CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM

A REMEDIAL DESIGN TOOL

Clark Fork River Operable Unit

Milltown Reservoir Sediments NPL Site

Prepared By:

Bitterroot Restoration, Inc.
Corvallis, Montana, USA

Reclamation Research Unit
Montana State University
Bozeman, Montana, USA

Prepared For:

CH2MHILL

and

U.S. Environmental Protection Agency
Region VIII, Montana Office

April 2004

TABLE OF CONTENTS

PREFACE 1
INTRODUCTION 2
 Brief Site Background 2
 Brief Site History 2
 Remedial Investigation 2
 Feasibility Study 3
 Record of Decision for the Clark Fork River Operable Unit 3
CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES) 3
 Purpose 3
 Data Quality Objectives 4
  Step 1. State the Problem 5
  Step 2. Identify the Decision 5
  Step 3. Identify the Inputs to the Decision 5
  Step 4. Define the Study Boundaries 6
  Step 5. Develop a Decision Rule 6
  Step 6. Specify Tolerable Limits on Decision Errors 6
  Step 7. Optimize the Design 7
 Data Measurement Objectives 7
  Precision 7
  Accuracy 7
  Representativeness 7
  Completeness 8
  Comparability 8
 CFR RipES Structure 8
 Streambank and Riparian Corridor Buffer 8
 Streambank Categories 9
  Class 1 streambanks 9
  Class 2 streambanks 9
  Class 3 streambanks 9
 Special Cases 13
  Tributary streams 13
  Secondary channels of the Clark Fork River 13
 Historic 100-Year Floodplain Contaminated Soils 13
  Slickens (exposed tailings) 13
  Impacted soils and vegetation areas 17
  Slightly impacted soils and vegetation areas 18
 CFR RipES Application 20
 Miscellaneous Site Types 23
 CFR RipES Process and Integration with Remedial Design 24
CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES) FOR
 STREAMBANK CORRIDOR BUFFER POLYGONS 27
 Polygon Delineation Criteria 27
 Field Form 27
 Live Vegetation and Streambank Integrity 27
 Overall Scoring 29

CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES) FOR SLICKENS (EXPOSED TAILINGS) POLYGONS 30
Polygon Delineation Criteria 30
Field Form..... 30
CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (RipES) FOR IMPACTED SOILS AND VEGETATION AREAS POLYGONS AND SLIGHTLY IMPACTED SOILS AND VEGETATIO AREAS POLYGONS 31
Polygon Delineation Criteria 31
Field Form..... 31
Live Vegetation Integrity..... 31
Contamination Severity 32
Overall Scoring 34
LITERATURE CITED 35

LIST OF TABLES

Table 1. Preliminary remedial action (RA) codes for major CFR RipES polygon categories..... 23

LIST OF FIGURES

Figure 1. Typical Clark Fork River Class 1 streambank 10
Figure 2. Clark Fork River Class 1 streambank adjacent to a slickens area (exposed tailings)..... 10
Figure 3. Typical Clark Fork River Class 2 streambank 11
Figure 4. Highly eroding Clark Fork River Class 2 streambank 11
Figure 5. Well-vegetated, stable Clark Fork River Class 3 streambank 12
Figure 6. Clark Fork River Class 3 streambank with visible tailings and appropriate deep, binding, woody vegetation..... 12
Figure 7. Clark Fork River slickens area (exposed tailings)..... 14
Figure 8. Clark Fork River slickens (exposed tailings) surrounded by pioneer species such as tufted hairgrass (*Deschampsia cespitosa*) and redtop (*Agrostis stolonifera*) 15
Figure 9. Clark Fork River slickens (exposed tailings) showing metals salts on the soil surface following a dry period. 15
Figure 10. Clark Fork River slickens area (exposed tailings) showing extensive areas of metal salts along with less than 25 percent vegetative canopy cover 16
Figure 11. Clark Fork River slickens area (exposed tailings) showing some metal salts, less than 25 percent vegetative cover, and tufted hairgrass (*Deschampsia cespitosa*) along the perimeter 16
Figure 12. Example of a Clark Fork River impacted soils and vegetation area. 17
Figure 13. Example of a Clark Fork River impacted soils and vegetation area in foreground surrounded by a stand of water birch (*Betula occidentalis*) and willows 18
Figure 14. Example of a Clark Fork River slightly impacted soils and vegetation area used as a cattle pasture 19
Figure 15. Hay meadow containing a Clark Fork River slightly impacted soils and vegetation area 19
Figure 16. Generalized key for categorizing CFR RipES polygons..... 20

Figure 17. Polygon characterization within the historic 100-year floodplain 21
Figure 18. CFR RipES polygon characterization for streambank and riparian corridor buffer polygons 22

APPENDICES

Appendix A: Notes on unusual aspects of the presence of tufted hairgrass (*Deschampsia cespitosa*) in the Upper Clark Fork River Valley 38
Appendix B: Logic matrix (dichotomous key) for deciding when to remove or keep a preferred woody plant 42
Appendix C: CFR RipES Field Form for Streambank and Riparian Corridor Buffer polygons 45
Appendix D: CFR RipES Field Form for Slickens (exposed tailings polygons) 46
Appendix E: CFR RipES Field Form for Impacted Soils and Vegetation Areas polygons and Slightly Impacted Soils and Vegetation Areas polygons 47

BOI041100002.DOC

PREFACE

The Clark Fork River Riparian Evaluation System (CFR RipES) is a decision-making tool, that allows the *Record of Decision* requirements to be implemented on a site-specific, refined, and definitive basis. The purpose of CFR RipES is to provide a data predicated design tool to identify and categorize polygons (delineated areas of land) based on landscape stability, contamination severity, and plant community attributes within the Clark Fork River OU.

CFR RipES was first described in a draft document in December of 2000 (RRU and RWRP). At the time of writing, several remedial alternatives were under consideration as eventually described in the *Feasibility Study* (ARCO 2002) for the CFR OU. Since December of 2000, the *Feasibility Study* was completed, the *Proposed Plan* (EPA 2002) describing the preferred cleanup strategy has been distributed for public comment.

An iterative process of successive drafts since 2000 of CFR RipES have been made by the authors as they gained more understanding of the nuances of questions that it needed to answer, and of the physical complexities of contaminant distribution on the floodplain and the different ways these are ecologically expressed. Additional fieldwork was conducted in the fall of 2002, and in the spring of 2003, the CFR RipES was applied to multiple locations within the CFR OU to calibrate and validate the system. In late August of 2003, the CFR RipES system was field demonstrated to a group of people representing landowners, state and federal agencies, and representatives of environmental advocacy organizations. This document describes CFR RipES that is congruent with remedial action goals, objectives, and requirements specified in the *Record of Decision*.

This document integrates the streambank and riparian corridor buffer concept, sets standards for classification of streambanks (Class 1, 2, or 3) as a function of physical stability and phytotoxicity, defines slickens (exposed tailings), defines impacted soils and vegetation areas, and defines slightly impacted soils and vegetation areas. This document also integrates data and information generated during fieldwork in 2002 and 2003, as well as comments received from the people during the August 2003 field demonstrations. It is noted that scoring categories, point allocations, and discriminatory thresholds have been greatly modified from the December 2000 document. New decision matrices have also been developed to reflect the remedy as described in the CFR OU *Record of Decision*.

INTRODUCTION

Brief Site Background

Mining for gold, silver, and especially copper began in the late 19th Century in the Butte-Silver Bow Creek area. Milling and smelting of these ores produced vast wealth and concurrently a variety of wastes including mine and process waters and contaminated tailings that were released into Silver Bow Creek. These wastes contained elevated levels of several metals and arsenic, as well as the acid producing mineral pyrite. These wastes were fluvially transported downstream and into the Clark Fork River. Transport rates varied depending on flow conditions caused by precipitation patterns. Large flood events, particularly in 1908, distributed the metal bearing wastes along the entire Upper Clark Fork River floodplain. Sedimentation ponds constructed at Warm Springs in 1918 and 1959 altered the amount and type of wastes reaching the Upper Clark Fork River. Contaminated tailings and sediments reaching the river after construction of the ponds were due to fluvial redistribution of deposited wastes in the river, contributions from other tributaries, and from occasional overflows and failures at the ponds. Mining wastes from the Old Works Smelters in Anaconda were also transported via Warm Springs Creek and other creeks into the Upper Clark Fork River.

In addition to fluvial deposition of contaminated tailings within the historic 100-year floodplain, agricultural fields were irrigated with water from the Clark Fork River that at times contained enriched concentrations of metals in the dissolved form and as suspended sediment. In some instances irrigation ditches overflowed or were breached, flooding fields down gradient of the ditches with river water. Soils in these irrigated fields now contain elevated concentrations of metals and arsenic resulting from these historic irrigation practices. The irrigated fields are located on terraces above the influence of metals and arsenic impacts associated with flood deposition, thus the mechanism of contaminant transport is fundamentally different for irrigated fields compared to impacted areas within the floodplain.

Brief Site History

The Clark Fork River Operable Unit (CFR OU) of the Milltown Reservoir/Clark Fork River Superfund Site was placed on the National Priorities List in 1984. The CFR OU is defined as "surface water, bed sediments, tailings, impacted soils, ground water, aquatic resources, terrestrial resources, irrigation ditches and related tailings deposits, and air located within and adjacent to the historic 100-year floodplain of the Clark Fork River" (EPA 1995). The CFR OU extends from the confluence of the old Silver Bow Creek channel and the re-constructed Mill-Willow Bypass some 120 miles to the upstream end of the Milltown Reservoir Operable Unit. A Remedial Investigation defining the nature and extent of contamination was completed (ARCO 1998). This investigation summarized the results of numerous existing environmental studies of impacted media and collected additional data to evaluate risk to human health and the environment and to develop and evaluate remedial alternatives. The Remedial Investigation process also included Treatability Studies designed to evaluate some potential alternatives, and both Human (EPA 1998a, addendum by Syracuse [2001]) and Ecological (EPA 1999, EPA 2001a) Risk Assessments to quantify threats to human health and environmental receptors. Studies addressing geomorphic stability and mass balance loading were also done (ARCO 2000a). A *Feasibility Study* (ARCO 2002) describing and evaluating remedial alternatives was prepared, and EPA issued a *Proposed Plan* describing the preferred alternative in August 2002. A *Record of Decision* defining the selected remedy for the CFR OU is being published by EPA, which this CFR RipES document accompanies.

Remedial Investigation

The EPA released for general distribution the Clark Fork River *Remedial Investigation* Final Draft Report in August 1998 (ARCO). This report characterized the nature and extent of contamination within the OU. The *Remedial Investigation* contains a description of the site conceptual model; characterization of soil/tailings, groundwater and surface water, streambed sediments, and biological resources; and fate and transport of contaminants from sources to receptors.

Feasibility Study

The Public Review Draft *Feasibility Study* Report was prepared by ARCO Environmental Remediation Limited (AERL) and submitted to EPA in March 2002. This document used data and information from the *Remedial Investigation* and the *Human Health Risk Assessment* and the *Ecological Risk Assessment* to identify, screen, and evaluate remedial alternatives that will reduce or eliminate environmental and human health risks. Eight primary alternatives and ancillary sub-alternatives were evaluated in detail. These analyses addressed how each alternative meets the following CERCLA criteria: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements; long term effectiveness and permanence; short term effectiveness; cost; reduction of toxicity, mobility and volume through treatment; implementability; State (Montana) acceptance; and community acceptance.

***Record of Decision* for the Clark Fork River Operable Unit**

The *Record of Decision* (EPA 2004) presents the selected remedy, which is described there in Part 2, Sections 13.2 and 13.3. The role and function of this CFR RipES tool, which is being issued as a companion document to the *Record of Decision,* is described in Section 13.6.1 of Part 2 the *Record of Decision*. The *Record of Decision* recognizes CFR RipES as the design tool for identifying and categorizing areas for remedial action.

The *Record of Decision* identifies five main categories of area for remedial action and the general priority and preference for the type of action to be implemented in each. A sixth category called "slightly impacted soils and vegetation areas" is added; thereby accounting for all of the land within the historic 100-year floodplain, since tailings contamination is found throughout the historic 100-year floodplain. These areas (defined in the *Record of Decision* and later in the document) are:

Streambank and Riparian Corridor Buffer

- Class 1 Streambanks
- Class 2 Streambanks
- Class 3 Streambanks

Historic 100-Year Floodplain Contaminated Soils

- Slickens (exposed tailings)
- Impacted Soils and Vegetation Areas
- Slightly Impacted Soils and Vegetation Areas

CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES)

Purpose

Scientists from the Riparian and Wetland Research Program (University of Montana) and the Reclamation Research Unit (Montana State University) initially developed a riparian evaluation system (RipES) for the CFR OU (RRU and RWRP 2000).

CFR RipES is a tool that allows the *Record of Decision* requirements to be implemented on a site specific, refined, and definitive basis. The purpose of CFR RipES is to provide a data predicated decision tool to identify and categorize polygons (delineated areas of land) based on landscape stability, contamination severity, and plant community attributes within the CFR OU. CFR RipES will make classifications and determine actions consistent with the standards set forth in the *Record of Decision*. The system contains the following elements:

- Definitions and scoring for three types of soils polygons and three types of streambank and riparian corridor buffer polygons;
- A 100 percent accounting of all areas in the historic 100-year floodplain within the CFR OU among the three types of soil polygons in Reach A and portions of Reach B;
- Numerical components with threshold scores that distinguish the severity of contamination of the floodplain soils, and thresholds that separate streambank riparian corridor buffer polygons into three classes; and
- A process for identification of data and information required to complete remedial designs for each polygon.

The numerical portion of the system is based upon the Land Reclamation Evaluation System (LRES) developed for the Anaconda Smelter NPL Site (EPA 1998b, CDM and RRU 1999, and ARCO 2000b), and the Riparian and Wetland Health Assessment protocols (Hansen and others 2000), which are used extensively in the western United States and Canada. The health assessment protocols (Hansen and others 2000), upon which the numerical evaluation of the ecological aspect of CFR RipES is based, were initiated in 1986 in a series of iterative steps wherein inter-disciplinary teams of natural resource professionals and scientists collaborated using the Delphi Method or Expert Opinion Method (Delbecq and others 1975, Schuster and others 1985) to write, field-test, and refine the protocols.

After the CFR RipES concept and initial format was officially accepted, a formalized and systematic field test and statistical analysis of it was conducted to finalize the design and prove the effectiveness and utility in practice. The authors wrote and received EPA approval of a Sampling and Analysis Plan in early 2003 (RRU and BRI 2003a) and conducted field sampling and testing during the summer of 2003. This further sampling and testing allowed adjustment of the formats, question item weighting, and discriminatory thresholds to achieve optimum differentiation among the pertinent types of streambank and soil polygon. Subsequent statistical analysis shows the tool to be useful and effective, as intended (RRU and BRI 2003b).

This document describes the CFR RipES system in relation to the CERCLA RD/RA process and the CERCLA RD/RA process. It builds on the initial RipES document (RRU and RWRP 2000) and integrates the thinking and rationale supporting the selected remedy as stated in the *Record of Decision*. CFR RipES will also be used to evaluate land reclamation designs, evaluate post-action effectiveness, and in monitoring and maintenance programs for reclaimed areas.

Data Quality Objectives

A Sampling and Analysis Plan was prepared to guide the validation of the CFR RipES system (RRU and BRI 2003a). As part of the Plan, the Data Quality Objectives process was integrated. This process provides a systematic planning tool based on the scientific method (APHA 1998). The process documents the criteria for defensible decision-making before an environmental data collection activity begins. The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified. The DQO process (EPA 1994) consists of seven steps of which the output from each step influences the choices that will be made later in the process. These steps include:

- State the problem;
- Identify decisions and actions;
- Identify inputs;
- Identify spatial and temporal limits;
- Develop a decision rule;
- Specify limits on decision errors; and
- Optimize design for collection.

Step 1. State the Problem—The problem was to devise a systematic way to identify areas (polygons) within Reach A and limited portions of Reach B of the CFR OU that require remediation to address effects of contamination from mining and smelting wastes, and to place these areas (polygons) into categories that determine appropriate remedial action(s), all in a manner consistent with the CFR OU *Record of Decision*.

Step 2. Identify the Decision—During development of the CFR RipES several questions were identified that are to be answered in order to classify streambank polygons, exposed tailings areas, and impacted and slightly impacted soils and vegetation areas. These questions included:

- What information and data are required to characterize streambanks as Class 1, 2, or 3?
- What characteristics (chemical, physical, and biological) define slickens (exposed tailings)?
- What characteristics (chemical, physical, and biological) define impacted soils and vegetation areas?
- What characteristics (chemical, physical, and biological) define slightly impacted soils and vegetation areas?
- How should streambank stability and contamination severity be evaluated for streambank polygons?
- How should ecological dysfunction and contamination severity be evaluated for floodplain contaminated tailings/soils polygons?
- How will the system be calibrated so that categorization and classification effectively separate polygons with different levels of dysfunction?
- How are the CFR RipES threshold scores developed?
- How are data gaps identified for a site or polygon?
- What data and information are required on a polygon-by-polygon basis to support remedial design?

Step 3. Identify the Inputs to the Decision—Informational variables required to answer the major questions posed above are:

- **Streambank and riparian corridor buffer polygon**—In order to categorize streambanks the following information and data are required for a polygon: (1) percent of the polygon with live plant canopy cover other than tufted hairgrass, (2) the completeness of the canopy of live, deep-binding, woody species in the polygon, and (3) the percent of the streambank length in the polygon that exhibits active lateral cutting. The minimum mapping unit of these polygons is 20 linear feet of streambank with a maximum length of 500 ft. These parameters are assessed using the CFR RipES Field Form for Streambank and Riparian Corridor Buffer Polygons. Threshold scores discriminate streambanks into three categories (e.g., Class 1, 2, or 3 streambank).
- **Slickens (exposed tailings) polygon**—In order to identify an area as a slickens, the following information and data are required for a polygon: (1) percent of the polygon with live plant

canopy cover, (2) whether there is tufted hairgrass (*Deschampsia cespitosa*) present, (3) whether efflorescent metal salts are visible on the soil surface during dry periods. The minimum mapping unit for slickens polygons is 400 square feet. Areas smaller than 400 square feet that have slickens characteristics are included within impacted soils and vegetation area polygons.

