CLARK FORK RIVER OPERABLE UNIT STRATEGIC PLAN

State of Montana's Remedy and Restoration Approach

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Prepared By

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1 Introduction

This Strategic Plan does not modify, replace, supersede, or make significant or fundamental changes to existing documents such as the Record of Decision, the Explanation of Significant Differences, Consent Decrees, Site-specific Memorandum of Agreement for the CFROU, or the Revised Restoration Plan for the Clark Fork River Aquatic and Riparian Resources (2020).

The purpose of this plan is to:

- Describe an integrated approach for the Montana Department of Environmental Quality and Natural Resource Damage Program (collectively, the State) to complete Remedy and Restoration activities within Reach A and a small portion of Reach B (Project Area) of the Clark Fork River Operable Unit of the Milltown Reservoir/Clark Fork River Superfund Site (CFROU, Figure 1).
- Describe the processes and decision criteria used in developing work sequence and priorities for remaining Remedy and Restoration.
- Make decision processes accessible to the public for better transparency to facilitate alignment among stakeholders and improve cohesiveness of State agencies.
- Summarize the background on the CFROU, define the State's goals and objectives, summarize costs associated with Remedy and Restoration, and outline an implementation plan and timeline.

The Strategic Plan will be evaluated by the State on an annual basis, with the budget being updated with yearly costs to accurately reflect current status of the project. When new ideas are integrated into the project, they will be integrated into the plan at that time.

1.1 Clark Fork River Operable Unit Overview and Current Status

The CFROU is a 120-mile stretch of river that flows from Warm Springs, Montana, to Missoula, Montana, and is contaminated with mine wastes from upstream Butte and Anaconda sources. A Record of Decision (ROD) signed in 2004 (EPA 2004) authorized removal of contaminated tailings from slickens areas, removal or treatment in place of impacted areas, streambank reconstruction, land management planning, and institutional controls. The State issued an Explanation of Significant Differences (ESD) in 2015 that is discussed in greater detail below. The ROD and ESD describe the remediation approach as the Selected Remedy (hereafter Remedy).

In 2007, the Natural Resource Damage Program (NRDP) developed the Revised Restoration Plan for the Clark Fork River Aquatic and Riparian Resources (NRDP 2007) to expedite recovery time for injured aquatic, riparian, and terrestrial resources in and along the Clark Fork River. The Restoration Plan, updated again in 2020 to incorporate new information (Restoration Plan) (NRDP 2020), was to be implemented along with the Remedy to the extent practicable, in order to avoid duplication of effort and unnecessary costs, and to maximize environmental benefits to the area. The Restoration Plan describes the restoration actions (hereafter Restoration).

As specified in a Site-Specific Memorandum of Agreement (SMOA 2008), the Montana Department of Environmental Quality (DEQ) acts as lead agency for the ROD to oversee, manage, coordinate, design, and implement the Remedy for the CFROU. The United States Environmental Protection Agency (EPA) is a support agency. The DEQ and NRDP coordinate implementation and integration of Restoration components into the Remedy. The United States Department of Interior (DOI) National Park Service (NPS) has a separate Restoration Plan and settlement for Remedy and Restoration actions specific to the Grant-Kohrs Ranch property; Remedy and Restoration on Grant-Kohrs Ranch property are not specifically identified in this plan. The four primary functions of consultation and coordination among the State agencies, for the purpose of this Strategic Plan, are to:

1) Maximize the use of resources available for, and environmental benefits to, the CFROU for the successful and cost-effective completion of the Remedy in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Consent Decree (MT v AR 2008),
2) Understand and receive the information to be collected,
3) Understand how that information is to be analyzed, and
4) Provide review and comment.

In 2008, a federal court entered a Consent Decree for the CFROU (and Butte Area One and Smelter Hill Area Uplands, which are not addressed by this Strategic Plan) (Clark Fork CD), and a second Consent Decree between the State and Atlantic Richfield Company (BP-AR) pertaining to natural resource damages (State CD II) (MT v. AR 2008). BP-AR paid the State approximately $121 million for the CFROU under the Clark Fork CD and State CD II: $94 million for DEQ to use best efforts to complete the cleanup work covered under the Clark Fork CD, and $27 million to the NRDP to restore, replace or acquire the equivalent of the injured aquatic and riparian resources for the CFROU. In addition, the State established the Clark Fork River Reserve Account in 2008 with $12.5 million: $9.4 million will be available to cover “Further Response Costs” defined to mean up to $9.4 million in response costs incurred by the State in developing and implementing the Remedy, on such costs. Under the terms of the 2015 SMOA Amendment, NRDP shall pay DEQ directly for Further Response Costs paid through transfer of the funds to the Clark Fork Site Response Action Account. The Clark Fork River Reserve Account allows for these funds to be used for State financial commitments contained in the CDs for the CFROU (e.g., Further Response Costs and additional costs by the State) and Anaconda (e.g., State property remedial commitments, State-owned property remedial commitments) as well as other Remedy or Restoration obligations.

An EPA fact sheet about the CFROU provides more information about the settlements and is included as Appendix B. It was understood at the time of settlement that the State would need to combine/integrate Remedy and Restoration funds to complete the State’s obligations.

Cleanup work started in 2010 with DEQ addressing the Trestle Area in Deer Lodge and residential yards along the river in Deer Lodge and along Eastside Road. The main Remedy and Restoration are primarily focused along a 43-mile stretch of the Clark Fork River from Warm Springs in Anaconda Deer Lodge County downstream to Garrison in Powell County. This is known as “Reach A” and is divided into 22 sections called Phases.

Data obtained from sampling at the CFROU site indicated that the Riparian Evaluation System (RipES), when applied by EPA in 2006 – 2007, did not fully or accurately distinguish the severity of contamination between delineated polygons of Severely Impacted Areas and Impacted Areas + Slightly Impacted Areas, nor between Impacted Areas and Slightly Impacted Areas. This demonstrated that the RipES process, as designed, is not effective in differentiating tailings and contaminated soils among polygons, with Severely Impacted Areas identifying the most highly contaminated areas, Impacted Areas identifying highly contaminated areas, and Slightly Impacted Areas identifying primarily nonactionable contamination.

Based on this new information and discussions among the State agencies, the ESD concluded that:

- Groundwater, riparian vegetation, geomorphic stability, contaminant sampling, and landownership will be analyzed to make final Remedial design determinations for Severely Impacted Areas, Impacted Areas, and Slightly Impacted Areas.

- Public and stakeholder involvement should be accomplished through the Design Review Team and DEQ's Community Involvement Plan.

In 2017, the State reviewed its progress toward completing integrated Remedial and Restoration work. Several data gaps and feasibility questions were identified and addressed with the following studies:

- Repository Study: DEQ funded a study assessing the potential to construct and utilize one or two alternative repositories versus hauling all waste to Opportunity Ponds as a means of reducing costs (Weston Solutions and Pioneer Technical 2018). The conclusions of this study confirmed the Opportunity Ponds repository as the most appropriate location for placement of the waste for remaining Phases upstream of Deer Lodge (Phases 4, 7 and 8-14). Other potential repository locations may be investigated on lands owned by the State, or downstream from Deer Lodge (Phases 17-22).

- Railroad Haul Study: In 2017, DEQ evaluated haul of waste to the Opportunity Ponds via railroad for remaining Phases through Grant-Kohrs Ranch (Phase 16) (Pioneer Technical 2017). The option was not cost effective at the time of investigation and was logistically problematic.

- Remaining Contaminated Soils and Floodplain Tailings Study, 2020: In 2020, NRDP funded data collection to estimate the volume of contaminated material in remaining Phases (Geum 2021). Stratified soil samples were collected from test pits, analyzed for contaminants with an X-Ray Fluorescence (XRF) device, and this information was used to assign a depth of contamination for each pit. These results are used in this Strategic Plan to estimate remaining removal volumes, which represent a high percentage of project costs. The data may be useable in future designs and will likely need to be supplemented with more detailed investigation.

- Hydraulic Modeling, 2020: In 2020, NRDP funded the development of a Reach A 1D hydraulic model using HEC-RAS analytic software (River Design Group 2021). This type of model predicts flows and depths in the river channel based on information about channel cross-sections and bank conditions. The purpose of this was to provide a single hydraulic model that functions for all of Reach A to predict post-cleanup floodplain elevations for each Phase, which is a factor for earthwork and affects cost estimates. In the future, engineers designing a specific Phase will be able to use this model to integrate more detailed Phase-specific hydraulic models through consistent tie-ins and assumptions, so design elevations are continuous from Phase to Phase.

- Slicken Assessment: Montana Fish, Wildlife and Parks and the Clark Fork Coalition (2022) completed an assessment of risk to aquatic life from slickens located near river banks by considering erosion risk, avulsion risk, slickens size and presence of bank calving. This information may be used along with other data to identify locations for integrated Remedy and Restoration action to address hot spots prior to scheduled action in a Phase.

As of September 2022, cleanup progress includes completion of seven river Phases (1, 2, 3, 5, 6, 15, 16) and the Deer Lodge Residential Yards, the Trestle Area, and East Side Road Pastures. Figure 2 shows the location and status of Clark Fork River Phases in the Project Area. From the original combined funds balance described above, a total of $106 million has been spent and $105 million remains, including earned interest. Cost projections using recent unit bid prices revealed that insufficient funds would remain to complete the final 15 Phases of work if implemented under initial design criteria, in particular those used to delineate the minimum extent of contaminated soil removals. Total costs developed in the ESD, when adjusted for inflation and earned interest, are consistent with updated projections in this Strategic Plan.

