantly reduce the opportunity for application of matching funding for the Region 2 area of MTFWP. Significant funding opportunities for beneficial fishery projects will remain through other organizations and agencies.

A portion of PM&E Plan and Bull Trout Conservation Measures funding (61 percent in 2003 and 42 percent in 2004) was dedicated to long-term beneficial projects restoring bull trout habitat (CFBLLC 2003b and CFBLLC 2004). The significant funding of habitat restoration is consistent through the ten years of PM&E funding and 2 years of Bull Trout Conservation Measures funding. These expenditures will continue to provide long-term off-site benefits to bull trout and bull trout designated critical habitat

PM&E and Bull Trout Conservation Measures fishery evaluations in the Project impact area identified 5 long-term effects resulting from the presence and operations of Milltown Dam (see Section 4.2.1 through Section 4.2.6). The FERC dam removal action would provide long-term benefits by elimination of the factors responsible for the adverse effects to bull trout and their habitat and the need for mitigation programs.

Implementation of the Proposed Action would occur after the removal of factors impacting bull trout and their proposed designated critical habitat, therefore eliminating the adverse effects of the project and the necessity for the mitigation programs.

4.1.2.6 Summary

The data discussed above suggest that bull trout, their proposed critical habitat, and other aquatic life downstream of remediation and restoration activities at the Milltown site (including removal of Stimson Dam and river channel and floodplain restoration upstream of the remediation area) would be adversely affected by elevated TSS concentrations during relatively brief intervals of the 4.3-year construction period. Adverse TSS-related effects resulting from these activities would be manifested as behavioral, sublethal, and paralethal effects, and perhaps as lethal effects among the more sensitive individuals. These effects would not be expected to cause severe or permanent habitat degradation. There would be no predicted exceedences of dissolved copper or dissolved arsenic temporary construction-related water quality standards from any of the remediation and restoration activities at the Milltown site, and thus no resultant adverse effects on bull trout or their proposed critical habitat from these contaminants.

The most likely periods for adverse impacts on the fishery, including bull trout and their proposed critical habitat, would be in about late fall/early winter 2004 (Stage 1), late fall/early winter 2005 (Stage 2), and early or mid-spring 2006 (modeled Stage 3; late Stage 2 in the current Envirocon schedule) when the three TSS peaks are predicted to occur. During these periods, TSS concentrations are predicted to increase for short periods of time, and to result in temporary adverse effects on aquatic organisms and their habitat. Bull trout exposed to these short-term increases in TSS levels would probably consist of adults and perhaps fish 2 or more years of age who have moved into the mainstem Clark Fork from tributaries where they were spawned and reared. This presumes that fish exposed to elevated TSS levels would remain in place rather than seek to avoid the affected area. Resultant short-term risks would be temporary in nature and would not be expected to result in long-term adverse effects on bull trout or their proposed critical habitat. As discussed previously, because of uncertainties associated with the Newcombe and Jensen (1996) TSS models it cannot be stated with a high level of confidence that there will be no mortality of bull trout from elevated TSS levels during site remediation/restoration activities. The potential for risk would be eliminated after all site remediation and restoration activities are completed at the end of 2008 or possibly 2009 (see schedule in Table 1).

Water quality and biological monitoring plans for the Proposed Action that were described for remediation and restoration activities in Chapter 2 will be used to determine whether TSS or other temporary construction-related water quality standards are being exceeded or aquatic organisms are being impacted so that corrective measures can be implemented if necessary. Temporary short-term risks may abate with the re-establishment of additional BMPs.

4.2 Long-Term Direct and Indirect Effects

Implementation of the Proposed Action would be expected to have an overall, long-term beneficial effect on bull trout and their proposed designated critical habitat. The Proposed Action would provide long-term benefits by eliminating a number of factors associated with Milltown Dam and Reservoir (such as fish passage barrier, reservoir sediments, modified natural hydrograph, and northern pike) and Stimson Dam (seasonal fish passage barrier) that have been identified as adversely affecting bull trout and their habitat (CFBLLC 2003a, EPA 2004). These benefits would be realized both upstream and downstream of the present location of Milltown Dam, and would extend indefinitely into the future. They would directly and indirectly contribute to the recovery of bull trout subpopulations and to improved conditions for the PCEs associated with proposed critical habitat in the lower, middle, and upper reaches of the Clark Fork River and tributaries. In addition, construction of a new, natural channel in the Clark Fork River will provide high-quality habitat for fish, including continuous upstream and downstream migration for all native and cold water fishes. It is expected that any residual adverse short-term effects would be outweighed by the long-term benefits expected to accrue to bull trout (and other aquatic resources) and bull trout proposed critical habitat after remediation and restoration activities have been completed.

Much of the following discussion of adverse effects associated with Milltown Dam and Reservoir has been summarized from detailed descriptions presented by CFBLLC (2003a), many of which were based on locally derived information gathered and reported by numerous researchers. Many of the references cited are the same references cited by CFBLLC (2003a) in the Milltown Dam Operations Internal Draft BA. Implementation of the Proposed Action would eliminate the potential for existing adverse effects to continue and provide long-term benefits to bull trout and their proposed designated critical habitat in the ways described below.

4.2.1 Upstream Fish Passage

Milltown Dam blocks upstream movements of bull trout and other fish species. CFBLLC's fish trap and haul program has realized some success since its implementation in 1998. As an example, nine bull trout were captured in 36 days of trapping at the dam between June 16 and November 3, 2000 (CFBLLC 2003a). CFBLLC (2003a) cautioned that numbers of bull trout captured in the radial gate pool at Milltown Dam for passage upstream should be considered as conservative estimates of actual fish run size. Schmetterling (2002) reported that the radial gate raceway currently captures about 12 percent of the trout attempting to pass Milltown Dam. Removal of Milltown Dam on the Clark Fork River, removal of Stimson Dam on the Blackfoot River, and construction of a new, natural channel in the Clark Fork and Blackfoot Rivers (discussed in the following section) under the Proposed Action would restore PCE #7 (migratory corridor). This would provide bull trout (and all other fish species) unimpeded, 100 percent upstream access from the lower and middle reaches to the upper reach of the Clark Fork River and its tributaries, compared to approximately 12 percent upstream passage success for trout at present. Bull trout would have access to key spawning sites in areas upstream of the dam and uninterrupted migration corridors to upstream habitat for uses other than spawning [for example, seasonal feeding areas (PCE #8, abundant food base) and cold water refugia (PCE #2, thermal refugia)] (CFBLLC 2003a). An additional benefit is that young bull trout spawned by adults over-wintering in the lower and middle reaches of the Clark Fork, but reproducing in the upper reach, could potentially emigrate downstream and contribute to bull trout populations below the dam site. Mature adults could subsequently return to their natal stream to spawn, thereby protecting or reestablishing and possibly connecting unique genetic and behavioral traits associated with a number of specific small bull trout local populations upstream of the dam site. CFBLLC (2003a) also suggested bull trout would benefit from increased upstream movements and productivity by other species, such as largescale sucker. CFBLLC (2003a) stated that the potential contribution of spawn from largescale sucker, the abundance of juvenile suckers as a food source for bull trout, and the general food resources spawning suckers could provide to areas upstream of Milltown Dam are probably large. These beneficial effects would represent an enhancement of PCE #8 (abundant food base).

CFBLLC (2003a) cited MTBRT (2000) concluding that the recovery of bull trout in Rock Creek, the Clark Fork River, and the Blackfoot River depends on increased numbers of spawning fish in more tributaries with broader geographical representation. Removal of Milltown Dam and Stimson Dam would contribute to accomplishing three primary objectives of the Clark Fork River restoration plan for bull trout as well as several major goals and objectives of the FWS Bull Trout Draft Recovery Plan (MBTRT 2000, FWS 2002, CFBLLC 2003a). These are: 1) protecting existing populations in core areas and maintaining genetic diversity in those remaining populations; 2) maintaining and restoring connectivity among historically connected areas; and 3) restoring and maintaining connectivity between historically connected restoration conservation areas.

4.2.2 River Restoration and Improved Habitat

River channel and floodplain restoration as described in the DCRP (see the Appendix) will restore the confluence of the Clark Fork and Blackfoot Rivers, the Clark Fork River upstream to Turah Bridge, and the Blackfoot River to upstream of Stimson Dam. This will result in habitat improvements that will benefit bull trout and other cold water fishes and invertebrates in approximately 5 miles of the Clark Fork River that have been inundated or otherwise adversely affected by the presence of Milltown Dam and Reservoir for a century, and in approximately 1.25 miles of the Blackfoot River that have been affected by the presence of Stimson Dam. Two of the DCRP design objectives associated with river restoration will provide broad benefits to bull trout and their habitat. These objectives are: 1) providing high-quality habitat for fish and wildlife, including continuous upstream and downstream migration for all native and cold water fishes; and 2) minimizing habitats that will promote non-native, undesirable fish species. Benefits to bull trout and their proposed critical habitat from river restoration would be manifested as enhancements to nearly all of the nine PCEs in the restoration area, as follows: PCE #1 (provides permanent waters with low levels of contaminants); PCE #2 (provides cold water refugia); PCE #3 (creates complex stream channels with woody debris, undercut banks, and a variety of water depths, velocities, and instream structures); PCE #4 (reduces substrate fines and embeddedness); PCE #5 (restores natural hydrograph, also see discussion in *Section 4.2.4, Reservoir Sediments, Drawdown, and Ice Scour Events*); PCE #7 (re-establishes migratory corridor and restores habitat connectivity); PCE #8 (enhances river food base); and PCE #9 (reduces numbers of predatory, interbreeding, non-native species).

4.2.3 Downstream Fish Passage

Milltown Dam constrains, but does not completely block, the downstream passage of bull trout. Downstream movements of bull trout through the reservoir and past the dam consist of emigrating juvenile bull trout, return spawning bull trout, and returns of migrating bull trout whose movements are not associated with spawning. CFBLLC (2003a) reported three primary routes exist for downstream fish passage past the dam, including over the spillway, through the radial gate, and through the generation turbines. CFBLLC (2003a) reported there are five kinds of adverse effects the Milltown Project can have on downstream movements of bull trout. These are manifested as impacts on various PCEs for bull trout proposed critical habitat and include: 1) failure to find passage downstream of the dam (PCE #7); 2) physical harm in passing through the turbines, over the spillway, or through the radial gate in returning to over-wintering habitat downstream of the dam (PCE #7); 3) possible increased predation by larger fish downstream of the dam on individuals stunned while moving over or through the dam (PCE #9); 4) increased predation/ competition by northern pike on emigrating juveniles moving through Milltown Reservoir (PCE #9, discussed further in *Section 4.2.5*); and 5) impingement on spillway panels and/or vegetation grates (PCE #7). All of these factors potentially adversely affect bull trout populations and PCEs for proposed critical habitat upstream and downstream of Milltown Dam. Removal of Milltown Dam under the Proposed Action would eliminate the potential for these adverse effects to occur. Their elimination would ultimately benefit bull trout and proposed critical habitat in the middle and upper Clark Fork River and tributaries in many of the same ways described for providing upstream passage and would contribute to the recovery of this species and its habitat.

4.2.4 Reservoir Sediments, Drawdown, and Ice Scour Events

The potential adverse effects on downstream aquatic resources, including bull trout and their proposed critical habitat, from increased TSS and metals levels during reservoir drawdown and the scour and release of sediments during unusual meteorological events was described previously in this BA. *Chapter 3, Section 3.6, Milltown Reservoir*, discussed in detail the results of ecological risk assessments directed at characterizing potential effects and degree of risk to aquatic life from increased metals and TSS levels under such circumstances. That assessment concluded that typical downstream concentrations of contaminants derived from Milltown Reservoir sediments are unlikely to be of concern, but that bull trout, as well as westslope cutthroat trout, could be subjected to stress during extraordinary occasions such as the 1996 ice scouring event (CH2M HILL 2000). The range of adverse effects could conceivably vary from acute under extreme meteorological conditions to possibly very subtle chronic effects at other times. Removal and isolation of Milltown Reservoir sediments under the Proposed Action would eliminate the potential for any such adverse effects to occur in the future. These beneficial effects would represent an enhancement of PCE #1 (permanent waters with low levels of contaminants) and PCE #4 (reduced substrate fines and embeddedness) and the restoration of PCE #7 (migratory corridor). This would remove a long-standing potential threat to bull trout and proposed critical habitat and, together with other remedial activities that would be carried out under the Proposed Action, would contribute to the recovery of this species and its habitat.

4.2.5 Natural Hydrograph

Operation of the Milltown Project can result in short-duration fluctuations in reservoir discharge and flow in the Clark Fork River downstream of Milltown Dam (CFBLLC 2003a). These events typically last no longer than 1 hour, but can modify the natural hydrograph by suddenly doubling river flows during the base flow period (July to March) or reducing river flows by approximately 50 percent just downstream of Milltown Dam. Depending on the time of year, the frequency of such fluctuations ranges from approximately twice per week to once per month (CFBLLC 2003a). Flow fluctuations such as these may potentially affect bull trout and their proposed critical habitat by affecting the abundance of aquatic insects and other benthic invertebrates, which are often important fish foods. Bull trout and their habitat also may be affected if sudden increases in reservoir discharges contribute to increased levels of suspended solids and metals downstream in the river. CFBLLC (2003a) concluded that these short-duration flow fluctuations have affected bull trout and their proposed critical habitat by modifying the natural hydrograph of the Clark Fork River, and possibly by reducing macroinvertebrate productivity and forage availability for bull trout. CFBLLC (2003a) also concluded that the potential release of low-level contaminants from Milltown Reservoir is not likely to affect bull trout growth or survival. Removal of Milltown Dam and removal and isolation of Milltown Reservoir sediments under the Proposed Action would eliminate the potential for these adverse effects. Their elimination would benefit bull trout and their proposed critical habitat through the enhancement of PCE #1 (low contaminant levels), PCE #5 (restore natural hydrograph), and PCE #8 (abundant food base).

4.2.6 Northern Pike

The shallow, weedy backwater areas of Milltown Reservoir provide very suitable spawning and rearing habitat for northern pike and have probably contributed to the success of this species in the impoundment (CFBLLC 2003a). Northern pike have been observed in both the Clark Fork and Blackfoot Rivers, but neither of these drainages provides suitable spawning or rearing habitat for this species (CFBLLC 2003a). As discussed previously, northern pike have the potential to adversely affect bull trout and PCE #9 in the reservoir and where they co-occur in the rivers by preying on bull trout and by competing with bull trout for food. Northern pike and bull trout are both highly piscivorous and can exhibit similar food preferences. CFBLLC (2003a) concluded in their analysis that northern pike in Milltown Reservoir are a direct source of mortality for bull trout and potentially affect the maintenance of existing bull trout populations using the Clark Fork River. Removal of Milltown Dam and construction of a new, natural channel at the confluence of the Clark Fork and Blackfoot Rivers under the Proposed Action would eliminate reservoir habitat and shallow, weedy backwater areas preferred by northern pike for spawning and rearing and restore riverine habitat more suitable for bull trout. It is anticipated that numbers of northern pike would eventually decline to very low levels because of habitat limitations in the restored Clark Fork River. Bull trout, PCE #8 (food base), and PCE #9 (predation) would be enhanced and benefit from declining numbers of northern pike in the remediation/restoration project area. These effects, like the other beneficial long-term effects discussed previously, would contribute to the recovery of bull trout and their habitat.

4.3 Cumulative Effects

Cumulative effects under Endangered Species Act (ESA) regulations are defined as those effects of future non-federal (state, local government, or private) activities that are reasonably certain to occur during the course of project activity and within the area of the federal action (the Proposed Action in this BA) subject to consultation. For the Proposed Action, the reasonably foreseeable future is defined to be the estimated 6 years that would be required for significant remedial and restoration activities within the remediation/restoration project area at Milltown Dam and Reservoir and Stimson Dam.

Future federal actions are subject to the consultation requirements established in Section 7 of the ESA and, therefore, are not considered cumulative to the Proposed Action. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time (40 CFR 1508.7).

CFBLLC (2003a), in the *Milltown Dam Operations Internal Draft BA*, summarized broad risk categories in the general area of Milltown Dam and Reservoir that can interact with bull trout because of their highly mobile nature and affect species survivability and the condition of PCEs for proposed designated critical habitat. These broad risk categories include environmental instability, introduced fish species, barriers to fish movements, habitat quality, and population attributes. Specific risks associated with these categories include legal and illegal introductions of fish, water management, municipal and industrial waste water dilution, irrigation diversions, rural and industrial development, mining, grazing practices, forestry practices, transportation systems, and recreational development. The potential cumulative effects of each were described by CFBLLC (2003a) and are briefly summarized below.

Requests to legally introduce new fish within the range of bull trout are reviewed by the MDFWP and the U.S. Fish and Wildlife Service (FWS). CFBLLC (2003a) stated that new legal introductions of fish in bull trout range would probably not be approved by these agencies, therefore limiting the potential for impacting bull trout and PCEs. The effects of illegal fish introductions on bull trout can not be predicted because such acts are random, and the species, location, and probability of introduction are unknown (CFBLLC 2003a).

CFBLLC (2003a) concluded in their analysis of potential cumulative effects that no new water management practices that could potentially affect bull trout or proposed critical habitat are likely to occur without FWS or MDFWP review and approval. They added that no new industrial or wastewater facilities are anticipated in the Milltown Project area in the next 6 years. However, they discussed the probable continuing development of rural areas, primarily for single family residences. In Missoula County and neighboring counties such development has occurred over the past decade. CFBLLC (2003a) stated that many of these developments have been in floodplains and on benches adjacent to the middle and upper Clark Fork River, the Blackfoot River, and Rock Creek. CFBLLC (2003a) concluded that such developments would continue, but that their potential effects on bull trout could probably not be measured.