- **Impacted soils and vegetation area and slightly impacted soils and vegetation area polygons**—In order to distinguish between an impacted soils and vegetation area and a slightly impacted soils and vegetation area, the following information and data are required for a polygon: (1) percent of the polygon with live plant canopy cover other than tufted hairgrass, (2) the amount of any tufted hairgrass present, (3) the percent of the area that is bare ground caused by tailings, (4) the depth and concentration of contamination, (5) the depth integrated soil pH, and (6) whether efflorescent metal salts are visible on the soil surface during dry periods. These parameters are assessed using the CFR RipES Data Form for Impacted Soils Area Polygons and for Slightly Impacted Soils Area Polygons. A threshold score discriminates polygons into the two categories. The minimum mapping unit for these polygons is 400 square feet.
- **Additional quantitative environmental data**—Additional data on a polygon-by-polygon basis will be required. One of the main data gaps identified is the lack of contamination severity information, specifically concentrations of the COCs (copper is used as a surrogate for all COCs), depth of contamination, depth to groundwater, and pH of the materials. Filling these data gaps will be necessary so that preliminary remedial actions can be assigned to a polygon. Additional data to support remedial design include acid base account, nutrient status of the newly constructed root zone, quality and quantity of imported materials, and others. See Part 2, Section 13.6, 13.7, and 13.8 of the *Record of Decision.*

Step 4. Define the Study Boundaries—Spatial boundaries of the CFR RipES evaluation encompass Reach A and limited portions of Reach B of the CFR OU. The temporal boundaries of the CFR RipES process begin with field use of the system and end when remedial designs are approved by the agencies.

Step 5. Develop a Decision Rule—The parameters of interest are those parameters scored during the field data collection. CFR RipES threshold levels were determined during the late 2002 field season and the summer of 2003, as the system was validated and calibrated. Validation of the threshold levels was made during the summer of 2003 and adjustments were made. Threshold scores are used to distinguish streambank categories or classes, and to identify impacted soils and vegetation sites that require remedial action and slightly impacted soils and vegetation areas that receive no action (or only monitoring). Areas with extensive exposed tailings (e.g., slickens) will all require remedial action, and therefore are not further categorized by a threshold score.

The scoring protocols will be used to categorize each polygon. In general, the lower the site score, the higher the intensity of action that may be required. There will be target levels (cutoffs) for different remedial action intensities, but the type of remedial action required on a specific polygon will ultimately be determined during the remedial design phase of the CERCLA process. Field and analytical information collected during the CFR RipES process will be vital in making design decisions. The CFR RipES score and supplemental descriptive information will be used during design, in concert with other design considerations (refer to Section 13.6.1.1 of the *Record of Decision*).

Step 6. Specify Tolerable Limits on Decision Errors—Tolerable limits on decision errors are built into the CFR RipES system. Most parameters scored on the field scoring system forms include a range for the parameter measured. For example, less than 25 percent canopy cover, or a range of contamination levels in the soil profile. These ranges are meant to envelop the limits on the decision errors made by field personnel and specify the tolerable limits on field decision errors.

The point system was designed with a lack of flexibility in order to increase scoring precision (i.e. repeatability) by limiting the effect of variability among observers. Although there is a range of values for each category of some parameters, the field observer must assign that range only one score. Intermediate values within the ranges do not translate to an intermediate score. This limitation of choices minimizes inter-observer variability.

Spatial heterogeneity in terms of contamination levels as well as the expressions of phytotoxicity within vegetation communities is apparent along the Clark Fork River. It is the goal of the CFR RipES system to be able to precisely and accurately score polygons in Reach A of the Clark Fork River. Precision is the ability of trained and experienced field personnel to repeatedly score a polygon with a variation in the overall score of less than $\pm$ 5 percent at the threshold value(s). The goal for bias is also $\pm$ 5 percent at the threshold value(s). Accuracy of arsenic and copper determinations will be determined by analyzing standard reference materials, field replicates, and field blanks inserted into the sample queue at a five percent rate.

Step 7. Optimize the Design—The data collection design specified in the field scoring was optimized during the field validation and calibration portion of this work in the late fall of 2002 and summer of 2003. One aspect of CFR RipES that optimizes the design is its capability for incorporating new analytical data into the scoring system as such data become available. The system utilizes previously collected data in the evaluation process to eliminate redundancy of data collection. Finally, the system increases field worker efficiency with the pre-assessment preparation. This preparation part of the system gives field personnel available information, pertinent to the field survey, on and attached to aerial photographs of sites for CFR RipES evaluation (refer to Section 13.6.1.1 of the *Record of Decision*).

Data Measurement Objectives
The field Quality Assurance program was designed in accordance with EPA's Guidance for the Data Quality Objectives Process (EPA 1994, 1998c).

Precision, accuracy, representative ness, completeness, and comparability (PARCC) parameters are indicators of data quality. PARCC goals were established for the calibration and validation of the CFR RipES system as part of the Sampling and Analysis Plan (RRU and BRI 2003a). The Data Summary Report (RRU and BRI 2003b) provides detailed results of the following QA/QC assessments:

Precision—Field duplicate samples, for the determination of pH and total copper and arsenic, were collected to provide a measure of the contribution to overall variability of field-related sources. Contribution of laboratory-related sources to overall variability is measured through various laboratory Quality Control samples, specifically XRF laboratory duplicates and laboratory splits. The acceptable RPD limits for field duplicates are less than 35 percent for soil. Chemical analytical data were validated for precision using field duplicates, and laboratory duplicates and splits. Acceptance windows for XRF precision are functions of both the analyte and the concentration. These are defined in the XRF LAP document (Ashe 1995). See Data Summary Report (RRU and BRI 2003b) for results.

Accuracy—Accuracy is the degree of agreement of a measurement with an accepted reference or true value, and is a measure of the bias in a system. Accuracy of this program was based on the results of National Institute of Standards and Technology Standard Reference Material samples inserted into the sample stream at the rate of 5 percent. Laboratory accuracy was based on the results of LCS analysis.

The detection limits specified in the XRF LAP (Ashe 1995) were sufficient to meet the needs of this project for each element (copper and arsenic) of interest. Refer to the Sampling and Analysis Plan and the Data Summary Report (RRU and BRI 2003a, 2003b).

Representativeness—This parameter was achieved through: a) careful, informed selection of sampling sites within each polygon, b) selection of testing parameters and methods that adequately define and characterize the extent of possible contamination and meet the required parameter reporting limits, c) proper gathering and handling of samples to avoid interference and prevent contamination and loss, and d) collection of a sufficient number of samples to allow for polygon characterization. It is acknowledged that defining the spatial distribution of the contaminants within a CFR RipES polygon is a very difficult task. The intent of the CFR RipES system validation sampling and analysis effort was to gain some additional conceptual understanding of the depth of contamination and the horizontal variation. These data will be most useful in determining sampling schemes that might be used during full-scale remedial design.

Completeness—Completeness is a measure of the amount of usable data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Those data that are validated and need no qualification (CFR Enforcement Quality Data), or are qualified as estimated data (CFR Screening Quality Data), are considered usable. Rejected data are not considered usable. Completeness was calculated following data evaluation (refer to Data Summary Report (RRU and BRI 2003b)). For the validation of CFR RipES, the completeness goal of 90 percent was exceeded for total copper and arsenic, as well as field pH determinations. The goal for XRF copper and arsenic data is enforcement quality data was also met (RRU and BRI 2003b).

Comparability—Consistency in the acquisition, handling, and analysis of samples is necessary for comparing results. Where appropriate, the results of analyses obtained can be compared with the results obtained in previous CFR *Remedial Investigation* studies. Standard US EPA analytical methods and QC, as well as those specified in the CFR SSI documents were used to ensure comparability of results with other analyses performed in a similar manner.

The Data Quality Assessments process (EPA 1998c) was used to evaluate the generated data in terms of meeting the stated Data Quality Objectives and in terms of meeting the measurement goals for accuracy, precision, representativeness, completeness, and comparability (refer to Data Summary Report).

CFR RipES Structure

Areas within the Upper Clark Fork River floodplain are classified for purposes of determining specific remedial actions based on landscape stability, contamination, and plant community dysfunction. Of first concern are those areas most in jeopardy of being eroded into the river channel. The CFR OU is divided into smaller units of land, called ***polygons,*** delineated and classified as candidates for the various kinds of remediation as described in the *Record of Decision.*

Four major types of site are defined below for the purpose of identifying areas for the various remedial actions:

1. Streambank and riparian corridor buffer;
2. Slicken areas (exposed tailings);
3. Impacted soils and vegetation areas; and
4. Slightly impacted soils and vegetation areas.

Other miscellaneous site types are also identified (i.e., irrigation ditches, contaminated upland areas, tributary streams, etc.). Remedial actions for these miscellaneous site types are discussed in Part 2, Section 13.6.1 of the *Record of Decision*. Characteristics of the major types of sites and remedial actions for each type are provided below.

Streambank and Riparian Corridor Buffer
The streambank and riparian corridor buffer is a zone of approximately 50 feet in width on each side of the river that may vary in width, depending on site specific conditions. For example, a severely eroding outer streambank may require more than 50 feet while on inside banks with point bars and along straight reaches of the stream where the erosive forces are minimal, the corridor may be less.

The streambank and riparian corridor buffer is delineated by measuring from the "bankfull" stage on each side of the stream out a flexible or variable distance (see preceding paragraph) ***OR*** where the historic 100-year floodplain elevation is reached. In other words, areas outside the historic 100-year floodplain are not included in the streambank and riparian corridor buffer. In cases where high banks are reached, the buffer will be narrower. Bankfull flow for the Clark Fork River at Deer Lodge has been calculated to be about 1,900 cfs (Griffin and Smith 2001). This equates to approximately a 7-year flood event. At this stage, the flow begins to spill out of the channel and disperse onto the floodplain.

The approximate 50 foot streambank and riparian corridor buffer zone on each side of the river will be broken into preliminary polygons based on live vegetative canopy cover, canopy cover of deep, binding, woody vegetation, and/or lengths of streambank erosion. The minimum mapping unit of these polygons is 20 linear feet of streambank with a maximum length of 500 feet. Polygon units will not cross land-ownership boundaries. These polygon units will be scored using the CFR RipES Field Form for Streambank and Riparian Corridor Buffer Polygons, thereby classifying streambanks into one of three categories designated as Class 1, 2, or 3 streambanks.

Streambank Categories
Class 1 streambanks—Phytotoxic conditions exist as demonstrated by an inability of the active channel areas to support and sustain significant amounts of woody and herbaceous vegetation. Streambanks are actively eroding and are significant contributors of contaminant release to the river (Fig. 1 and 2). Remedial actions for this class include removal of phytotoxic materials and revegetation with deep, binding, woody vegetation. These actions will be implemented from a line at the lateral extent of inundation at bankfull stage out to approximately 50 feet from that line. Specific actions at a Class 1 Streambank will be determined in accordance with *Record of Decision* specifications and after consideration of design factors. Design factors include: depth of removal (this is not necessarily the same as depth of contamination), depth to the water surface, depth to groundwater, current streambank stability, current vegetation status, infrastructure (bridges, culverts, etc.), surface drainage, future land use, BMPs, and others.

Class 2 streambanks—These streambanks demonstrate some current woody and herbaceous vegetation, but are contaminated, unstable, and eroding (Fig. 3 and 4). Remedial actions for this class include supplemental revegetation and planting of deep, binding, woody vegetation. Reconfiguration of the streambanks may require minor removal or *in-situ* treatment. Design factors include current streambank stability, current vegetation status, infrastructure, surface drainage, future land use, BMPs, and others.

Class 3 streambanks—These streambanks are contaminated but they may have varying amounts of deep, binding, woody vegetation holding the streambank in place (Fig. 5 and 6). Remedial actions possible for these areas include no action or minor actions to enhance woody vegetation within the buffer corridor and/or BMPs. Design factors are: current vegetation status, current streambank stability, knowledge of underlying contamination, and current and future land use.

Figure 1. Typical Clark Fork River Class 1 streambank

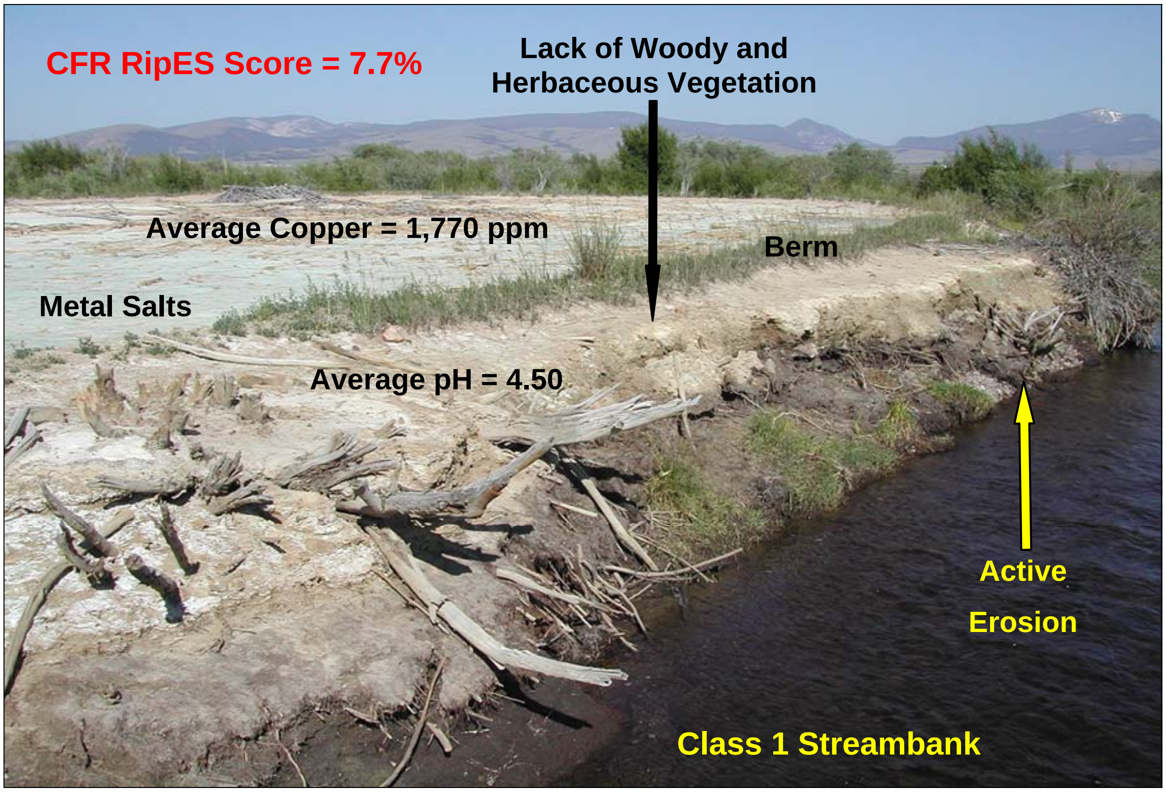

Figure 2. Clark Fork River Class 1 streambank adjacent to a slickens area (exposed tailings)