Previously, the minimum extents of removals have been determined using a buffer determined by a conservative estimate of projected channel movement 100 years into the future. This approach recognized that the Clark Fork River is located in an alluvial gravel-bed floodplain and is therefore naturally dynamic due to variable flows and sediment transport processes. Resulting lateral movement causes erosion, which recruits contaminated soils and floodplain tailings directly into the aquatic environment. Therefore, replacing contaminated soils with clean floodplain soils within this dynamic zone is an effective protective remedial measure.

Because the initial method to estimate the extents of this dynamic zone resulted in a conservative buffer that was not required by the ROD/ESD, the State modified the method used to determine projected channel movement over 100 years to be less conservative but still protective. This updated approach removes contaminated soils and floodplain tailings from a narrower overall buffer around the Clark Fork River channel (i.e., Channel Migration Zone (CMZ)) and also allows for removal of additional contaminated materials in more dynamic areas where risks to the aquatic and riparian environment are most acute. The updated approach, its resulting design criteria, and its associated implementation plan are described in this document. The Restoration Plan outlined Restoration actions based on an assumption that the Remedy would remain the same as described in the ESD and the design document referenced in the Restoration Plan. Although the Remedy is the same as described in the ESD, the method to determine channel movement within the 100-year floodplain has been updated from the Clark Fork River design approach used in completed Phases and referenced in the Restoration Plan. The State has evaluated this change and determined that it is a nonsignificant change that does not require an update to the Restoration actions identified in the Restoration Plan.

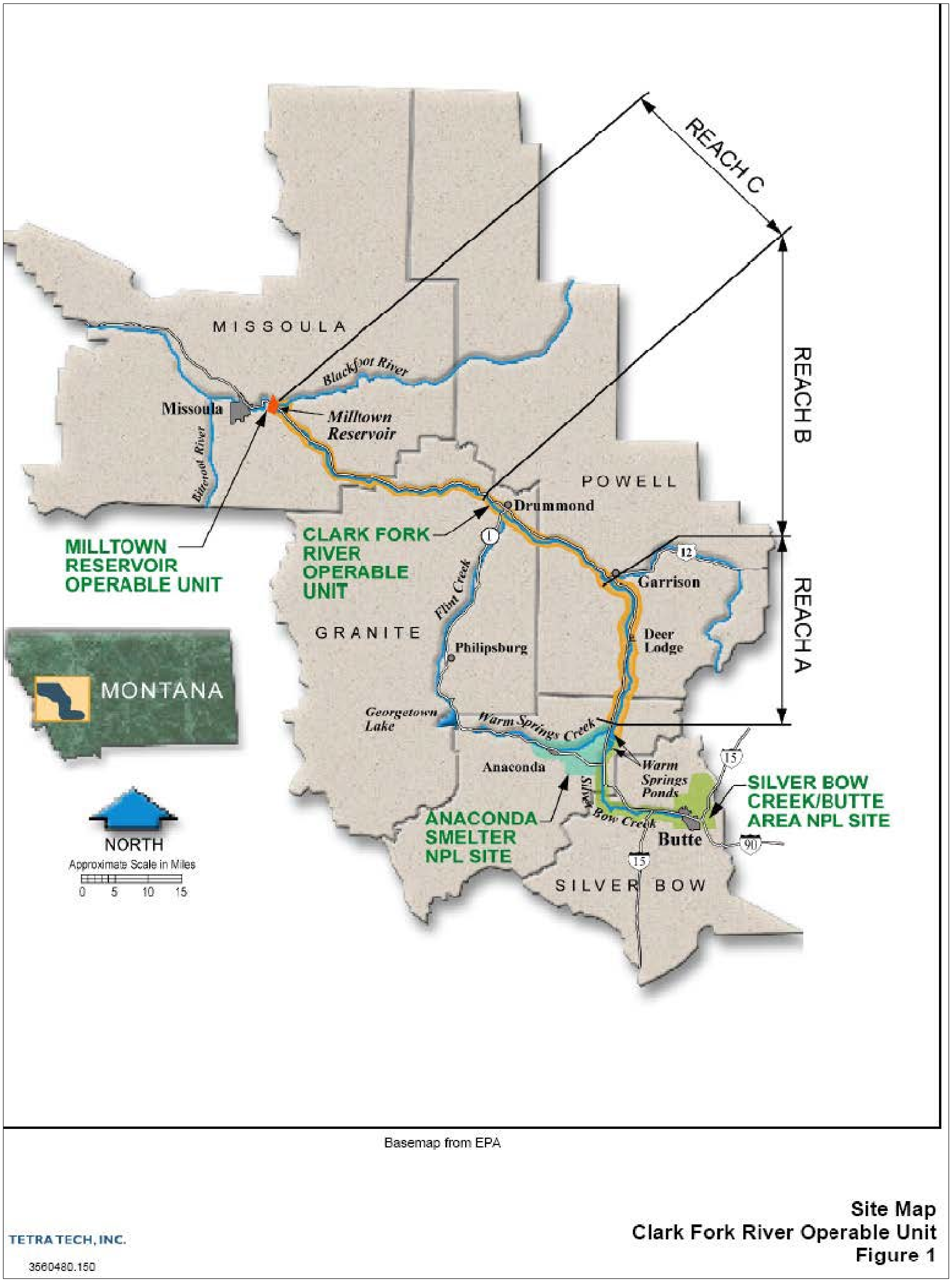

Figure 1. Location of the Clark Fork River Operable Unit (CFROU).

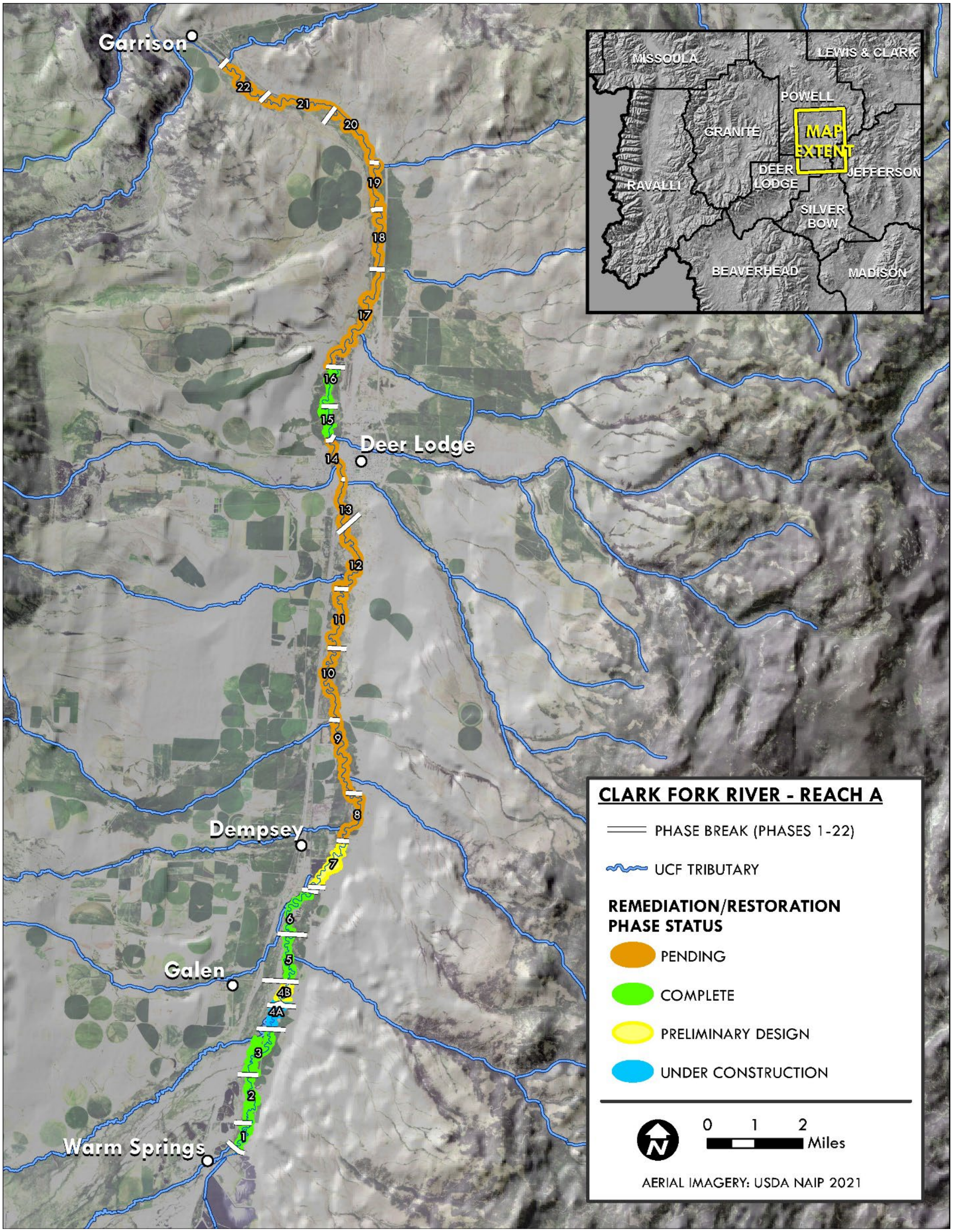

Figure 2. CFROU Phases and status within Reach A.

2 Goals and Objectives

This section describes goals and objectives for this Strategic Plan and links them to strategies and metrics (Table 1). The four goals can be summarized as remediate, restore, integrate and communicate. These goals and objectives are not intended to change the remedial action objectives in the ROD (Appendix G) or the goals and objectives in the Restoration Plan.

Goal 1 - Remediate. Protect human health and the environment by reducing unacceptable risk from historic mining contamination in the Clark Fork River floodplain.

> **Objective 1-1.** Remove or treat approximately 2.7 million cubic yards of contaminated soils and floodplain tailings and remediate/restore approximately 1,000 acres of mining contamination in the Clark Fork River floodplain per the criteria outlined in Section 4.3.1, below.
>
> **Objective 1-2.** Meet surface water and groundwater quality standards, including the waived standard for copper in surface water.
>
> **Objective 1-3.** Achieve human health action levels within the Clark Fork River 100-Year floodplain.