CFBLLC (2003a) stated that no new mining projects or significant new grazing programs on private lands beyond existing grazing activities are anticipated in the Milltown Project area in the next 6 years. CFBLLC (2003a) also recognized the recently completed Native Fish Habitat Conservation Plan by Plum Creek Timber Company, in consultation with FWS and the National Marine Fisheries Service (NMFS), and special management actions by the Montana Division of Forestry would prevent or minimize forestry-related adverse effects on bull trout. In addition, any construction or maintenance of transportation or conveyance systems in the remediation/restoration project area not associated with the CERCLA project, such as highways, railroads, and pipelines, would require state and federal permits, which would trigger reviews by the FWS and MDFWP. These reviews should eliminate or minimize the potential for adversely affecting bull trout or proposed designated critical habitat.

CFBLLC (2003a), in their review of possible cumulative effects in the Milltown Project area, concluded that recreational use and the development of recreational facilities in the Milltown Project area are not expected to increase significantly in the next 6 years to levels that would potentially affect bull trout or proposed designated critical habitat.

4.4 Conservation Actions

The Proposed Action described in Chapter 2 of this BA essentially consists of a series of remediation and restoration actions that will individually and collectively contribute to the long-term conservation and recovery of bull trout subpopulations and their proposed designated critical habitat in the lower, middle, and upper reaches of the Clark Fork River, Blackfoot River, Rock Creek, and their tributaries. Conservation actions that will be implemented to remediate existing problems associated with Milltown Dam and Reservoir include the removal and isolation of Milltown Reservoir sediments, the removal of Milltown Dam and Stimson Dam, construction of a temporary bypass channel with a fish passage structure (as described in *Section 2.1.1, Bypass Channel Construction*), and the construction of a new, natural channel at the confluence of the Clark Fork and Blackfoot Rivers and upstream within the remediation/restoration project area. As discussed previously, fish passage through the temporary bypass structure is an EPA (remedy) issue being consulted on in this BA and not a CFBLLC/FERC (license surrender) issue. The FWS will be consulted for guidance throughout the remedial/restoration design process and implementation of the remedial and restoration actions. As described in *Section 4.2* of this chapter, these actions will result in long-term benefits and contribute to the recovery of bull trout and their proposed critical habitat by eliminating a series of existing adverse or potentially adverse effects associated with upstream and downstream fish passage past Milltown Dam and Stimson Dam, contaminated sediments present in Milltown Reservoir and their release downstream of Milltown Dam, and the occurrence of northern pike in Milltown Reservoir.

Two additional conservation actions intended to minimize or avoid the potential for adversely affecting bull trout and proposed designated critical habitat will be implemented during sediment removal/isolation, dam removal, and channelization activities. These actions also were described in *Chapter 2, Project Description*, and their effectiveness assessed in *Section 4.1* of this chapter. The first additional conservation action is the interim upstream fish passage program implemented by CFBLLC in accordance with their FERC license conditions, which will remain in effect and CFBLLC will be responsible for until the removal of Milltown Dam is completed. As discussed previously, fish passage prior to and during the removal of Milltown Dam may not be achievable for approximately 1 year (March through November) during the initial first full year of construction (Stage 1) as the reservoir pool is drawn down for construction of the bypass channel. The current Envirocon SOW schedule calls for Stage 1 drawdown to begin December 1, 2004, and last through December 22, 2005. Interim fish passage measures will remain in effect until all construction work at the dam has been completed and bull trout can move unimpeded upstream and downstream past the former Milltown Dam site. The second additional conservation action consists of implementing a number of measures to avoid or minimize the potential for degradation of water quality and proposed designated critical habitat during site remediation and restoration activities. Key engineering controls and BMPs will be employed and include carefully planning of the timing and sequence of reservoir drawdown and dam removal, and isolating the most highly contaminated sediments with sheet piling and a bypass channel. Water quality and biological monitoring programs will be conducted in an iterative risk assessment-feedback framework to determine if biological resources are being protected, and, if not, what additional management measures or adjustments to construction activities are practical to protect bull trout, their proposed critical habitat, and other aquatic resources.

CFBLLC (2003a) noted that restoration plans for bull trout rely upon the recovery of migratory life history forms in an interconnected system of large rivers and their tributary streams. Implementation of the conservation actions within the framework of the Proposed Action described in this BA will contribute to the restoration and recovery of bull trout and to improvement in the quality of PCEs associated with bull trout proposed critical habitat in the lower, middle, and upper Clark Fork River, Blackfoot River, Rock Creek, and their tributaries.

CHAPTER 5

Determination of Effects

The assessment of potential effects in *Chapter 4, Effects of the Action,* concluded that implementation of the Proposed Action would be expected to have an overall, long-term beneficial effect on bull trout and their proposed designated critical habitat. The Proposed Action would provide long-term benefits by eliminating and/or improving a number of factors and conditions associated with Milltown Dam and Reservoir, such as fish passage barrier, reservoir sediments, modified natural hydrograph, and reservoir habitat for northern pike, that have been identified as adversely affecting bull trout and PCEs for their proposed critical habitat (CFBLLC 2003a). These expected benefits would be realized both upstream and downstream of the present location of the Milltown Dam site, would extend indefinitely into the future, and would directly and indirectly contribute to the recovery of bull trout subpopulations and their proposed critical habitat in the lower, middle, and upper reaches of the Clark Fork River and its tributaries. Removal of Stimson Dam on the Blackfoot River and construction of a new, natural channel at the confluence of the Clark Fork and Blackfoot Rivers also would contribute to the recovery of bull trout subpopulations and their proposed critical habitat.

Despite these overall expected benefits, there is a potential for two types of short-term adverse effects on bull trout and their proposed critical habitat while implementing the Proposed Action. The first type of effect would be associated with providing interim upstream fish passage during site remediation activities. It is likely that not all bull trout accumulating below Milltown Dam will be captured and transported around the dam. The resultant adverse effect from the interruption of upstream fish passage is that the 2006 year class would be reduced. However, unlike existing conditions, this adverse effect would be short-term in nature and eliminated once Milltown Dam is removed.

The second type of short-term effect would be associated with site remediation and restoration activities. TSS concentrations are predicted to increase for short periods of time as described in *Section 4.1.2, Water Quality, Habitat, and Fisheries*, resulting in some adverse effects on bull trout and their proposed critical habitat at behavioral, sublethal, and paralethal effects levels, and perhaps lethal effects levels among the more sensitive individuals. Resultant short-term risks would be temporary in nature, and risks and effects should abate with completion of the specific activity or establishment of additional BMPs. They would not be expected to result in long-term adverse effects on bull trout or on bull trout proposed critical habitat.

The potential adverse effects described above would not be expected to be substantive in terms of bull trout subpopulations or proposed critical habitat within the Lower, Middle, and Upper Clark Fork River CHSUs. In addition, it is expected that any residual adverse short-term effects would be outweighed by the long-term benefits expected to accrue to bull trout and their proposed critical habitat once remediation and restoration activities have been completed. However, as described above and in Chapter 4, there is the possibility that remedial actions could result in some incidental take of individual bull trout, which is a federally listed species, and some short-term adverse impacts to bull trout proposed critical habitat, which also is subject to provisions of the ESA. Therefore, the appropriate finding under the ESA with respect to the Proposed Action is that it "May Affect, Is Likely To Adversely Affect" bull trout and bull trout proposed designated critical habitat on a short-term basis during construction. The Proposed Action would not result in the "Destruction or Adverse Modification" of proposed designated critical habitat for bull trout because of the short-term and limited extent of the expected adverse impacts and the magnitude of beneficial effects. As discussed above, the overall long-term effect of the Proposed Action will be to benefit and contribute to the recovery of bull trout subpopulations and their proposed designated critical habitat in the lower, middle, and upper Clark Fork River, Blackfoot River, Rock Creek, and their tributaries.

CHAPTER 6

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Appendix

Draft Conceptual Restoration Plan for the Clark Fork River and Blackfoot River Near Milltown Dam

DRAFT CONCEPTUAL RESTORATION PLAN FOR THE CLARK FORK RIVER AND BLACKFOOT RIVER NEAR MILLTOWN DAM

PREPARED FOR:

State of Montana, Natural Resource Damage Program and Department of Fish, Wildlife and Parks, in consultation with the U.S. Fish and Wildlife Service and Confederated Salish and Kootenai Tribes.

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Photo Courtesy of the Atlantic Richfield Company

DRAFT CONCEPTUAL RESTORATION PLAN FOR THE CLARK FORK RIVER AND BLACKFOOT RIVER NEAR MILLTOWN DAM

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DRAFT CONCEPTUAL RESTORATION PLAN FOR THE CLARK FORK RIVER AND BLACKFOOT RIVER NEAR MILLTOWN DAM

1.0 INTRODUCTION (GOALS AND OBJECTIVES)

The State of Montana in consultation with other trustees, including the U.S. Fish and Wildlife Service and the Confederated Salish and Kootenai Tribes, contracted with Water Consulting, Inc. and Wildland Hydrology, Inc. to prepare a Conceptual Restoration Plan (CRP) and detailed cost estimate for restoration activities associated with the Milltown Reservoir Sediments Operable Unit. The CRP will integrate with and supplement Environmental Protection Agency's (EPA) Proposed Plan for removing Milltown dam and some of the polluted sediments deposited upstream of the dam.

It is contemplated that, due to time limitations and lack of site-specific data, the development of a complete restoration plan will be conducted in phases.

Phase 1 is this Conceptual Restoration Plan (CRP); this is a broad scale plan to provide restoration concepts, draft plan views and elevation information. The level of detail is adequate to provide the best possible cost estimate based on existing information.

Phase 2 would refine and validate the CRP with additional field data, analyses and surveys, including: additional topographic surveys; sediment entrainment data; bridge pier scour analyses; reference reach selection and data collection (Rosgen Levels 1 through 4 data); regional hydrologic analyses (using ongoing USGS work); field validation of proposed plan view and profile; ice potential and scour analysis; and peer review of potential recreational boating designs.

Phase 3 would be the final design phase, which will provide detailed design drawings and information adequate to permit and implement the project. This phase will include erosion control, revegetation, monitoring, maintenance, refined cost estimates, materials, equipment, implementation details and FEMA floodplain map revision analyses.

<u>OBJECTIVES OF THE CRP</u>

The following objectives will be addressed in the CRP:

- Restore the confluence of the Blackfoot and Clark Fork Rivers to a naturally functioning, stable system appropriate for the geomorphic setting;
- Use native materials, to the extent practicable, for stabilizing channel, banks and floodplains to improve water quality by reducing bank erosion of contaminated sediments;

- Provide adequate channel and floodplain capacity to accommodate sediment transport and channel dynamics appropriate for the geomorphic setting;
- Provide high quality habitat for fish and wildlife, including continuous upstream and downstream migration for all native and coldwater fishes;
- Provide high quality wetlands and riparian communities, where feasible and appropriate for the proposed streamtype;
- Improve visual and aesthetic values through natural channel design, revegetation and the use of native plants and materials;
- Assess the pros and cons of removing or relocating the powerhouse and other dam structures not removed by remedy, with consideration of cost and integrity of remediation and restoration. Also consider the risk of damage to the restored reaches due to backwater effects during floods;
- Minimize habitats that will promote non-native, undesirable fish species;
- Supplement revegetation activities proposed by remedy to increase floodplain vegetation diversity; and
- Provide increased recreational opportunities compatible with other restoration goals, such as river boating and fishing.

This CRP differs from the EPA's proposed plan for remediation in that the concept of natural channel design techniques are used to create a stream system that includes an active channel designed to accommodate the normal annual high flow (bankfull discharge) and a floodplain that fits the geomorphic setting to accommodate flood flows. The traditional method employs standard engineering techniques that include an armored channel that will accommodate the 100-year flood within the channel banks. Natural channel design (NCD) aims to restore natural channel stability, or dynamic equilibrium and habitat to impaired streams (Brown, et al. 2001). Streams in dynamic equilibrium are generally more biologically productive, providing higher quality and more complex habitat than altered or unstable streams. When properly applied, NCD methods provide a robust, widely tested, and well-accepted approach to the design of natural channels that successively achieve habitat and geomorphic restoration objectives while functioning during extreme flood events (Schmetterling and Pierce, 1999). NCD is the foundation for developing a naturally stable channel design and meeting habitat restoration objectives.

The Rosgen Stream Classification System (RSCS) and reach characterization techniques are core to this methodology and in its rudimentary form, categorize streams into one of eight primary stream types (Rosgen, 1996; Bain and Stevenson, 1999). However, the RSCS is only an initial step to a complex protocol for temporally evaluating geomorphic stability, sediment availability and transport competency, and riparian condition. Geomorphic indicators (bankfull channel), prediction (reference reaches and dimensionless ratios), and method validation (regional curves) define naturally functioning channels. NCD focuses on restoring geomorphic characteristics while incorporating fish habitat structures composed of native materials in natural arrays that better replicate native salmonid habitat as necessary for restoring inland native fish populations.

For additional information on NCD, including Brown, et.al. (2001) and Rosgen (1998), refer to Appendix 9.

2.0 GEOMORPHIC OVERVIEW, REACH DELINEATION AND DESCRIPTIONS

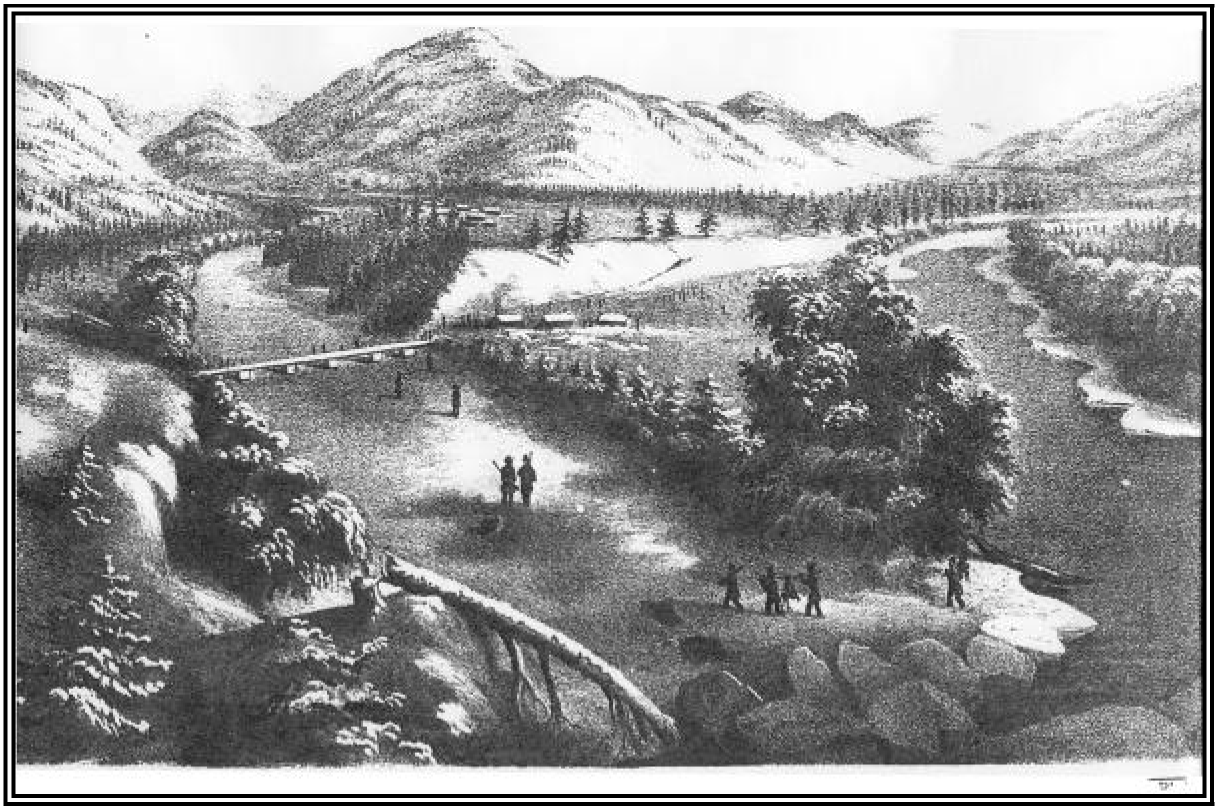
This section will describe the extents and limits of the project area, discuss the geomorphic setting, and provide an evaluation of the direct and indirect effects of Milltown dam. The extent of upstream effects of the Stimson diversion dam will also be discussed.

2.1 GEOMORPHIC OVERVIEW

The Clark Fork River System is formed in a broad, low gradient, alluvial valley with a wide floodplain and adjacent terraces. Stream types in this setting tend to be C4 channels characterized by riffle-pool morphology and wide, flat, densely vegetated floodplains adjacent to the channels (Rosgen, 1996). These streams are highly sinuous, with bank stability related to dense rooting of shrubs and trees along the stream banks. Bed materials are predominantly gravel with some component of cobble and sand. These channels are highly prone to increased bank erosion and sediment supply when the vegetation is disturbed or the channel modified. The Clark Fork River just upstream from the confluence would naturally transition from a C4 channel to a B3c channel as the valley narrows due to confinement by the rock outcrop near the Milltown dam and the glacial outwash terrace from the Blackfoot River. Step-pool morphology and moderate width, sloping flood prone areas adjacent to the river characterize B3c stream types. A well-vegetated flood prone area allows for flood flows to spread out twice the width of the active channel, dissipating energy over a wider surface. The "c" designation indicates that the gradient is very low, in this case less than 0.005 ft./ft. B3c stream types have a low gradient, low sinuosity and tend to be very stable. Bed materials are predominantly large cobble, with some component of small boulder and gravel.

The Blackfoot River system and valley is dominated by glacial landforms, including moraines, glacial outwash terraces and lake sediments. In the lower Blackfoot River area near the confluence of the two rivers, the river has carved a fairly narrow valley through Belt series bedrock formations and either bedrock or coarse glacial outwash terraces that bound the Blackfoot River. Predominant stream types in this setting are B3c and F3 where the river has incised into the outwash terraces. F3 stream types are characterized by riffle-pool morphology and are deeply incised into a gentle gradient valley, which means that these streams do not have an adjacent floodplain. During a flood event, all the flow is contained within a narrow corridor rather than spreading out onto a floodplain. F3 stream types can be very stable in an un-altered condition. Sinuosity in this case is low, width:depth ratios are high and gradient is about 0.002 ft./ft. Bed materials are predominantly cobble, with some component of small boulder and gravel.