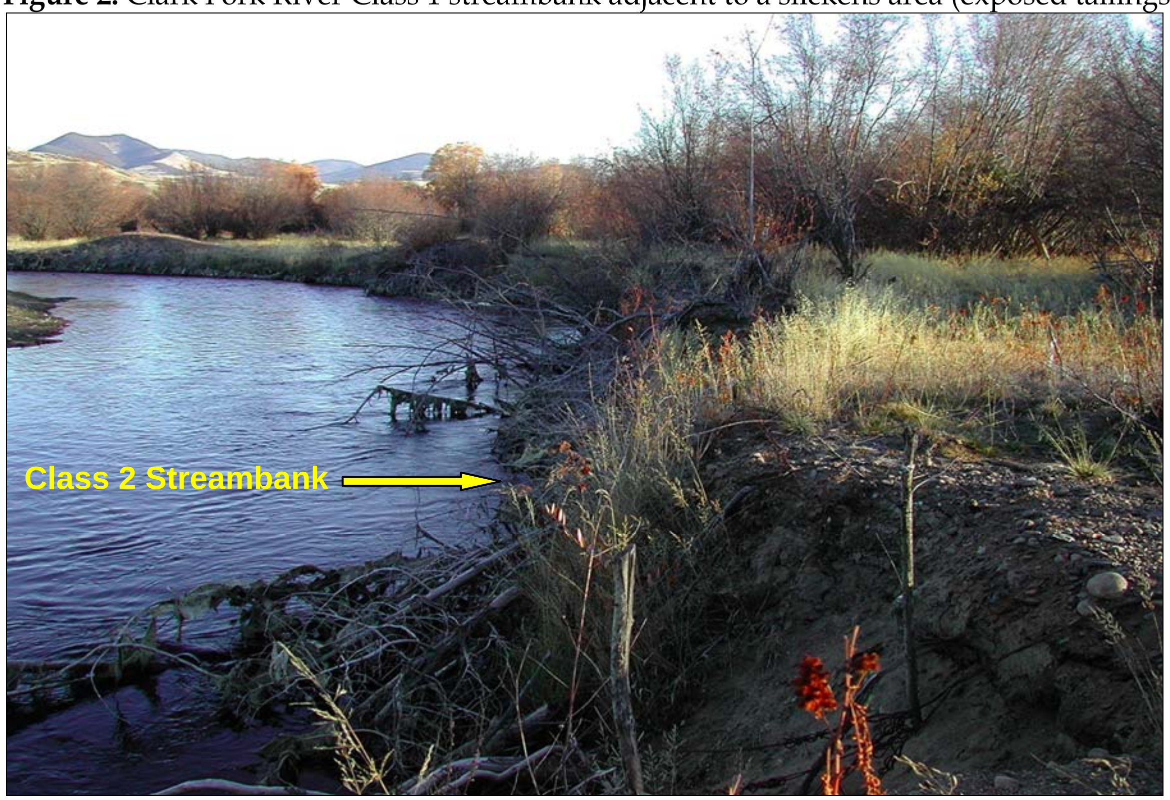

Figure 3. Typical Clark Fork River Class 2 streambank

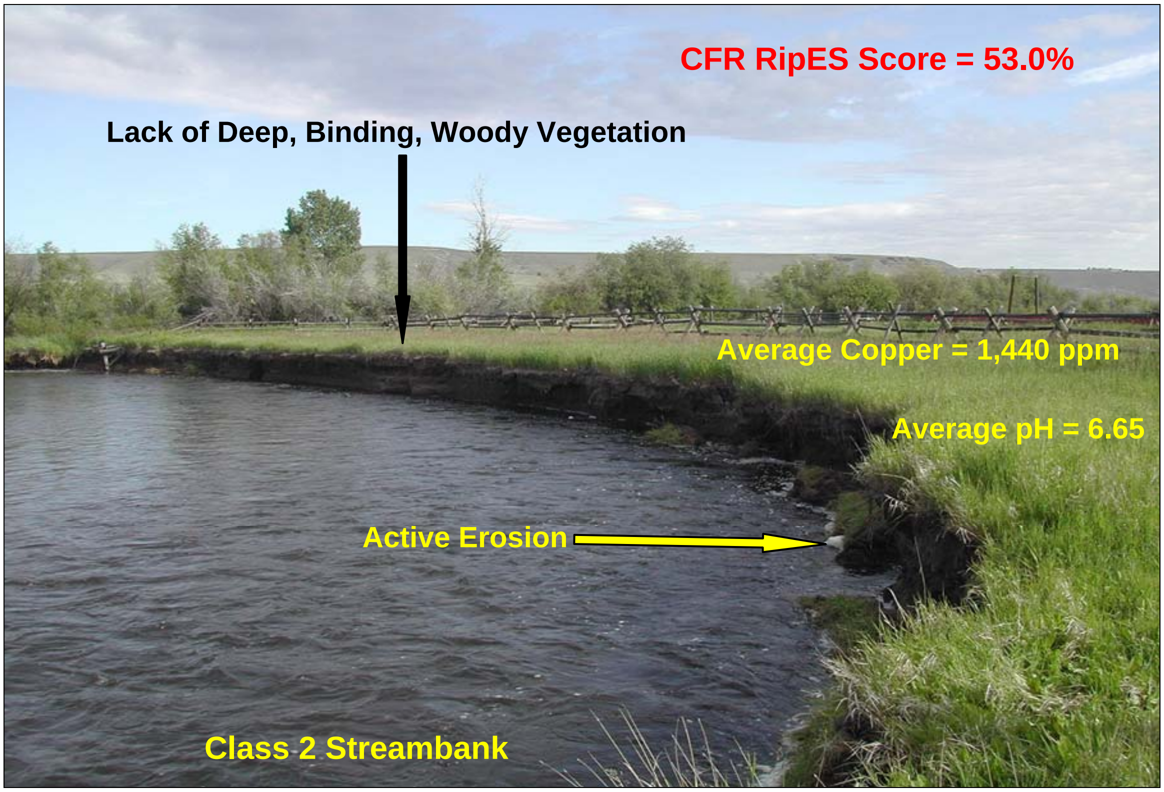

Figure 4. Highly eroding Clark Fork River Class 2 streambank

Figure 5. Well-vegetated, stable Clark Fork River Class 3 streambanks

CFR RipES Score = 100%

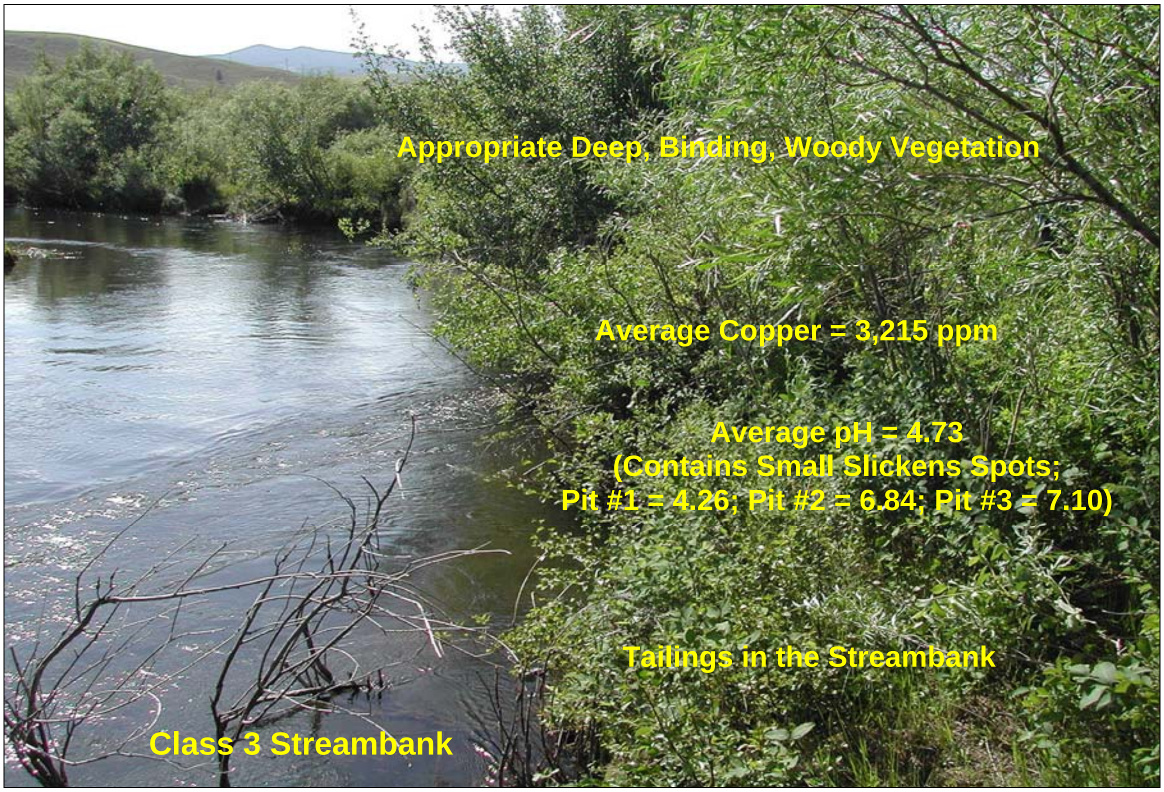

Figure 6. Clark Fork River Class 3 streambank with visible tailings and appropriate deep, binding, woody vegetation

Special Cases

Streambank and riparian corridor buffer polygons will be delineated for evaluation and classification for appropriate remedial actions on sites beyond the main channel of the Clark Fork River within the OU. These are tributary streams and secondary channels of the Clark Fork River.

Tributary streams—Tributaries within the CFR OU (e.g., Lost Creek, Warm Springs Creek, Dutchman Creek, Racetrack Creek, Cottonwood Creek, and others) may have transported contaminants from other NPL sites in the basin, or may have been contaminated during depositional flood events from the Clark Fork River. Tributaries having perennial flow will be protected with a streambank buffer 25 feet wide within the CFR OU, unless this width extends outside the historic 100-year floodplain of the Clark Fork River.

Secondary channels of the Clark Fork River—Also of concern are secondary channels forming islands on the Clark Fork River floodplain. Secondary channels with perennial flow throughout their length and having connection to the main channel of the river at both ends will also be protected with a flexible or variable streambank and riparian corridor buffer of 25 ft, unless this width extends outside the historic 100-year floodplain of the Clark Fork River.

Historic 100-Year Floodplain Contaminated Soils

Contaminated soils within the historic 100-year floodplain may consist of:

- Slickens (exposed tailings);
- Impacted soils and vegetation; and
- Slightly impacted soils and vegetation.

Slickens (exposed tailings)—These areas generally lack vegetation and present a principal waste in the Clark Fork River OU, along with Class 1 Streambanks. Estimated in the RI/FS at about 167 acres, but possibly up to 250 acres, in Reach A. These slickens areas are contamination-caused, mostly-bare ground. Scattered throughout Reach A, the areas number in the hundreds, are usually a fraction of an acre in size, and are too toxic to support most vegetation or soil organisms. These areas are usually easy to recognize. Remedial action for most of these areas is removal, except as described below. Removal of slickens areas adjacent to an active channel is part of the streambank remedial action.

Slickens (exposed tailings) (Fig. 7, 8, 9, 10, and 11), are characterized as follows:

1. Because of phytotoxic condition, these areas are generally devoid of vegetation, supporting less than 25 percent live plant canopy cover.
2. Tufted hairgrass (*Deschampsia cespitosa*) is present, if there is any live vegetation (See Appendix A for a discussion of the special indicator value of this species).
3. Efflorescent metal salts are visible on the soil surface during dry periods.

Slickens (exposed tailings) and underlying contaminated soil which meet these criteria will be removed, with a limited exception. For the exception to occur, all of the following criteria as defined by CFR RipES must be met:

- The slickens area is small - less than 400 square feet;
- The contamination is less than 2 feet deep;
- The contamination is widely dispersed or separated by vegetation;
- The contamination is contiguous with impacted soils and vegetation areas that will be treated in place; and
- The area is not too wet or otherwise unable to be treated effectively.

Slickens that are less than 400 square feet and less than 2 feet in depth and not too wet will be treated *in-situ* if they are next to or contained within an impacted soils and vegetation area that is designated to be treated *in-situ*. These small slickens within or next to areas to be treated *in-situ* will be removed if they are thicker than 2 feet or too wet to treat.

Isolated, small slickens areas (less than 400 square feet) that are not contiguous with impacted soils and vegetation areas will not be removed in most cases. These areas are too small to bring in removal equipment without significant destruction of the surrounding unimpacted areas. *In-situ* treatment will be done in these areas where practicable. These areas will also not be mapped under the CFR RipES protocols.

Often there will be areas of slickens interspersed with areas of woody vegetation. On sites that will receive remedial treatment by removal of contaminated soil or of *in-situ* treatment, some woody plants will necessarily be affected. The desired option is to leave as many as possible of certain “preferred woody plant species” in place that are already growing on the floodplain within the CFR OU. This will be accomplished by working around them whenever practicable and whenever the overall goals of the project can still be achieved by doing so. Woody vegetation patches within a large general area of slickens area can often be separated as smaller polygons of more healthy vegetation from the more severe slickens area polygons.

When a decision must be made whether to remove or keep a particular shrub or patch of shrubs in question, the dichotomous key provided in Appendix B will serve as the logical matrix.

Figure 7. Clark Fork River slickens area (exposed tailings)

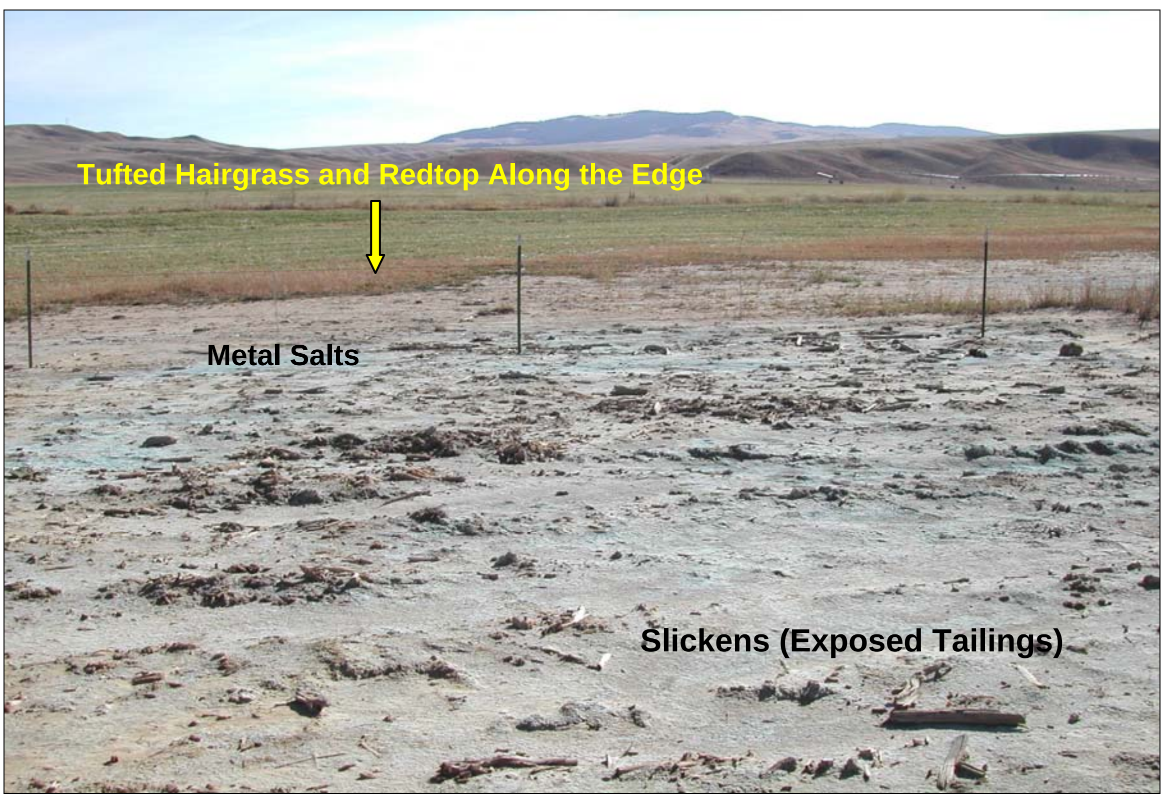

Figure 8. Clark Fork River slickens (exposed tailings) surrounded by pioneer species such as tufted hairgrass (*Deschampsia cespitosa*) and redtop (*Agrostis stolonifera*)

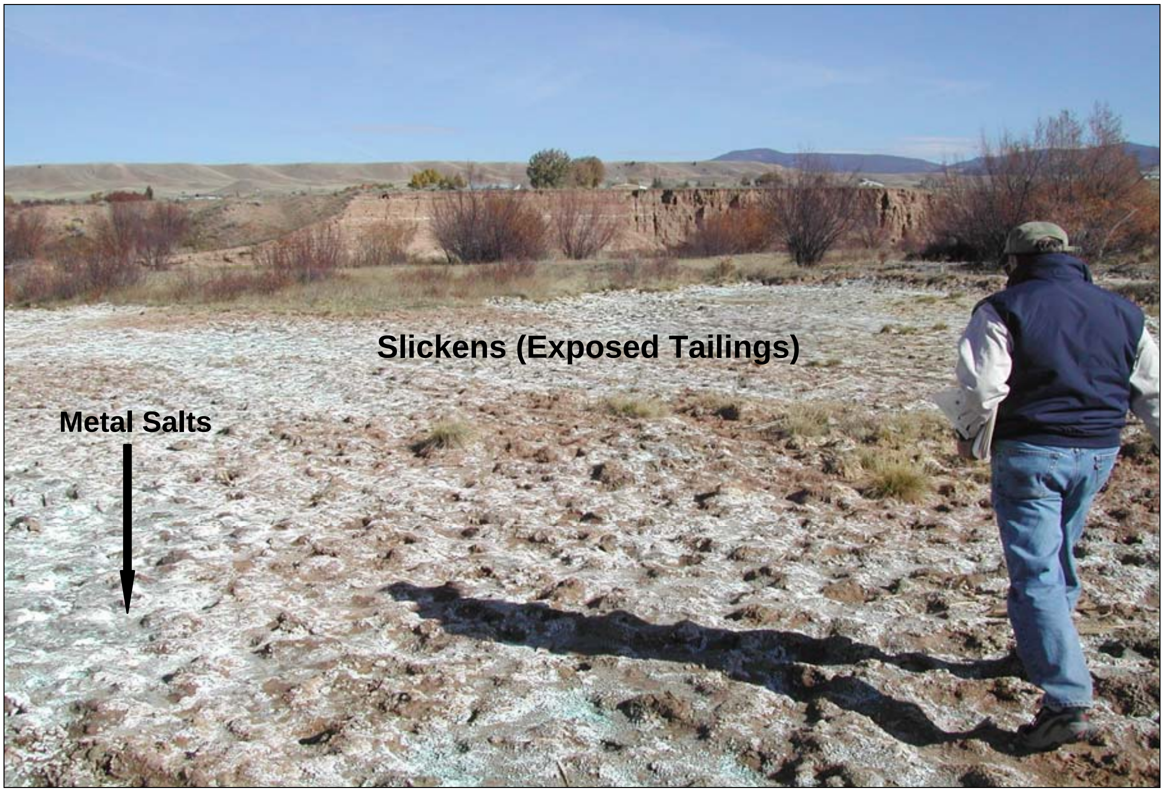

Figure 9. Clark Fork River slickens (exposed tailings) showing metal salts on the soil surface following a dry period