The strategy for completing Goal 1 is to pursue removals and/or other treatments according to this Strategic Plan. Progress toward achieving Goal 1 will be measured in terms of cubic yards of contamination removed, acres remediated and restored, and by comparing monitoring data to surface and groundwater standards and other specific requirements within the ROD.

Goal 2 - Restore. Restore terrestrial and aquatic habitats and related natural processes.

> **Objective 2-1.** Restore native vegetation on streambanks and in the floodplain.
>
> **Objective 2-2.** Create conditions that will result in a trend toward improved aquatic and terrestrial habitat.
>
> **Objective 2-3.** Restore habitat connectivity including hydrologic connection between the river and floodplain.

The strategy for completing Goal 2 is to re-create natural processes, minimize Remedy and Restoration costs, and maximize ecological benefits. Progress toward achieving Goal 2 will be measured using data sets available from current monitoring activities including water quality, fish, macroinvertebrates, and vegetation. Monitoring is described further in Section 8, Monitoring and Adaptive Management.

Goal 3 - Integrate. Implement an integrated Remedy and Restoration approach that achieves Goals 1 and 2 efficiently while maximizing use of limited resources.

To accomplish Goal 3, DEQ and NRDP will work together and with a multidisciplinary team of professionals to implement the Strategic Plan with available funds in a timely manner. Progress toward achieving Goal 3 will be evaluated by comparing progress, expenses and remaining funds to the schedule and budget described in this Strategic Plan. Conducting annual lookbacks and incorporating lessons learned are an important part of implementing the Remedy and Restoration efficiently and effectively.

Goal 4 - Communicate. Communicate progress and modifications to the Strategic Plan effectively to other agencies, stakeholders, and the public.

To accomplish Goal 4, the State will be transparent and involve landowners, the public and stakeholders in the Remedy and Restoration process. This goal will be evaluated by the number of public meetings, timely distribution of progress reports, number of and participation in site tours, and other measures of community engagement.

Table 1. Relationship among goals, objectives, strategies, and metrics.

Goal	Objectives	Strategies	Metrics
1. Remediate Protect human health and the environment by reducing unacceptable risk from historic mining contamination in the Clark Fork River floodplain	Remove approximately 2.7 million cubic yards of contaminated soils and floodplain tailings and remediate/restore approximately 1,000 acres of mining contamination in the Clark Fork River Floodplain. Meet surface water and groundwater quality standards, including the waived standard for copper in surface water. Achieve human health action levels within the Clark Fork River 100-Year Floodplain.	Pursue removals and other remedial actions according to selected alternatives in ROD, ESD, and Strategic Plan.	Cubic yards removed Acres remediated Surface water and groundwater standards
2. Restore Restore terrestrial and aquatic habitats and related natural processes	Restore native vegetation on streambanks and in the floodplain. Create conditions that will result in a trend toward improved aquatic and terrestrial habitat. Restore habitat connectivity including hydrologic connection between the river and floodplain.	Re-create natural processes to minimize Remedy and Restoration costs and maximize ecological benefits.	Current monitoring and associated data sets, including: Water quality Fish Macroinvertebrates Vegetation Geomorphology
3. Integrate Implement a combined Remedy and Restoration approach that achieves Goals 1 and 2 efficiently while maximizing use of limited resources	Complete work through Phase 22 with remaining funds. Identify partnerships to leverage existing funds. Identify sources of additional funds.	DEQ and NRDP work together and with a multidisciplinary team to implement this plan with available funds in a timely manner. DEQ and NRDP will work with partners to identify sources of additional funds.	Compare progress, expenses and remaining funds to the schedule and budget described in this Strategic Plan
4. Communicate Communicate progress and modifications to the Strategic Plan effectively to other agencies, stakeholders and the public	Hold an annual Design Review Team meeting. Hold annual public meetings and site tours. Produce quarterly progress reports.	Be transparent and involve landowners, the public and stakeholders in the Remedy and Restoration process.	Number of public meetings Timely distribution of progress reports Number of and participation in site tours Other measures of community engagement

3 Remaining Phase Sequencing

The State divided the Project Area into 22 constructable sections called Phases. This section describes criteria developed to determine the prioritization of remaining Phases of Remedy and Restoration. In general, future Phases will be constructed from upstream to downstream, with some exceptions based on a set of criteria determined by evaluations completed by NRDP, Montana Fish, Wildlife and Parks (FWP), and the Clark Fork Coalition, referenced in Section 1.1. These criteria consider areas with high risk of erosion and subsequent entrainment of contamination into the aquatic environment, areas of high contamination, areas where it would be cost-effective to combine work in multiple Phases from a constructability perspective, and areas where high quality habitat is currently present in non-remediated areas. For each criterion, thresholds are identified for assigning a particular Phase as either high, moderate or low priority for sequencing. Phases meeting a greater number of high priority criteria could be considered for construction earlier than other Phases, regardless of their position in the upstream to downstream order.

Table 2 describes each criterion and the threshold for assigning priorities. Table 3 shows priority ranking for each criterion by Phase.

Table 2. Phase sequencing criteria.

Criteria	Description	High Priority	Moderate Priority	Low Priority
Risk of Entraining Tailings	How many acres of floodplain were converted to river (eroded) per year, per river mile, between 2006 and 2019? ** Higher erosion poses more acute risk.*	> 0.25	0.2 - 0.25	< 0.2
Contaminated Soils and Floodplain Tailings	How many cubic yards of contaminated soils and floodplain tailings are present within the channel migration zone? High public use? ** Removing more contamination in a phase means more progress toward overall cleanup totals. High public use defaults to high priority.*	> 200,000	100,000 – 200,000	< 100,000
Constructability	Can multiple phases be constructed with one integrated network of haul roads and other construction site infrastructure? ** Combining infrastructure results in cost savings.*	Three or more phases	Two phases or uncertain	One phase
Ecological Function	What quality of habitat is available in non-remediated Phases? ** Fish and wildlife displaced by work may use adjacent high-quality habitat as refugia. So high quality habitat is low priority for sequencing.*	Low	Moderate	High

Table 3. Priorities by Phase for each Phase sequencing criteria.

	High Priority		Moderate Priority		Low Priority

PHASE	CRITERIA			
	Risk of Entraining Tailings	Contaminated Soils/Tailings Volume	Constructability	Ecological Function
4b	Low	Low	Low	Low
7	Moderate	High	Low	High
8	Moderate	Moderate	Moderate	Moderate
9	Moderate	Moderate	Moderate	Moderate
10	High	Moderate	High	Low
11	High	High	High	Moderate
12	High	High	High	Moderate
13	Moderate	High	Moderate	High
14	Low	High	Moderate	High
17	Moderate	High	Moderate	Moderate
18	Moderate	Low	Moderate	Moderate
19	High	Low	Moderate	Moderate
20	Moderate	Moderate	Moderate	Moderate
21	Moderate	Moderate	Moderate	Moderate
22	High	Moderate	Moderate	Moderate

Based on these criteria, the State would implement integrated Remedy and Restoration actions by Phase using the following sequence. Phases are listed in order of construction and the reason for their placement in the sequence is described for each Phase. Potential schedules for construction of each Phase are described in Section 6, Alternative Remedy and Restoration Actions.

1. Phase 7. This Phase would be completed after Phase 4A. Phase 7 is the next downstream Phase that has not been completed, except for Phase 4B described below. This Phase has high public use with a fishing access site.

2. Phases 13 and 14. Phase 13 includes Arrowstone Park in Deer Lodge which has high public use. Phase 14 is a small area contiguous with Phase 13. These Phases would be completed concurrently with Phases 10 and 11.

3. Phases 10, 11 and 12. These Phases exhibit the highest risk of entraining tailings based on acres of floodplain per river mile eroded into the river over time. Therefore, they pose the most acute risk to aquatic habitat because all or most of this eroded material is contaminated soils and floodplain tailings. Phases 11 and 12 have relatively high volumes of contaminated materials, so completing these Phases earlier would result in substantial progress toward completing the cleanup in the Project Area. Construction in Phases 10, 11 and 12 would be supported by a single infrastructure of haul roads because they all share the same access point from Sager Lane.
4. Phase 4B. Once Phases 10, 11 and 12 have been completed for reasons described above, Phase sequencing would be completed from upstream to downstream for remaining Phases. Phase 4B is the furthest upstream remaining Phase.
5. Phases 8 and 9. Phases 8 and 9 are the next downstream Phases. These Phases will have provided refugia for fish and wildlife during and after construction of Phase 7 and 10 through 12.
6. Phases 17, 18, 19, 20, 21 and 22. The remaining Phases downstream from Deer Lodge would be completed in order from upstream to downstream. Because a large proportion of these Phases is located on a single ownership, some of these Phases may be combined to take advantage of efficiencies with design and construction infrastructure, like Phases 10, 11 and 12.

4 Design Criteria

This section describes the basis for design criteria in the ROD, the ESD, and in other guiding documents; the approach to identifying the spatial extents of remediation; and specific guidance that will be used to develop designs within Phases.

4.1 Design Criteria Basis

Successful cleanup of streambanks and floodplains contaminated with mine waste within the CFROU depends not only on removal of contamination but also upon establishing functional plant communities that will stabilize soils against wind and water erosion, minimize human health and ecological risks by reducing transport of Contaminants of Concern (COCs) to groundwater and surface water, and comply with Applicable or Relevant and Appropriate Requirements (ARARs described in the ROD, Appendix A). To attain this success on the Clark Fork River and floodplain, it is necessary to establish permanent naturally functioning vegetative cover that minimizes direct contact between water and mine wastes, provides geomorphic stability to streambanks and to the floodplain, and minimizes surface erosion that transports contaminants to the river and to groundwater.