Where the two rivers converge, the valley narrows, confining the river between steep valley walls and coarse glacial outwash terraces. Historically, the Clark Fork River downstream from the confluence would naturally shift to a B3c or an F3 streamtype, depending on the degree of incision into the terrace. Stream gradient is about 0.002 ft./ft. The historic drawing of the confluence of the Clark Fork and Blackfoot Rivers during the winter of 1861-1862 provides a depiction of the confluence area before the Dam and railroads were constructed. Whether this depiction is accurate is not certain; however, evaluation of this drawing indicates that both rivers were B3c type streams at the confluence. The Clark Fork valley appears to widen farther upstream in the drawing, with the River becoming less entrenched and more a C streamtype. A high glacial outwash terrace is also prominent at the confluence of the two rivers.



2.2 UPSTREAM AND DOWNSTREAM LIMITS OF THE DIRECT AND INDIRECT EFFECTS OF MILLTOWN DAM

In order to effectively determine the components and costs necessary to restore the site, it is appropriate to stratify the project area into river reaches that have similar characteristics and restoration potential. One of the criteria that is necessary to determine costs and extent of treatment area is to evaluate where the upstream and downstream limits of the direct and indirect effects of Milltown dam. River reaches will be further stratified in the next section. For Milltown dam, all available survey data, aerial photos, the Federal Emergency Management Agency (FEMA), Flood Insurance Rate Maps (FIRM) (Aug. 1988) and field reviews were used to determine where the upstream extent of the backwater deposition. Specifically, the upstream limit of the effects of Milltown dam was determined from:

- The change in gradient (valley, streambed and flood profile) caused by the backwater effect of the dam during a large flood stage, such as the 1908 flood;
- The change in valley morphology and floodplain from a narrower floodplain with terraces to a broader floodplain with no terraces caused by backwater deposition burying the historic floodplains;
- The change in vegetation from coniferous species more common on the low terrace to deciduous species more common on the floodplain; and
- The uppermost extent of Sediment Accumulation Areas IV and V.

While it is not possible to determine the exact point on the Clark Fork River where the upstream effects of the dam end with the limited existing information, all four criteria placed the endpoint for the disturbance in a zone that was about 3,000 feet in length. The zone occurred from about 10,000 feet to about 13,000 feet upstream from the dam. For the limited purposes of this analysis and cost estimate, the upper limit of the backwater effects of the dam was selected at approximately the midpoint in this range at about 11,500 feet upstream from the dam. The actual upstream extent of the backwater deposition could be upstream or downstream by as much as 1,500 feet.

Please refer to Figure 2, Appendix 1 for a display of the designated upstream limit of the backwater effect of the Milltown dam compared to Sediment Accumulation Areas IV and V. This designated upstream limit will be a reach break point as described in Section 2.3. Refer to Section 2.4 for a more detailed description of processes associated with backwater deposition and the effects on individual reaches.

The effects of Milltown dam do not end at the dam structure, but also extend downstream on the Clark Fork River for a certain distance. It is not possible to determine the actual downstream extent of the influence of the dam with the limited available data and analyses. However, for the purposes of restoration, it is recommended that the restoration effort extend downstream to a stable point, as described in the next paragraph.

When combined with the river water that flows over the spillway, the large bay created by releases through the turbine gates creates a channel that is about twice as wide as the normal dimensions for the lower Clark Fork River. The river splits into two channels around an island that is probably the result of sediment deposition at the downstream end of the large pool where the two flow paths converge. The island and split channels could also be influenced by the railroad crossing downstream from Milltown dam. The overly wide area extends downstream past the railroad crossing to the point that the two channels converge. Just downstream from the point of convergence, the river transitions into a stable F type channel that appears to be functioning adequately at a point about 2,800 feet upstream from the I-90 bridge. For the limited purposes of this analysis and cost estimate, this point was selected as the downstream extent of the effects of the Milltown Dam.

In summary, the downstream effects include channel scour and over-widening from releases of water from the spillway and through the turbines. The island and split channels formed downstream from the dam are most likely the result of the release patterns. The effect appears to end by Station 28+00. Also, the dam most likely traps and stores bedload sediment during normal high flow periods, which generally leads to a coarsening of the bed (increasing the particle size distribution) by causing the gravels to be scoured out of the reach without being replaced by upstream sources. This can influence habitat and productivity by reducing the amount of fine gravels that would be resident in the system.

The upstream extent of the backwater effects from Milltown dam on the Blackfoot River was determined based on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) longitudinal profile at larger flood stages and field reviews of the lower river. The FEMA profile indicates a distinct drop in water surface elevation at the Stimson diversion dam indicating a backwater effect from the diversion dam. Downstream from the Stimson diversion dam, the water surface is essentially flat at larger flood stages, indicating that the backwater effect from Milltown dam ends at the Stimson diversion dam. For this reason, the reach break on the Blackfoot River will be just downstream from the Stimson diversion dam.

There are other considerations that could influence the decision to include some of the costs of restoration of the Blackfoot River (BFR) upstream from Stimson diversion dam with the lower reach of the BFR. First, with Milltown dam removed, the Stimson diversion dam becomes a fish barrier year round. At present, the Stimson diversion dam may be a barrier only part of the year and therefore, removal of Milltown dam will have an effect on the upper BFR reach. Secondly, the drop in water surface elevation after Milltown dam is removed will create additional head (or drop) over Stimson diversion dam, which will increase the potential for scour and undercutting of the diversion dam. This increase in head could threaten the integrity of the Stimson diversion dam. Therefore, the Stimson diversion dam may be at an increased risk of failure following removal of Milltown dam.

2.3 REACH DELINEATION OF RIVERS IN PROJECT AREA

The two rivers were delineated into reaches based on five criteria: 1) geomorphic setting of rivers; 2) potential streamtype for restoration; 3) degree of detailed information; 4) the upstream extent of the direct or indirect influence of Milltown dam, which was covered in Section 2.2.; and 5) the nearest stable point or unchanging feature upstream and downstream from the primary project area as described in the following discussion. Figure 1, Appendix 1 displays the selected reach delineations for the project area.

The rivers were divided into the following reaches:

- CFR 1 – Clark Fork from just upstream from the I-90 bridge upstream to the confluence of the rivers. The straight-line valley length of this reach is approximately 5,250 feet.
- CFR 2 - Clark Fork from the confluence upstream to approximately the Duck Bridge grade. The valley length of this reach is approximately 3,850 feet.
- CFR 3 – Clark Fork from Duck Bridge upstream to the upper most extent of the backwater deposition caused by Milltown dam as described in Section 2.2. The valley length of this reach is approximately 7,000 feet.

- CFR 4 - Clark Fork from Reach 3 upstream to include the Turah Bridge (and the nearest stable point). The valley length of this reach is approximately 15,400 feet.
- BFR 1 – Blackfoot from the confluence upstream to the Stimson diversion dam, as described in Section 2.2. The valley length of this reach is approximately 5,650 feet.
- BFR 2 – Blackfoot from Stimson diversion dam upstream until the backwater effect of diversion dam and channel constriction diminishes. Refer to Section 2.4, BFR2, for a description of the upstream endpoint. The valley length of this reach is approximately 6,500 feet.

See Appendix 2 for photographs of each of these reaches.

For a stream restoration project to be successful, it is important to start the restoration at the upstream extent of the unstable reach or altered reach of river. This is important to minimize the risk that the river will change its location or channel upstream from the project and enter the project at an inappropriate location. There are many case examples of the consequences of failing to extend the restoration upstream to a stable point or some other feature that will not change. Therefore, to minimize the risk of severe damage or failure of a restoration effort, a stable or unchanging feature must be identified. Since the Clark Fork River has highly altered in some reaches extending upstream to Deerlodge, MT, there was a need to identify some closer upstream endpoint. The Turah Bridge was selected as the upstream point because it is likely to remain in place in the future to provide access to private lands on the south side of the valley. As described in Section 2.4, the Clark Fork River is relatively unstable and highly altered upstream from Milltown dam all the way to the Turah Bridge. The bridge section can provide a relatively stable section from which to link the proposed restoration effort. Therefore, Reach CFR 4 is delineated as the upstream extent of the backwater effects of Milltown dam upstream to approximately the Turah Bridge.

As described in Section 2.2, downstream from Milltown dam, the stable endpoint for the restoration effort would be about 2800 feet upstream from the I-90 Bridge. However, for consistency in linking all the data sources together, the reach CFR 1 was extended downstream to the upstream edge of the I-90 bridge. For the remainder of the CRP, the upstream edge of I-90 bridge is labeled as Station 0+00 on the proposed longitudinal profile. There are no restoration treatments proposed for the 2800 feet between the I-90 bridge and Station 28+00.

A similar logic is applied to the Blackfoot River for Reach BFR 2. As described in Section 2.2, there is a backwater effect from the Stimson diversion dam also and the diversion dam is at an increased risk of damage or failure with the removal of Milltown dam. It would also become a fish migration barrier during most flow periods. Because of these factors and the need to extend the restoration up to a stable, upstream point, Reach BFR 2 was delineated and continues upstream to a stable point as discussed in Section 2.4, BFR 2.

2.4 EXISTING AND POTENTIAL RESTORED CONDITIONS

The physical configurations of the two rivers have been highly modified by Milltown Dam and the deposit of industrial mining and other sediments, and to a lesser degree by other upstream influences. The Blackfoot River is directly affected by encroachment from Highway 200, fills at the Stimson lumber mill, the Stimson diversion dam, highway bridges and the backwater effect caused by Milltown dam. The result is that the lower Blackfoot River downstream from the Stimson diversion dam is in the backwater of Milltown dam and is an F type channel. Upstream from Stimson diversion dam, the channel varies between an F channel and a B3c channel due to backwater sediment deposition and artificial elevation of the channel bed. The Clark Fork River is directly affected by similar impacts, in addition to encroachment and channelization by railroad grades.

The potential streamtype used for restoration is the most probable streamtype given the geomorphic and valley setting modified by the limitations imposed by human-caused or other influences that are not subject to change. For example, the most probable historic streamtype for a segment of river being evaluated may be a C type channel, but because of encroachment by a highway fill, the potential streamtype may be changed to a B type channel in a narrower valley. If more than one potential streamtype is possible, usually the most stable and productive streamtype is selected that will meet the objectives of the project.

CFR 1

Milltown dam is in the upstream end of this reach and affects the channel both upstream and downstream, as described in Section 2.2. Historically, this channel would most likely have been a B3c streamtype in a fairly narrow valley bounded by a high glacial outwash terrace on the north and a bedrock valley wall to the south. The river transitions into a stable F3 streamtype between the dam and the I-90 bridge downstream. The existing channel is overly wide due to river flows being split between the spillway and turbine outlets. The large bay downstream from the dam is about twice as wide as the normal channel dimensions. The island that has formed downstream between the dam and the railroad crossing is a stable feature, but probably did not occur before the dam was constructed. However, the split channel presents some opportunities for side channel habitat and additional recreational experience. For these reasons, the proposed streamtype for the area between the confluence and the F3 type channel is a B3c with a diverging side channel that is less than 30 percent of the river flow during bankfull conditions. The valley gradient for this reach would be a constant 0.002 ft./ft. over a distance of about 5,250 feet.

CFR 2

Before Milltown dam was constructed, this reach was most likely a transition zone between the wider valley and C type stream channel upstream to a narrower B type channel for some distance upstream from the confluence, as described in Section 2.1. A brief analysis was conducted for other valley transition reaches on the Blackfoot River, Clark Fork River and Rock Creek in similar geomorphic settings. The objective was to determine the potential length of the transition zone between a C type stream and a B type stream under natural conditions. Five transition reaches were located and evaluated for valley and channel characteristics. That information was used to determine that the transition zone for the CFR and BFR confluence area should be about 3,000 foot long. The meander geometry also changes somewhat in transition zones, and those values were calculated and used in the proposed plan view design (refer to Sheet CFR 2, Appendix 4).

The existing conditions were created shortly after Milltown dam was constructed. The dam created backwater conditions (ponding of the water, which reduces gradient and energy available for transporting sediment) extending upstream into Reach CFR 3. During the large flood of 1908, tremendous loads of sediment were deposited in the backwater zone upstream from the dam. The deposition filled existing channels, causing the river to create new channels in the path of least resistance. With no vegetation to stabilize the banks and a lower overall gradient, the channels tend to convert to a braided condition. During subsequent high flow years, the deposition progressed upstream, which reduces the gradient and energy available for moving sediment. The stream responds to the decrease in energy by filling the existing channel with bedload sediment and creating new channels in a similar fashion. The backwater effect of the Milltown dam was compounded by the Duck Bridge railroad crossing, which was a valley constriction and also created backwater conditions during large floods. The end result is a completely flat, braided plain that extends upstream into Reach CFR 3.
With the dam and contaminated sediments removed from Area I, the opportunity would exist to create a setting similar to the historic conditions. The proposed streamtype for CFR 2 is a C4 channel transitioning into a B3c channel. The valley gradient would increase from about 0.002 ft./ft. upstream from the Duck Bridge grade to about 0.005 ft./ft. in reach CFR 2. The valley length for Reach CFR 2 is about 3,850 feet.

<u>CFR 3</u>

This reach was most likely a C4 channel historically with a wide, densely vegetated floodplain bounded by terraces. The existing situation is affected by backwater deposition from the Milltown Dam during flood events and the resultant channel system has changed into a braided D4 type system as discussed for Reach CFR 2. Sediment deposition has occurred for several thousand feet upstream, which has buried the historic terraces. The deposition and backwater from the dam has formed extensive wetlands, however, and vegetation communities have probably shifted from a mix of coniferous forests on the terraces and deciduous vegetation on the floodplain to predominantly deciduous and wetland vegetative types. The lower 2,200 feet of floodplain is essentially flat, corresponding to the normal high water conditions for the dam.

The potential streamtype in the area is a predominantly single thread C4 channel with off-channel wetlands supported by subsurface flows from adjacent hill slopes. The lower 2,200 feet of the channel and floodplain will need to be reconstructed at a lower elevation to prevent a flat discontinuity in the channel and valley gradient. The floodplain should span the belt width of the channel (width between the lateral extents of opposing meanders measured perpendicular to the slope of the valley). In other words, the valley gradient should remain at a constant 0.002 ft./ft. over a distance of about 7,000 feet. The floodplain should narrow gradually between the upstream and downstream segments.

<u>CFR 4</u>

This reach is similar to CFR 3 except that it is upstream of the backwater deposition and effects of Milltown dam. The historic streamtype was most likely a C4 streamtype; however, channelization and encroachment from the highway and railroad grades have altered the channel and valley bottom significantly. Other influences include agriculture, grazing, timber removal, commercial, and residential development. Several sub-reaches of the Clark Fork within Reach

CFR 4 have responded to increased sediment supply and bank erosion by converting to a braided D4 type channel. These braided channels are typically highly unstable with bank erosion occurring on one or both banks almost continually along its length. High width:depth ratios reduce sediment transport capacity and in many cases D4 channels are in an aggrading trend (stream bed is elevated due to sediment deposition). The existing channel varies from C4 stream types to reaches of D4 and F4 stream types where the channel is either braiding or confined by berms, respectively. The potential streamtype is a C4 channel and can be created by re-activating abandoned meanders linked by new channel segments constructed to the appropriate dimensions. Overall floodplain width, belt width should remain unchanged and valley gradient will remain at about 0.003 ft./ft. over a distance of about 15,400 feet.

BFR 1

The lower Blackfoot River was most likely a B3c channel upstream from the confluence before the Milltown dam was constructed. The glacial outwash terraces that confined the later extent of the floodplain remain, although the terraces are now highly developed for industrial, commercial, and residential land uses. The existing channel is affected by backwater conditions from the Milltown dam as well as five major highway and railway bridges. With the Milltown dam removed, the width between the terraces is sufficient to re-create a B3c channel type, similar to historic conditions. The five bridges complicate restoration, but would not prevent the conversion back to a B3c streamtype. The original gradient is unknown, but without reconstructing the bridges, the final gradient of the River will be dictated by the depth of the bridge piers and the allowable scour depth. The gradient would remain consistent at about 0.002 ft./ft. upstream from the Highway 200 Bridge, but would steepen to about 0.005 ft./ft. downstream to the confluence. For these reasons, the potential streamtype for BFR 1 is a B3c streamtype. A narrow, sloping flood prone area could be created by reshaping the channel cross section and redefining the thalweg. The valley length of this reach is about 5,650 feet.

BFR 2

The upper Blackfoot River reach was most likely similar to the lower reach and was probably a B3c channel type. The dominant streamtype upstream from BFR 2 is a B3c channel type with the exception of reaches that have encroachment from road systems. These reaches are usually F3 stream types. The existing conditions are highly altered by the Stimson diversion dam, a large fill along the mill encroaching into the river, sediment deposition created by backwater conditions related to the fill and the dam, and highway encroachments. With Stimson diversion dam and the fill removed, the potential streamtype for the entire reach would be a B3c channel. Like Reach BFR 1, the channel could be reshaped into a narrower channel with a sloping flood prone area adjacent to the channel. Overall valley gradient is about 0.003 ft./ft. over a distance of about 6,500 feet.

The upstream extent of Reach BFR 2 was determined using the FEMA FIRM profiles and a field review intended to document channel depositional features that could be related to backwater effects of the Stimson diversion dam and the channel fill constricting the river just upstream from the dam. Upstream from the Stimson diversion dam, the point where the depositional features start to disappear is approximately the same point where the flood profile gradient begins to steepen (Cross section U on the FEMA profile). Apparently, the backwater effect of the Stimson diversion dam, in conjunction with the channel constriction just upstream from the dam, affects the river during large floods for approximately 6,500 feet upstream. An actual ending point could not be determined with the limited data available. In addition, other effects make the exact point difficult to determine, such as the constriction of the channel in several places from Highway 200 upstream from the Stimson diversion dam. For the limited purposes of this CRP, a point about 6,500 linear feet upstream from Stimson diversion dam will be used as the upstream terminus of Reach BFR 2.