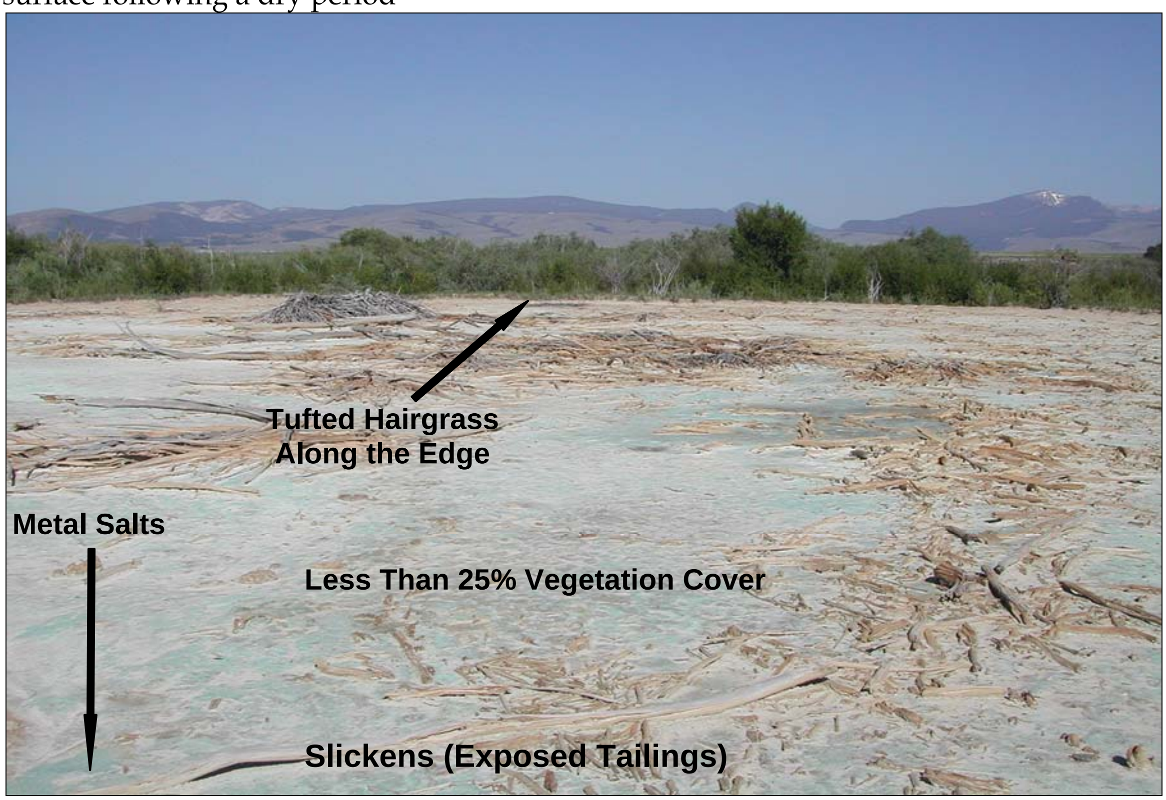

Figure 10. Clark Fork River slickens area (exposed tailings) showing extensive areas of metal salts along with less than 25 percent vegetative canopy cover

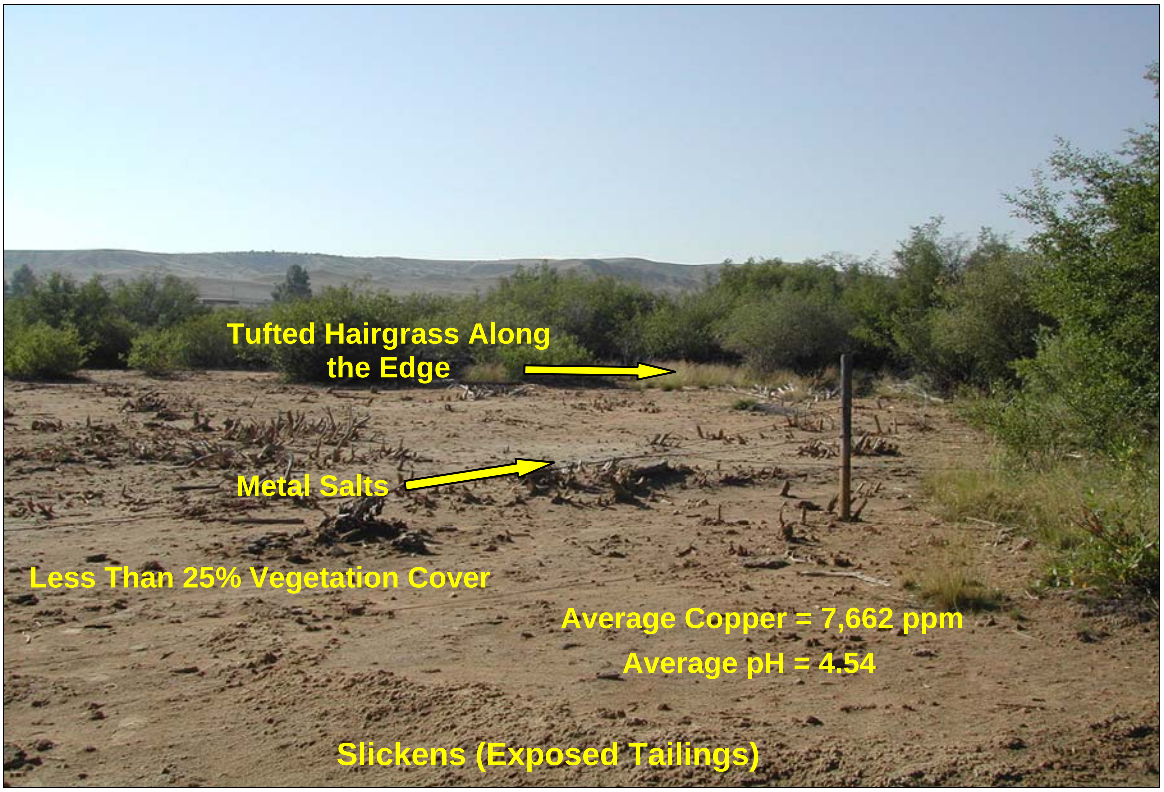

Figure 11. Clark Fork River slickens area (exposed tailings) showing some metal salts, less than 25 percent vegetative canopy cover, and tufted hairgrass (*Deschampsia cespitosa*) along the perimeter

Impacted soils and vegetation areas—These sparsely vegetated areas amount to everything between slickens and slightly impacted soils and vegetation areas (Fig. 12 and 13). Impacted soils and vegetation areas will generally be treated *in-situ*, unless the tailings and impacted soils in a given area extend more than 2 feet below ground surface. In that case, the tailings and impacted soils will be removed. Other impacted soils and vegetation areas that are too wet for implementation of *in-situ* treatment techniques will also be removed. Old river channels (oxbows) and wetlands will be evaluated using CFR RipES. If they have high quality vegetation and score 75 percent or more on CFR RipES, they will not be remediated. If they have impacted vegetation and soils, and the contaminated tailings and soils are deeper than 2 feet, or the soil is too wet; they will be removed and replaced in a manner that re-establishes a productive and healthy wetland. If the tailings and contaminated soils are less than 2 feet deep in an old oxbow channel, and it is not too wet, the area will be treated *in-situ*.

Impacted soils and vegetation areas are characterized as follows:

1. The degree of phytotoxicity in these areas is quite variable, but they do sustain at least 25 percent live plant canopy cover.
2. Tufted hairgrass (*Deschampsia cespitosa*) has greater than 1 percent canopy cover.
3. Efflorescent metal salts may be visible on the soil surface during dry periods.
4. Small, individual areas of exposed tailings (that appear as small slickens) may be present.
5. Concentrations of COCs within the soil profile exceed the geometric mean values for unimpacted soils for Reach A of the CFR OU. Copper is used as a surrogate for the COCs; soils with copper concentrations exceeding 300 ppm within the profile are considered impacted by mining-related activities.
6. The minimum polygon size is 400 square feet.

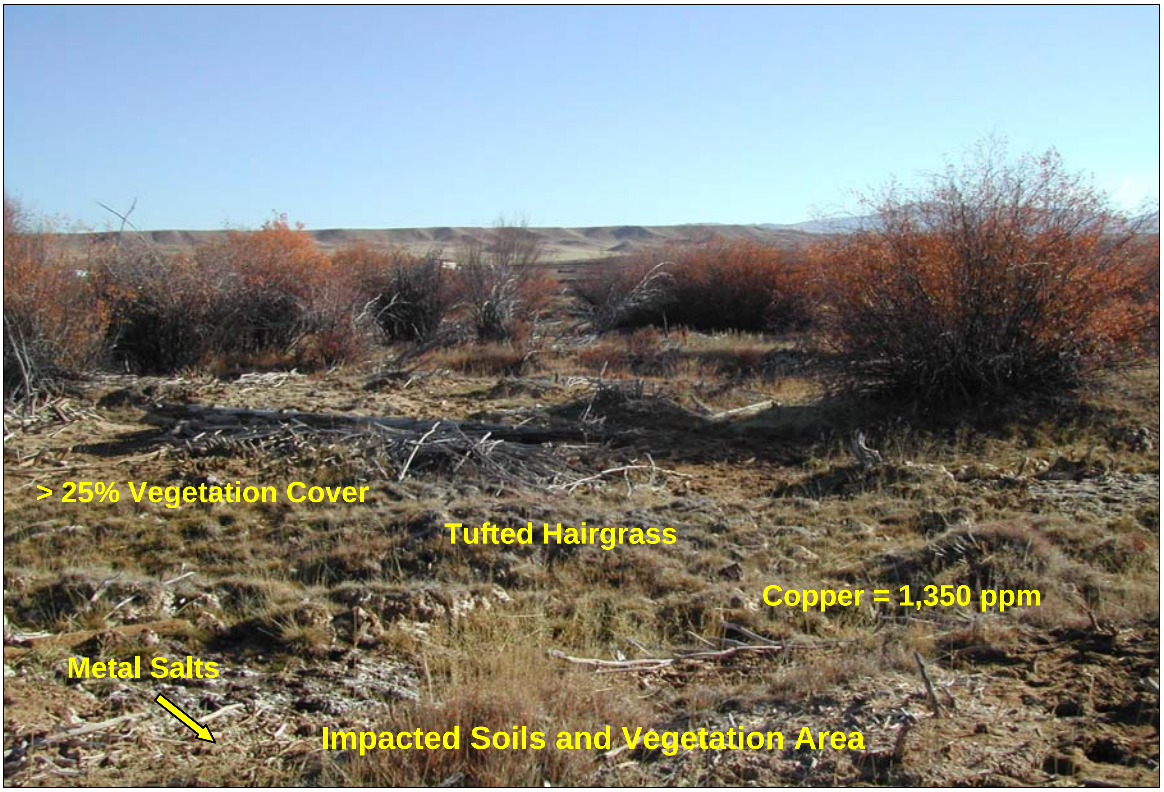

Figure 12. Example of a Clark Fork River impacted soils and vegetation area

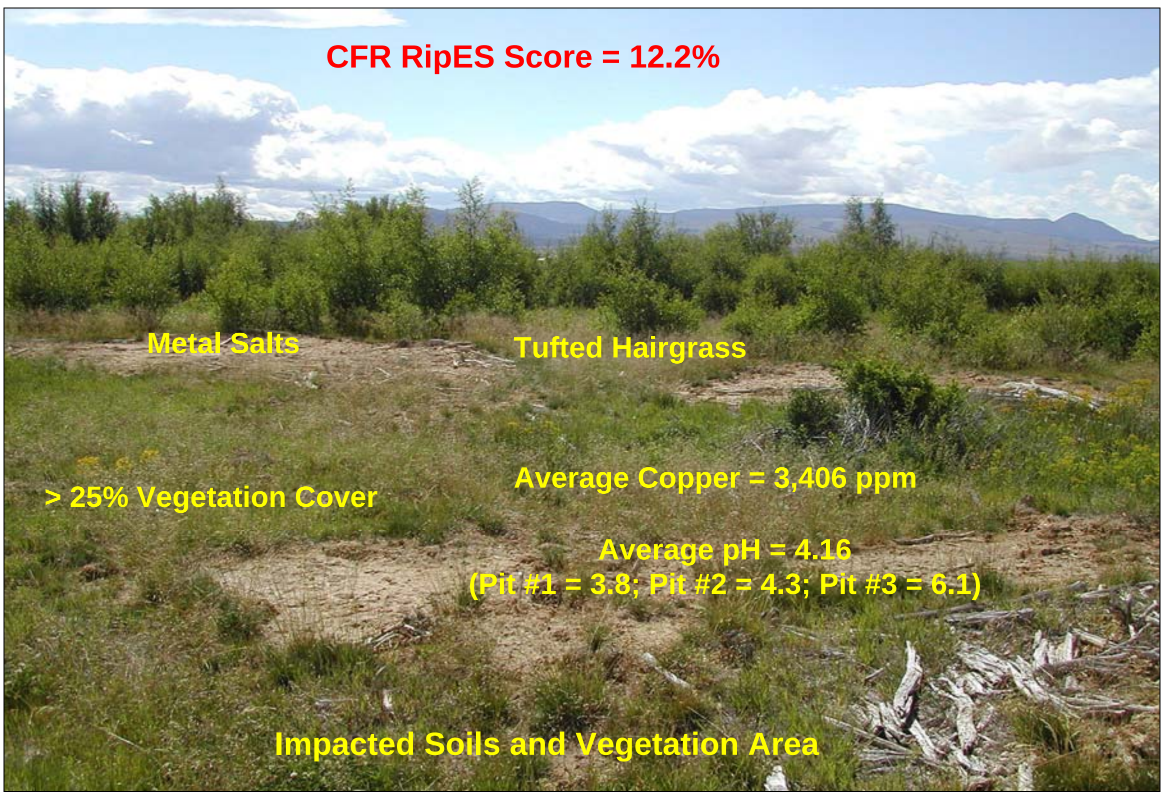

Figure 13. Example of a Clark Fork River impacted soils and vegetation area in foreground surrounded by a stand of water birch (*Betula occidentalis*) and willows

Slightly impacted soils and vegetation areas—These areas do not meet the characteristics or definitions of streambank and riparian corridor buffer, slickens (exposed tailings), or impacted soils and vegetation area. They are generally well vegetated and display no visible evidence of contamination from tailings, although the soil may contain copper contamination above 300 ppm (Fig. 14 and 15). Remedial actions for these areas are no action, or BMPs and ICs.

Slightly impacted soils and vegetation areas characterized as follows:

1. The area expresses no evidence of phytotoxicity and has less than 1 percent bare ground caused by contaminated tailings.
2. Tufted hairgrass (*Deschampsia cespitosa*) has less than 1 percent canopy cover.
3. No efflorescent metal salts are visible on the soil surface during dry periods.
4. Concentrations of COCs within the soil profile exceed the geometric mean values for unimpacted soils for Reach A of the CFR OU. Copper is used as a surrogate for the COCs; soils with copper concentrations exceeding 300 ppm within the profile are considered impacted by mining-related activities.

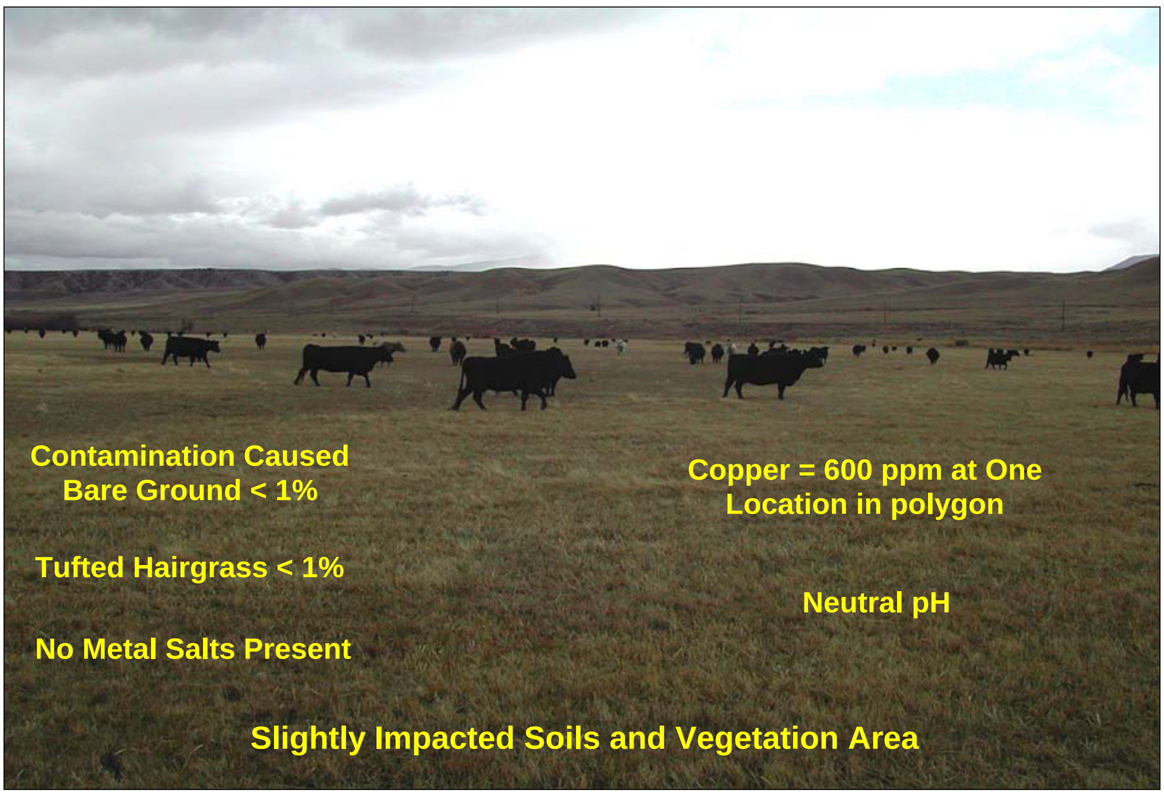

Figure 14. Example of a Clark Fork River slightly impacted soils and vegetation area used as a cattle pasture

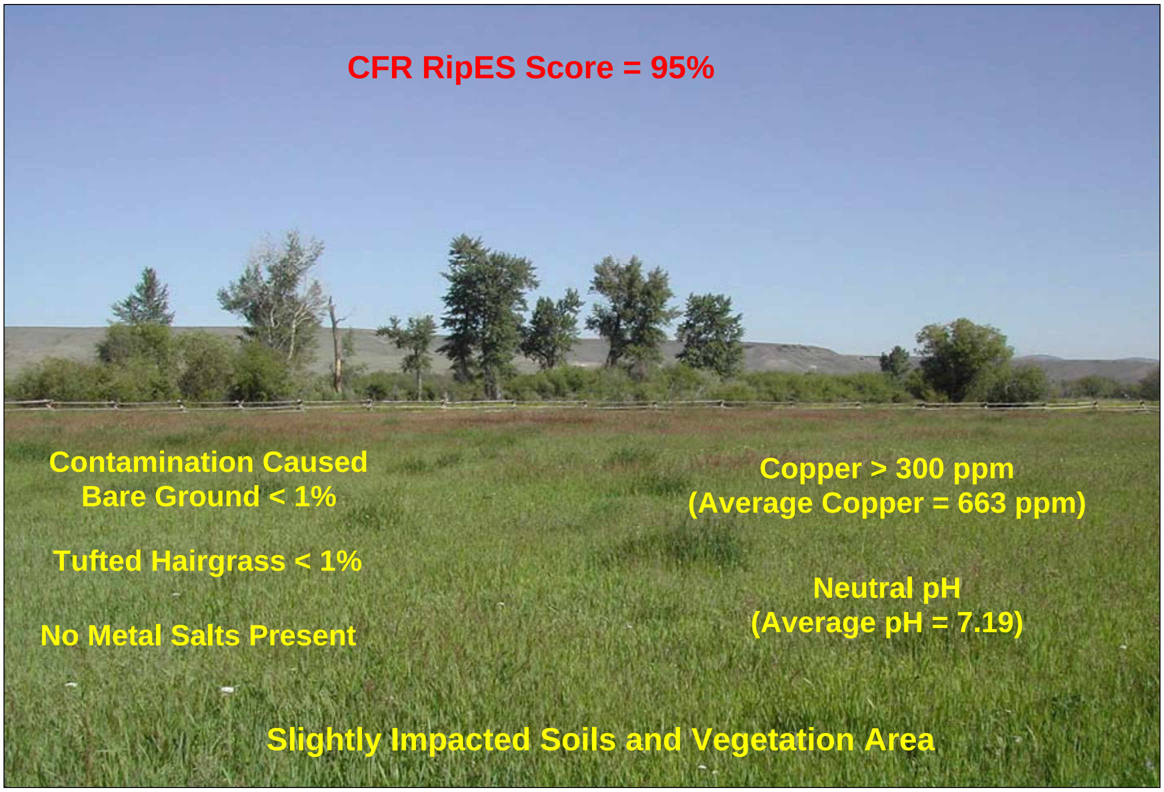

Figure 15. Hay meadow containing a Clark Fork River slightly impacted soils and vegetation area