A significant consequence of contaminated sediment deposition is that the current floodplain is elevated to a degree that limits overbank flows, which greatly reduces riparian vegetation. Without normal periodic overbank flows and connection to groundwater, the Remedy and Restoration will not establish sufficient permanent naturally functioning vegetative cover necessary to meet surface and groundwater ARARs and vegetation performance standards identified in the ROD. Therefore, the areas where contaminated soils and floodplain tailings are excavated will only be partially backfilled to create a lower floodplain, allowing overbank flows during high flow periods and providing floodplain vegetation direct access to groundwater.

This Strategic Plan supports the State in meeting performance standards for the streambank corridor set out in the ROD. Streambank guidelines from the SMOA were considered and included where appropriate. The actions of removing tailings and impacted soils, stabilizing streambanks, and revegetating the riparian corridor and floodplain should significantly reduce streambank erosion and release of contamination to the river. These actions, when implemented with construction Best Management Practices (BMPs), are expected to meet a majority of the factors affecting bull trout habitat within the Upper Clark Fork River and as identified in the U.S. Fish and Wildlife Service's Biological Opinion (USFWS 2004).

4.2 Channel Migration Zone as a Base Remedy

The CMZ used for integrated Remedy and Restoration work prior to 2022 was updated in January 2022 by Applied Geomorphology, Inc. and Geum Environmental Consulting, Inc., using data collected by University of Montana Western. The updated CMZ was developed relative to the 2019 channel location, so this Strategic Plan is based on the most current available data. Data sources and methods used to update the CMZ are described in Appendix C. This CMZ represents a zone where there is risk of the river entraining contaminated soils and floodplain tailings into the aquatic ecosystem. The risk is quantified based on known channel movement rates. The mean movement rate within each geomorphic subreach defines the CMZ and captures an area that is feasible to remediate with available funds while also being protective. This area is referred to in the following sections as the base Remedy.

The ROD calls for "stabilizing eroding streambanks and providing an approximately 50-foot wide protective riparian corridor on both sides of the river." Removing contaminated soils and floodplain tailings within the base Remedy will accomplish this. This also leaves funds available to remove additional contaminated soils and tailings within the 100-year floodplain, in areas where channel movement rates are high and where higher priority removal areas described in the ROD are present. The following section describes the approach to estimating potential expansion areas from the base Remedy. This combination of methods is protective of human health and the environment, increases protectiveness in high-risk areas, and accomplishes Restoration objectives where opportunities to restore important habitats are present.

4.3 Other Design Criteria or Guidance

4.3.1 Contaminant Removal Criteria

This section describes criteria from the ROD and the ESD. These criteria have been applied on previous Phases.

Tailings/impacted soil will be removed under the following conditions:

- Arsenic levels exceed the human health standard in the surface interval, and action levels are defined in the ROD for different land uses.
- The sum of COCs (arsenic, cadmium, copper, lead, zinc) exceeds 1,400 mg/kg (parts per million) (DEQ 2014) and any of the following where removals outside the base Remedy (CMZ) are determined on a case-by-case basis:
    - The lowest contaminated interval of metals is deeper than 24 inches;

    - The contamination lies within the CMZ regardless of depth;
    - Arsenic exceeds the human health standard at the surface and the sum of COCs exceeds 1,400 mg/kg at an interval shallower than 24 inches; or
    - Limited areas outside the CMZ where contaminated materials are shallower than 24 inches but are contiguous to removal areas, for construction efficiency.
- Areas of uncommon native vegetation such as cottonwood stands, peatlands, and other high-quality wetlands may be preserved, and contamination left in place.

4.3.2 Vegetation Preservation

In general, vegetation preservation areas are within Slightly Impacted Soils and Vegetation Areas according to the ROD and are "generally well vegetated and display no visible evidence of contamination from tailings," although contaminated soils and floodplain tailings may be present. Remedial actions for these areas are No Action or BMPs and Institutional Controls (ICs). Further, potential vegetation preservation areas must meet the following criteria:

- Preservation areas are not more than 1 foot above design grade;
- Leaving patches of vegetation on slightly higher ground does not create channelized flow paths;
- Preservation areas do not occur near the channel on both sides of the river, which could result in concentration of flows on the floodplain; and
- Preservation areas do not create construction constraints.

4.3.3 Floodplain Reconstruction Design Guidance

Floodplains should be reconstructed to maximize natural floodplain function and the potential for native riparian and wetland plant communities to establish and produce habitat that achieves Restoration objectives. Specific guidance includes:

- Minimize avulsion risks;
- Incorporate microtopography and woody debris into the floodplain, depending on circumstances within a Phase (e.g., landowner preferences, availability of materials, site-specific objectives);
- Where feasible, construct wetlands and swales in areas where contaminated soils and floodplain tailings removals leave low topography, to minimize backfill quantities and maximize hydrologically connected off-channel aquatic habitat; and
- Incorporate side channels to maximize surface flows across the floodplain and connect backwater areas and wetlands.

4.3.4 Streambank Design

According to the SMOA, the State and EPA will use streambank design guidelines "during the development and review of remedial design for the CFROU site. In addition, the State may propose design methods and techniques other than those described in the ROD for consideration during design for joint approval of plans, as described in the Consent Decree." Based on the SMOA guidelines and approved streambank methods from completed Phases, general guidance for streambank design includes:

- Streambanks (top of bank) should be designed to the average Q1.5 elevation;
- Streambanks should be designed to withstand the 10-year return flow (Q10) shear stress, including stable toe;
- Banks should be constructed from native materials that will support establishment of native woody riparian vegetation with deep binding root mass, while providing short term erosion resistance;
- Banks should be designed to allow natural channel migration after a short-term period of stability (5 to 10 years) so floodplain vegetation can develop; and
- Other bank treatments may be appropriate to protect infrastructure.

The current suite of streambank treatments includes:

- Preserve Vegetation: Per the SMOA, in the context of streambanks, "native, desirable woody vegetation should not be disturbed during remediation to the maximum extent possible." In completed Phases, the State has recognized a necessity to remove woody vegetation on banks where both the vegetation and contaminated soils and floodplain tailings will be entrained into the aquatic ecosystem through imminent erosion processes. However, some bank vegetation has also been preserved where woody vegetation with deep binding root mass is present in areas where past bank movement rates have been very low.
- Double Vegetated Soil Lift (DVSL): This bank treatment uses layers of coir fabric wrapped around 1 foot thick soil layers (lifts) and incorporates willow cuttings to provide temporary bank stability and deeply rooted woody vegetation directly on streambanks. Note: The DVSL treatment provides only moderate quality fish habitat in the short term. In addition, coir fabric has been difficult to source in 2022. Therefore, this treatment is being phased out in favor of brush matrix treatments described below.
- Brush Matrix: This bank treatment is a mixture of brush and live dormant willow cuttings. It may incorporate high density willow clumps or juniper trees in areas with higher shear stress and where immediate overhanging bank habitat is desired. Root wads may be incorporated into particularly high stress or transition areas. In some cases, bank toe reinforcement is included and sized according to site-specific conditions.
- Brush Trench: The brush trench is a row of brush and live dormant willow cuttings partially buried in a trench. These are used to transition from streambanks to floodplain, such as at the top of point bars or lateral bars. Brush trenches are also being used behind streambank treatments in select floodplain areas to add more depth of woody vegetation cover along streambanks.

- Rip-rap: Rip-rap is rock bank armor used to protect infrastructure, where the objective is to prevent bank movement.
- No Treatment: No treatment may be appropriate on banks where the river has eroded into terraces where no contaminated soils and floodplain tailings are present.

4.3.5 Channel Realignment/Reconstruction

In most cases, the Clark Fork River channel is excluded from the Remedy. One exception includes areas where extremely deep contamination in the floodplain can be most effectively removed by including small sections of channel realignment as part of the Remedy. Other exceptions include river reaches where channel realignment would support Restoration objectives. In areas where there is a high risk of avulsion or where avulsions have occurred, the channel including bed and banks may be reconstructed. Appendix E provides example criteria for addressing avulsion areas.

4.3.6 Vegetative Backfill Design Criteria

The ROD provides some criteria for vegetative backfill which is soil placed on the surface of the floodplain to support plant growth. Based on analysis of existing offsite and onsite borrow sources, other criteria have been added as part of designing and constructing completed Phases. Table 4 includes vegetative backfill criteria being used by the State, criteria from the ROD, and notes describing rationale for changes or additions if necessary.

Table 4. Soil suitability criteria for CFROU vegetative backfill. Specific criteria will be developed for each Phase in consultation with EPA.