3.0 HYDROLOGY AND FLOOD SERIES ANALYSIS

This section will summarize the hydrology of the project area and provide an estimation of the bankfull discharge and flood characteristics for the two rivers.

3.1 GENERAL DESCRIPTION

The watershed area upstream of Milltown dam encompasses 5,984 square miles (3,829,760 acres), with elevations ranging from 3,218 feet at the Milltown dam powerhouse to over 8,000 feet at both the Blackfoot River and Clark Fork River sub-watershed divides. The Clark Fork River watershed is located west of the Continental Divide with most of the headwater streams originating along the Continental Divide. The Blackfoot River sub-watershed has relatively high mean annual precipitation ranging from 16 inches at the confluence with the Clark Fork River to 60 inches at the watershed divide (USDA Soil Conservation Service, 1990). The Clark Fork River sub-watershed has a lower mean annual precipitation ranging from 14 inches near Milltown dam to 50 inches at the divide (USDA Soil Conservation Service, 1990). A majority of the precipitation in both sub-watersheds occurs as snow that typically melts between April and June producing snowmelt runoff dominated hydrographs.

USGS gauging stations provide historical flow information for the Blackfoot River and the Clark Fork River both upstream and downstream of the project area. Discharge on the Blackfoot River is slightly regulated by Nevada Creek Reservoir and is affected by the appropriation of surface water for the irrigation of approximately 20,000 acres. Discharge on the Clark Fork River above Milltown dam is somewhat regulated by the Warm Springs Ponds on Silver Bow Creek near Anaconda and Georgetown Lake on Flint Creek and is affected by the appropriation of surface water for the irrigation of approximately 100,000 acres. Discharge on the Clark Fork River above Milltown dam is heavily regulated with diurnal fluctuations and is affected by the appropriation of surface water for the irrigation of approximately 120,000 acres.

3.2 HYDROGRAPH DISCUSSION

Mean daily discharge values from the pertinent USGS stream flow gauging stations were reviewed to evaluate the timing, magnitude, and duration of peak and base flow discharges. In addition to providing important data for channel design, this information was used to forecast stream flow conditions that will likely be experienced during the implementation phase of this project.

Based on data available for the periods of record, the Blackfoot River typically flows less than 700 cfs from September through March with baseflow (discharge less than 600 cfs) discharge occurring from mid-December through early February. Discharge typically exceeds 5,000 cfs from mid-May through mid-June with peak flows occurring in early June. The Clark Fork River at Turah Bridge typically flows less than 1,000 cfs from July through March and experiences baseflow (discharge less than 700 cfs) conditions from early August through early September, and from mid-to-late December. Flows on the Clark Fork River at Turah Bridge typically exceed 2,000 cfs from early May through late June with peak flows occurring in early June. The Clark Fork River above Missoula typically flows less than 2,000 cfs from July into March with baseflow conditions (discharge less than 1,500 cfs) from mid August through early October, and from early December through February. Flows on the Clark Fork River below the confluence typically exceed 8,000 cfs from mid-May through late June with the highest flow typically occurring during the first week of June. Low flow conditions in the Clark Fork River in August and September are related to surface water appropriations and diversions for a variety of beneficial uses.

BANKFULL DISCHARGE ANALYSIS

The bankfull discharge is the most frequently re-occurring flow associated with moving sediment, forming and shaping bars, and maintaining the main morphological characteristics of natural stream channels (Rosgen, 1994). Bankfull discharge is associated with a momentary maximum flow, which, on average, has a recurrence interval of 1.5-1.8 years as determined using a flood frequency analysis (Dunne and Leopold, 1978). WCI performed a detailed analysis to calibrate bankfull discharge for the Blackfoot River and the Clark Fork River upstream and downstream of the confluence with the Blackfoot River. The first analytical method determined bankfull discharges using both past USGS flood frequency analyses and USGS regional equations (Omang, 1992). The second analytical method determined bankfull discharges using historical gage data and applied six different statistical approaches. In most cases, the error factor was less than 15%. The bankfull discharge results are a first estimation and will require further validation during consecutive design phases of this project. The following table summarizes the bankfull discharge for specific reaches in the project area.

TABLE 1
THE PREDICTED BANKFULL DISCHARGE (CFS), RANGE, AND MARGIN OF ERROR FOR THE CLARK FORK RIVER (UPSTREAM OF THE CONFLUENCE), BLACKFOOT RIVER (UPSTREAM OF THE CONFLUENCE), AND THE CLARK FORK RIVER (DOWNSTREAM OF THE CONFLUENCE).

	CLARK FORK RIVER (UPSTREAM OF CONFLUENCE)	**BLACKFOOT RIVER (UPSTREAM OF CONFLUENCE)**	**CLARK FORK RIVER (DOWNSTREAM OF CONFLUENCE)**
Bankfull Discharge	3,300	7,400	10,600
Margin of Error	± 320	± 740	± 1,060
Range	2,880 – 3,530	6,660 – 8,140	9,540 – 11,660

<u>FLOOD SERIES ANALYSIS</u>

A detailed flood frequency analysis using historical gage data and several statistical distributions was performed to determine discharges associated with selected recurrence intervals. Statistical analyses included normal distribution, log-normal distribution, gumbel distribution, extreme value distribution, and log-Pearson III distribution. Analyses were performed for the four pertinent USGS Gages, including: 1) the Blackfoot River near Bonner (#12340000); 2) the Clark Fork River at Clinton (#12331900); 3) the Clark Fork River at Turah Bridge (#1234550); and 4) the Clark Fork River above Missoula (#12340500). The periods of record for each gage are 68 years, 14 years, 16 years, and 72 years, respectively. The following table summarizes the discharge values produced by applying the statistical method with the highest correlation coefficients for the individual USGS stream flow gages.

TABLE 2
THE PREDICTED DISCHARGE (CFS) FOR SELECTED RECURRENCE INTERVALS USING THE STATISTICAL METHOD WITH THE HIGHEST CORRELATION COEFFICIENT.

USGS GAGING STATION	DISCHARGE ASSOCIATED WITH RECURRENCE INTERVAL (CFS)						
	$Q_{1.5}$	Q_2	Q_5	Q_{10}	Q_{20}	Q_{50}	Q_{100}
Clark Fork-Upstream	3,500	4,740	8,210	10,930	13,850	18,080	21,600
Blackfoot River	6,350	8,500	12,650	15,570	18,490	22,430	25,520
Clark Fork-Downstream	11,500	14,460	22,040	27,480	32,980	40,480	46,400

As summarized in Table 2, the predicted bankfull discharges for the Clark Fork at Turah Bridge, the Clark Fork River near Missoula, and the Blackfoot River near Bonner were 3,500, 6,350, and 11,500 cfs, respectively. When compared to the predicted bankfull discharges presented in Table 1, the $Q_{1.5}$ estimate is within 15 percent of the predicted bankfull discharge, which further validates the prediction.

4.0 CHANNEL DIMENSIONS AND HYDRAULIC ANALYSIS

This section will predict the preliminary proposed channel dimensions to be used in the conceptual design. Channel design dimensions and meander geometry relationships are presented along with hydraulic calibration of the dimensions.

4.1 CHANNEL AND FLOODPLAIN DIMENSIONS

4.1.1 OVERVIEW

Natural channel design requires that the active channel be sized to accommodate the bankfull discharge and an adequate vegetated floodplain (or flood prone area) be constructed to convey flood flows of higher magnitude. The geomorphology of this area suggests that a single thread channel of both C (riffle/pool dominant habitat) and B (riffle/step pool dominant habitat) stream types, depending on the slope and degree of entrenchment or width of available floodplain, are appropriate.

Channel design parameters and dimensions include the bankfull discharge, width, mean depth, maximum depth, scour depth, cross-sectional area, and the width:depth ratio. Design dimensions are developed through a rigorous process that includes analog based hydraulic modeling (i.e. HEC-RAS), analytical field calibration (i.e. reference reach surveys), and empirical approaches (i.e. regional curves). For this level of design, a brief field review was conducted to measure existing bankfull widths in nearby undisturbed ("reference") sections, but no detailed channel surveys or hydraulic modeling of existing conditions was conducted. Channel dimensions for both riffle and pool habitat features have been developed for each reach. The bankfull discharge, depth, channel roughness, and slope all serve to determine the necessary cross-sectional area for a reach. An iterative process of refinement allows for the design channel to produce in-channel shear stresses sufficient to maintain sediment entrainment. Pool dimensions have been tailored to provide deep pool habitat with cover that is critical for over wintering and over summering for large and small fish, including bull trout.

4.1.2 CHANNEL DIMENSIONS

Three sets of channel dimensions for the Clark Fork River have been developed and are summarized in Tables 3 and 4. Detailed cross-section templates for each set of channel dimensions are included in Appendix 3. In the upper portion of the project area upstream of Duck Bridge, slope and floodplain availability allow for a designed C4 stream type with corresponding channel characteristics and dimensions noted in Table 3. From The Duck Bridge downstream to the confluence with the Blackfoot River, the Clark Fork River transitions from a C4 channel type to a B3 type (refer to Section 2.4 for a more detailed discussion on this transition). B3 channel type design dimensions for the Clark Fork River from The Duck Bridge downstream to the confluence with the Blackfoot River are summarized in Table 3.

TABLE 3: Design dimensions for Reaches CFR3 and CFR4 of the Clark Fork River (upstream of the Duck Bridge).

CLARK FORK RIVER (UPSTREAM OF DUCK BRIDGE) BANKFULL CHANNEL DESIGN DIMENSIONS C4 STREAM TYPE		
PARAMETER/FEATURE	**POOL**	**RIFFLE**
Discharge	3,300 cfs	3,300 cfs
Width	156 ± 10 ft	130 ± 10 ft
Mean Depth	4.8 ft	5.8 ft
Max. Depth	14.5 ft	7.2 ft
Scour Depth	20.3 ft	8.7 ft
Cross-Sectional Area	860 ft^2	750 ft^2
Width/Depth Ratio	N/A	22.4

TABLE 4: Design dimensions Reach CFR2 of the Clark Fork River (upstream of the confluence).

CLARK FORK RIVER (UPSTREAM OF CONFLUENCE) BANKFULL CHANNEL DESIGN DIMENSIONS B3 STREAM TYPE		
PARAMETER/FEATURE	**POOL**	**RIFFLE**
Discharge	3,300 cfs	3,300 cfs
Width	140 ± 10 ft	125 ± 10 ft
Mean Depth	4.4 ft	4.8 ft
Max. Depth	12.0 ft	6.0 ft
Scour Depth	15.4 ft	7.7 ft
Cross-Sectional Area	690 ft^2	600 ft^2
Width/Depth Ratio	N/A	26.0

One set of channel dimensions for the Blackfoot River was developed and is presented in Table 5. These B3 channel type dimensions are suitable for both Reach BFR1 and Reach BFR2 of the Blackfoot River.

TABLE 5: Design dimensions for Reaches BFR1 and BFR2 of the Blackfoot River.

BLACKFOOT RIVER (UPSTREAM OF CONFLUENCE) BANKFULL CHANNEL DESIGN DIMENSIONS B3 STREAM TYPE		
PARAMETER/FEATURE	**POOL**	**RIFFLE**
Discharge	7,400 cfs	7,400 cfs
Width	195 ± 10 ft	175 ± 5 ft
Mean Depth	6.0 ft	6.6 ft
Max. Depth	16.5 ft	8.6 ft
Scour Depth	21.2 ft	10.6 ft
Cross-Sectional Area	1,335 ft^2	1160 ft^2
Width/Depth Ratio	N/A	26.5

A final set of channel dimensions for the Clark Fork River downstream of the confluence with the Blackfoot River was developed and is summarized in Table 6. The B3 channel type dimensions are suitable for Reach One of the Clark Fork River.

TABLE 6: Design dimensions for Reach CFR1 of the Clark Fork River (downstream of the confluence).

CLARK FORK RIVER (DOWNSTREAM OF CONFLUENCE) BANKFULL CHANNEL DESIGN DIMENSIONS B3 STREAM TYPE		
PARAMETER/FEATURE	**POOL**	**RIFFLE**
Discharge	10,600 cfs	10,600 cfs
Width	235 ± 5 ft	215 ± 5 ft
Mean Depth	8.3 ft	9.2 ft
Max. Depth	20.2 ft	11.5 ft
Scour Depth	29.4 ft	14.7 ft
Cross-Sectional Area	2270 ft^2	1,970 ft^2
Width/Depth Ratio	N/A	23.4

All cross-sectional design parameters for riffle habitats are summarized in Table 7. Riffle sections are compared because most parameters are based on a bankfull width at a stable riffle section and these sections tend to be the most hydraulically consistent. It may be noted that the width, depth and cross sectional area is less for the B3c reach of the CFR 2 than the C4 reach of CFR 4. This decrease in size is due to the increase in gradient for CFR 2, which increases velocity and necessitates a reduction in channel capacity to maintain a channel that just contains the bankfull discharge.

TABLE 7: Summary table of bankfull channel design dimension (riffle habitat features) for all reaches.

SUMMARY OF BANKFULL CHANNEL DESIGN DIMENSIONS RIFFLE HABITAT DIMENSIONS				
PARAMETER/FEATURE	**CLARK FORK RIVER**	**CLARK FORK RIVER**	**BLACKFOOT RIVER**	**CLARK FORK RIVER**
	REACHES CFR3 & 4	**REACH CFR2**	**REACHES BFR1 & 2**	**REACH CFR1**
Stream Type	C4	B3	B3	B3
Discharge	3,300 cfs	3,300 cfs	7,400 cfs	10,600 cfs
Width	130 ± 10 ft	125 ± 10 ft	175 ± 5 ft	215 ± 5 ft
Mean Depth	5.8 ft	4.8 ft	6.6 ft	9.2 ft
Max. Depth	7.2 ft	6.0 ft	8.6 ft	11.5 ft
Scour Depth	8.7 ft	7.7 ft	10.6 ft	14.7 ft
Cross-Sectional Area	750 ft^2	600 ft^2	1,160 ft^2	1,970 ft^2
Width/Depth Ratio	22.4	26.0	26.5	23.4

4.2 PLAN FORM GEOMETRY

Plan view geometry and characteristics are also a function of the bankfull discharge and the bankfull design width. The most probable channel patterns for the project area reaches were determined from empirical models developed by Leopold et al (1964), Williams (1986), Rosgen (1996), and WCI's reference reach database. Plan view design parameters were calculated for the individual project reaches and are summarized in Table 8. Bankfull channel parameters included the design sinuosity, meander length range, curvature radii, and step frequency. The design belt width, a floodplain characteristic, is also included.

TABLE 8: Summary table of plan form channel and floodplain design dimension for all reaches.

SUMMARY BY REACHES BANKFULL CHANNEL DESIGN DIMENSIONS				
	CLARK FORK RIVER	**CLARK FORK RIVER**	**BLACKFOOT RIVER**	**CLARK FORK RIVER**
PARAMETER/FEATURE	**REACHES 2, 3 & 4**	**REACH 2**	**REACHES 1 & 2**	**REACH 1**
Stream Type	C4	B3	B3	B3
Design Sinuosity	1.5	1.3	1.3	1.3
Meander Length Range	1,500 ± 250 ft (1,250–1,750)	1,560 ± 250 ft (1,310–1,810)	2,100 ± 350 ft (1,750–2,450)	
Radius of Curvature Range	455 ± 130 ft (325–585)	455 ± 130 ft (325–585)	610 ± 175 ft (1,750–2,450)	
Step Frequency Range	N.A.	4-5* Wbf (520-650)	4-5*Wbf (700-875)	4-5*Wbf (860-1,075)
Meander width ratio Belt width Range	4-20 (520-2,600)	2-6 (260-780)	2-5 (350-875)	

The empirical models provided a range of values for channel pattern attributes rather than specific values for channel pattern. All values will be validated in Phase 2 (refer to Section 5.8). The channel patterns and locations may be adjusted to account for the final condition of the valley bottom following reservoir sediment removal. Where feasible, the new channel will be constructed to incorporate established existing vegetation to provide bank stability and habitat, beneficial characteristics for rehabilitating the constructed reaches.

4.3 HYDRAULIC ANALYSIS

WCI performed several different preliminary hydraulic analyses during the development of each set of design dimensions. This analysis focused on three independent techniques. First, hydraulic geometries were developed at the pertinent gage station that provided initial information regarding the relationship of cross-sectional area, width, hydraulic radius, mean depth, and wetted perimeter to the bankfull discharge. This type of relational information was then used and extrapolated to develop the first revision of the design dimensions. WCI then utilized information from FEMA regarding water surface slopes, predicted bankfull discharge, and the preliminary design dimensions for each reach as input into a hydraulic modeling software called WinXSPro (USDA, 1998). This analysis is one-dimensional (cross-sectional) in nature and was iteratively used to refine the each reach's design dimensions to insure that it had the correct cross-sectional geometry to convey the bankfull discharge. Finally, WCI developed a preliminary two-dimensional hydraulic method using HECRAS (hydraulic modeling software developed by the U.S. Army Corps of Engineers). This analysis was critical in further refining the preliminary channel and floodplain design dimensions to insure that the design channel is capable of conveying the discharge and sediment that the watershed naturally produces. Design dimensions of the active bankfull channel were refined throughout this process to focus on in-channel conveyance of the bankfull discharge. Less interest and effort was placed on developing detailed stage height relationships for large magnitude flood events.

Further analyses will be required during Phase 2 and Phase 3, as further described in Sections 5.8 and 5.9.