CFR RipES Application

The characterizations of contaminated soils above will account for the majority of land within the CFR OU that is to be considered for remedy. (CFR RipES is not applicable to the historically irrigated upland areas. Historically irrigated lands will be evaluated for human health risks and remediated if necessary.) After a polygon has been delineated using the delineation criteria described above, application of the flow-chart keys in Figures 16, 17, and 18 will provide the correct classification, and Table 1 will indicate the correct subset of remedial actions from which to draw the remedial design. Also refer to Part 2 Section 13.6 of the *Record of Decision.*

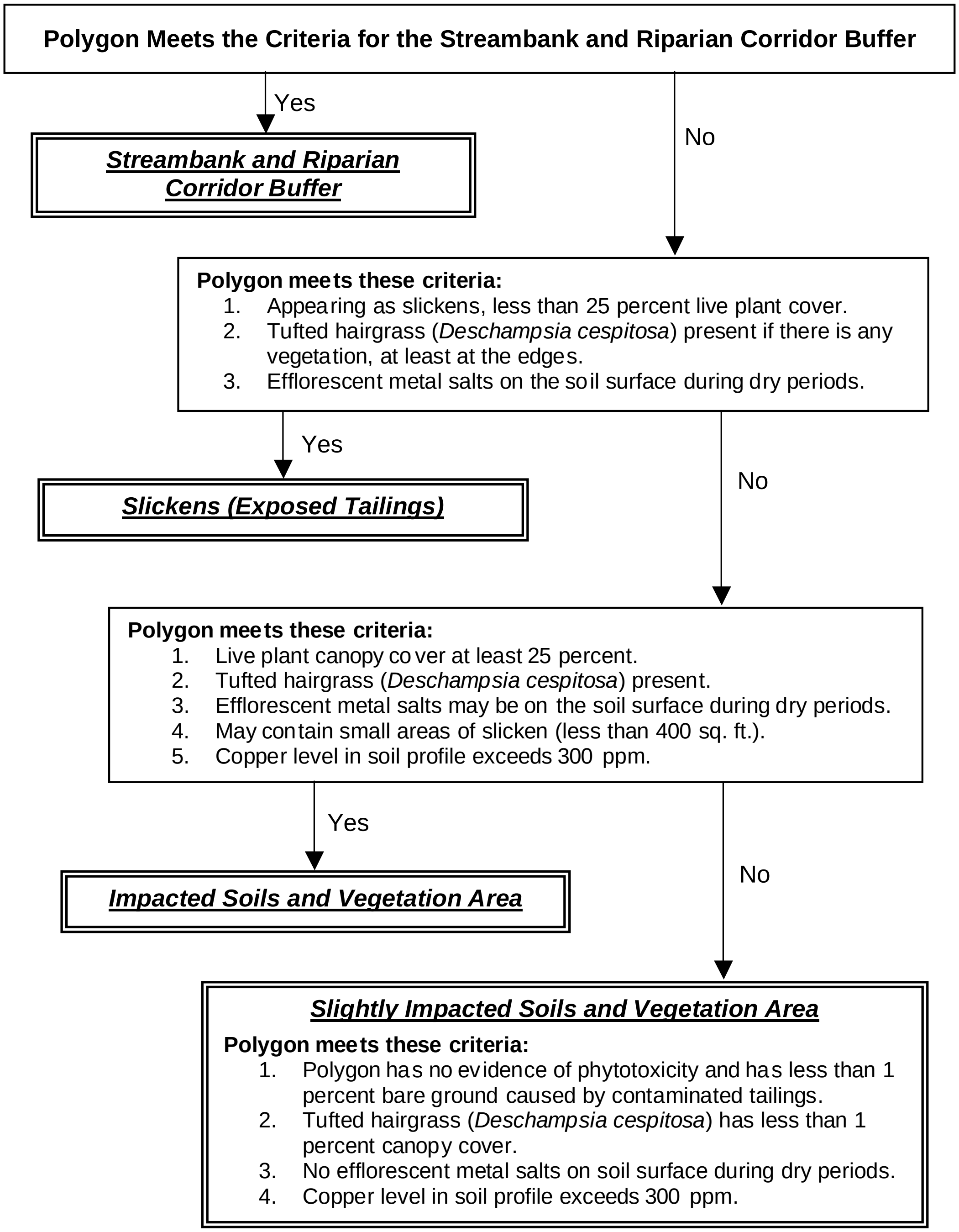

Figure 16. Generalized key for categorizing CFR RipES polygons

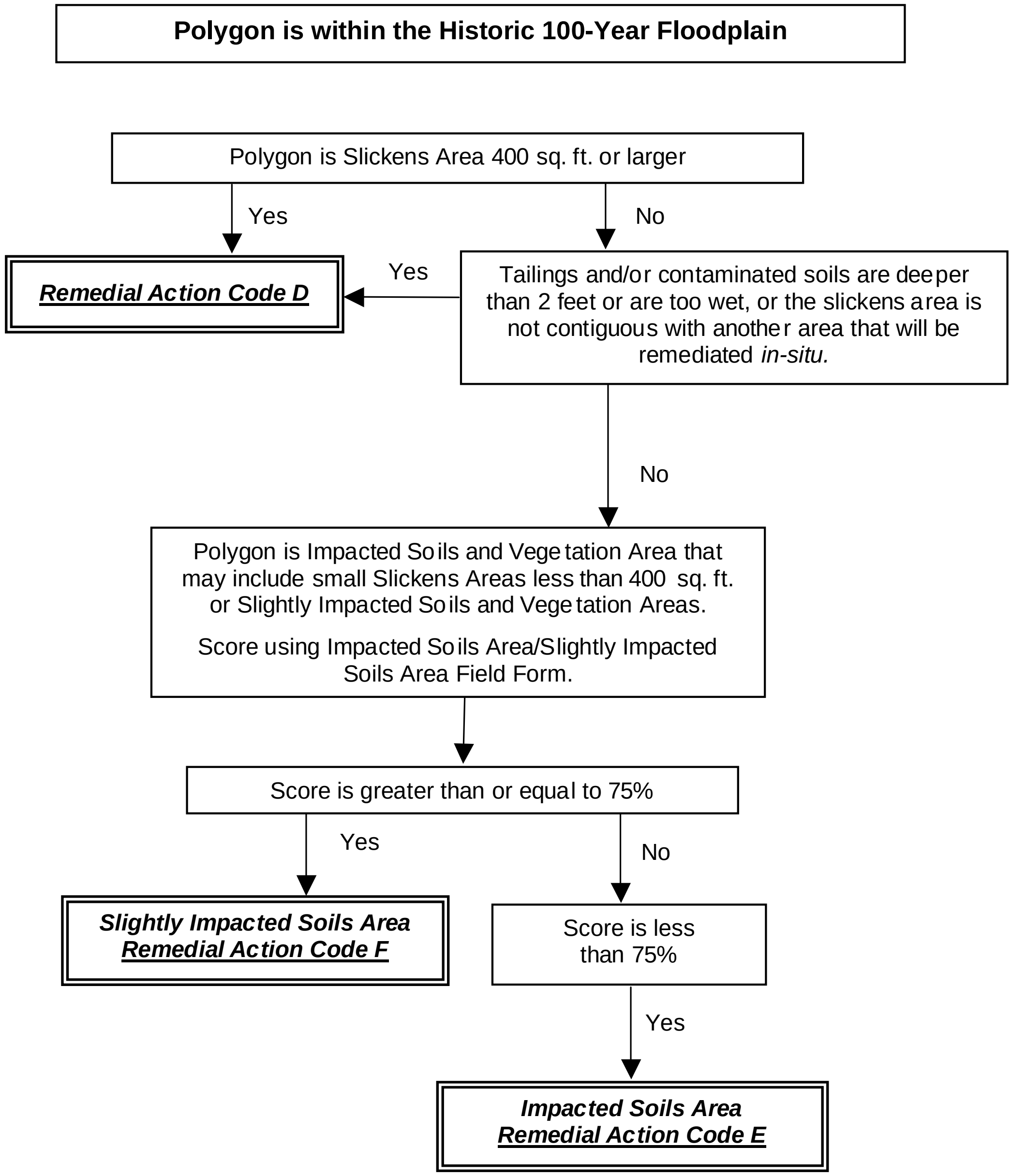

Figure 17. Polygon characterization within the historic 100-year floodplain

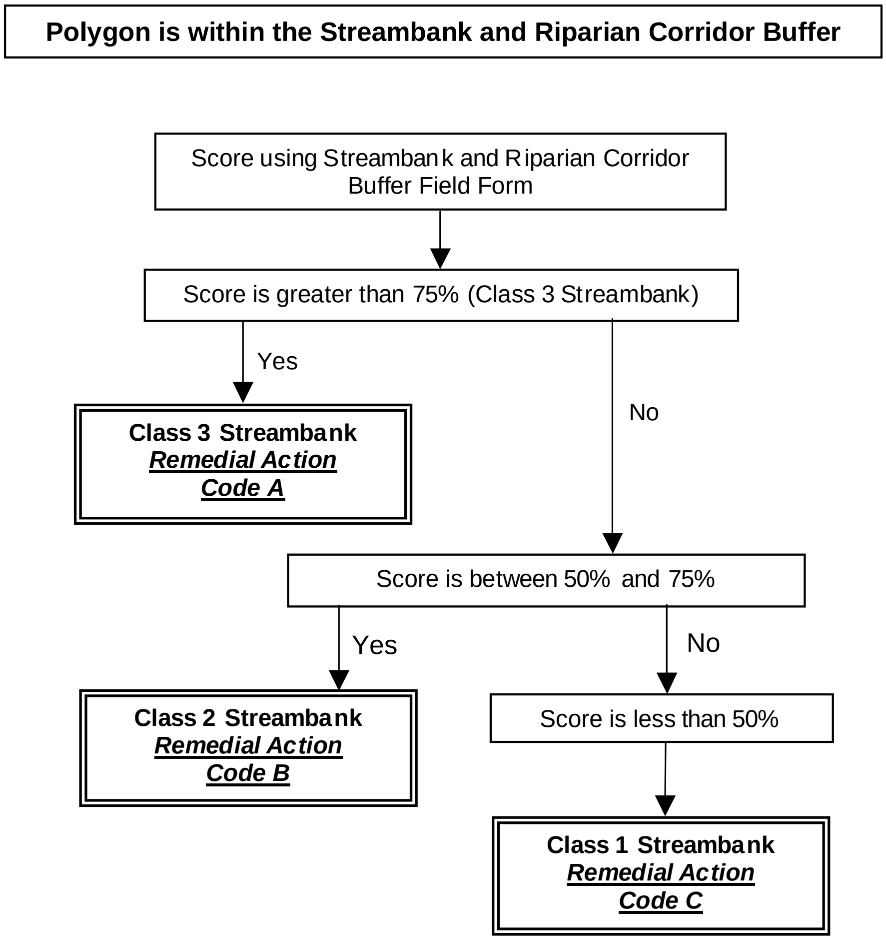

Figure 18. CFR RipES polygon characterization for streambank and riparian corridor buffer polygons

Table 1. Preliminary remedial action (RA) codes for major CFR RipES polygon categories

CFR RipES Polygon Category	RA Code	Preliminary Remedial Action Recommendations[1]
Class 3 Streambank	A	Remedial actions include no action or minor actions to enhance vegetation within the buffer corridor and/or BMPs.
Class 2 Streambank	B	Polygons with Class 2 streambanks will receive remedial actions intended to secure streambank stability through establishment of appropriate deep, binding, woody vegetation. Remedial actions may include reconfiguration of the banks, minor removal/ replacement and/or in-place treatment of contaminated materials, followed by supplemental planting of deep, binding, woody vegetation and revegetation with appropriate herbaceous species and BMPs.
Class 1 Streambank	C	Class 1 streambanks will receive treatment(s) chosen from a set of remedial actions depending upon site-specific characteristics. Remedial actions for this class include removal of phytotoxic materials and revegetation with deep, binding, woody vegetation and an understory of appropriate herbaceous species. BMPs.
Slickens (Exposed Tailings)	D	Remedial action for most of these areas is removal, with the exception as noted previously. Removal of slickens areas adjacent to active channel are part of the streambank remedial actions. BMPs and ICs.
Impacted Soils and Vegetation Areas	E	Impacted soils and vegetation areas will generally be treated *in-situ*, with two exceptions: 1) when the tailings and contaminated soils in a given area extend more than 2 feet below ground surface (In which case, all of the material will be removed.), and 2) when the tailings and contaminated soils are in a saturated condition which makes *in-situ* treatment impracticable (In which case, the contaminated material will be excavated). Old river channels in the floodplain will be addresses as described previously. BMPs and ICs.
Slightly Impacted Soils and Vegetation Areas	F	Remedial actions are no action, or BMPs.

[1]Data gaps need to be identified in order to define remedial action(s) and to satisfy initial remedial design specifications. These may include pH, concentrations of COCs in the soil profile, depth to permanent groundwater level, thickness of contaminated materials, acid-base account, organic matter level, and others.

Miscellaneous Site Types

There are several landscape areas or features that may contain contaminated materials by having one of the following:

1. Conveyed contaminated waters, i.e., drainage ditches;
2. Contaminated through historical irrigation, i.e., current or abandoned ditches; and
3. Subsequent separation of the historic 100-year floodplain from the present FEMA 100-year floodplain by human structures such as highways and railroads.

These areas, with the exception of historically irrigated fields (which will be evaluated under the human health component), are to be considered in the remedial design. If this consideration shows soil contamination above action levels or impacted soils and vegetation communities, appropriate remediation will be designed for these areas.

These miscellaneous site types are further defined as:

1. Old river channels and oxbows that may be well vegetated, but may have thick deposits of buried contaminated tailings in contact with ground water. (These sites do not meet the criteria for slickens or impacted soils and vegetation areas as defined in this document.)
2. Irrigation ditches, drainage ditches, and canals that may have conveyed contaminated waters and sediment. Irrigation ditches that conveyed historically contaminated water will be sampled through a representative sampling program to be developed to ensure that contaminate concentrations do not cause unacceptable risks to human health or the environment, as further described in Part 2, Section 13.8.3 of the *Record of Decision.*
3. Perennially or seasonally flooded wetlands that may contain contaminated sediment with hydrologic connectivity to groundwater and surface waters.
4. Contaminated areas that may be located within the historic floodplain, but outside the current Federal Emergency Management Agency (FEMA) defined floodplain. Some of these areas are separated from the main part of the floodplain by the Interstate 90, railroad berms, and other cultural structures.

These minor site types may contain much higher levels of contamination than adjacent areas because of particular historic circumstances. Removal, if feasible, will often be required. Therefore, these areas will be delineated as separate CFR RipES polygons, and evaluated accordingly for their potential need for remediation.

CFR RipES Process and Integration with Remedial Design

The CFR RipES process is to be applied to all lands within the historic 100-year floodplain of the Clark Fork River. The CFR RipES process is a critical detail design component which, for a specific landowner, involves a series of steps beginning with delineation of land ownership boundaries and noting areas having similar ecological attributes on aerial photographs, and ends by delineating specific locations of slickens, impacted soils and vegetation, slightly impacted soils and vegetation and classification of Class 1, 2, and 3 streambanks. While at the property, additional design data and information will also be collected necessary to complete remedial design. It is envisioned that during remedial design, coordinated teams of ecologists and engineers will work together, with the ecologists scoring polygons and engineers surveying the polygons and both working to produce GIS maps of the landscape, and collecting samples and other required design data and information for analyses. The general remedial design data gathering process is as follows:

1. Delineate existing land ownership boundaries, irrigation ditches, and fence lines on aerial photographs.
2. Delineate preliminary polygons on aerial photography for the following soil categories (minimum mapping unit size is 400 ft^2) (Note: this must account for 100 percent of the property that lies within the historic 100-year floodplain.):
    a) Slickens (exposed tailings);
    b) Impacted soils and vegetation areas; and
    c) Slightly impacted soils and vegetation areas.
3. Delineate a preliminary approximately 50 foot streambank and riparian corridor buffer zone on aerial photographs along both sides of the streambank. The buffer zone extends back

approximately 50 foot from the bankfull stage on each side of the river. The actual width of the approximately 50 foot buffer zone is a function of the geomorphic characteristics of the river. For example, in those instances where the river abuts a high bank that is considered upland, the buffer zone width is reduced.