Parameter	State's suitability criteria	ROD criteria	Comments
Physical Characteristics			
Soil Texture	Sandy loam to clay loam with 35% or less clay material.	Sandy loam or finer; clay not acceptable.	35% or less clay material considered consistent with the ROD requirement because many loamy soils contain up to this much clay content.
Coarse Fragment Content	Maximum rock size is 6 inches (15 cm).	Same	Taken from the ROD.
Particle Size Distribution	Particles > 0.079 inches (2 mm) will constitute < 45% by volume.	Same	Taken from the ROD.
Chemical Characteristics			
pH	> 6.0 and < 8.5 standard units	> 6.5 and < 8.5 standard units	Lower limit of 6.0 allowed since greatest nutrient availability occurs around 6.5.
Specific Conductivity	< 4.0 dS/m in wetland and riparian areas and < or = to 6.0 dS/m in upland areas.	< 4.0 dS/m	6.0 dS/m considered suitable for many upland plant species (Scianna 2003).
Sodium Adsorption Ratio (SAR)	≤ 12	Not in ROD	≥ 13 SAR suggests likelihood of reduced soil permeability and decreased plant survival and growth (MT NRCS 1996).
Exchangeable Sodium Percentage (ESP)	<15	Not in ROD	ESP ≥ 15% is considered sodic and therefore unsuitable as growth media (Tiedemann and Lopez 2004).
Organic Matter (%)	> 1.5% (by weight) in upper 6 inches for upland and riparian areas.	> 1.5% (by weight) in upper 6 inches for upland areas; 5%-7% for riparian areas.	5% to 7% OM in riparian areas is high.
Element Analysis			
Arsenic	< 30 mg/kg	Same	Taken from the ROD
Cadmium	< 4 mg/kg	Same	Taken from the ROD
Copper	< 100 mg/kg	Same	Taken from the ROD
Lead	< 100 mg/kg	Same	Taken from the ROD
Zinc	< 250 mg/kg	Same	Taken from the ROD

4.3.7 Revegetation Design Guidelines

Design guidelines for revegetation are based on the idea that it is fully integrated with the floodplain design. Success of revegetation efforts depends on a floodplain that is hydrologically connected with the river and supports processes that drive riparian vegetation establishment and plant community development over time. Guidelines include:

- Maximize potential for overbank flows, including flow paths and depressions, to support flooding and sediment deposition/scour in the floodplain. This will support natural revegetation of native riparian trees and shrubs in some areas and limit the need for nursery stock and associated maintenance.
- Where nursery stock is used, it should be appropriate native species and grown from site-adapted seed. Match plants to hydrologic zones or appropriate habitats.
- Use vegetative cuttings as part of streambank treatments and in the floodplain, as available.
- Protect nursery stock from browse.
- Plant nursery stock when dormant, in the fall or spring.
- Vegetation maintenance should be anticipated and budgeted for in project plans.

5 Costs

To estimate costs associated with Remedy and Restoration of the CFROU, an analysis was performed using information from completed Phases to estimate the costs of design, construction, management, monitoring and maintenance for the remaining Phases. Based on Phase sequencing criteria described in Section 3, Remaining Phase Sequencing, the State's proposed implementation schedule assumes one Phase will be constructed in most years. The cost estimate includes several assumptions in addition to variable inputs, allowing for numerous scenarios to be compared. This cost estimate can be used throughout project implementation to develop budgets, evaluate costs for remaining phases, and allocate funds.

Construction costs for each remaining Phase were developed by using a bid item list, applicable to all Phases. Remedy, Restoration and construction activities were itemized and assigned a measurable unit value and a price per unit. To derive quantities for each phase, spatial analyses were performed in GIS to calculate linear feet of streambank, estimated removal and backfill volumes, distance to borrow sources, and distance to a repository. Price per unit was estimated using the three lowest bids from the Phase 3 construction project, which is the most recent cost information available. Total construction cost was calculated per Phase using the quantities and the price per unit.

To further refine the construction cost estimate for each Phase, several spatial analysis inputs were turned into variables that can be manipulated. These variables include the percentage of each streambank treatment type, borrow source onsite versus offsite, and percentage of additional removals outside the CMZ. This makes it possible to evaluate costs by Phase using the most likely construction scenarios based on data specific to each Phase.

Construction management and engineering design costs are assumed to be 6% and 10% of construction cost, respectively. Annual monitoring is assumed to cost $210,000 based on recent years' expenditures. Annual maintenance costs are assumed to be $300,000 based on recent years' expenditures. Between DEQ and NRDP, annual agency costs are $350,000. Inflation rates and the rate of return on the fund are variable inputs that can be updated over time and are currently at 1.73% and 2%, respectively, based on information provided by the Montana Board of Investments.

Table 5 provides cost estimates for each Phase, in 2022 dollars, following the State's proposed implementation schedule. Costs are based on base Remedy (removing tailings within the CMZ) plus 16% for additional work including Restoration. Data underlying cost assumptions will be updated over time, and actual interest rates and cost escalation will vary over time. Therefore, this cost estimate will need to be updated annually, or at the completion of each Phase, to make sure sufficient funds are available to complete the integrated Remedy and Restoration work. Based on current information, this cost analysis shows that it will be possible to complete the work given a scenario that is somewhere between the low-end and high-end scenarios. While estimated construction years for each Phase are shown in Table 5, this is a baseline estimate: the exact year in which Remedy occurs is subject to change.

Combining DEQ and NRDP budgets will allow NRDP to provide a larger financial contribution to the overall costs of construction by implementing Restoration Plan actions in tandem with the Remedy. NRDP funds would still be required to be used for Restoration responsibilities under the Restoration Plan. Potential cost saving measures are identified in Section 6, Alternative Remedy and Restoration Actions.

Table 5. Total estimated costs by Phase (base Remedy plus 16%). Costs are in 2022 dollars.

Construction Year	Estimated Year	Phases Under Construction	Estimated Capitol Costs	Monitoring	Agency Costs	Maintenance	Estimated Total Costs
1	2023	4A	$5,600,000	$210,000	$350,000	$300,000	$6,460,000
2	2024	7	$4,060,000	$210,000	$350,000	$300,000	$4,920,000
3	2025	10, 13	$10,240,000	$210,000	$350,000	$300,000	$11,100,000
4	2026	11, 14	$8,660,000	$210,000	$350,000	$300,000	$9,520,000
5	2027	12A	$4,280,000	$210,000	$350,000	$300,000	$5,140,000
6	2028	12B	$4,280,000	$210,000	$350,000	$300,000	$5,140,000
7	2029	4B	$2,660,000	$210,000	$350,000	$300,000	$3,520,000
8	2030	8	$4,270,000	$210,000	$350,000	$300,000	$5,130,000
9	2031	9	$7,250,000	$210,000	$350,000	$300,000	$8,110,000
10	2032	17A	$4,200,000	$210,000	$350,000	$300,000	$5,060,000
11	2033	17B	$4,200,000	$210,000	$350,000	$300,000	$5,060,000
12	2034	18	$4,210,000	$210,000	$350,000	$300,000	$5,070,000
13	2035	19	$4,280,000	$210,000	$350,000	$300,000	$5,140,000
14	2036	20	$6,210,000	$210,000	$350,000	$300,000	$7,070,000
15	2037	21	$5,660,000	$210,000	$350,000	$300,000	$6,520,000
16	2038	22	$5,630,000	$210,000	$350,000	$300,000	$6,490,000
17	2039	Closure	$1,700,000	$210,000	$350,000	$300,000	$2,560,000
18	2040	Maintenance		$210,000	$350,000	$300,000	$610,000
19	2041	Maintenance		$210,000	$100,000	$300,000	$610,000
20	2042	Maintenance		$210,000	$100,000	$300,000	$410,000
21	2043	Maintenance		$210,000	$100,000	$100,000	$410,000
22	2044	Maintenance		$210,000	$100,000	$100,000	$410,000
Total			**$87,390,000**				**$104,460,000**

6 Alternative Remedy and Restoration Actions

The ESD emphasizes the importance of developing designs based on site-specific information. Following this guidance and applying the design criteria described in Section 4, designs for each Phase will be based on a common base Remedy defined by the CMZ and additional remedial actions guided by the results of design-level investigations. In addition, several other alternatives may be considered as part of designing each Phase. These alternative design approaches and elements are described below and shown in Table 6, along with comments about their feasibility, sustainability, ability to meet Strategic Plan Goals, associated risk, effect on reconnecting the floodplain, and potential effect on cost.

Onsite borrow may be available on lands owned by the State of Montana or on other large, contiguous private lands with landowner approval that include substantial areas of adjacent uplands. Obtaining borrow onsite can save costs because haul distances are less than if hauling borrow from the Beck Borrow source west of Racetrack. Onsite borrow can include alluvium or vegetative backfill and may need to be amended to meet design criteria for vegetative backfill.

Maximizing side channels and depressions supports several Restoration Plan elements including Floodplain Diversity Enhancement, Additional Revegetation and Aquatic Habitat Enhancement. In addition, leaving low areas of the floodplain supports revegetation objectives of the Remedy and results in less backfill needed, which would be a cost savings.

Protecting reclaimed/restored parcels using land protection mechanisms such as conservation easements would result in a more protective combined Remedy and Restoration because long-term land management and development can be aligned with the goals of this Strategic Plan. If long-term land use supports sustaining the combined Remedy and Restoration, maintenance costs and costs of ongoing BMPs and ICs could be less than if land is not protected.

Restoring in-channel aquatic habitat directly supports a Restoration Plan objective. Recent updates to streambank treatments, such as increasing overhanging bank vegetation and using larger wood in brush banks, contribute to aquatic habitat while directly supporting Remedial design criteria for streambanks and reducing costs compared to other techniques.

Removing hotspots of contaminated materials prior to Remedy is an action described in the Restoration Plan. This alternative action could address direct delivery of metals contamination to the aquatic ecosystem where Slickens are located directly on river banks. However, there could be added costs from multiple mobilizations of construction equipment into the same area and the need to stockpile contaminated materials and move them more than once.

Restoring areas outside the remedial boundary is an action describe in the Restoration Plan. This may involve removing narrow bands of contaminated soils and tailings outside of the high-risk Slickens and Impacted Areas. Such removals could result in hydrologically reconnecting areas of floodplain or connecting the remediated/restored floodplain to a nearby unique habitat, such as a peatland.

Reducing the CMZ to a 50-year buffer may be appropriate on lands owned by the State of Montana or in other locations where long-term land use is focused on natural processes and habitat. This could result in less potential disturbance than would occur on lands where agriculture or more active use is the long-term objective. This could also be a necessary cost-saving measure as part of managing the State's combined fund balances.

Constructing more than one Phase (or portion of a Phase) per year would result in the combined Remedy and Restoration being completed quicker than if only one Phase per year is completed. This would require multiple construction contracts to be managed concurrently.