5.0 PROPOSED RESTORATION STRATEGY AND RECOMMENDATIONS

5.1 COMPARISON OF EPA'S PROPOSED PLAN TO THE CRP

For the development of this CRP it is assumed that EPA's Proposed Plan for the Milltown Reservoir Sediments Operable Unit will include the following remedial actions, a derivation of the Feasibility Study Alternative 7A2:

1. Sediments from Area I will be removed to an elevation that represents the level of the buried alluvium. These sediments will be removed from the site and transported to a repository west of the reservoir.
2. Area III channel sediments will be left in place out of the 100-year floodplain. The sheet pile used to isolate Area 1 sediments will be removed or left in place and cut off below ground surface.
3. The Milltown dam spillway and radial gate structures will be removed to allow construction of a channel designed to carry the 100-year flood. Other dam structures, the powerhouse, divider block, and north abutment wall will be left in place.
4. Grade control will be established on the Clark Fork River in the area of Duck Bridge and on the Blackfoot River near the interstate 90 overpass.
5. A river channel will be excavated into the alluvium. The channel on the Clark Fork River will be capable of carrying the 100-year flood within it's banks. The streambanks will be a rip-rap type bank throughout the Area 1 and extending through the removed dam. The confluence of the Clark Fork River and Blackfoot River will be established upstream of the present dam location.
6. The floodplain of the Clark Fork River will be backfilled to re-establish a floodplain and proper grade. The floodplain will be re-vegetated with grasses.

EPA's proposed plan includes all of Reach CFR 2 and parts of Reaches CFR 1 and BFR 1. As noted in previous sections, Reaches CFR 1 extends further downstream and BFR 1 extends further upstream. As discussed on Section 2.2 through 2.4, CFR 3 includes that portion of the Clark Fork River that is directly affected by Milltown dam. CFR 4 and BFR 2 are included to extend the CRP to the nearest stable point.

The proposed restoration strategy coordinates with some of these treatments, modifies or enhances other treatments and replaces some treatments altogether to fit the Natural Channel Design (NCD) concept. A brief comparison of the two approaches is provided in the following discussion, identified by the same bullet number as used above. Complete details of the proposed restoration plan are included in the Sections 5.2 through 5.4.

1. This action is assumed to be fully implemented and is unchanged in the CRP.
2. The CRP proposes to remove all sheet piling.
3. The CRP proposes to remove all dam structures, including the powerhouse, divider block, and north abutment wall while re-grading the entire area into channel and floodplain. Because of the historical nature of the powerhouse, it may be appropriate to build a replica of the powerhouse on site out of the floodplain. Parts of the powerhouse, such as the generators, could be relocated on the replica.
4. The CRP proposes grade control throughout all reaches with the use of many different kinds of structures designed to benefit natural channel processes, fish habitat, fish passage, flood plain function, boating and other resource goals. Descriptions of the proposed structures are in Section 5.2 through 5.4. No single, massive grade control structures are planned, as proposed in the EPA proposed remediation plan.
5. The CRP proposes to excavate the new channel into the alluvium, where necessary, but the channel will be designed to carry the bankfull discharge (1.5-year flood), rather than the 100-year flood. The Natural Channel Design concept used in the CRP promotes the design of a channel that can accommodate the normal annual high flow within the active channel. A floodplain or flood prone area is designed adjacent to the active channel to accommodate a whole range of flood flows including the 100-year flood. Stream banks would be stabilized using a much softer approach, using rock and log structures designed to meet the objectives outlined in Section 1.0, specifically, minimal streambank erosion of areas containing significant levels of contamination. No rip-rap or armored banks are proposed in the CRP. The confluence of the two rivers would be established upstream from the present dam location, but would be slightly downstream of the confluence proposed in the EPA proposed plan.
6. The floodplain of the Clark Fork River will be backfilled to the grade necessary to re-establish a floodplain or flood prone area appropriate for the geomorphic setting. This floodplain or flood prone area would be activated during most years to some degree, rather than only above the 100-year flood as in the EPA proposed plan. Revegetation treatments proposed in the CRP are much more aggressive and intensive to promote true restoration of the floodplain and riparian areas in order to meet the established objectives. EPA's proposed plan includes only grasses, with no discussion of how the natural riparian species would re-colonize the site. The CRP augments the planting of grasses

with a full complement riparian, upland and wetland species designed to replace the habitats that occupied the site prior to dam construction. Refer to Section 5.4.5 for a description of all revegetation treatments proposed in the CRP.

The CRP utilizes the natural channel design (NCD) concept, which aims to restore natural channel stability, or dynamic equilibrium, and habitat to impaired streams. When properly applied, NCD methods provide a robust, widely tested, and well-accepted approach to the design of natural channels that successively achieve habitat and geomorphic restoration objectives while functioning during extreme flood events (Schmetterling and Pierce, 1999). NCD is the foundation for developing a naturally stable channel design and meeting habitat restoration objectives. NCD focuses on restoring geomorphic characteristics while incorporating fish habitat structures composed of native materials in natural arrays that better replicate native salmonid habitat as necessary for restoring inland native fish populations. Additional information on NCD can be found in Appendix 9.

5.2 PLAN VIEW, LONGITUDINAL PROFILE, CROSS SECTIONS

All available data sources were used to develop the plan view alignments, longitudinal profiles and cross sections. Data sources included the FEMA FIRM maps (1988), Land and Water Consulting, Inc. cross-section data (1998), aerial photogrammetric base map by Horizons, Inc. (2000), and the Sediment ISOPAC Map (Titan Environment, 1995, geo-referenced by EMC^2 in 2002). All data were geo-referenced to NAD, 1983, and NAVD 1988.

The data was generally adequate for a conceptual level design, but large data gaps existed, particularly in Reaches CFR 3 and 4. The plan view was developed using standard channel and meander geometry dimensions as described in Section 4. The channel plan view is considered conceptual at this point due to very limited data. The detailed plan view alignments can be validated and updated during Phase 2 of the design process.

The longitudinal profile was developed with the objective of keying the proposed floodplain to existing floodplains and vegetated features. Valley gradients were kept as constant as possible to minimize potential problems associated with sudden changes in gradient. The proposed gradient is shown as a water surface profile at bankfull stage and a consistent bed profile that is parallel to the water surface profile. The bed gradient is not intended to illustrate pool, riffle, run and glide habitats, but rather to indicate the elevation of the grade control at any point in the profile. More detailed profiles can be developed during Phase 2 of the design process.

For the Clark Fork River Reaches, the valley gradient is illustrated rather than the stream profile. There is enough uncertainty in the plan view of the proposed C type channel and a high sinuosity so that the profile could vary significantly. For this reason, the valley profile is illustrated with the understanding that the channel gradient can be calculated by dividing the total change in elevation by the total channel length. The Blackfoot River system had much less uncertainty and also a very low sinuosity, so the channel gradient is shown in this case. In other words, there is little difference between the valley profile and the channel profile for the Blackfoot River. Refer to Appendix 7 for displays of the longitudinal profiles.

Cross sections were developed using the template channel geometry and dimensions overlain on the existing land surface or the surface predicted to exist after sediment removal. There is a high level of uncertainty associated with the post-sediment removal land surface, so the channel cross sections are considered conceptual. Floodplains were designed to minimize cuts or fills and to meet the minimum criteria in most cases.

5.3 PROPOSED CHANNEL FEATURES, STRUCTURES AND DETAILS

This section will summarize the proposed channel features and quantities. For more detailed estimates of the number of structures, cut and fill volumes and quantities, refer to the cost estimate sheets included in Appendix 6. Most features discussed in this section are displayed on the Plan View Sheets in Appendix 4.

TABLE 9
PROPOSED CHANNEL AND REACH DIMENSIONS

CHARACTERISTIC	REACH						
	BFR-1	BFR-2	CFR-1	CFR-2		CFR-3	CFR-4
Proposed Stream Type	B3c	B3c	B3c	B3c	C4	C4	C4
Entrenchment	1.7	2.0	1.2	3-9	3-9	9-19	4-8
Width/Depth	26	26	23	22	26	22	22
Valley Length (ft)	5650	6500	5250	3850		7000	15400
Stream Length (ft)	6100	7600	5500	4300		10400	19400
Sinuosity	1.1	1.2	1.04	1.1	1.3	1.48	1.3
Stream Gradient (mean)	0.002-0.005	0.002	0.002	0.005	0.004	0.0013	0.0024
Valley Gradient (mean)	0.002-0.005	0.002	0.002	0.006	0.006	0.002	0.003
Belt Width (ft)	300-350	300-350	225-700	400-1200		1000-1400	500-800
Meander Width Ratio	2-5	2-5	1.2	2-5	4-20	4-20	4-20

5.3.1 CFR 1 AND POWERHOUSE

The proposed channel is a $B3_c$ channel with a mean gradient of about 0.002 ft./ft. The minimum flood prone width for this channel is about 500 feet compared to a width of about 250 feet available with only the spillway and radial gates removed. The limited width created by removing only the spillway and radial gate necessitates removing all the dam structures, including the powerhouse, divider block and north abutment wall to create an adequate floodplain. If the powerhouse and associated structures were to be left in place, this CRP should not be implemented. In order to secure the physical and biological functions as well as a stable self-maintaining channel, which are objectives of this project, all dam structures must be removed or relocated out of the flood prone area. Specifically, the reasons the powerhouse and associated structures need to be removed are as follows:

- With the powerhouse in place, the limited width of the flood prone area would create a severe constriction, which will cause backwater deposition (excess sediment deposition/ aggradation) during even moderate flood events (see Appendix 2, Photo 5 – CFR 1). Plan View Sheet CFR 1 in Appendix 4 and the cross section sheet in Appendix 7 illustrate the approximate floodplain needed for a five-year return interval flood (about 22,000 cfs) without creating backwater deposition. The floodplain width for a five-year return interval flood is about 330 feet (extending about half way through the powerhouse structure).

- A 100-year return interval flood would be about 46,000 cfs, which would require a flood prone width of at least 500 feet to minimize the risk of creating backwater effect. Naturally stable B_3 stream types have an entrenchment ratio of up to 2.2 (flood prone width/ bankfull width) at an elevation two times maximum bankfull depth. With the powerhouse in place, a major flood would create backwater conditions that would bury the entire channel and some of the floodplain with large cobble and small boulder sized bedload sediment.

- Following each major flood, within the area affected by backwater deposition, all structures would be filled with sediment. This would increase the risk that the floodwaters would attempt to flank structures and create new channels.

- Excessive maintenance would be required after even small floods. Maintenance would include channel and floodplain excavation and disposal of the gravel; reconstructing structures; and complete revegetation. The maintenance would add a large cost to the project after each flood, which would continue indefinitely into the future.

- Aquatic habitat would be damaged following flood events as a result of sediment deposition and the subsequent maintenance.

- The constriction would increase velocity during all flood events, which would likely preclude fish migration during that period.

- The constriction and backwater would result in increased flood stage upstream from the powerhouse as well as increased shear stress and scour at the constriction and immediately downstream.

- The sudden expansion downstream from the constriction would create back-eddy erosion on the stream banks downstream from the constriction.

In summary, this CRP is designed to achieve all the objectives outlined in Section 1.0. The design is predicated on the removal of the spillway, powerhouse and all associated structures. Without removing all of the dam structures, the CRP will not be successful, the objectives will not be met and the CRP should not be implemented.

With the powerhouse and north abutment wall removed, the flood prone area on the north side would be filled and graded at the appropriate elevation. Some of the Area III sediments on the northeast side of the confluence would be needed to grade the bay where the turbines discharge into a floodplain. The island downstream between the Milltown dam and railroad bridge would remain with part of the flows routed through the side channel (less than 30 percent during bankfull conditions). The side channel presents some opportunities for fish habitat and additional recreational experience. Initial calculations suggest that cuts and fills will balance in reach CFR 1.

Downstream from the railroad crossing the side channel converges with the main channel. At this point, the river transitions into a stable F3 type channel. No additional work is proposed at this time between the I-90 bridge (Station 0+00) and Station 28+00 in CFR 1. The railroad bridge has an adequate span to accommodate the channel and flood prone area. A “W” weir or similar structure would need to be designed in Phase 3 to route the flows between the bridge piers to maximize sediment transport efficiency and minimize scour. Details of bridge construction are not known at this time.

Structures proposed in this reach would serve multiple functions: grade control and step pool morphology; bank stabilization; fish habitat complexity and river floating. Because this reach has a step-pool morphology and it is a large river, the structures would be constructed primarily of large rock, but large woody debris and root wads would be incorporated into all structures for habitat. Refer to Section 5.4 for descriptions and illustrations of the proposed structures. The detail sheet in Appendix 5 is an example of how a combination of these structures could be placed in this reach. Proposed structures include “J” Hook vanes, cross vane, single and double wing deflectors, converging roller eddy composites and converging rock clusters. This reach would be completely reshaped in to a steeper overall gradient and flows the channel will be narrower and deeper than the existing conditions. Shear stresses would also be greater on fresh fill material used to construct the channel and banks. Grade control and bank stabilization structures would need to be constructed at the proposed density and frequency to prevent channel down cutting and bank erosion until the natural sorting can take place and the revegetation matures. These structures are designed to allow fish passage upstream and downstream at most flow conditions present when the fish are conditioned to move. Also, river boating opportunities are enhanced with the proposed structures. Rock structures constructed with large rock are appropriate in this geomorphic setting with the south bank occurring on a bedrock outcrop.

5.3.2 CFR 2

As described in Section 2.4, this reach would be constructed to a C4 stream type in the upper half of the reach, transitioning into B3c streamtype for the lower half of the reach. Floodplain widths would also transition from about 1,000 feet wide at the Duck Bridge grade to about 300 feet near the confluence. Stream gradient would range from about 0.004 ft./ft. in the upstream C4 stream type portion to about 0.005 ft./ft. in the lower B3c stream type portion.

Area III sediments with low contaminate concentrations would be graded to fill some of the volume created by the removal Area I sediment. The Area II sediments would be suitable for building floodplains and terraces. Also, since the Duck Bridge grade on the south side creates a constriction on the floodplain during major floods, the fill should be excavated down to floodplain elevation and used as fill for the low areas. Removing the Duck Bridge fill will allow a smooth transition from a wider floodplain to a narrower floodplain that will eliminate rapid constriction during major floods. After these areas are re-graded, there would be a deficit of about 336,000 cubic yards of fill material that would need to be imported to the Reach. Coarse cobble and gravel should be imported to construct the channel and banks throughout the reach. Excess excavated material from Reach BFR 2 would be ideal for this application because it is clean and has about the correct size composition.

The Area III sediments that currently have relatively high contamination concentrations would be re-graded slightly to provide drainage, and revegetated in place. This area can be described as the existing CFR channel bed, from the existing confluence upstream, to a point opposite Station 80+00 on the proposed channel alignment (Sheet CFR 2 in Appendix 4). This is at about the transition point between the B3c and C4 channel types. The floodplain narrows significantly at this point. Under the remediation plan, the sheet piling that was placed along the north bank of the CFR during the Area I sediment removal would be cut down to just below the finished grade where the high contamination sediment is to remain in place. Under this CRP, all of the sheet piling would be removed. The floodplain would be graded up to this existing elevation at about a 4:1 slope. This area would be higher in elevation than the 500-year flood level and would be isolated from any flood by deep fills and gentle, revegetated slopes. Sheet CFR 2 in Appendix 4 and Example cross-section in Appendix 7 illustrate the treatments in this reach.

Structures proposed for the downstream $B3_c$ portion of this reach are primarily rock grade control and bank stabilization structures similar to Reach CFR 1. The gradient is steeper in this reach than in either the upstream or downstream reaches. Most of the new channel would be constructed on fresh fill that would not have the natural sorting and grade control of an existing river. To prevent the potential for down cutting and bank erosion that would take place without the structures, fairly high densities of structures are proposed. The detail sheet in Appendix 5 is an example of the types and placements for the proposed structures in CFR 2. The grade control structures are design to create a step-pool morphology and that would allow fish passage upstream and downstream. Also, river boating opportunities are enhanced with the proposed structures. These structures would replace rip-rap and "soft" bank stabilization proposed in the EPA remediation plan.

The upstream C4 portion of the reach would be stabilized with primarily large wood structures such as root wad/log vanes combination structures with rock J hook and large woody debris jam structures. Refer to Section 5.4 for descriptions and illustrations of the proposed structures. These structures are necessary for grade control and bank stabilization until the bed material can become naturally armored and bank vegetation matures. A rock "sill" is proposed at the upstream end of this reach, approximately where the Duck Bridge fill is to be removed to ensure that the newly constructed floodplain remains secure until the vegetation matures. The sill would be constructed at floodplain grade and is basically a trench excavated into the floodplain about three (3) feet deep and filled with large rock. The sill is capped with sod so that it is not visible. This sill could be incorporated into a foundation for a trail or link into proposed bridge abutments.

A footbridge has been proposed in the vicinity of the Duck Bridge grade to connect trails on the north and south sides of the Clark Fork valley. Proposed design criteria for the footbridge are included in Section 5.5. An aggressive revegetation plan is proposed for all reaches following construction to re-create the riparian and upland habitats that were present prior to dam construction. The proposed revegetation treatments are summarized in Section 5.4.5.

5.3.3 CFR 3

The upstream end of Reach 3 would be reconstructed to a predominantly single thread C4 channel with the existing channels converted to discontinuous wetlands with excavated gravel and soil from the new channel alignment. The channel would be constructed so that the proposed floodplain elevations would match the existing floodplain elevations and established floodplain vegetation. The new channel would have hydraulic and meander geometry appropriate for the geomorphic setting and size of the river. Channel gradient would be about 0.0013 ft./ft. over the total channel length. Whenever possible, the new channel would channel would be constructed to re-activate abandoned oxbows and meanders.

To maintain a consistent grade, the downstream portion of the reach would need to be constructed so that the floodplain would be excavated to a lower elevation. At the downstream end of the reach, the floodplain would be lowered by up to four (4) feet to maintain a relatively consistent stream gradient through the reach. The width of the floodplain would gradually be reduced from greater than 2,000 feet to about 900 feet at the downstream end of the reach. The narrowing of the floodplain would continue downstream into reach CFR 2 to create a smooth transition during large flood events.