4. Conduct initial consultation with landowner about present and future management desires (e.g., grazing pasture versus alfalfa field) and any limitations to remedial design such as locations of temporary haul roads.
5. Obtain landowner approval to conduct CFR RipES of his/her property.
6. Conduct CFR RipES field reconnaissance, adjust preliminary polygon boundaries, and sample and collect data for scoring and classifying the following polygons:
    a) Soils polygons (slickens, impacted soils and vegetation areas, and slightly impacted soils and vegetation areas); and
    b) Streambank polygons (Class 1 Streambanks, Class 2 Streambanks, and Class 3 Streambanks).
7. Delineate the approximately 50 foot streambank and riparian corridor buffer zone into preliminary polygons based on live vegetative canopy cover and/or canopy cover of deep, binding, woody vegetation. There is a strong bias to leaving deep, binding, woody vegetation undisturbed. The minimum mapping unit of these polygons is 20 linear feet of streambank with a maximum length of 500 feet.
8. Delineate areas of deep, binding, woody vegetation outside the approximate 50 foot streambank and riparian corridor buffer zone. These represent areas where mature woody vegetation may be obtained and utilized as tipped over willows in streambank treatment types 3 and 4. There is a strong bias to leaving deep, binding, woody vegetation undisturbed.
9. Further subdivide (categorize) the streambank based on actively laterally cutting streambanks/critical shear stress areas. Assign a streambank treatment type to each subdivision. The minimum mapping unit length for this purpose is 10 linear feet of streambank. Data will be collected to determine the critical shear stresses associated with each streambank.
10. Conceptual streambank treatment designs were developed as examples for the Upper Clark Fork River and are described in Appendix B to the *Record of Decision*. The conceptual treatments are as follows:
    a) No treatment necessary—This applies to streambanks where there is adequate deep, binding, woody vegetation already in place, and no additional work on the site is necessary.
    b) Treatment 1 (vegetation augmentation)—This treatment requires augmenting existing deep, binding, woody vegetation with additional woody vegetation.
    c) Treatment 2—This treatment is for streambanks where low critical shear stresses are acting on the immediate streambank. This treatment involves the use of pre-vegetated coir roll-sod with a toe protection of fiber-rolls pre-vegetated with sandbar willow (*Salix exigua*).
    d) Treatment 3—This treatment is for streambanks where moderate critical shear stresses are acting on the immediate streambank. This treatment involves the use of pre-vegetated coir roll-sod with a toe protection of fiber-rolls pre-vegetated with sandbar willow (*Salix exigua*) on top of a rock roll. Also included is tipped over mature willow on a spacing that will depend on river morphology along the streambank to deflect and dissipate the energy of the stream.
    e) Treatment 4—This treatment is for streambanks where high critical shear stresses are acting on the immediate streambank. This treatment involves the use of pre-vegetated coir roll-sod with a toe protection of rock mattress. Also included is tipped over mature

willow on a spacing that will depend on river morphology along the streambank to deflect and dissipate the energy of the stream.

Other site-specific conditions may dictate design modifications.

11. Identify data needs to be filled to define remedial action(s) and to satisfy initial remedial design specifications. These may include pH, concentrations of COCs in the soil profile, depth to permanent groundwater level, thickness of contaminated materials, acid-base account, soil organic matter level, and others identified. Sampling will be conducted on the polygons to fulfill these gaps using a Sampling and Analysis Plan developed for the CFR OU. The intent is to sequence the CFR RipES scoring and sampling concurrently so that data are collected in an efficient manner and landowners disturbance is minimized.
12. Develop a preliminary design for the property. Components of Phase 1 preliminary design include the following:
    - Base map with layer displaying 1 foot contours;
    - Location of CFR RipES defined polygons for streambanks, slickens, impacted soils and vegetation areas, and slightly impacted soils and vegetation areas
    - Transportation corridors and existing roads;
    - Locations of temporary fences;
    - Locations of potential staging areas;
    - Locations of wetlands and irrigation and drainage ditches;
    - Locations of water access points for livestock;
    - Locations of temporary bridges;
    - Locations of vegetation that is to be removed during clearing and grubbing, and locations of salvageable vegetation that can be used during remediation; and
    - Other appropriate data and information.
13. Present preliminary remedial design and preliminary construction schedule for the property to the landowner including weed management plan, preliminary grazing management plan, BMPs, and ICs. Obtain landowner feedback.
14. Prepare revised design and preliminary construction schedule based on landowner feedback.
15. Submit to appropriate Agencies for review. Obtain agency's approval and then obtain landowner access for implementation.

CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES) FOR STREAMBANK AND RIPARIAN CORRIDOR BUFFER POLYGONS

This evaluation is intended for use in the field by appropriately trained and qualified personnel. Knowledge of the local flora and of riverine channel and floodplain morphology, as well as visible indications of site contamination by metals, is required. The resulting polygon score is used to rate the degree of phytotoxic effect on site from mining-related metals contamination. Several items involve estimation of vegetation canopy cover. For these estimations, use the Daubenmire (1959) method of canopy cover estimation. This is a very efficient and reliable method for doing work of this nature, ***when the observers are adequately skilled, practiced, and have calibrated their individual assessments for consistency of call.*** Frequent and periodic tests and recalibration exercises are recommended for quality control.

Ocular estimation of detailed site characteristics may be difficult on large, brushy sites where visibility is limited, however extreme precision is not required. It is important to remember that the rating score is not an absolute value. The factor breakout categories and point weighting in the evaluation are based on the collective experience of an array of riparian scientists, soil scientists, range professionals, and land managers.

Each factor below is to be scored according to conditions observed within the polygon. The evaluator will estimate the parameter in question, select the appropriate scoring category, and enter that value on the field form. Do not introduce bias by using some preconceived notion of what the parameters should be.

Polygon Delineation Criteria

The streambank and riparian corridor buffer is delineated by measuring from the "bankfull" stage (the lateral extent of inundation by the 1.5-year mean flood) on each side of the stream out approximately 50 feet that is flexible or variable in width, ***OR*** where the historic 100-year floodplain elevation is reached. In other words, areas outside the historic 100-year floodplain are not included in the streambank and riparian corridor buffer; and in cases where high banks are reached, the streambank and riparian corridor buffer will be less.

The streambank and riparian corridor buffer along each side of the river will be broken into polygon units based on three types of river planar morphology: convex curvatures (outside curves), concave curvatures (inside curves), and straight channel stretches no longer than 500 feet. A minimum mapping unit (MMU) of 20 linear feet will be used to delineate the polygons. Polygon units will not cross land-ownership boundaries.

Field Form

The field form for streambank and riparian corridor buffer polygons is found in Appendix C. The field form contains questions on critical aspects of live vegetation and streambank integrity. These questions were designed to access the impact of mine wastes to the vegetation and the streambank stability on the site.

Live Vegetation and Streambank Integrity

Plant community integrity is essential for a riparian system to perform its normal functions. For example, riparian vegetation dissipates the energy of flowing water and stabilizes streambanks, thereby reducing erosion and introduction of streambank material into the channel. Riparian vegetation also inhibits surface water transport of upland soil into the stream. These functions are particularly important during spring runoff periods and after major summer or fall rains.

Riparian vegetation also traps sediment already being carried by the stream, thereby promoting streambank building and development of new bars. These become the sites for new pioneer vegetation that further enhance system stability. Sediment retention is all the more important because excessive sediment loads reduce habitat quality for aquatic life (including fish) and destabilize the natural hydrologic regime of the system. Healthy riparian systems enhance water quality downstream by filtering out organic and chemical pollutants from the channel as well as before they reach the channel.

Appropriate riparian vegetation shields soil and water from wind, sunlight, and raindrop impact. This reduces erosion due to wind and the disruptive impact of rainfall as well as promoting ground water recharge by enhancing storm water infiltration. Vegetation canopy cover provides shade, thereby reducing water temperatures and improving aquatic habitat. Dense vegetation can reduce soil compaction by the presence of healthy root systems and by limiting accessibility of both domestic livestock and wild ungulates to sensitive sites. Although an increase in vegetation may increase evapotranspiration rates, in natural riparian systems the benefits offset this loss.

Finally, riparian areas are rich in biotic production. The presence of water and essential nutrients make these areas among the most productive sites of a landscape, especially in the arid and semi-arid western United States. Near streambank riparian vegetation produces the bulk of the organic detritus necessary to support healthy benthic communities.

Most of the factors rated in this evaluation are measured by ocular estimation. Such estimation may be difficult on large, brushy sites where visibility is limited, but extreme precision is not necessary. While the rating categories may be broad, evaluators do need to calibrate their eye with practice. It is important to remember that a rating is not an absolute value. The factor breakout groupings and point weighting in the evaluation score are based on the collective experience of an array of riparian scientists, soil scientists, range professionals, and land managers.

1. **Live vegetative canopy cover (excluding tufted hairgrass [*Deschampsia cespitosa*]).** River floodplains located in inter montane valleys of western Montana, such as the Upper Clark Fork River Valley, will under natural, undisturbed conditions have a nearly complete canopy cover of live vegetation. Lack of vegetation cover indicates severe disturbance to riparian sites. Live vegetation cover helps to stabilize banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts and others 1987). Live vegetation cover is ocularly estimated using the canopy cover method described by Daubenmire (1959). Do not include the canopy cover of tufted hairgrass (*Deschampsia cespitosa*) in with live vegetative canopy cover estimates, since along the Clark Fork River this species indicates mine waste metals contamination.

   Scoring (represents 53.8 percent of total points):
   21 = More than 90 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   14 = 80 to 90 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   7 = 70 to 80 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).

0 = Less than 70 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).

2. **Completeness of the canopy of deep, binding, woody vegetation.** Streamside vegetation stabilizes the streambank structure to the extent that it provides deep, binding roots. Species such as willows (*Salix* spp.), water birch (*Betula occidentalis*), and cottonwoods (*Populus* spp.) provide excellent protection with deep, binding root mass. ***DO NOT*** include shallow rooting species such as snowberry (*Symphoricarpos* spp.), rose (*Rosa* spp.), and currants/ gooseberries (*Ribes* spp.). These short statured species do not provide adequate deep, binding root mass to effectively stabilize a stream the size of the Clark Fork River.

   The ability of the woody vegetation to protect the streambank and floodplain during overbank flows is directly related to the completeness of its cover over the soil surface. Estimate the percent of the area within the buffer zone polygon that is actually covered by the canopy of these deep, binding, woody species.

   Scoring (represents 23.1 percent of total points):
   9 = The canopy of deep, binding, woody plant species covers at least 80 percent of the area within the buffer zone.
   6 = The canopy of deep, binding, woody plant species covers between 60 and 80 percent of the area within the buffer zone.
   3 = The canopy of deep, binding, woody plant species covers between 40 and 60 percent of the area within the buffer zone.
   0 = The canopy of deep, binding, woody plant species covers less than 40 percent of the area within the buffer zone.

3. **Amount of active lateral cutting of the streambank.** Record the percent of the streambank length within the polygon that is actively cutting (eroding laterally). Any cutting occurring within the past year is considered active. Cut banks with vegetation establishing are considered healing and the cutting no longer active. This is indicated by the lack of perennial plant species on the streambank face and by on-going erosion. Cutbanks with perennial plant species established are considered to be healing, and are no longer actively cutting.

   Scoring (represents 23.1 percent of total points):
   9 = No more than 5 percent of the streambank length in the polygon is actively cutting.
   6 = Between 5 and 15 percent of the streambank length in the polygon is actively cutting.
   3 = Between 15 and 35 percent of the streambank length in the polygon is actively cutting.
   0 = More than 35 percent of the streambank length in the polygon is actively cutting.

Overall Scoring:
Greater than 75.0% = Class 3 Streambank
50.0%-75.0% = Class 2 Streambank
Less than 50.0% = Class 1 Streambank

CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES) FOR SLICKENS (EXPOSED TAILINGS) POLYGONS

This evaluation is intended for use in the field by appropriately trained and qualified personnel. Knowledge of the local flora and of river channel and floodplain morphology, as well as visible indications of site contamination by metals, is required. For answering CFR RipES data form questions, use the Daubenmire (1959) method of canopy cover estimation. This is a very efficient and reliable method for doing work of this nature, ***when the observers are adequately skilled, practiced, and have calibrated their individual assessments for consistency of call.*** Frequent and periodic tests and recalibration exercises are recommended for quality control.

Polygon Delineation Criteria

Polygons to be evaluated are located throughout the historic 100-year floodplain (the area potentially containing tailings and contaminated soils). These polygons are delineated to circumscribe areas that fit the criteria defined below for sites with soils and/or vegetation impacted by mining-related metals contamination. These polygons will be further delineated using property ownership boundaries, certain landform topographic breaks, certain land use breaks (i.e., fences, roads, etc.), and other considerations as needed.

Slickens (exposed tailings) are generally characterized by a lack of vegetation, and are defined by these criteria:

1. Because of phytotoxic condition, these areas are generally devoid of vegetation, supporting less than 25 percent live plant canopy cover.
2. Tufted hairgrass (*Deschampsia cespitosa*) is present, if there is any live vegetation, at least at the edges.
3. Efflorescent metal salts are visible on the soil surface during dry periods.

No scoring is used on these polygons. If a site meets the criteria defined above, the site is designated a slickens (exposed tailings) area polygon.

Field Form

The field form for slickens (exposed tailings) polygons is found in Appendix D. Although no rating is scored for slickens polygons, a field form is necessary to record sampling and administrative data (date, location, etc.).

**CLARK FORK RIVER RIPARIAN EVALUATION SYSTEM (CFR RipES)
FOR IMPACTED SOILS AND VEGETATION AREAS POLYGONS AND
SLIGHTLY IMPACTED SOILS AND VEGETATION AREA POLYGONS**

This evaluation is intended for use in the field by appropriately trained and qualified personnel. Knowledge of the local flora and of riverine channel and floodplain morphology, as well as visible indications of site contamination by metals, is required. The resulting polygon score is used to rate the degree of phytotoxic effect on site from mining-related metals contamination. Several items involve estimation of vegetation canopy cover. For these estimations, use the Daubenmire (1959) method of canopy cover estimation. This is a very efficient and reliable method for doing work of this nature, ***when the observers are adequately skilled, practiced, and have calibrated their individual assessments for consistency of call.*** Frequent and periodic tests and recalibration exercises are recommended for quality control.

Ocular estimation of detailed site characteristics may be difficult on large, brushy sites where visibility is limited, however extreme precision is not required. It is important to remember that the rating score is not an absolute value. The factor breakout categories and point weighting in the evaluation are based on the collective experience of an array of riparian scientists, soil scientists, range professionals, and land managers.

Each factor below is to be scored according to conditions observed within the polygon. The evaluator will estimate the parameter in question, select the appropriate scoring category, and enter that value on the field form. Do not introduce bias by using some preconceived notion of what the parameters should be under different conditions or at a different time.

Polygon Delineation Criteria
The CFR RipES Field Form for Impacted Soils and Vegetation Areas Polygons and Slightly Impacted Soils and Vegetation Areas Polygons is used on areas located within the historic 100-year floodplain (the area potentially containing tailings and contaminated soils). These polygons are delineated to circumscribe areas that fit the criteria defined above for sites with soils and/or vegetation impacted by mining-related metals contamination. These polygons will be further delineated using property ownership boundaries, certain landform topographic breaks, certain land use breaks (i.e., fences, roads, etc.), and other considerations as needed. A minimum mapping unit (MMU) of 400 square feet will be used to delineate the polygons.

Field Form
The field form for Impacted Soils and Vegetation Area and Slightly Impacted Soils and Vegetation Area Polygons is found in Appendix E. It is comprised of two main components: live vegetation integrity (representing 54.9 percent of the total score), and contamination severity (representing 45.1 percent of the total score). Ecologists view vegetation as an integrator of the environmental factors on the landscape, and it condition reflects back to them this integration. With this in mind, the questions on the field form that pertain to the live vegetation integrity component were designed to access the impact of mine wastes to the vegetation. Therefore, even though the field form distinguishes two main

components, both components are measuring the magnitude of mine waste impacts within the polygon.

Live Vegetation Integrity (represents 54.9 percent of total score)
While some land use practices may cause relatively small amounts of bare ground, only phytotoxic soil conditions normally result in large percentages of unvegetated area on natural (wild) plant communities on river floodplain sites in this region. Tufted hairgrass (*Deschampsia cespitosa*) is identified as the plant species on the Upper Clark Fork River floodplain with the greatest positive correlation to near-surface metals contamination (Riparian and Wetland Research Program 1998).

1. **Live vegetative canopy cover (excluding tufted hairgrass [*Deschampsia cespitosa*]).** River floodplains located in inter montane valleys of western Montana, such as the Upper Clark Fork River Valley, will under natural, undisturbed conditions have a nearly complete canopy cover of live vegetation. Lack of vegetation cover indicates severe disturbance to riparian sites. Live vegetation cover helps to stabilize banks, control nutrient cycling, reduce water velocity, provide fish cover and food, trap sediments, reduce erosion, and reduce the rate of evaporation (Platts and others 1987). Live vegetation cover is ocularly estimated using the canopy cover method described by Daubenmire (1959). Do not include the canopy cover of tufted hairgrass (*Deschampsia cespitosa*) in with live vegetative canopy cover estimates, since along the Clark Fork River this species indicates mine waste contamination.

   Scoring (represents 25.6 percent of total points):
   21 = More than 90 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   14 = 80 to 90 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   7 = 70 to 80 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).
   0 = Less than 70 percent of the polygon area is covered by the canopy of live plants (excluding tufted hairgrass [*Deschampsia cespitosa*]).

2. **Amount of tufted hairgrass (*Deschampsia cespitosa*) present.** Tufted hairgrass (*Deschampsia cespitosa*) has been shown to correlate strongly (in non-agronomic plant communities) with the near-surface presence of contaminated tailings on the Clark Fork River floodplain (Riparian and Wetland Research Program 1998). The most phytotoxic sites (slickens) are devoid of vegetation, but with a lesser degree of contamination, tufted hairgrass is the first species found to survive (scattered, small amounts in stunted growth form). With still less concentration redtop (*Agrostis stolonifera*), sandbar willow (*Salix exigua*), water birch (*Betula occidentalis*), and Baltic rush (*Juncus balticus*) commonly are found along with the tufted hairgrass (*Deschampsia cespitosa*). On sites with very low concentrations of contaminated tailings, the tufted hairgrass is only a very small component of the plant community. On sites with no mine tailing impact, no tufted hairgrass (*Deschampsia cespitosa*) is likely to be found.