Addressing hot spots. In addition to the above alternatives, some areas may be identified where Remedy and/or Restoration may be warranted before a Phase is scheduled for work to begin. For example, ICs have failed in some areas where berms separating Slickens from riverbanks have failed. In these areas, short-term BMPs may be implemented to protect the aquatic environment from pulses of concentrated metal salts during high intensity rain storms. Other site-specific actions may be identified to address immediate risks or opportunities that align with the ROD, ESD and Restoration Plan. When potential actions such as these are identified by stakeholders or the public, the State will evaluate these requests within the framework of this Strategic Plan and the ROD, ESD and Restoration Plan.

Table 6. Alternatives for design approaches and comments about strategic considerations.

Alternative Action	**Technical Feasibility**	**Long-term Sustainability**	**Strategic Plan Goal #1** Protect human health and the environment	**Strategic Plan Goal #2** Restore habitat	**Risk**	**Floodplain Reconnection**	**Cost**
Onsite borrow	Has been done previously	N/A	N/A	Potential for additional habitat features using borrow areas	Sandy borrow can limit vegetation success (Phase 2)	Developing borrow sources in floodplain may result in addition connected areas	Low haul cost
Maximize side channels and depressions	Has been done previously in Phase 1	Better support for natural floodplain processes	N/A	Directly results in more, diverse habitat features, addresses a Restoration Plan action	Increases flow paths for surface water, but allows for more flood relief from main channel	Creates defined flow paths where surface water can access floodplain	More depressions and channels mean less backfill needed
Protect reclaimed/ restored parcels (e.g., conservation easement)	Has been done previously	Allows for long-term land use supported Strategic Plan goals	Provides long-term assurance that land will be managed to sustain the reclaimed/ restored condition	Provides long-term assurance that land will be managed to sustain the reclaimed/ restored condition	Reduces risk of land uses diminishing the protective and restorative effects of the project	N/A	Administrative cost
Restore in-channel aquatic habitat	Has been done previously in the watershed	Supports Restoration Plan goals long-term	N/A (not addressed in the Record of Decision)	Directly addresses a Restoration Plan action	Partially mitigates risks from residual contamination	N/A	Restoration cost outside Remedy

Alternative Action	**Technical Feasibility**	**Long-term Sustainability**	**Strategic Plan Goal #1** Protect human health and the environment	**Strategic Plan Goal #2** Restore habitat	**Risk**	**Floodplain Reconnection**	**Cost**
Remove hotspots prior to Remedy	Has not been done previously		Can remove highest risk areas sooner	Can eliminate the most acute risks to aquatic habitat earlier	Disturbance from two mobilizations, need to stockpile tailings on site.	Portions of floodplain may be reconnected sooner	Requires additional mobilization and handling of material
Restore areas outside the remedial boundary	Has been done previously on Phases 5-6	Supports Restoration Plan goals long-term	N/A (not addressed in the Record of Decision)	Directly addresses a Restoration Plan action	Increased area of short-term disturbance, long-term adds buffer to remedial boundary	Could result in additional connected floodplain	Restoration cost outside Remedy
Reduce CMZ to 50-year buffer	Some streambank buffers may be too narrow and pose constructability problems	Separates river movement from contamination for less than 100 years	Less area is cleaned up	Smallest area of restored habitat	Smallest disturbance area, but higher risk of river eroding into contamination long-term	Reduced area is hydrologically reconnected to river	Reduced volume material hauling results in cost savings
Construct more than one Phase per year	Has been done previously but requires more agency capacity	Shorter completion time frame but same long-term result	Reduces threats to human health and environment more quickly	Faster pace restores habitat more quickly, addresses temporal loss	Larger area of floodplain disturbed concurrently	N/A	May reduce time effect of cost escalation

7 Implementation Plan

This Strategic Plan provides a framework for planning and designing future Phases of the Project Area following the sequence shown in Table 5. When planning begins for a new Phase or multi-Phase project, the State will evaluate the current fund balance and compare it to previous projections and future needs. Based on the fund balance, updated information and site-specific conditions, the State will select appropriate alternative actions and carry them forward to design. Typical steps to design and implement work within a Phase include:

Design investigations. Data from soil test pits are collected to determine the horizontal and vertical extent of contamination. Hydrology is evaluated to identify flows to be used as inputs to a hydraulic model. These flows may be adjusted if tributary inputs are present within a Phase. A hydraulic model is developed to identify river stage at particular flows, which supports designing river banks and floodplain features. Model outputs are also used to identify areas where high velocity and shear stress may influence designs. Vegetation communities are mapped to identify potential preservation areas, and to provide a basis for establishing objectives such as acres of woody vegetation or other habitat components to replace. Other design criteria information, as identified in Section 4, Design Criteria, is collected or identified at this time.

Preliminary design. Once design investigations have been completed, an interdisciplinary design team meets with DEQ and NRDP to develop the proposed contamination removal boundary and depths of removals using the information and criteria identified in the previous step. Each discipline brings their investigation results, and this information is used to help establish the base Remedy and any additional removals outside the CMZ. During the meeting, the team discusses any features like old channels, oxbows or secondary channels that should be preserved or rebuilt. Potential Restoration opportunities, alternative actions, channel realignments or necessary structures are also identified and discussed. Results of vegetation mapping are used to identify unique areas that may need to be preserved, or land uses that must continue post-Remedy. A field visit is conducted to determine bank treatments and specifically locate point bars, lateral bars, secondary channels and any other features that could influence the hydraulics of the channel. A Preliminary Design Plan is developed that describes the basis for design and includes plans and typical details showing combined Remedy and Restoration actions. Feedback from the Design Review Team (see below) and the public is incorporated into a final preliminary design, which is provided to the EPA for approval.

Design Review Team (DRT) and public meetings. The Preliminary Design Plan is presented to the DRT, which is a group of stakeholders representing state and federal agencies, tribal government, local government, citizen groups and landowners. Preliminary designs are presented to the public as part of regular updates.

Final Design. To keep designs consistent with the Strategic Plan, the design base Remedy must be within the estimated cost for a Phase (Table 5). If that is the case, then additional removals outside the CMZ (Section 4.2.2) and other restoration actions can be considered. These additional removal areas and other actions are selected by the State with input from the design team. Designs are finalized in the form of a bid package to support selecting a contractor to implement combined Remedy and Restoration work within the Phase.

7.1 Integration of Remedy and Restoration

Roles and responsibilities of the State agencies, in particular protocols for communication and cooperation between DEQ and NRDP, are described in a 2022 memorandum (Appendix F). This 2022 memorandum describes roles and responsibilities, communication protocols, contracting, design considerations, and other topics between the agencies.

7.2 Public Engagement

A Community Involvement Plan (CIP) (DEQ and EPA 2017) established guidelines for how the State will work together to inform and engage the public. The purpose of the CIP is to inform the public of the nature of environmental issues associated with the site, and to involve the public in cleanup decisions that will affect program responses under consideration, progress being made to implement cleanup remedies, and public interests. As part of this Strategic Plan, the State will work to implement the CIP and keep it updated with current information, contacts and links to sources of information.

At a minimum, the State will hold two public meetings a year to discuss with the public what has been completed, what is planned, and monitoring data that shows what is working and what needs to be changed.

7.3 Budget Projections and Plan Updates

The State will complete budget projections annually. These projections will provide information about what has been spent during the previous year. The State will also develop budget projections after the completion of each Phase, or at least every three years, to estimate expenditures going forward.

This plan will be updated at least every three years. Updates will document lessons learned, studies completed, budget projections, and descriptions of issues that have arisen and how they were addressed.

8 Monitoring and Adaptive Management

8.1 Past and Current Monitoring

The DEQ oversees Remedy-related monitoring in the CFROU. Monitoring has been conducted annually since 2010. Data are collected on multiple environmental parameters in order to meet the requirements of Sections 13.11.4.2 and 13.11.4.3 of the ROD, including surface water chemical composition, instream sediment load, and the abundance and composition of periphyton, macroinvertebrates, vegetation, and birds. Fish are monitored by FWP in consultation with NRDP. Annual reports summarize results, evaluate progress toward performance goals and describe general trends. Table 7 includes a summary of sample parameter locations and sampling frequency. Figure 3 displays sampling site locations and Table 8 includes a description of each site. Details for each parameter are discussed below, and a comprehensive report is included in the most recent Sampling and Analysis Plan (RESPEC 2020a).

Table 7. Summary of Upper Clark Fork Remedy-related sample parameter locations and frequency.

Parameter	Number of Sampling Locations	Sampling Frequency
Surface Water	Up to 16 sites: 7 mainstem and 9 tributary	4 quarterly monitoring events and occasionally additional sampling events for spring runoff.
Stream Flow	Up to 16 sites: 7 mainstem and 9 tributary	Concurrent with Surface Water sampling.
Instream Sediment	Up to 16 sites: 7 mainstem and 9 tributary	2 monitoring events per year in 2nd and 3rd quarter.
Fish	10 or more mainstem sites Various sites in 29 priority tributaries	Mainstem sites monitored annually April and May. Tributary sites monitored every 2-5 years with more frequent monitoring at specific restoration project locations.
Periphyton	Up to 16 sites: 7 mainstem and 9 tributary	1 monitoring event per year in 3rd quarter.
Macroinvertebrates	Up to 16 sites: 7 mainstem and 9 tributary	1 monitoring event per year in 3rd quarter.
Vegetation	6 transects per Phase: 3 on each side of the river	1 monitoring event per year during the growing season after runoff. Monitored by Phase in post-Remedy years 1, 2, 3, 4, 5, 7, and 10.*
Birds	Varies by Phase: Typically 2 to 4 sites per Phase	Monitoring weekly from April 1 to June 30.