The transition to a lower elevation floodplain would be similar to historic conditions and would also greatly reduce the amount of fill required in CFR 2 by lowering the entrance elevation into the reach. Initial calculations indicate that the cuts and fills would balance in the upstream portion of this reach, but the lower portion would result in an excess of about 170,000 cubic yards of fill. Any excess excavated material could be used to fill the floodplains in Reach CFR 2. Any material with contaminant concentrations in excess of desired amounts would be treated to meet the objectives. Whenever possible, existing vegetation would be salvaged and transplanted to the new floodplain elevation. Refer to Section 5.4.5 for the revegetation details.

Any new channel construction would require bank stabilization and grade control until the vegetation can mature. Bank stabilization is necessary not only for proper function of the designed channel, but also especially important in this reach to minimize the amount of contaminated sediments that would be incorporated into the system through bank erosion. Most of the proposed grade and bank stabilization would be accomplished with structures constructed predominantly of wood, such as root wad/log vane combinations with rock “J” hooks and root wad debris jam clusters. Some of the grade control could be accomplished with armored pool tail out structures composed of the largest rock found in the bed (D84-D100 size clast). The number of structures are calculated based on structure size, gradient and stream meander geometry. The grade control structures are designed to match the pool-to-pool spacing common in C4 channels. These structures are designed to function naturally in this geomorphic setting and match the natural stream aesthetics. Fish passage and habitat enhancement are also designed into these structures. Refer to Section 5.4 for more detailed discussion of the structures.

The existing wetlands along the southern portion of this reach would not be graded. It is anticipated that these wetlands and old channels will remain at the low terrace elevation and would be fed by subsurface water from adjacent hill slopes. These wetlands would likely be intermittent with less surface water supplied from the main channel. The existing stream channels would be filled intermittently, leaving sections of unfilled channel that will be converted to shallow wetlands. These wetlands would receive water during flood events and when the water table was higher than the bottom elevation of the old channels. To minimize the potential for colonization by undesirable non-native fish species, these wetlands would remain isolated.

5.3.4 CFR 4

This reach would be converted from a braided D4 channel with intermittent F4 reaches to a C4 channel in the same manner as the upstream end of Reach CFR 3, with the new channel floodplain at the same elevation as the existing floodplain features. Like Reach CFR 3, the existing channels would be filled intermittently, or plugged, with excavated material from the new channel locations. Initial calculations indicate that cuts and fills would balance throughout this reach.

The average stream gradient through this reach would be about 0.002 ft./ft. Proposed structures in this reach would be primarily constructed of large wood similar to the upper end of Reach 3. The same types of structures would be constructed in similar locations. The purpose of the structures is for bank stabilization and grade control until natural processes can take over. The number of structures was calculated based on a representative reach of about 2,000 feet of channel where structures were designed in at the appropriate spacing and intervals. The density of structures was extrapolated to the remainder of the Reach. Structure spacing is variable depending on meander geometry, structure type and the pool-to-pool spacing appropriate for the reach.

There would be a short reach of B3c channel constructed through the Turah Bridge section and a rock “W” weir structure constructed at the bridge to effectively transport water and sediment through the bridge section. Refer to Section 5.4 for descriptions and examples of structures.

5.3.5 BFR 1

This reach would be converted from an F4 channel with backwater conditions to a B3c channel with step pool morphology and a narrow, well-vegetated flood prone area. This would be accomplished by reshaping the existing bed material to narrow and deepen the thalweg and grading excess material up to form a sloping flood prone area. Upstream of the Highway 200 Bridge the gradient is about 0.002 ft./ft. The gradient would steepen to about 0.005 ft./ft. downstream of the Highway 200 Bridge. Initial calculations indicate that cuts and fills balance in this reach.

There are two abandoned piers in the river at the old Highway 200 Bridge crossing that need to be removed to improve channel stability. Most of the bridge spans are adequate to span the active channel and flood prone area, but the railroad bridge is skewed enough to reduce the effective capacity to pass flood flows. A series of rock “W” weirs (one weir at each bridge) would be necessary to split the active channel around the piers while maintaining hydraulic function. These “W” weirs also prevent scour around piers and will pass fish effectively. River boating rafters also tend to enjoy the hydraulic conditions promoted by “W” weirs. Section 5.4 includes details and examples of proposed structures. Refer to Section 5.4.6 for a more detailed discussion of the bridge recommendations.

Other channel structures would be similar to those on the CFR reaches 1 and 2, with rock steps constructed to stabilize the grade and promote fish passage as well as river boating. The detail sheet in Appendix 5 is an example of how a combination of these structures could be placed in this reach.

5.3.6 BFR 2

As discussed in previous sections, the key to restoration in this reach is to remove the Stimson diversion dam and the fill that is encroaching into the river just upstream from the dam. Without removing both features, there is limited opportunity to eliminate the backwater conditions and sediment deposition that has occurred upstream. This constriction, along with the Stimson diversion dam creates a backwater condition that causes sediment deposition and aggradation to occur for at least 6,500 feet upstream. Within the fill that is constricting the river, Stimson diversion dam has a small lagoon and a building of unknown purpose. The building may need to be replaced at some other location. This and removal of the fill would require landowner cooperation and approval.

Also, as noted previously, the Stimson diversion dam is in poor condition and following removal of Milltown dam, would become a fish barrier and should be removed. This reach would be converted from B3c channel with a high width:depth (w:d) ratio and an F4 channel in places to a B3c channel with a lower w:d ratio and a narrow, well vegetated flood prone area. Much of the deposited sediment can be reshaped to create the appropriate channel and flood plain dimensions, but an excess of about 277,000 cubic yards of sediment should be removed and possibly exported to CFR 2. Some of this material is located at the channel constriction and immediately upstream. The clean gravel and cobble sediment would be ideal for the steeper B channel reach of CFR 2. If the material were not exported to CFR 2, there would be additional costs associated with transportation and disposal.

The abandoned railroad bridge piers at about Station 88+00 should also be removed to improve sediment transport and channel stability in this reach. Structures proposed for this reach would be similar to reach BFR 1 and would be constructed primarily of large rock to stabilize the grade and promote fish passage as well as river boating. The detail sheet in Appendix 5 is an example of how a combination of these structures could be placed in this reach. These structures would be consistent with the morphology of the BFR in this canyon reach.

5.4 CHANNEL CONSTRUCTION AND RESTORATION TECHNIQUES

5.4.1 CHANNEL CONSTRUCTION

The CFR and BFR channels would be constructed to the proper cross-section dimensions, planforms, and profiles in order to convey the flows and transport the sediment made available by the watershed. The restored channels would be designed to minimize near-term lateral channel migration while allowing long-term channel adjustment within the respective floodplains. The proposed channel alignments include constructing new channel reaches and modifying existing channel sections. Reconstructing the channels in the project area will improve the amount of fish habitat in the project area, increase the amount of river-floodplain edge, and reduce the energy gradient. The combination of bank stabilization and grade control structures will limit bank erosion in areas with contaminated sediments left in place to slow erosion rates over time. All structures ultimately rely on an aggressive revegetation plan that would result in a vigorous, dense riparian community that would promote long-term bank stability and floodplain stability.

Natural channel design techniques would be employed and include constructing a two-stage channel to accommodate the predicted hydrograph conditions. A two-stage channel includes a bankfull channel to convey the average annual flood and sediment (bankfull flow) and a floodplain designed to accommodate flows of greater magnitude, including the 100-year flood. Channel-floodplain interaction would reduce in-channel water velocities, shear stress, and bank erosion. Constructed floodplains would serve to moderate flood peaks, store fine sediment, and increase late-season base flows in the respective project reaches.

For new channel reaches, the channel would be built in conjunction with the new floodplain construction following removal and disposal of the polluted sediments. In modified channel reaches where new channel excavation is not necessary, the channel cross-section dimensions, plan form and profile would be shaped to the appropriate design dimensions. The designed channel pattern will minimize backwater macrohabitats that provide preferred habitat for introduced northern pike.

Bank stabilization, grade control, step-pool, and fish habitat structures would be constructed using native materials and would be designed to mimic naturally occurring habitat arrays found in stable stream reaches (Table 10). Rootwads, large woody debris jams, and vegetation would be used for bank stabilization. Grade control structures including cross-vanes, "W" weirs, rock and log straight vanes, and rock and log "J" hook vanes would also provide valuable bank protection. These structures are designed work in concert to provide a complete array of habitat features in a channel system. For example, a log "J" hook vanes might be designed in proximity to a large woody debris jam to provide all the habitat components in a relatively short distance. Higher gradient B stream type reaches on the lower reaches of the Blackfoot and Clark Fork Rivers would be constructed with additional grade control structures designed as low stage steps to create step-pool morphology, including single and double wing deflectors, convergent roller structures, and convergent rock clusters. Descriptions of these structures are included in the following sections.

The proposed structures would be constructed to maximize fish habitat complexity while providing for upstream and downstream fish passage for all native and coldwater fish species. Structures promote flow convergence to increase water depths and diversify channel hydraulics during low flow periods. Flow convergence will also maintain sediment transport competency and pool scour during elevated flows. Deeper pools typically sustain greater numbers of individuals and species of fish compared to shallow pools with less habitat complexity. Large woody debris is also incorporated into structure design to increase fish habitat diversity. The proposed grade control structures are favored by the river boaters to enhance diversity and recreational opportunity. The structures are also designed to mimic natural structures to fit in with the geomorphic setting, thus enhancing aesthetics.

The selected structures have been successfully employed in streams throughout Montana, Idaho, Utah, Oregon, Washington, and Colorado. Structures are sized on a site-specific basis in accordance with the bankfull channel dimensions and the bankfull discharge. Results from project monitoring programs suggest the benefits of the proposed structures to both fisheries and channel stability (WCI *unpublished data*; Schmetterling and Pierce 1999).

TABLE 10

PROPOSED FISH HABITAT, GRADE CONTROL, BANK STABILIZATION, RIVER BOATING STRUCTURES AND DERIVED BENEFITS TO FISH.

STRUCTURE	MATERIALS	PURPOSE	BENEFITS TO FISH
Rootwad Revetments	Logs and Rootwads	Dissipate energy directed at stream bank, fish habitat	Overhead cover, insect production, interstices for YOY and juvenile fish
Large Woody Debris Jams	Logs, rootwads, small woody debris	Dissipate energy, provide bank protection	Overhead cover, flow break, debris collector, diverse habitat
Straight and "J" Hook Vanes	Logs and Rock	Reduce near bank shear stress, enhance channel margin complexity, grade control	Create deep pool habitat critical cover for adult over wintering and summer refuge
Cross-vanes	Rock	Grade control and scour pool formation	Create deep pool habitat and sort gravel for spawning
"W" weirs	Rock	Grade control and scour pool formation	Create deep pool habitat and sort gravel for spawning
Vegetation Transplants	Vegetation	Provide long-term bank stability, organic material source, and stream shading	Overhead natural cover, stabilize banks, insect production, and increased bank and habitat complexity

5.4.2 BANK STABILIZATION STRUCTURES

Bank stabilization structures are necessary for maintaining bank integrity on restored stream reaches until planted vegetation is capable of providing natural bank stabilization. Structures are expected to last for a limited period of time until vegetation provides bank stability in perpetuity. Bank stabilization structures also serve to diversify available fish habitat. Prescribed structures provide overhead cover, flow path complexity, interstitial hiding spaces, and visual separation for fish. Species and age-classes typically segregate according to these microhabitat attributes to reduce inter-size-classes and inter-species interactions. In the Reaches CFR 3 and 4, large wood based structures would be the dominant bank stabilization structures. These structures include rootwad/log vane "J" hook combinations, rootwad composites and large woody debris jams. Constructed with whole cottonwoods, conifers and other native riparian species, structures would emulate naturally occurring habitat arrays. Materials would project varying distances from the bank to deflect scouring eddies away from the bank as well as to diversify fish habitat around the structures. The following section outlines the prescribed structures.

ROOTWAD REVETMENTS

The purpose of bank placed rootwads is to dissipate water velocities and shear stress in the near-bank region until dense riparian vegetation becomes established. A secondary function and benefit of these structures is the diverse fish habitat that is created. Single rootwad structures would consist of a footer log, anchor rocks, and rootwad. Spacing between rootwads would depend on their position relative to other structures. Rootwads would often be used to complement other structures to increase the amount of bank protection provided by the complementary structure. Each rootwad revetment would have two to four mature willow transplants with attached root masses placed around the point of streambank intersection. Additional plantings would also be completed to improve the long-term natural bank stability. Complementary woody debris would be added to the rootwad revetments to increase fish habitat and bank protection.

LARGE WOODY DEBRIS JAMS

Large woody debris jams are constructed to mimic naturally occurring woody jams that typically form in the lower 1/3rd of meander arcs. Natural jams form over time as high water events overtop the lower portion of the meander, depositing wood on the floodplain. Large wood traps smaller materials, increasing the volume of the jam. Jams create diverse aquatic and overhead habitat for fish, riparian habitat for mammals, and perches for birds. Sizable jams provide bank protection and may create protected growing areas for vegetation.

Constructed woody debris jams are built with several large trees, various sizes of rootwads, small diameter woody material, and large anchor rocks. The large trees are tied into the bank and anchored with large rocks. Other woody material is interlaced among the large key trees to create a diverse array of woody material. Several rootwads and logs are extended out into the channel to diversify the local aquatic environment. Overtime the jams are expected to grow in size as the jam captures other woody debris transported during high water.

5.4.3 GRADE CONTROL STRUCTURES

Various grade control structures are prescribed for the restoration project. Grade control structure types and locations would vary according to specific project reaches and project goals. For example, the upstream part of the Reach CFR 2 would include cross-vanes and "J" hook vanes using a combination of large woody debris and large rock. Other structures that would provide river boating opportunities in addition to grade control would be constructed in the downstream B stream type reaches planned for the lower Clark Fork and Blackfoot River segments. Structures will effectively address bed stability concerns and provide enhanced river boating recreation opportunities where appropriate.

The grade control structures maintain the designed channel profile elevations in addition to addressing fish passage and habitat needs. Fish passage concerns are addressed by the design of the prescribed grade control structures. Each structure typically concentrates flows to the thalweg, or deepest portion of the channel. Focusing flows in this manner sustains a deeper low flow water column providing better connectivity during late season base flows.

Structures are also designed to improve flow convergence and sediment transport during high flows. Vane arm gradient and angle from the bank affect the hydraulic head the structures create. A steeper vane arm gradient results in greater hydraulic acceleration over the structure and into the pool created by the structure. This acceleration is necessary for maintaining sediment transport through the pool and subsequently, the depth of the pool. The vane arm gradient and arm length also affect the degree of bank protection created by the grade control structure. A longer, flatter vane arm protects a greater bank distance than a short, steep vane arm.

Rootwads and other large woody debris are typically incorporated into the grade control structure to increase the habitat diversity in the pool. Woody materials are anchored in between or below the vane arms. Material positioning influences vane hydraulics and pool scour, creating a range of aquatic habitats in the project area.

The designed structures would allow for fish passage. Fish passage is typically a concern during base flows when portions of the stream may become disconnected if the streambed is too wide and the water too shallow. Each grade control structure would be designed to have no more than 0.5 ft. to 1.0 ft. of drop (water surface from the structure throat to the water surface downstream) during base flow conditions. Gaps between structure rocks would also allow fish passage from the pool downstream, upstream through the structure. During the majority of the hydrograph, water depths over the vane structures would be sufficient for all species and most age classes to navigate the structures. Fish have been observed inhabiting feeding positions on the downstream sides of vane throats where the flow is focused. During high flows, fish will likely seek refuge in the deep, complex pools. Although the water accelerates over the vane structure, water velocities should not exceed the burst swim speeds of most fish species given the short distance of accelerated velocities.

The hydraulic drop created by the structures also appears to attract spawning salmonids. The hydraulic formed by the vertical distance between the upstream water surface and the downstream water surface increases the flow water through the gravel on the upstream side of the vane arms. Pool tailouts downstream of the structures are also attractive spawning areas for trout. The combination of optimal gravel sizes, the short distance to deep water, and enhanced inter-gravel flow make pool tailouts downstream from grade control structures optimal spawning areas for salmonids.

LOG AND ROCK STRAIGHT VANES

Straight vanes are built as log or rock vanes. These structures tie into the bank at approximately the bankfull elevation and intersect the channel bed at a point upstream. The slope and length of the vane are determined according to the local channel conditions and purpose of the structure (i.e. bank stabilization versus habitat creation). Straight vanes function by deflecting the high velocity thalweg away from the streambank thereby decreasing the near-bank shear stress. Log vanes are generally preferred over rock vanes as log vanes are less costly (in terms of materials and construction time) and are more natural in appearance. Rock vanes are typically used if large logs are not available or when the long-term stabilization of the channel at the specific location is a necessity.

LOG AND ROCK "J" HOOK VANES

"J" hook vanes are similar to straight vanes except that a log or rock "J" hook is added to the straight vane. The "J" hook concentrates the thalweg more than the straight vane. "J" hooks are typically preferred for this reason. While providing protection for the constructed streambank bank and channel, this structure also allows for efficient transport of bedload and suspended sediment. "J" hook vanes provide grade control and are also used to help maintain extended pool lengths in meanders. Footer rocks are placed below the predicted scour depth to prevent undermining of the structure during high flows. Logs of sufficient size may be used in place of large rock where possible. Log vanes are typically less expensive and easier to install than rock vanes, though they are less permanent than rock structures.

ROCK CROSS-VANES

Cross vanes provide long-term grade control in reconstructed stream channels. Natural channels maintain grade control through undulations in the bed profile (riffle-pool sequences). It is necessary to include some sort of grade control in reconstructed channels due to the non-sorted nature of channel material (gravel, cobble, and sand) following construction. The streambed is unarmored following construction. Cross-vanes would be built according to design channel dimensions and include footer rocks to prevent undermining of the structure during high flows. Constructed scour pools below the cross vane structure will enhance fish habitat and create pools for over-wintering of the resident fishery.