   Scoring (represents 29.3 percent of total points):
   24 = Tufted hairgrass (*Deschampsia cespitosa*) has less than 1 percent canopy cover in the polygon.
   18 = Tufted hairgrass (*Deschampsia cespitosa*) represents 1 to 5 percent of the canopy cover in the polygon.
   12 = Tufted hairgrass (*Deschampsia cespitosa*) represents 5 to 20 percent of the canopy cover in the polygon.

6 = Tufted hairgrass (*Deschampsia cespitosa*) represents 20 to 40 percent of the canopy cover in the polygon.
0 = Tufted hairgrass (*Deschampsia cespitosa*) represents over 40 percent of the canopy cover in the polygon.

Contamination Severity (represents 45.1 percent of total score)
Contaminant inputs into riparian systems from tailings and associated metal laden sediment and water (i.e. contaminated material) are responsible for ecological impacts (i.e., phytotoxicity, lack of vegetation in general, or limited species richness, impaired water quality, and detrimental effects to aquatic and terrestrial biota. Severity of contamination is measured by the extent of contaminant deposits (volume and concentration), effects to riparian vegetation (tailing-caused bare ground or sparsely vegetated areas), and risk of release of contamination to the stream by mobilization and due to proximity to the river. Contaminated material includes contaminated tailings, soil/tailing mixtures, buried alluvium, buried soil, and cover soil. These media definitions and contaminant concentrations are reported in Table 3-6 of the *Remedial Investigation* (ARCO 1998).

3. **Percent of polygon area with bare ground caused by tailings.** Bare ground is soil not covered by plants, litter or duff, downed wood, or rocks larger than 2.5 inches. Bare ground caused by tailings must be distinguished from bare ground resulting from other causes by the presence of either of two indicators of metals contamination: 1) the presence of tufted hairgrass (*Deschampsia cespitosa*) in the polygon, and 2) metal salts visible on the soil surface during periods of dry weather.

   Human land uses causing bare ground, such as livestock grazing, recreation, roads, and other agricultural or industrial activities, are excluded from consideration here. Furthermore, not all bare ground represents a deterioration of riparian health. Sediment deposits by the river and other natural bare ground are also excluded. (The authors recognize that sediment deposits can be due to human activities in the watershed. However, it is difficult to train observers to make consistent calls from such criteria. Therefore, we have chosen to not use this in the evaluation system.) The evaluator is to count only the bare ground in the polygon that is attributable to metals contamination.

   Scoring (represents 14.6 percent of total points):
   12 = Less than 1 percent of the polygon is bare ground caused by tailings.
   9 = 1 to 5 percent of the polygon is bare ground caused by tailings.
   6 = 5 to 15 percent of the polygon is bare ground caused by tailings.
   3 = 15 to 30 percent of the polygon is bare ground caused by tailings.
   0 = Over 30 percent of the polygon is bare ground caused by tailings.

4. **Contamination concentration and depth (copper).** The concentration of the COCs, as well as depth of the contamination, are important considerations in selecting appropriate remedial actions. The degree to which contaminated materials impair ecosystem function is related to the depth of contaminated material present in a polygon. Infrequent and thin deposits of contaminants may be assimilated into the ecosystem without major environmental effects, whereas thick and/or spatially extensive deposits can arrest normal ecological processes. Vertical extent of contaminated material (that may include exposed tailings, contaminated soil or sediment, buried contaminated tailings, re-deposited contaminated tailings, etc.) is often difficult to estimate due to the complexity of a fluvial system such as the Upper Clark Fork River. Extensive deposits of thick tailings may abut areas lacking contamination. Analytical data are required because contamination cannot be visually determined. This is especially true where contaminated water has percolated through dark native

soil leaving no visual contaminant marker. A Sampling and Analysis Plan will be developed to specify soil sampling procedures for the CFR RipES.

The degree of impact to riparian ecosystems by contaminated material is a function of the toxicity of contaminants present and the extent of contamination above the levels at which the riparian system can attenuate or assimilate them. Five contaminants were identified as being present in the CFR OU at levels of concern for human and environmental health. Human health risk-based action levels for arsenic are not included in this score. Of the five environmental COCs (Cu, Pb, Zn, Cd, and As) at the site, copper is used as a surrogate for the group of five listed COCs.

The geometric mean value for copper concentration in unimpacted soils was defined in the *Remedial Investigation* (ARCO 1998) as 303 ppm.

Scoring (represents 12.2 percent of total points):
10 = Less than 300 ppm copper in the top 18 inches of the soil profile.
8 = Between 301 and 600 ppm copper in the top 18 inches of the soil profile.
6 = Between 601 and 900 ppm copper in the top 18 inches of the soil profile.
4 = Between 901 and 1,200 ppm copper in the top 18 inches of the soil profile.
2 = Between 1,201 and 1500 ppm copper in the top 18 inches of the soil profile.
0 = More than 1,501 ppm copper in the top 18 inches of the soil profile.

5. **Contamination mobility (geochemical).** Complex biogeochemical processes dictate the degree to which contaminants present in riparian corridors may be released to the environment. Principle factors controlling the release of contamination include physical and geochemical characteristics of the contaminated media. The principal physical factor controlling contaminant release is erosion that is addressed by the degree to which the riparian corridor is covered with stabilizing vegetation and the proximity of the contaminants to the stream channel. Principle geochemical factors implicated in the mobilization of contaminants are pH and the presence of readily soluble metal surface salts (efflorescent salts). Low soil pH conditions result in elevated metal levels in the soil solution and increased probability that metals will be leached deeper in the soil profile, or ultimately delivered to shallow aquifers hydraulically connected to the river.

Scoring (represents 14.6 percent of total points):
12 = pH of top 18 inches of the soil profile is greater than 6.5 s.u.
8 = pH of top 18 inches of the soil profile is between 5.5 and 6.5 s.u.
4 = pH of top 18 inches of the soil profile is between 4.5 and 5.5 s.u.
0 = pH of top 18 inches of the soil profile is less than 4.5 s.u.

Efflorescent metal salts commonly occur on the soil surface of barren tailing deposits and commonly express metal levels that are orders of magnitude above the bulk concentration of the underlying tailing material. The salts are transient features on the landscape, most commonly observed during periods of dry weather, appearing when contaminated waters are wicked to the soil surface and evaporated, thereby precipitating a salt. Surface salts are commonly white in color, but metal salts also may occur as brown, yellow, blue, or green coatings on the soil surface. Not all surface salts have elevated metal content, but when they do occur on contaminated material, elevated metal levels are expected.

Scoring (represents 3.7 percent of total points): (*If the soils are wet, efflorescent metal salts may not be visible. In that case, replace both Actual Score and Possible Score with NA.*)

3 = No efflorescent metal salts are present on the soil surface during dry periods.
0 = Efflorescent metal salts are present on the soil surface during dry periods.

Overall Scoring:
At least 75.0% = Slightly Impacted Soils and Vegetation Area
Below 75.0% = Impacted Soils and Vegetation Area

LITERATURE CITED

APHA. 1998. Stand Methods for the Examination of Water and Wastewater, 20th Edition. Prepared jointly and published by the American Public Health Association, American Water Works Association, and Water Environment Federation. American Public Health Association, Washington, DC, USA.

Ashe 1995. Clark Fork River Superfund Site Investigations Laboratory Analytical Procedure for X-Ray fluorescence analysis of solid media. ARCO, Anaconda, Montana, USA.

Atlantic Richfield Company. 1998. Final Draft Remedial Investigation Report. Milltown Reservoir Sediments NPL Site. Clark Fork River Operable Unit. Atlantic Richfield Company, Anaconda, Montana, USA.

Atlantic Richfield Company. 2000a. Preliminary Assessment of the Geomorphic Stability of the Clark Fork River in Deer Lodge Valley, Montana and "Geomorphology, Floodplain Tailings, and Metal Transport in the Upper Clark Fork River, Montana, " Anaconda, Montana, USA.

Atlantic Richfield Company. 2000b. Data Summary Report for LRES Phase III Sampling and Analysis Plan. ARCO Environmental Remediation Limited, Anaconda, Montana, USA.

Atlantic Richfield Company. 2002. Feasibility Study Report. Milltown Reservoir Sediments NPL Site. Clark Fork River Operable Unit. ARCO Environmental Remediation Limited, Anaconda, Montana, USA. 1,580 p.

CDM and Reclamation Research Unit. 1999. Preliminary Draft, LRES Phase II Report, Preliminary Land Reclamation Alternatives, Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, Montana, USA. Prepared by CDM Federal Programs Corp., Helena, Montana, USA, and Reclamation Research Unit, Montana State University, Bozeman, Montana, USA.

Daubenmire, R. D. 1959. A canopy-coverage method of vegetation analysis. Northwest Science 33:43-66.

Delbecq, A. L., A. H. Van de Ven, and D. H. Gustafson. 1975. Group techniques for program planning: a guide to nominal group and Delphi processes. Glenview, Illinois, USA. Scott Foresman. 174 p.

Griffin, E. R. and J. D. Smith. 2001. Analysis of vegetation controls on bank erosion rates, Clark Fork of the Columbia River, Deer Lodge Valley, Montana. WRIR 01-4115. USDI Geological Survey, Boulder, Colorado, USA. 8 p.

Hansen, Paul L., William H. Thompson, Robert C. Ehrhart, Dan K. Hinckley, Bill Haglan, and Karen Rice. 2000. Development of methodologies to evaluate the health of riparian and wetland areas. *In:* Proceedings of the Fifth International Symposium of Fish Physiology, Toxicology and Water Quality, November 10-13, 1998, Hong Kong, China. Vance Thurston, Editor. EPA/6000/R-00/015. United States Environmental Protection Agency, Office of Research and Development, Washington, DC, USA. 300 p.

Platts, W. S., C. Armour, G. D. Booth, M. Bryant, J. L. Bufford, P. Cuplin, S. Jensen, G. W. Lienkaemper, G. W. Minshall, S. B. Monsen, R. L. Nelson, J. R. Sedell, and J. S. Tuhy. 1987. Methods for evaluating riparian habitats with applications to management. USDA Forest Service General Technical Report INT-221. Intermountain Research Station, Ogden, Utah, USA. 187 p.

Reclamation Research Unit and Riparian and Wetland Research Program. 2000. Riparian Evaluation System Draft Document Clark Fork River Operable Unit, Milltown Reservoir Sediment NPL Site, Prepared for EPA by the Reclamation Research Unit, Montana State University, and the Riparian and Wetland Research Program, the University of Montana. 2000.

Reclamation Research Unit and Bitterroot Restoration, Inc. 2003a. Final Draft Sampling and Analysis Plan for Clark Fork Riparian Evaluation System (RipES). Prepared for CH2M Hill, Boise, ID, and for the U. S. Environmental Protection Agency, Region VIII, Montana Office, Helena, Montana, USA.

Reclamation Research Unit and Bitterroot Restoration, Inc. 2003b. Data summary report for Clark Fork Riparian Evaluation System (RipES) summer 2003 field activities. Prepared for CH2M Hill, Boise, ID, and for the U. S. Environmental Protection Agency, Region VIII, Montana Office, Helena, Montana, USA.

Riparian and Wetland Research Program. 1998. Clark Fork River Riparian Zone Inventory Addendum. Clark Fork River Operable Unit, Milltown Reservoir NPL Site. Riparian and Wetlands Research Program, School of Forestry, University of Montana, Missoula, Montana, USA. 51 p. plus 195 map sheets.

Schuster, Ervin G., Sidney S. Frissell, Eldon E. Baker, and Robert S Loveless, Jr. 1985. The Delphi Method: Application to Elk Habitat Quality. USDA Forest Service Research Paper INT-353. Intermountain Research Station Ogden, Utah, USA. 32 p.

Syracuse Research Corporation. 2001. Baseline Human Health Risk Assessment for the Clark Fork River Operable Unit of the Milltown Reservoir Sediments National Priority List Site. Addendum 1. Risk based concentrations for exposure of recreational visitors at Arrow Stone Park to arsenic in soils and tailings. Prepared for U.S. EPA, Region 8 by Syracuse Research Corporation, Denver, CO.

US Environmental Protection Agency. 1994. Guidance for the data quality objective process. EPA QA/G-4, Document Number EPA/600/R-96/055. EPA Office of Research and Development, Washington, DC, USA.

US Environmental Protection Agency. 1995. Administrative Order on Consent for the Clark Fork River Operable Unit of the Milltown Reservoir Sediments Superfund Site. Docket No. CERCLA VIII-90-07.

US Environmental Protection Agency. 1998a. Baseline Human Health Risk Assessment for the Clark Fork River Operable Unit of the Milltown Reservoir Sediments National Priority List Site. Final. Prepared by Roy F. Weston. US Environmental Protection Agency, Region 8, Denver, Colorado, USA.

US Environmental Protection Agency. 1998b. Record of Decision. Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site, Anaconda, Montana. US Environmental Protection Agency, Region 8, Montana Office, Helena, Montana, USA.

US Environmental Protection Agency. 1998c. Guidance for data quality assessment. Practical Methods for Data Analysis, EPA QA/G-9. Document Number EPA/600/R-96/084, EPA Office of Research and Development, Washington, DC, USA.

US Environmental Protection Agency. 1999. Ecological Risk Assessment of the Clark Fork River Operable Unit, Milltown Sediments/Clark Fork River Superfund Site. Prepared by ISSI Consulting Group, Inc., Denver, Colorado, USA. US Environmental Protection Agency, Region 8, Denver, Colorado, USA. 932 p.

US Environmental Protection Agency. 2001a. Clark Fork River Operable Unit, Ecological Risk Assessment, prepared by Syracuse Research Corporation for US Environmental Protection Agency, Region 8, Montana Office, Helena, Montana, USA.

US Environmental Protection Agency. 2001b. Clark Fork River Operable Unit, Human Health Risk Assessment Addendum, prepared by Syracuse Research Corporation for US Environmental Protection Agency, Region 8, Montana Office, Helena, Montana, USA.

US Environmental Protection Agency. 2002. Clark Fork River Operable Unit, Superfund Program Clean-up Proposal of the Milltown Reservoir/Clark Fork River Superfund Site. US Environmental Protection Agency, Region 8, Montana Office, Helena, Montana, USA.

APPENDIX A

NOTES ON UNUSUAL ASPECTS OF THE PRESENCE OF TUFTED HAIRGRASS (*DESCHAMPSIA CESPITOSA*) IN THE UPPER CLARK FORK RIVER VALLEY

NOTES ON UNUSUAL ASPECTS OF THE PRESENCE OF TUFTED HAIRGRASS (*DESCHAMPSIA CESPITOSA*) IN THE UPPER CLARK FORK RIVER VALLEY

Distribution

Tufted hairgrass (*Deschampsia cespitosa*) is a common, native, cool season, perennial bunchgrass found in mountain and prairie grassland communities throughout the northern hemisphere (Munshower 1998). It is found in open bogs, wet meadows, streambanks, and prairie sites, as well as in the spruce/fir zone of higher elevations. It is adapted to a wide range of soils textures, including moderately saline and alkaline sites (Stubbendieck and others 1992).

Thompson and Hansen (2001, 2002) describe a tufted hairgrass (*Deschampsia cespitosa*) habitat type in the grassland regions of southeastern Alberta and southwestern Saskatchewan in moist basin sites where drought conditions on glaciated topography have brought about accumulations of alkali salts. These stands of tufted hairgrass (*Deschampsia cespitosa*) occur in strictly herbaceous communities in association with such alkaline tolerant species as inland saltgrass (*Distichlis spicata*), foxtail barley (*Hordeum jubatum*), and Baltic rush (*Juncus balticus*). Closer to the Upper Clark Fork River, similar stands of tufted hairgrass (*Deschampsia cespitosa*) (some nearly monospecific) occur in the Ninepipes-Kicking Horse area of the Flathead Indian Reservation in western Montana on glaciated prairie pothole topography. However, these occurrences of tufted hairgrass (*Deschampsia cespitosa*) differ in sites from those along the Upper Clark Fork River. Occurrence of tufted hairgrass (*Deschampsia cespitosa*) along the Upper Clark Fork River is unique in our experience by its riverine setting and by having tree or shrub species associated.

Mueggler and Stewart (1980) describe high elevation habitat types (above 6,000 ft) having tufted hairgrass (*Deschampsia cespitosa*) co-dominant with sedges or other grasses on moist southwestern Montana mountain slopes and northwestern Montana wet meadows in high valley bottoms. Kovalchik (1987) describes a tufted hairgrass (*Deschampsia cespitosa*) plant association for central Oregon that closely resembles the types described by Mueggler and Stewart (1980). In no case does any other worker in the region describe a naturally occurring community with tufted hairgrass (*Deschampsia cespitosa*) in a situation similar to the Upper Clark Fork River Valley.

Habitat—Tufted hairgrass (*Deschampsia cespitosa*) is extraordinary in its range of tolerance of several habitat variables. In light of this very broad ecological amplitude, it should not be surprising to find that the species is quite plastic in its responses to different phenological and environmental situations. It has been reported that a population of tufted hairgrass (*Deschampsia cespitosa*) growing on mine tailings has developed such a need for trace metals, that this population is not present on uncontaminated sites (Bonneau 2000). Tufted hairgrass (*Deschampsia cespitosa*) invades disturbed sites and is moderately aggressive on mesic, mid to higher elevation acid mine sites (Munshower 1998).

Elevation—Tufted hairgrass (*Deschampsia cespitosa*) occurs at elevations in North America ranging from sea level to over 14,100 ft (Walsh 1995). Hitchcock and others (1969) state that the species occurs in the Pacific Northwest from alpine ridges to moist prairies and coastal marshes.

Moisture—Along the moisture gradient, tufted hairgrass (*Deschampsia cespitosa*) is found on sites that range from saturated habitats along the edges of marshes and bogs, to moist areas along drainage ditches and the bottoms of prairie draws, to dry slopes at the higher elevations (Walsh 1995).

***Soil Type*—**Tufted hairgrass (*Deschampsia cespitosa*) grows on a variety of soil types and textures. It is found on sandy loam, sandy clayey loam, silty loam, loam, loamy clay, and clay. It is found on gravel in Alaska, Michigan, and Utah. It occurs on granitic material in Idaho and Wyoming. It is found on peat in British Columbia and on calcareous seeps in Illinois. It grows on pumice in Oregon and on volcanic soils in Wyoming (Walsh 1995).