* *Phases currently include Phases 1 through 8 and 15 and will increase with remedial actions. Fifteen sites have been sampled consistently since 2018.*

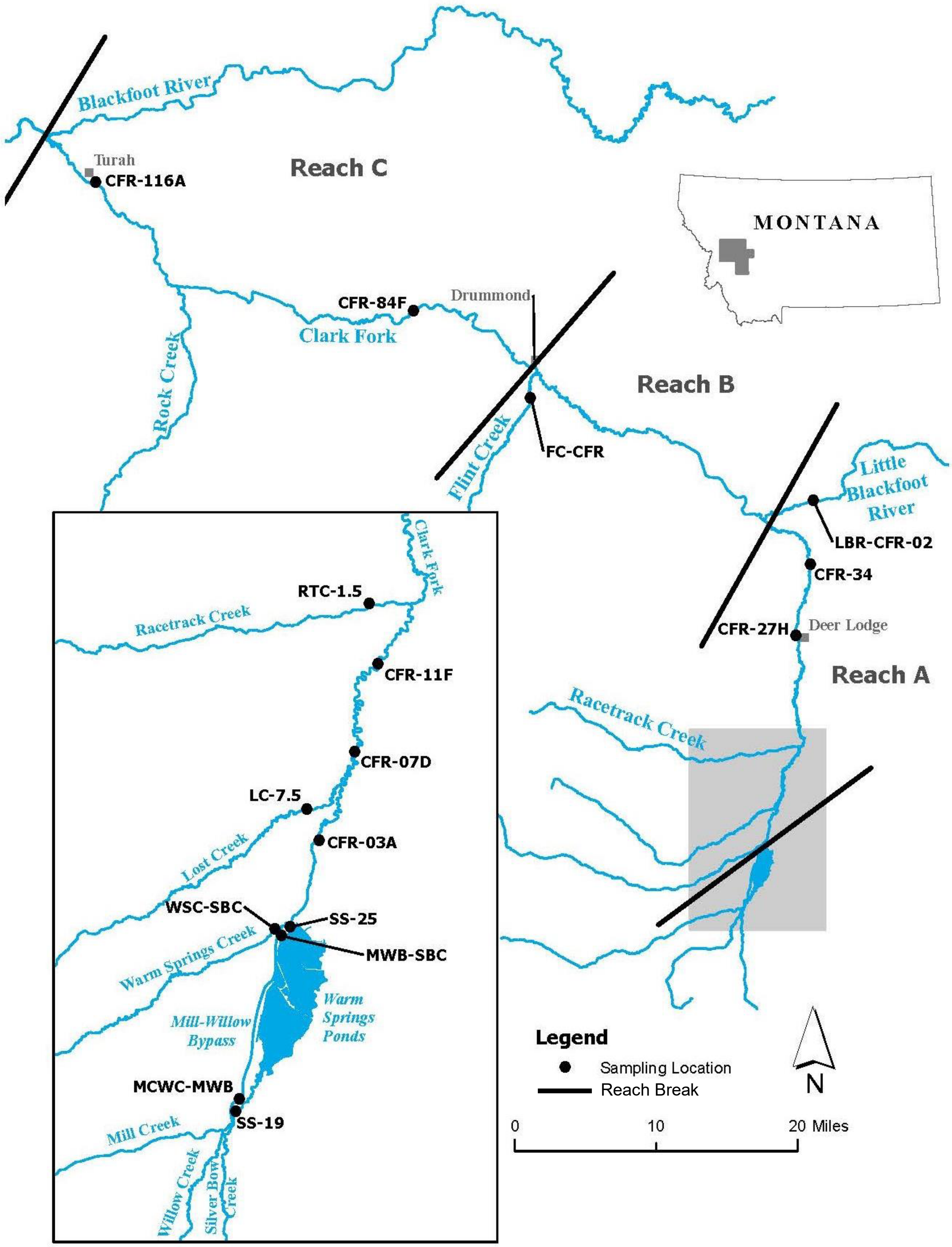

Figure 3. Sampling locations for surface water, stream flows, instream sediments, periphyton and macroinvertebrates. Not all locations are sampled for each parameter yearly. Locations are labeled by site ID. Figure from 2019 Monitoring Report (RESPEC 2020b).

Table 8. Sampling locations (past or current) for surface water, stream flow, instream sediment, periphyton and macroinvertebrate sampling. Not all locations are sampled for each parameter yearly. Table adapted from 2019 Monitoring Report (RESPEC 2020b).

Sampling Locations		**Co-located USGS Streamflow ID**
Site ID	**Description**	
Mainstem Sites		
CFR-03A	Clark Fork River near Galen	12323800
CFR-07D	Clark Fork River at Galen Road	none
CFR-11F	Clark Fork River at Gemback Road	none
CFR-27H	Clark Fork River at Deer Lodge	12324200
CFR-34	Clark Fork River at Williams-Tavenner Bridge	none
CFR-84F	Clark Fork near Drummond	12331800
CFR-116A	Clark Fork at Turah	12334550
Tributary Sites		
SS-19*	Silver Bow Creek at Frontage Road	none
SBC-P2	Silver Bow Creek at Pond 2 outfall	none
SS-25	Silver Bow Creek at Warm Springs	12323750
MCWC-MWB	Mill-Willow Creek at Frontage Road	none
MWB-SBC	Mill-Willow Bypass near mouth	none
WSC-SBC	Warm Springs Creek near mouth	12323770
LC-7.5	Lost Creek near mouth	12323850
RTC-1.5	Racetrack Creek near mouth	none
LBR-CFR-02	Little Blackfoot River at Beck Hill Road	none
FC-CFR	Flint Creek near mouth	12331500

**Typically collected as part of the Streamside Tailings Operable Unit.*

8.1.1 Surface Water

Surface water samples have been collected at up to sixteen sites: seven along the Clark Fork mainstem and nine within tributaries. Surface water samples are collected a minimum of four times per year. Additional samples are occasionally collected during spring runoff events. Chemical constituents of water samples (analytes) regularly analyzed in a laboratory are listed in Table 9 below. Surface water analytes are evaluated relative to performance standards for metals (arsenic, cadmium, copper, lead, and zinc) established in the ROD and applicable ARARs (DEQ 2014 and 2019).

Table 9. Analytes regularly analyzed in surface water samples takes within the CFROU.

Category	Analytes
Physical properties and inorganics	Solids, Total Suspended (at 105 C) Alkalinity, Total (as CaCO3) Hardness (as CaCO3) Alkalinity, Bicarbonate (as HCO3) Chloride Sulfate
Nutrients	Nitrogen, Ammonia (as N) Nitrogen, Nitrate-Nitrite (as N) Nitrogen, Total Phosphorus, Total
Dissolved metals	Arsenic Cadmium Copper Lead Zinc
Total recoverable metals	Total Recoverable Metals Digestion Arsenic Cadmium Calcium Copper Lead Magnesium Potassium Sodium Zinc Mercury Methylmercury

8.1.2 Stream Flow

Stream flow is measured at the same sites where surface water sampling occurs and at the same frequency. At sites that correspond with United States Geological Survey (USGS) gauge locations, streamflow data is monitored continuously throughout the year by the USGS (see Table 8). Sampling locations that do not correspond with USGS gauge locations are measured using either a portable electromagnetic streamflow meter (Marsh-McBirney Flo-Mate 2000) or acoustic doppler current profiler (Teledyne StreamPro ADCP).

8.1.3 Instream Sediment

Instream sediment samples are collected at most of the surface water and stream flow sites. Instream sediment samples are collected twice per year in the first and third quarter. Instream sediment sampling consists of a composite of five samples collected from different depositional areas within a sample site. Analytes analyzed in a laboratory include total metals digestion, arsenic, cadmium, copper, lead, and zinc. No performance standards for instream sediment are established in the ROD. Instead, reference values from consensus-based sediment quality guidelines for benthic organisms (RESPEC 2021) are used to evaluate the likelihood of benthic organism impacts from environmental stressors.

8.1.4 Periphyton

Periphyton samples are collected at most of the same sites as surface water, stream flow, and instream sediment samples. Periphyton samples are collected once per year in the third quarter and include soft-bodied (non-diatom) and silica-walled (diatom) algae. Periphyton are analyzed for taxa richness and Shannon Diversity and use diatom bioassessment indices including Increaser Taxa bioindices, Diatom Association Metrics for Montana Mountain Streams, Ecological Indicator Values of Freshwater Diatoms, and site-specific narratives. These assessments determine a level of impairment from poor water quality resulting from metals, nutrients, or other water chemistry parameters. No performance standards for periphyton are established in the ROD.

Site specific narratives include a review of the bioindices and statistics mentioned above as well as three additional bioindices specific to the northwestern United States: the relative abundance of metals-tolerant taxa; the metal Increaser Taxon 102 biometric to diagnose stress from metal contamination; and the percentage of motile and highly motile taxa.

8.1.5 Macroinvertebrates

Macroinvertebrate samples are collected at most of the same sites as surface water, stream flow, instream sediment and periphyton samples. Macroinvertebrates are sampled once per year in the third quarter. In 2017, sample analysis methods changed from a Hess sampling device to a kick net method (RESPEC 2019). Methods to assess macroinvertebrate impairment include the Montana Valley and Foothill Prairies (MVFP) bioassessment index, the Hillsenhoff Biotic Index (HBI), and the Metal Tolerance Index (MTI) developed for the Clark Fork River watershed. Macroinvertebrate samples are processed and identified by Rhithron Associates, Inc. laboratory. No performance standards for macroinvertebrates are established in the ROD. Instead, narrative interpretations of macroinvertebrate data results determine probable stressors.

8.1.6 Vegetation

Vegetation is monitored using a transect approach with six transects per phase (three on each side of the river). Transects begin at the streambank, span a 50-feet buffer “Riparian Zone”, extend into a “Transition Zone” to the 100-year floodplain, and may extend further into an “Upland Zone” outside of the 100-year floodplain. Monitoring metrics along the transect include percent canopy cover of non-weed perennial vegetation, percent canopy cover of woody species (woody cover does not apply to Upland Zones), and percent canopy cover of noxious weeds. Monitoring occurs in post-Remedy years 1, 2, 3, 4, 5, 7, and 10. Vegetation metrics are evaluated relative to performance standards established in the ROD.