ROCK "W" WEIRS

The design of the "W" weir is similar to the cross-vane in that both sides are vanes directed from the approximate bankfull elevation upstream to a point where the vane intersects the channel bed. The "W" weir divides the river into fourths with the vane arms intersecting the bed at ¼ and ¾s of the channel width (Rosgen 2001). The center portion of the structure rises in the downstream direction to form a "W" looking from upstream to downstream. The multiple vane arms and center structure increase the number of flows paths, diversifying aquatic habitat around the structure. “W” weirs maintain deep pools in a similar manner to the aforementioned vanes and cross-vane.

COBBLE PATCHES

Natural stream channels sort and transport bed material in a manner that provides for natural grade control. In some areas of the project, channel materials would be sorted during construction to generate material ranging from the D_{84} – D_{100} of the channel bed material (the largest material that is generally not transported). Additional materials may be imported to the project site depending on the availability of on-site materials. These materials would be placed in the designed bed profile to provide grade control at pool tailouts. Cobble patches may also be used in lieu of cross-vanes where additional grade control is not necessary.

TABLE 11

PROPOSED STRUCTURES DESIGNED TO PROVIDE GRADE CONTROL AND STEP POOL MORPHOLOGY ON THE LOWER CLARK FORK AND BLACKFOOT RIVERS. ALSO FISHERIES BENEFITS ARE INCLUDED.

STRUCTURE	MATERIALS	BOATING BENEFIT	FISHERIES BENEFIT
Converging Rock Clusters	Rock	Diversify flow paths and create complex currents	Diverse flow paths
Converging Roller Eddy with Rock Vane	Rock	Diversify flow paths and create complex currents, create eddies, deflect thalweg to center channel	Diverse flow paths and backwater resting areas
Converging Roller Eddy with Rootwad	Rock	Diversify flow paths and create complex currents, create eddies, rootwad bank protection	Diverse flow paths and backwater resting areas
Double Wing Deflectors	Rock with cobble fill material	Flow acceleration and eddy backwater creation	Diverse flow paths, deep pool habitat, and backwater resting areas
Single Wing Deflector	Rock with cobble fill material	Flow acceleration, complex currents, and eddy creation	Diverse flow paths, deep pool habitat, and backwater resting areas
Random Rock Cover	Rock	Diversify flow paths and create complex currents	Diverse flow paths

5.4.4 ADDITIONAL GRADE CONTROL STRUCTURES

Mr. Dave Rosgen, P.H. has developed a suite of six structures that create the step-pool effect on larger B type stream systems to stabilize the streambed and dissipate energy. These structures also produce dynamic hydraulics preferred by river boaters (Table 11). These structures are planned for the higher gradient B stream type sections of the lower Clark Fork and Blackfoot Rivers (CFR 1, CFR 2 and BFR 1) where the channel profiles are somewhat steeper, the valleys narrower, and the channel pattern is slightly straighter. The combination of these conditions would allow a channel design that maintains channel and bed stability, sediment transport, flow conveyance, fish habitat and passage, as well as recreational boating opportunities. The prescribed structures would require large rock and woody debris similar to the aforementioned grade control and bank stabilization structures.

CONVERGING ROCK CLUSTERS

This structure is comprised of multiple boulder clusters that create diverse flow paths. The structure emulates a series of natural rock outcroppings. Fish habitat would be enhanced by the structures and fish passage would not be affected.

CONVERGING ROLLER EDDY WITH ROCK VANE

The structure is built with at least two rock downstream-facing offsetting vane arms. The arms deflect the flow back and forth and create eddy backwaters on the downstream side of each arm. A standard rock cross vane is positioned downstream of the rock arms. The vane deflects the thalweg back towards the middle of the channel. The structure would allow fish passage at all flow levels.

CONVERGING ROLLER EDDY WITH ROOTWAD

This structure performs similarly to the aforementioned structure except that the rock vane is replaced with a large rootwad. The rootwad creates local scour and enhanced fish habitat. The structure would allow fish passage at all flow levels.

DOUBLE WING DEFLECTORS

The double wing deflectors are placed across from each on the channel margins. The structures are built with large rock in-filled with finer material. The double wing deflectors concentrate the flow to the middle of the channel with a subsequent acceleration of water between the narrowed channel. The elevated water velocities increase the shear stress and scour potential. A large deep pool is typically maintained downstream of the double wing deflectors. The pool would provide fish habitat and would allow fish passage at all flow levels.

SINGLE WING DEFLECTORS

Single wing deflectors are offset from each other in a reach of the channel. The current deflects back and forth across the channel between the deflectors. The structures are built with large rock in-filled with finer material. The deflectors concentrate the flow to the middle of the channel with a subsequent acceleration of water between the narrowed channel. The elevated water velocities increase the shear stress and scour potential. A large deep pool is typically maintained downstream of the double wing deflectors. The pool would provide fish habitat, and the structure would allow fish passage at all flow levels. Large eddy backwaters form on the downstream sides of the deflectors, providing resting areas for both boaters and fish.

RANDOM ROCK COVER

Similar to the converging boulder clusters, the random rock cover diversifies the channel and flow paths. Boulder clusters offer obstacles for boaters and create variable currents for fish. The structures are expected to provide diverse fish habitat without affecting fish passage.

In summary, the proposed channel construction and prescribed structures are designed to emulate natural systems. The designed two-stage channels would be constructed according to the geomorphic setting, valley type, infrastructure considerations, and recreation objectives. The designed channels will convey the flows and transport the sediment made available by the Blackfoot River and Clark Fork River watersheds. The bankfull channel will convey approximately the 1.5-year to 1.8-year events while larger flows will access the adjacent floodplain. Bank stabilization, grade control, and river boating structures would benefit the resident and migratory fisheries by providing local habitat and reconnecting migration routes currently severed by Milltown dam. The prescribed structures would not impede upstream or downstream fish migration for the targeted native and coldwater sport fish species.

5.4.5 SUMMARY OF RE-VEGETATION PLAN

The proposed EPA's remediation plan proposes to revegetated disturbed areas with only grasses. To restore the area to a condition similar to pre-dam construction, with all riparian, upland and wetland components functioning in concert, the remediation plan must be supplemented with an aggressive revegetation plan. The importance of a practical and cost effective revegetation plan and the diligent implementation of that plan cannot be overstated nor over-emphasized. The revegetation activities will be key to the success of the overall project and ultimately meeting the objectives established for this CRP. Natural channel design concepts rely on effective revegetation and existing vegetation to provide long-term bank stability, provide energy dissipation and sediment storage on floodplains, provide shade and long-term woody debris recruitment for aquatic habitat and desired aesthetics.

By design, this revegetation plan is conceptual in nature and provides the foundation for a comprehensive, site-specific plan and prescriptions that would be developed once the overall stream restoration project design is finalized. The treatments, techniques and plant materials are described in general terms and apply to broad geomorphic areas.

This revegetation plan was developed to meet multiple objectives including:

- Re-establishment of a native plant community;
- Mitigate surface erosion and associated off-site impacts;
- Restore a healthy, diverse and viable edaphic (soil) environment;
- Provide for slope and bank stability while minimizing maintenance;

- Re-establish/enhance terrestrial, riparian and aquatic habitat for dependent species;
- Inhibit the establishment of undesirable plant species including noxious weeds; and
- Post-project visuals and esthetics.

This revegetation plan initiates the processes that provide for a diverse, resilient and self-sustaining native plant communities and ecosystems. No revegetation plan is capable of precisely replicating the pre-disturbance native plant communities. Depending on the existing vegetation and the successional stage of the plant community it may not be practical, desirable or even possible to do so. This plan "jump-starts" the recovery of the complex ecologic interactions and reintroduces biological diversity to the project area following restoration activities.

Under this CRP, plant densities and species would be site specific for each of the following treatment areas:

- Stream banks: All stream banks would receive some level of revegetation. Banks along straight reaches and along the "inside" banks of meanders would be treated but to a lesser degree than the higher energy banks. The "outside" banks of meanders require a more rigorous revegetation treatment due to their exposure to high energy and shear stresses during period of high stream flows;
- Abandoned channels: Those sections of active channel that would no longer exist following channel realignment;
- Floodplain: Includes that area outside the active channel that is inundated during flood flows;
- Wetlands: This includes areas of standing water in abandoned channels that are retained after construction of the new channel. They would be converted into a wetland ecosystem with water depths less than four feet;
- Terraces and Uplands: These are the xeric or drier areas at a higher elevation than the adjacent floodplain;
- Other disturbed sites are areas that are disturbed as a result of construction activity such as access routes, borrow sites, etc.; and
- Existing riprap placed along banks during previous efforts to stabilize the stream banks. Vegetation will increase bank stability, provide habitat and improve esthetics.

These geomorphic categories will help ensure that areas of different moisture regimes would be planted with appropriate species thus increasing the survival rate throughout the project area. Following is a brief summary of the re-vegetation plan.

WOODY VEGETATION:

Trees and shrubs used at the Milltown site would be containerized native plants with an established root system. The plants would be grown in a 3-inch diameter by 14-inch long (minimum) up to 36-inch long container. Wetland species would be grown in six cubic inch containers. Cuttings would be limited to native willow species harvested from on-site and/or adjacent areas. They would average 40 inches in length. Cuttings would be planted so the basal end is submerged in or very near groundwater for the majority of the year, this would increase their survival rate.

An expandable stinger or a ripper-type attachment would be used to install plants. Photographs of the planting equipment and projects where this technology has been used are in Appendix 10. Prior use of this technology has resulted in increased survivability at harsh sites and is particularly suited to Montana as many areas are moisture limited for the majority of the year. This equipment is capable of consistently getting plants and cuttings deep into the soil where there is more available moisture than conventional means. This method relies on fewer laborers, decreased logistics, and additional costs associated with large planting crews. In addition, containerized plants would be inoculated with a diversity of beneficial soil microbes to improve tree and shrub vigor and increase survival rates.

GRASS SEED

The revegetation effort would also include three to four native seed mixes that would be specific to landform and edaphic conditions. A quality organic fertilizer would be applied to all disturbed areas to increase initial vigor of grass establishment. Disturbed soils would be inoculated with a diversity of beneficial soil microbes to further stimulate vegetation. A quality wood-fiber mulch with tackifier and/or straw would be applied on the surface of disturbed areas to help retain soil moisture, lower surface temperatures and control on-site erosion. Hydro mulching is the preferred application method for seeding this project. Since the hydro mulching process seeds, fertilizes and mulches in one step, it is more time effective than other methods of seeding grasses that may require up to three different passes with a machine or laborer.

EROSION CONTROL:

In the majority of the Milltown project area, mulching/hydro mulching would suffice for erosion control needs. Areas that are sloped and may erode would be treated more aggressively to alleviate soil losses. Control measures would include: erosion control blanket, straw, either spread or use the bale whole, and soil tackifying agents as deemed necessary.

5.5 BRIDGE RECOMMENDATIONS

Existing bridges in the project area were evaluated to determine the potential limitations posed on the conceptual restoration plan. The seven bridges in the project area are the Interstate 90 East Bridge, the Interstate 90 West Bridge, the Burlington Northern Railroad Bridge, the State Highway 200 Bridge the old State Highway 200 Bridge (foot travel only), the County Road Bridge at Turah and the railroad bridge downstream from Milltown dam. The first five of these structures span the Blackfoot River in Reach BFR1, while the Turah Bridge is in Reach CFR 4. The railroad bridge downstream from Milltown dam is in Reach CFR 1. Plans were obtained for the Interstate 90 Bridges only. Plans for the other bridges could be acquired and reviewed as part of Phase 2. A brief field review of the bridges was conducted to photograph the structures, measure span lengths and identify pier locations.

Due to the existing over-widened condition of the Blackfoot River, all five bridges could adequately span the proposed minimum 245-foot floodplain width of the Blackfoot River without creating a backwater affect. In addition, adequate freeboard is available for all five bridges during a 100-year flood event. However, each bridge contains one or more piers that would likely fall within the proposed bankfull channel. Piers located in the bankfull channel could be subjected to scour and debris accumulation during ice flows or flood events. For this reason, a scour and ice flow analysis is proposed as part of Phase 2.

The Turah Bridge appears to have an adequate span for the upper Clark Fork, but channel changes and modifications upstream have resulted in an over-widened and unstable braided condition. There is one pier in the active channel presently.

The railroad bridge in CFR 1 has an adequate span to accommodate the channel and flood prone area. A "W" weir or similar structure would need to be designed in Phase 3 to route the flows between the bridge piers to maximize sediment transport efficiency and minimize scour. Details of bridge construction are not known at this time.

Ideally, bridge piers should be located outside of the bankfull channel. Since modifications to the bridge structures are not part of the scope of this project, other alternatives were explored. To mitigate the possible effects of pier scour, hydraulic structures such as "W" weirs are recommended and included in the conceptual restoration plan. Refer to the plan view alignment sheets for the proposed locations of these structures. "W" weirs are designed to split the flow around a pier thus creating an area of lower shear stress and reduced scour at the pier. Moreover, "W" weirs provide grade control and habitat complexity. In addition to installing hydraulic structures to mitigate pier scour, it is recommended that any abandoned piers or abutments within the bankfull channel be removed. The old State Highway 200 Bridge contains two abandoned piers that should be removed to increase the efficiency of the proposed channel and decrease unnecessary pier scour.

Photo 5.1
The Old Highway 200 Bridge

(Note the two abandoned piers that are recommended for removal.)

To account for the change in channel gradient that will be caused by removal of the dam, the longitudinal bed profile of the Blackfoot River may have to be adjusted in the vicinity of the five bridges. Due to the limited available information, it was difficult to determine the exact change in bed elevation that would be required. However, it is estimated that the change in bed elevation could be between one and three feet at the bridge locations. Regardless, future proposed bridge scours studies identified in Phase 2 would be required to determine pier foundation depths and, if necessary, limit the change in bed elevation at the pier locations.

Photo 5.2
Example of a "W" weir

In addition to examining existing bridges, efforts were made to identify a potential location for a new pedestrian bridge within the project area. It is assumed that this bridge would be used for non-motorized traffic, such as pedestrians and cyclists. One potential location is the site of the old Duck Bridge (refer to Plan view sheet CFR 2 in Appendix 4). Due to encroachment on the floodplain, the old approach embankments associated with this bridge have been recommended for removal. A new pedestrian bridge should be designed to span the bankfull width of the Clark Fork (130 ft.) at this location to minimize disruption of the flows and sediment transport in the active channel. The bridge piers should be outside the active channel and there should be some floodplain available within the bridge span. This will greatly reduce the risk of scour and adverse affects on the channel and recreational boating. These criteria would result in a minimum bridge span of approximately 170 feet. Since the floodplain at this location is approximately 800 foot in width, the pathway leading to the bridge could be set at floodplain grade, while the bridge and its approaches could be set at least three (3) feet above the 100-year flood elevation to allow clearance for debris during floods.

Several options are available for bridge types. It is estimated that costs could be between $200,000 and $400,000 for a pre-fabricated pedestrian bridge. Please refer to the detail sheet in Appendix 7 for a conceptual cross section of the proposed pedestrian bridge.

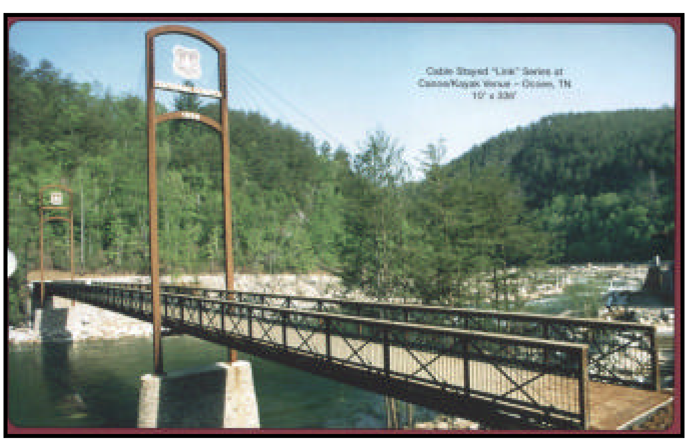


Photo 5.3
Example of a Cable Stay Pedestrian Bridge

(Note that the piers are located outside of the bankfull channel and the bridge spans part of the floodplain.)

5.6 TIMELINE AND CONSTRUCTION SEQUENCING

TIMELINE

Due to the size and complexity of this project, it is recommended that the following phased construction approach be used. To the extent possible, efforts have been made to link the river restoration construction phases with the major components of the dam removal and sediment removal activities.

Year 1	Phase 2 begin
Year 2	Phase 2 end, Phase 2 Design/permitting Begin
Year 3	Phase 3 Design end / Begin sediment removal/ Construct the upper half of CFR4
Year 4	Continue sediment removal / Construct the lower half of CFR4
Year 5	Continue sediment removal/ Construct upper half of CFR3
Year 6	Complete sediment removal/ Construct lower 1/2 of CFR3 and lower 1/2 of BFR2
Year 7	Construct upper half of BFR2, and CFR2
Year 8	Construct, upper half of BFR1
Year 9	Remove spillway/Begin construction of CFR1
Year 10	Remove Powerhouse/Construct lower half of BFR1/Complete CFR1
Year 11	Rebuild replica of Powerhouse on site above the floodplain.

Since Reach CFR4 is beyond the impacts of the dam and the most upstream reach, it is the most flexible reach. CFR4 could be constructed as early as year 3, or after the construction of the other reaches. The upper half of Reach CFR3 is similar to CFR4 and could be constructed as early as year 3 or after the construction of the other reaches. The excess sediment generated in the lower half of CFR3 is planned for floodplain fill material in CFR2, so it cannot be constructed until at least part of the sediment removal in CFR2 is complete. Likewise, if the excess sediment generated in BFR2 is to be used for floodplain fill material in CFR2, it could not be constructed until most of the sediment removal in CFR2 is complete. The lower part of BFR2, the upper part of BFR1, and CFR2 should be constructed after sediment removal is complete but prior to dam removal so as not to create a fish barrier with Stimson diversion dam. Removal of the spillway and diversion of the water through the Power House should allow the construction of CFR1 to commence. Once CFR1 is complete, the flow can be diverted into the new CFR1 channel and the Power House can be removed and the lower half of BFR1 can be completed.