***Soil Chemistry*—**Tufted hairgrass (*Deschampsia cespitosa*) is adapted to cool, acid sites, but is also found on somewhat alkaline soils. It has been found on soils varying from pH 3.3 on mine tailings in Ontario to pH 8.4 in central Idaho. It generally grows best in soils with pH 5.2 to 5.5. It can also tolerate saline conditions of salt marshes along the Oregon coast. Some populations of tufted hairgrass (*Deschampsia cespitosa*) have adapted to mine spoils with elevated levels of heavy metals (Walsh 1995). Many ecotypes of this species have varying genetic composition expressing specific metal and environmental tolerances (Munshower 1998).

***Grazing Response*—**Tufted hairgrass (*Deschampsia cespitosa*) is a palatable forage grass for livestock and wildlife ungulates. The cover and abundance of the species will decrease under heavy grazing pressure (Hansen and others 1988, Tannas 1997, Bonneau 2000). The species is often found on disturbed sites and has been successfully used to revegetate high elevation mined sites (Hansen and others 1995; Hansen and others 1988).

We have no reported comparable occurrence of tufted hairgrass (*Deschampsia cespitosa*) elsewhere in the region to help explain its ecological position on the Upper Clark Fork River floodplain. Scientists at the University of Montana reported a strong positive correlation between tufted hairgrass (*Deschampsia cespitosa*) and the presence of tailings in the soil surface horizon (Riparian and Wetland Research Program 1998). In light of this obvious relationship and a lack of analytical inquiry into the nature of the physiological processes at work, we can only say that tufted hairgrass (*Deschampsia cespitosa*) enjoys an unexplained competitive advantage over other species on these sites where this particular suite of mine tailings has created chemical conditions phytotoxic to the normal vegetation community of the valley. Certainly, the species tolerance of acidic conditions (Walsh 1995) gives us one possible explanation.

LITERATURE CITED

Bonneau, André. 2000. Deschampsia cespitosa (L) Beauv. In: Rangeland Ecosystems and Plants. University of Saskatchewan (Internet website: http://www.usask.ca/agriculture/plantsci/classes/range/dechampsiacespitosa.html (September 16, 2003)

Hansen, Paul L., Steve W. Chadde, and Robert D. Pfister. 1988. Riparian Dominance Types of Montana. University of Montana. Missoula, Montana, USA. 411 pp.

Hansen, Paul L., Robert D. Pfister, Keith Boggs, Bradley J. Cook, John Joy, and Dan K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Riparian and Wetland Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula, Montana, USA. 646 p.

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1969. Vascular Plants of the Pacific Northwest. Volume 1. University of Washington Press, Seattle, Washington, USA.

Kovalchik, Bernard L. 1987. Riparian zone associations: Deschutes, Ochoco, Fremont, and Winema National Forests. USDA Forest Service Region 6 Ecology Technical Paper 279-87. Pacific Northwest Region, Portland, Oregon, USA. 171 p.

Mueggler, W. F. and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. General Technical Report. INT-66. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah, USA. 154 p.

Munshower, Frank F. 1998. Grasses and grasslike species for revegetation of disturbed lands in the Northern Great Plains and adjacent areas with comments about some wetland species. Reclamation Research Unit Publication No. 9805. Montana State University. Bozeman, Montana, USA. 181 pp.

Riparian and Wetland Research Program. 1998. Clark Fork River Riparian Zone Inventory Addendum. Clark Fork River Operable Unit, Milltown Reservoir NPL Site. Riparian and Wetlands Research Program, School of Forestry, University of Montana, Missoula, Montana, USA. 51 p. plus 195 map sheets.

Stubbendieck, James, Stephan L. Hatch, and Charles H. Butterfield. 1992. North American range plants, fourth edition. University of Nebraska Press. Lincoln, Nebraska, USA. 493 pp.

Tannas, Kathy. 1997. Common plants of western rangelands. Volume I: grasses, grass-like species, trees and shrubs. Lethbridge Community College. Lethbridge, Alberta, Canada. 312 p.

Thompson, William H. and Paul L. Hansen. 2001. Classification and management of riparian and wetland sites of the Saskatchewan prairie ecozone and parts of adjacent subregions. Saskatchewan Wetland Conservation Corporation. Regina, Saskatchewan, Canada. 298 p.

Thompson, William H. and Paul L. Hansen. 2002. Classification and management of riparian and wetland sites of the Alberta Grassland Natural Region and adjacent subregions. Bitterroot Restoration, Inc. Prepared for the Alberta Riparian Habitat Management Program-Cows and Fish, Lethbridge, Alberta, Canada. 416 p.

Walsh, Roberta A. 1995. In: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2003, September). Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/ [September 16, 2003].

APPENDIX B

LOGIC MATRIX (DICHOTOMOUS KEY)

FOR DECIDING WHEN TO REMOVE OR KEEP

A PREFERRED WOODY PLANT

DECIDING WHETHER TO REMOVE OR TO KEEP A PREFERRED WOODY PLANT

Because preferred woody plants occur on all kinds of sites and distribution patterns, a systematic protocol is needed for deciding when to remove and when to leave a particular plant. A dichotomous key is provided below a systematic procedure for deciding this issue on the basis of location and condition of plants.

"Preferred woody species" includes the following:

- All willow species (*Salix* spp.)
- Water birch (*Betula occidentalis*)
- Red-osier dogwood (*Cornus stolonifera*)
- Common chokecherry (*Prunus virginiana*)
- Western serviceberry (*Amelanchier alnifolia*)
- Mountain alder (*Alnus incana*)
- Black cottonwood (*Populus trichocarpa*)

Key for Deciding Whether to Remove or to Keep a Woody Plant
Instructions—Read both parts of each couplet pair carefully before deciding which part is the better answer. Decide which side of the couplet pair is most nearly true (this may require a judgment call in some cases), and proceed to the next couplet indicated, until you arrive at an answer to remove or keep.

1. Woody plant is near the streambank (within 10 ft, approximately one mature shrub width) **2**

1. Woody plant is not within 10 ft of the streambank **3**

    2. Contaminated soils contiguous to the plant are being removed, ***AND*** visibly contaminated soil extends into the main root mass of the plant, ***AND*** bank stabilization Treatment 2, Treatment 3, or Treatment 4 is being implemented at this point along the bank ....**REMOVE**

    2. Contaminated soils contiguous to the plant are not being removed, ***OR*** visibly contaminated soil does not extend into the main root mass of the plant, ***OR*** bank stabilization Treatment 2, Treatment 3, or Treatment 4 is not necessary at this point along the bank .... **KEEP**

3. Woody plant is more than 10 ft from the streambank, but is within the Streambank Riparian Buffer Zone **4**

3. Woody plant is outside the Streambank Riparian Buffer Zone **9**

    4. The area that includes the woody plant is a slickens (contaminated soil will be removed) **5**

    4. The area that includes the plant is to have impacted soils treated *in-situ* **7**

5. Woody plant is isolated (10 ft or farther from other plants of preferred woody species) **6**

5. Woody plant is not isolated (closer than 10 ft to other plants of preferred woody species; i.e., a subpolygon can be drawn around a group of preferred woody plants, including this one, to leave undisturbed within the slickens area of contaminated soil being removed)................................ **KEEP**

    6. Woody plant is of seedling/sapling age class ***OR*** is decadent (has more than 30 percent dead wood in its upper canopy)...**REMOVE**

    6. Woody plant is of mature age class ***AND*** is not decadent (does not have more than 30 percent dead wood in its upper canopy).. **KEEP**

7. Woody plant is isolated (10 ft or farther from other plants of preferred woody species) **8**

7. Woody plant is not isolated (closer than 10 ft to other plants of preferred woody species; i.e., a subpolygon can be drawn around a group of preferred woody plants, including this one, to leave undisturbed within the slickens area of contaminated soil being removed.)............................... **KEEP**

    8. Woody plant is of seedling/sapling age class ***OR*** is decadent (has more than 30 percent dead wood in its upper canopy)...**REMOVE**

    8. Woody plant is of mature age class ***AND*** is not decadent (does not have more than 30 percent dead wood in its upper canopy).. **KEEP**

9. Woody plant is isolated (10 ft or farther from other plants of preferred woody species) ....**REMOVE**

9. Woody plant is not isolated (closer than 10 ft to other plants of preferred woody species; i.e., a subpolygon can be drawn around a group of preferred woody plants, including this one, to leave undisturbed within the slickens area of contaminated soil being removed)................................ **KEEP**

APPENDIX C

CFR RipES FIELD FORM FOR

STREAMBANK AND RIPARIAN CORRIDOR

BUFFER POLYGONS

CFR RipES Scoring Form for Streambank and Riparian Corridor Buffer Polygons

Data Record No.: ____________

Streambank Class: ____________________________

This streambank polygon lies within this (these) soil polygon(s): ____________ ; ____________ ; ____________

ADMINISTRATIVE DATA

A1. Field data collected by: ______________________________

A2. Funding Agency/Organization: ______________________________

A3. Year: ______ **A4.** Date field data collected: ____________ **A5.** Observers: ______________________________

A6. Landowner: ______________________________

A7. Weather: ______________________________

LOCATION DATA

B1. County/Municipal District: ______________________________

B2. Location: ______________________________

B3. Land Legal Description: 1/4 1/4 Sec: _____ ; 1/4 Sec: _____ ; Sec: _____ ; Township (NS): ______ ; Range (EW): ______

B4a. UTM coordinates of polygon UPSTREAM END: Easting: ____________ ; Northing: ____________ ; Zone: ______

B4b. UTM coordinates of polygon DOWNSTREAM END: Easting: ____________ ; Northing: ____________ ; Zone: ______

B4c. UTM coordinates of any other point of interest in the polygon: East: ____________ ; North: ____________ ; Zone: _____

B4d. Comments: ______________________________

B5. Quad map(s): ______________________________ ; ______________________________

SITE CHARACTERISTIC DATA

Physical Properties

C1. Evidence of high groundwater? (Yes/No): ______

C2. Drainage ditch(es) present? (Yes/No): ______

C3. Irrigation ditch(es) present? (Yes/No): ______

C4. Has the polygon been tilled? (Yes/No): ______

C5. Proximity of tilling to CFR: ______ meters; ______ feet

GENERAL COMMENTS

Data Record No.: ______

RipES STREAMBANK BUFFER ZONE FIELD DATA QUESTIONS

Live Vegetation and Streambank Physical Integrity	Data Observed	Scoring Points Actual	Scoring Points Possible
1. Percent Live Vegetative Canopy Cover (Excluding Tufted Hairgrass):			
2. Completeness of the Canopy of Live Deep, Binding Woody Species:			
3. Amount of Active Lateral Cutting of the Streambank:			
Vegetation and Streambank Physical Integrity Total:			

Rating Calculation:

(Actual Score/Possible Score) X 100 = Rating Percent — Streambank Class

Streambank Rating Calculation: ______ / ______ **x** 100 **=** ______ ______

Rating Percent Range	***Streambank Class***
Over 75.0%	***Class 3***
50.0-75.0%	***Class 2***
Below 50.0%	***Class 1***

PHOTO DATA

Photo No(s): View(s):

APPENDIX D

CFR RipES FIELD FORM FOR

SLICKENS (EXPOSED TAILINGS) POLYGONS

CFR RipES Data Form for Slickens Area Polygons

Data Record No.: ____________

Does this polygon area contain any length of streambank? (Yes/No): _______

If **Yes,** give the Streambank Buffer Polygon record number(s): ____________ ; ____________ ; ____________

ADMINISTRATIVE DATA

A1. Field data collected by: ____________

A2. Funding Agency/Organization: ____________

A3. Year: _______ **A4.** Date field data collected: ____________ **A5.** Observers: ____________

A6. Landowner: ____________

A7. Weather: ____________

LOCATION DATA

B1. County/Municipal District: ____________

B2. Location: ____________

B3. Land Legal Description: 1/4 1/4 Sec: _____ ; 1/4 Sec: _____ ; Sec: _____ ; Township (NS): _____ ; Range (EW): _____

B4. UTM coordinates of the polygon centroid: Easting: ____________ ; Northing: ____________ ; Zone: _______

B5. Quad map(s): ____________ ; ____________

SITE CHARACTERISTIC DATA

Physical Properties

C1. Evidence of high groundwater? (Yes/No): _______

C2. Drainage ditch(es) present? (Yes/No): _______

C3. Irrigation ditch(es) present? (Yes/No): _______

C4. Has the polygon been tilled? (Yes/No): _______

C5. Proximity of tilling to CFR: _______ meters; _______ feet

Geo-Chemical Properties

C6. Average pH: _______

C7. Average copper concentration (ppm): _________

C8. Average arsenic concentration (ppm): _________

C9. Metal salts present on surface? (Yes/No/NA): _______

NOTE: Answer "NA" ONLY when wet conditions may have dissolved salts from the surface.

GENERAL COMMENTS

____

____

____

____

____

____

____

Data Record No.: ____________

SOIL PIT COMPOSITE DATA

	Easting (X)	Northing (Y)	Zone	Total Copper (ppm)	Total Arsenic (ppm)	Composite Pit pH	Pit ID No.
Pit 1:							
Pit 2:							
Pit 3:							
Pit 4:							
Pit 5:							

INDIVIDUAL SOIL SAMPLE DATA

Pit #	Sample Bag No.	Depth (in.)	Sample Description	Copper (ppm)	Arsenic (ppm)	pH

Data Record No.: ____________

RipES SLICKENS AREA POLYGON FIELD DATA QUESTIONS

NOTE: A polygon is a Slickens Area ONLY if all four questions in this section are answered "Yes," with the exception that D3 may be answered "NA" when conditions are wet.

D1. Does the polygon support less than 25 percent live plant canopy cover due to phytotoxic conditions? (Yes/No): ______

D2. If there is any live vegetation in the polygon, is tufted hairgrass (*Deschampsia cespitosa*) present? (Yes/No): ______

D3. Are efflorescent metal salts visible on the soil surface in the polygon during dry periods? (Yes/No/NA): ______

NOTE: Answer "NA" ONLY when wet conditions may have dissolved salts from the surface.

D4. Is the polygon area at least 400 square feet? (Yes/No): ______

PHOTO DATA

Photo No(s):	View(s):

APPENDIX E

CFR RipES FIELD FORM FOR

IMPACTED SOILS AND VEGETATION AREA POLYGONS AND

SLIGHTLY IMPACTED SOILS AND

VEGETATION AREA POLYGONS

CFR RipES Data Form for Impacted Soils Area Polygons and for Slightly Impacted Soils Area Polygons

(Not for Use on Slickens Areas)

Data Record No.: ____________

Category of Soils Impact: ________________________________

Does this polygon area contain any length of streambank? (Yes/No): ______

If **Yes,** give the Streambank Buffer Polygon record number(s) __________ ; __________ ; __________

ADMINISTRATIVE DATA

A1. Field data collected by: ____

A2. Funding Agency/Organization: ____

A3. Year: ______ **A4.** Date field data collected: __________ **A5.** Observers: ____________________

A6. Landowner: ________________________________

A7. Weather: ____

LOCATION DATA

B1. County/Municipal District: ____________________

B2. Location: ____

B3. Land Legal Description: 1/4 1/4 Sec: _____ ; 1/4 Sec: _____ ; Sec: _____ ; Township (NS): _____ ; Range (EW): _____

B4. UTM coordinates of the polygon centroid: Easting: __________ ; Northing: __________ ; Zone: ______

B5. Quad map(s): ____________________ ; ____________________

SITE CHARACTERISTIC DATA

Physical Properties

C1. Evidence of high groundwater? (Yes/No): ______

C2. Drainage ditch(es) present? (Yes/No): ______

C3. Irrigation ditch(es) present? (Yes/No): ______

C4. Has the polygon been tilled? (Yes/No): ______

C5. Proximity of tilling to CFR: ______ meters; ______ feet

Geo-Chemical Properties

C6. Average pH: ______

C7. Average copper concentration (ppm): ________

C8. Average arsenic concentration (ppm): ________

C9. Metal salts present on surface? (Yes/No/NA): ______

NOTE: Answer "NA" ONLY when wet conditions may have dissolved salts from the surface.

GENERAL COMMENTS

Data Record No.: ____________

SOIL PIT COMPOSITE DATA

	Easting (X)	Northing (Y)	Zone	Total Copper (ppm)	Total Arsenic (ppm)	Composite Pit pH	Pit ID No.
Pit 1:							
Pit 2:							
Pit 3:							
Pit 4:							
Pit 5:							

INDIVIDUAL SOIL SAMPLE DATA

Pit #	Sample Bag No.	Depth (in.)	Sample Description	Copper (ppm)	Arsenic (ppm)	pH

Data Record No.: ____________

RipES IMPACTED SOILS AREA POLYGON FIELD DATA QUESTIONS

Vegetation Community Integrity	Data Observed	**Scoring Points** Actual	Possible
1. Percent Live Vegetative Canopy Cover (Excluding Tufted Hairgrass):			
2. Percent of Tufted Hairgrass Canopy Cover in the Polygon:			
Vegetation Community Integrity Total:			

Contamination Severity	Data Observed	Actual	Possible
3. Bare Ground Caused by Tailings:			
4. Contamination Concentration and Depth:			
5. Comtamination Mobility (Geochemical) pH:			
Are Metal Salts Visible on the Surface During Dry Periods (Yes/No/NA)?			
Contamination Severity Total:			
Overall Polygon Total:			

NOTE: Answer "NA" ONLY when wet conditions may have dissolved salts from the surface.

Rating Calculation:

(Actual Score/Possible Score) X 100 = Rating Percent

Vegetation/Streambank: ______ / ______ **x** 100 **=** ________

Contamination: ______ / ______ **x** 100 **=** ________

Overall Rating: ______ / ______ **x** 100 **=** ________

Category of Soils Impact

____

Rating Percent Range	*Category*
Over 75.0%	***Slightly Impacted Soils Area***
Below 75.0%	***Impacted Soils Area***

PHOTO DATA

Photo No(s):	View(s):