Typically, it is recommended that construction begin at the upstream end of the project and proceed downstream. Having the dam in place during the construction of the upper reaches will provide a means to minimize passing turbid waters downstream.

CONSTRUCTION SEQUENCING

WCI has developed a construction-sequencing plan based on the project design and past experience with projects of similar scope and complexity. The complete construction sequencing is too detailed for this conceptual design, but is available upon request. General steps for the sequencing are listed below.

Task 1: Construction Staking

Task 2: Sort and Distribute Materials in Project Area

Task 3: Construct Water Diversions

Task 4: Initial Channel Shaping and Excavation

Task 5: Structure Placement for Bank Stabilization and Habitat Creation

Task 6: Final Channel Shaping

Task 7: Reintroduce Water into the New Channel

Task 8: Reclamation of Diversion Channels and Floodplain Construction

Task 9: Revegetation of all Disturbed Areas

Task 10. Cleanup of Construction Areas

5.7 PHASE 2 NEEDS

The following items would be necessary to validate the CRP and collect the necessary data to proceed with a final design.

- Develop Digital Terrain Model using survey of existing ground and photogrammetric mapping
- Bridge Analysis- scour and ice potential determination
- Sediment Entrainment Analysis
- Refine Draft Channel Dimensions
- Finalize Flood Series Analysis
- Evaluate Land or Easement Purchase (Note: These costs not included in Restoration Plan Cost Estimate.)
- Evaluate whether restoration or design conforms with remedial action requirements.

5.8 PHASE 3 FINAL DESIGN NEEDS

During completion of Phase 2, final design could be initiated. The design tasks listed here are associated only with the plans and treatments of the CRP and would replace similar design tasks in EPA's proposed remediation plan associated with channel construction in the Area I sediment removal area. The design tasks associated with the remainder of EPA's proposed remediation plan would need to be completed. The design tasks listed in the following section would most likely be completed on a reach-by-reach basis about two years before the construction is scheduled. Tasks included under the Final Design phase include, but are not necessarily limited to the following:

- Finalize plan view pattern, longitudinal profile, and cross-section dimensions;
- Ground truth proposed alignment with Technical Review Committee;
- Develop proposed Digital Terrain Model;
- Calculate earthwork and develop construction heap flow charts;
- Perform channel and floodway modeling (HEC-RAS);
- Specify material types, quantities, and dimensions by reach;
- Engineer bank stabilization, grade control, fish habitat, and recreational in-channel structures;
- Prepare detail sheets for all major design components, including longitudinal profile, plan view pattern, channel cross-sections, and proposed structures and revegetation components;
- Prepare construction sequencing report, including equipment specifications;
- Prepare water quality mitigation and dewatering plans for construction; and
- Prepare and submit CLOMR/LOMR to the Federal Emergency Management Agency and Missoula County Floodplain Administrator.

The final design report would include all appurtenant analyses used to complement the final design report and detail sheets.

5.9 MONITORING NEEDS

The proposed EPA remediation plan includes monitoring for groundwater, surface water (quality and quantity) and biological conditions. It is assumed that the proposed monitoring will accomplish all of the needs for those resources. The CRP introduces several concepts that will also require monitoring to determine performance of the treatments in meeting the objectives and to initiate maintenance, if needed, to bring the performance into compliance with the objectives. The proposed monitoring for the CRP would be in addition to that monitoring proposed in the EPA remediation plan. It would primarily consist of monitoring the channel conditions, including stability and performance, and would occur on the first year of implementation one reach and on every other subsequent over a period of 10 years. The proposed monitoring has been developed over the last several years to meet the requirements of the permitting agencies. In other words, the permitting agencies will require monitoring similar to the proposed plan for the river restoration to be permitted.

To monitor the channel condition, permanent cross-sections and longitudinal profile (LP) stations would be established. Cross-sections would be located in multiple representative pool, riffle, and run habitats. A channel survey, pebble count, and photo point would be completed at each cross-section. The LP stations would be established at channel habitat feature transitions (top or riffle, pool) to quantify channel feature changes. Bank pins would also be installed at selected locations in project and untreated reaches to compare bank erosion and sediment input rates.

Elevation measurements and photo points would also be completed for each structure. Measuring structure and bed elevations over time would improve the understanding of sediment transport, energy dissipation, and habitat maintenance created by the structures.

Vegetation monitoring would include evaluating treated and untreated reaches for relevant attributes such as vegetation composition and cover, utilization, shrub and tree regeneration, and coarse woody debris. Perhaps one, tenth-acre plot placed in representative sites of each project area would provide a sufficient sample. Noting the presence and abundance of noxious vegetation, particularly where weeds have been treated with this project, would be essential to the vegetation-monitoring program.

One of the restoration goals is to improve fish habitat and fish passage through the project areas. The fish population-monitoring program should focus on sampling the project areas. Montana Fish, Wildlife & Parks may also opt to continue with on going radio telemetry studies designed to track native bull trout and westslope cutthroat trout.

At this time, the proposed monitoring program is still in the planning phase. The preceding recommendations are based on standard monitoring techniques. A monitoring program would be critical for evaluating restoration success. Specific monitoring is usually developed during the design and permitting phase of a project.

5.10 MAINTENANCE NEEDS

A maintenance regime would be implemented to address re-vegetation, structure and channel adjustments that may occur following project construction. The proposed maintenance plan includes assessing the project areas 1, 3, 5, 7, and 10 years after the completion of the projects. The maintenance budget would be one percent of the project cost weighted by the length of the project reach. Maintenance may include reconstructing failed structures, adding additional structures, additional vegetation planting, noxious weed treatments or channel modifications.

6.0 COST ANALYSIS

This section will present the data sources, cost assumptions and unit costs for proposed treatments. Actual cost estimates are included in Appendix 6. The cost estimates do not include those costs already covered by the EPA's Proposed Plan for remediation. As discussed in Section 5, some of the EPA's proposed treatments are not necessary, or used in this CRP. The exact cost differences are not possible to determine, however, by comparing the cost estimates presented in Appendix 6 with those from the EPA proposed remediation plan, this differences may be estimated.

This section includes a discussion of how the costs were developed for the restoration cost estimate. More specifically, general information related to cost sources, assumptions, unit costs and contingencies is provided.

It is recognized that landowner cooperation and approval will be necessary in order to assure the success of this restoration project. These cost estimates, however, do not include the costs of land or easements, which may be necessary or appropriate to facilitate the project. These cost estimates also do not include the costs of building a replica of the powerhouse, although this is also contemplated as part of this plan.

6.1 COST DISCUSSION FOR CHANNEL AND STRUCTURE PROPOSALS

SOURCES OF INFORMATION

The Option 3 Cost Estimate prepared by the USACE was used as a baseline for WCI's restoration cost estimate for reach CFR2 and portions of reaches CFR1 and BFR1. WCI's estimate includes costs for three additional reaches, BFR2, CFR3 and CFR4 as well as the remainder of reaches BFR 1 and CFR1. As discussed in Section 2.0, it was determined that the construction of the additional reaches is essential to providing a long-term, comprehensive restoration plan.

Other available information used for the restoration cost estimate included the Draft Sediment/Dam Removal Cost Estimate Report for the Milltown Reservoir Site prepared by EMC[2] dated August 13, 2002. From this report, a topographic map of the site after sediment removal was obtained and used to estimate cut/fill quantities for the restoration cost estimate. In addition, the Clark Fork and Blackfoot Rivers Channel Cross-Section Surveys by Land and Water Consulting, Inc. dated February 1997 was also used to estimate cut/fill quantities. Estimates for re-vegetation and structures were based on WCI's experience with projects on rivers of similar size and complexity.

Whenever possible, unit costs estimated with the USACE Tri-Service Cost Engineering System (TRACES) Project MLTN21 (12/02) were used in the CRP cost estimation. The summary of costs provided by the USACE Government Estimate Total Costs for Option 3- Cost Estimate (12/2002) was used to as a pattern to provide the estimated costs for the CRP.

The Focused Feasibility Study (FFS, June 2001) estimates the total cost for removing Milltown Dam, powerhouse and all associated structures at $5,096,085 without contingency; this cost was used in the CRP Cost Estimate because the CRP calls for the removal of all these structures. The cost of removing the dam spillway and radial gate, along with some of the mitigation measures necessary to remove the spillway, are included in the EPA remediation plan. Therefore, it is recognized that there is some duplication of costs in the two plans, which can be accounted for if the two plans are integrated as one plan.

ASSUMPTIONS AND UNIT COSTS

Unit costs for earthwork were divided into three categories and derived from the USACE estimate. A unit cost of $3.93/cy was deemed appropriate for on-site (localized) cut and fill earthwork within a reach. The unit cost was derived from USACE unit costs for excavation of $3.32/cy plus grading at an additional $0.61/cy, for a total of $3.93/cy. This is consistent with construction costs on past restoration projects managed by WCI. A unit cost of $3.10/cy was applied to the quantity of fill that must be imported to those reaches that have a net deficit of material. This cost was taken directly from the USACE estimate and is based on similar assumptions. A unit cost of $3.32/cy was applied to the quantity of excess fill that must be excavated and exported from those reaches that have a net surplus of material. This cost was taken directly from the USACE estimate and is based on similar assumptions as well. When excess gravel is taken from one site and hauled to another site and graded, as is the case with excess from CFR 3 hauled to CFR 2, the costs are additive; i.e. $3.32/cy to excavate and load plus $3.10 to haul and grade equals $6.42/cy total.

In two reaches, the unit costs for earthwork deviate from unit costs applied to the other reaches. For Reach CFR 2, the cost of grading the Area III sediments to construct the floodplain in the same reach, lower unit costs were applied. In this case, the unit cost of $2.71/cy that was used for growth medium grading from the USACE estimate was used for CFR 2. For CFR 3, due to the uncertainty of toxic sediment location concentrations, all unit earthwork costs in this reach were increased by 25% to account for the possibility of additional soil treatments and/or material handling costs.

An additional line item was added to the cost of CFR 1 to account for the cost of removing the powerhouse and related structures. This cost was taken directly from the Dam Removal Cost Estimate prepared by USACE as referenced in Section 6.1.

Structure costs were determined based on the total quantity of materials that would be required for each type of structures multiplied by the estimated number of structures in each Reach. Since a good rock source exists close to the project area, it was assumed that transportation costs would be lower than normal. However, large rock is expensive to quarry and transport to the site. It is estimated that the average cost for rock delivered to the site would be $40/ cubic yard. This unit cost is based on WCI's past experience with the average cost for rock from the same quarry hauled less than five miles.

The other material that would need to be transported to the site would be large wood. A total quantity of trees was determined and an average cost of obtaining and transporting those trees to the site was estimated. An average cost of $125 per standard tree and $250 per large tree was used in the cost evaluation. This unit cost is the average cost for WCI projects over the last two years for gathering and transporting whole trees. The actual cost can vary greatly depending on availability of the trees and distance to transport.

Equipment time was also estimated for each structure and multiplied by the number of structures in each reach. The total costs for materials and equipment time was determined and summarized for each reach. An example of a cost analysis sheet for each structure is in Appendix 8.

Staking and survey costs are estimated by WCI's Professional Land Surveyor (PLS), with experience in surveying and staking projects of this size. Erosion control fencing used unit costs from the USACE TRACES cost estimate (12/2002). Mobilization and cleanup was estimated using the number of pieces of equipment times an average cost of $500 per piece for a typical mobilization into and out of a project site. Cleanup was assumed to be double the demobilization cost. The Project Management, Phase 3 Final design, Construction Oversight and Permitting used the USACE cost percentages based on total project size. WCI personnel estimated Construction Oversight and Design separately and the results were similar to the USACE percentages, lending validation of the assumptions.

WCI professionals who perform data collection and prepare monitoring plans for rivers of this size estimated the Phase 2 task costs and monitoring requirements for each reach. These estimates are based on actual estimates of the tasks to be completed. The details of the actual cost estimates are available upon request.

Maintenance costs are assumed to be one percent of the total project cost every other year for five years following the project implementation. This assumption is valid based on WCI's past experience in implementing projects on rivers of this size.
Miscellaneous costs were usually the most difficult to determine, usually because little information is know about the design or construction of item in question. For example, an estimate of $25,000 was assumed for moving the building of unknown purpose in reach BFR 2. This cost is only an assumption without knowing the purpose of the building or how far it may need to be moved. These cost items are useful more as a placeholder to be validated in Phase 2 and 3 of the CRP. Most of the items have a very small cost when compared to the total cost for the completing the reach and would be covered by the contingency. Where miscellaneous costs can be validated, it is noted in the individual cost estimate for the reach.

6.2 RE-VEGETATION COST REFERENCES AND ASSUMPTIONS

STRATIFICATION OF PROJECT AREA

The project area has been subdivided on the basis of geomorphic setting and re-vegetation treatment differentiation. The stratifications include streambanks, floodplains, wetlands, alluvial depositional areas, Holocene terraces and other disturbed upland areas. The proposed re-vegetation prescription "package" for each subdivision has unique attributes. The individual areas where delineated through a combination of aerial photo interpretation and post-construction landscape position associated with the conceptual design. Another category was "other disturbed upland areas" to account for constructed slopes, borrow sites, roadways, etc. These areas were determined based on professional experience with previous large river restoration projects.

AREA TO BE TREATED

The areas to be treated within each of the geomorphic landforms were determined by comparing the existing vegetation conditions to the anticipated post-construction conditions. For example, in areas where the channel was going to be relocated from its present location the resulting "abandoned channel" would be void of vegetation and the soils would have low inherent fertility and be course-textured with low water holding capacity. Based on native plant community of typical undisturbed lands with similar characteristics the re-vegetation prescription was developed. AutoCAD was utilized to determine the acreage of the landforms within each of the stream reaches. The acreage was multiplied by the desired tree/acre stocking to determine the total number of containerized plants and cuttings required. The actual acreage for each land type is included in the cost estimates for each project reach.

CONTAINERIZED PLANT MATERIALS AND CUTTINGS

The costs for containerized plants and cuttings are based on WCI's considerable re-vegetation experience and use of state-of –the –art planting equipment and technology. The cost estimate for plant materials was $11 per containerized plant, $9.00 for wetland plants and $3.50 for cutting. The numbers of plants and cuttings in a given prescription is based on the desired spacing. For example, a 10' x 10' spacing requires 436 plants per acre. The cost per plant and cutting are consistent with other large projects and includes seed collection and seedling propagation, inoculating the containerized plants with beneficial soil microbes, mobilization of plants and equipment, and installing the plants/cuttings. The greatest success rate for the cuttings is attained with two cuttings per planting hole. The costs also include the re-vegetation of sites previously considered to be "unplantable" such as riprap, cobble, etc.

TRANSPLANTS AND SOD

Strategically placed sod mats are effective for armoring constructed stream banks and abandoned channels, and provide "instant" vegetation. Transplants of woody plant placed in and around stream bank structures add to structure stabilization.

The cost includes both the salvage sod and transplants during construction activities and importing these materials from dedicated collection areas. The area to be treated with sod and/or transplants was calculated from AutoCAD generated data. The length of bank to be sodded was converted to acres for consistent costing. The cost of $3,250 per acre is based on WCI's records and includes mobilization, harvesting, transporting and placement of the sod/transplants. The cost of temporarily storing and caring for sod and transplants is also included.

SEEDING

The seed mix consisting of native species would be applied at a rate that provides a surface coverage of approximately 90 - 100 seeds per square foot. The numbers of seeds per pound varies considerable by species; therefore, the actual quantity of seed needed is dependent on the final mixes approved for the project. All seed mixes would be certified as being noxious weed free. Native seed mixes vary but average around $8 per pound with an application rate of about 25 pounds per acre.

Depending on terrain and access the seed would be applied by a combination of manual and mechanical techniques. A non-persistent "nurse" or "cover" crop would be seeded in some areas to facilitate the establishment of the native species.

HYDROMULCHING

Hydromulching is a very effective method of uniformly applying seed, mulch, fertilized, tackifier, soil organisms and other soil amendments and would be used extensively to accomplish the revegetation. The water-based slurry is sprayed directly on disturbed sites. Hydromulching is also an effective at controlling localized erosion. The inoculants would closely replicate local microbial populations. The organic fertilizer would provide a long-term source of nutrients and add humus to the soil. The costing includes high quality wood fiber mulch and organic based tackifier. The cost of $2,100 per acre includes mobilization, all products and application. Acreages were calculated using AutoCAD.

<u>INVASIVE VEGETATION INCLUDING NOXIOUS WEEDS</u>

Noxious weeds and other invasive vegetation are well established within the project area and, despite recommended mitigation efforts, it is inevitable that weeds would establish to some degree within areas disturbed by construction activities. A post-construction herbicide treatment program of disturbed areas would be necessary. Annual treatments over the three to five years following project completion would be required. The costs are based on an aggressive program of all disturbed areas and are based on industry standards. Post-treatment monitoring will be the best indicator of mitigation measures and control treatments. Monitoring will validate the accuracy of the cost estimated. The cost of treating noxious weeds is included in the semi-annual maintenance cost estimate discussed in Section 5.10.

6.3 CONTINGENCY

The restoration cost estimates were prepared without existing detailed ground surveys or a definitive ground surface after the excavation of reservoir sediments. Since approximately 55% of the restoration cost estimate is earthwork and is highly dependent on information developed by others, there is a significant level of uncertainty with the cost estimate. Up to this point, several assumptions and contingencies have been applied to the estimates and information used by WCI. Therefore, a contingency of 25% has been applied to WCI's estimate. For projects with significant uncertainty and limited information such as this, a contingency of 15% to 35% is not uncommon. For example, the MCACES cost estimate (EMC2, 10/31/2000) uses a contingency of 35% for the Dam removal costs. That document states that for feasibility/reconnaissance lever estimates, a contingency of 25% is normally used.

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