8.1.7 Birds

Bird monitoring data is collected by GoBirdMontana, LLC. The number of monitoring locations varies by Phase and occurs weekly at each monitoring site in the second quarter of the year. Bird number and species are recorded during each monitoring session and data analyses include species richness and relative abundance. Species are also analyzed for riparian-dependent or riparian-obligate breeders to better evaluate riparian development and health. No performance standards for bird data are established in the ROD.

8.1.8 Wetlands

A Performance Standard at the Clark Fork Site is the No Net Loss standard for wetlands: "The State shall evaluate wetlands in accordance with the Clark Fork Basin 4-step process described in the January 27, 1992 letter from AR to EPA, and shall ensure that the Remedy is designed and implemented to optimize wetlands development and ensure compliance with the No Net Loss performance standard," (SMOA 2008).

8.1.9 Fish

Annual fish monitoring is conducted by FWP on the mainstem Clark Fork River from Warm Springs to Bearmouth at seven sites. Mark-recapture population estimates are conducted at seven sites annually and result in measures of trout density (fish/mile). FWP also conducts trout population estimates in recently or soon to be remediated sites. In addition to trout population estimates, FWP conducts surveys of all fish species at three sites on the Clark Fork River. These monitoring activities result in measures of trout density (fish/mile) species composition. Fish population surveys are also conducted in tributaries throughout the Upper Clark Fork River Basin.

8.2 Project Effectiveness Monitoring

Vegetation and geomorphic monitoring of each Phase occurs after integrated Remedy and Restoration has been completed as described in *Clark Fork River Operable Unit Reach A, Geomorphology and Vegetation Monitoring Plan: Clark Fork Site* (Geum and AGI 2015). This monitoring plan includes an initial qualitative rapid assessment (QRA) step where an Adaptive Management Team evaluates each completed Phase. The QRA is intended to help determine whether a project phase is meeting goals or objectives, the level of further effectiveness monitoring required (if any), and any immediate maintenance actions needed. The QRA is designed so a Phase can be evaluated in a one-day field effort. Geum (2017) is an example report from a QRA assessment.

The Adaptive Management Team is unique to each project Phase but generally consists of personnel from DEQ, NRDP, FWP and project designers, so that the people making observations in the field are directly connected with decisions about project maintenance or future designs. Effectiveness monitoring data collection, including the QRA step, occurs only in the years identified in the specific vegetation and geomorphology monitoring plan (Monitoring Plan) for each Phase, or when triggered by events such as floods or land management changes. The amount and type of data collected and the need to collect additional data outside of designated monitoring years is determined by the Adaptive Management Team through the QRA process.

Table 10 gives an overview of effectiveness monitoring metrics and assessment locations. Effectiveness monitoring commences the first growing season after integrated Remedy and Restoration has been completed in a Phase.

During the QRA, the Adaptive Management Team walks through the Phase to observe and record monitoring metric assessments. Data are recorded in broad categories that match performance thresholds and can be readily observed, rather than using detailed measurements that require analysis for interpretation.

Once the QRA is complete, the Adaptive Management Team determines whether each metric is trending toward meeting objectives, has an uncertain trend, or is obviously not going to meet objectives. The Adaptive Management Team then determines whether subsequent effectiveness monitoring is needed to reduce uncertainty about progress toward meeting performance targets. The purpose of the QRA is to ensure that the project is trending towards meeting objectives and that major issues are identified, the effects evaluated, and potential actions implemented in a timely manner to ensure project success. In addition, lessons learned from completed Phases can quickly be applied to future Phases.

Table 10. Summary of effectiveness monitoring metrics, methods of assessment, and general assessment locations.

Monitoring Metric	Method	Location
Geomorphology		
Cross section dimensions	Visual assessment of aggradation/degradation trends	Stream channel
Pool density and residual pool depth	Visual assessment of aggradation/degradation trends	Stream channel
Floodplain connectivity	Visual assessment of floodplain inundation indicators	Project wide
Floodplain stability	Visual assessment of extent, size, and connectivity of floodplain channels	Where floodplain erosion is observed
Secondary channel stability	Visual assessment of avulsion risk associated with secondary channels	Designed secondary channels
Vegetation		
Canopy cover woody vegetation on streambanks	Visual assessment of approximate percent cover of woody vegetation is recorded by streambank	Streambanks
Canopy cover floodplain woody vegetation	Visual assessment of approximate percent cover of woody vegetation is recorded by plot	Pre-determined survival plots
Canopy cover of herbaceous vegetation	Visual assessment of approximate percent cover of herbaceous vegetation is recorded by cover type or transect segment including recording the presence noxious weeds	Pre-determined floodplain transects
Woody vegetation survival	Count of living plants	Pre-determined survival plots
Proportional abundance of floodplain cover types	General observations of cover type development	Project-wide
Natural recruitment	General observations of where natural recruitment is occurring	Project-wide with focus on streambanks and point bars
Woody browse levels	General observations of browse	Pre-determined survival plots and project-wide
Wetland assessment	General observations of wetland development	Project-wide

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Appendix A. State of Montana Contacts--2023

2023 Clark Fork River Operable Unit State of Montana Contacts

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Appendix B. EPA Fact Sheet

EPA United States Environmental Protection Agency

January 2008

Superfund Program Consent Decree **Fact Sheet**

Clark Fork River Operable Unit

of the Milltown Reservoir/Clark Fork River Superfund Site

On February 7, 2008, the Consent Decree for the Clark Fork River Operable Unit of the Clark Fork River/Milltown Reservoir Superfund Site (the CFR Site) will be lodged with the Federal District Court of Montana by the U.S. Department of Justice (DOJ). DOJ will accept comments on the CFR Site consent decree during a 60-day comment period. This marks the successful conclusion of negotiations between the government cleanup agencies and the responsible party (RP) and clears the way for site cleanup to begin.

The Consent Decree—more than 150 pages long—describes in detail each party's responsibilities during the CFR Site cleanup. The Consent Decree states the following for the CFR Site:

- As the RP, the Atlantic Richfield Company (AR), a wholly owned subsidiary of British Petroleum, will pay EPA and the State of Montana Department of Environmental Quality (DEQ) $83.3 million (the estimated cost of the CFR Site remedy) plus approximately $11.7 million in interest, for remedy cleanup costs up front and to "cash out" of the project. Contingency plans are in place for additional funding if the amount agreed upon today is not enough. AR also will pay $26.724 million, plus interest, to the State for Clark Fork Site Restoration work, and $4.75 million to the Department of the Interior (DOI), for past costs and additional restoration activities at the CFR Site.
- The State of Montana Department of Environmental Quality (DEQ) will be the lead agency conducting the bulk of the combined cleanup work.
- The U.S. Environmental Protection Agency, Region 8 (EPA), along with the National Park Service (NPS), will oversee DEQ's work throughout the project.

Cleanup Process for the Clark Fork River Site

2009: Anticipated start of full-scale cleanup. Cleanup may take 10 to 12 years.

2008: Consent Decree lodged.

2006 and 2007: RipES evaluation performed by EPA to prepare for remedy implementation.

2005: Negotiations begin with Atlantic Richfield for remedy implementation and resolution of costs. Two other sites, various Federal agencies, and the Montana DEQ become parties in the negotiation.

2004: Release of the Record of Decision, which describes the cleanup approach.

2002: Release of Proposed Plan for cleanup. EPA responds to more than 2,000 public comments.

State Natural Resource Damages

Besides the Clark Fork Site Restoration funding and activities described above, the Consent Decree also addresses these State Natural Resource Damage claims:

- AR will pay $28.05 million, plus interest, to the State for Butte Area One Restoration actions.
- AR will pay $13.226 million, plus interest, to the State for the Anaconda Uplands Restoration actions. The State will use a portion of this money to implement EPA remedial actions, along with restoration actions, on land owned by the State near Anaconda. Much of the State's work will address contaminated areas in the Mount Haggin Wildlife Refuge.
- AR will pay $4.5 million to the State for past costs incurred by the State for NRD litigation and assessment costs.

Background and Site History

The CFR Site is a 120-mile stretch of river that runs from Warm Springs, Montana, to Missoula, Montana, and is contaminated with mine wastes from upstream Butte and Anaconda sources (see map on page 3). In 2004, EPA selected a final remedy for the CFR Site that calls for careful removal of contaminated tailings from slickens areas (areas devoid of vegetation because of contaminants), treatment in place of impacted areas, streambank reconstruction, land management planning, and institutional controls. The framework for determining what aspect of the remedy applies to a particular area is called RipES, the Riparian Evaluation System.

In 2005, the United States (through EPA) began negotiations with AR for remedy implementation and resolution of interim costs (past costs prior to 2004 were settled in a prior Consent Decree). The discussions also included response and natural resource damage (NRD) claims by DOI for the Grant-Kohrs Ranch National Historic Site (a unit of the National Park Service), and 15 parcels of land managed by the Bureau of Land Management (BLM). At the same time, the State of Montana initiated discussions with AR for settlement of its remaining NRD claims for the CFR Site, and for two upstream sites: Butte Area One and Anaconda Uplands.

Slickens areas are exposed tailings that are devoid of vegetation.

By combining negotiations, all parties were able to resolve extremely complex issues, and the result is the three-party CFR remedy plus restoration Consent Decree, accompanied by a separate State/AR Consent Decree.

Typically, an RP will conduct cleanup work with oversight from EPA. However, recognizing that combining remediation with restoration efforts provided an opportunity to maximize the effectiveness of the total cleanup, EPA and DEQ agreed to the concept of a "cash out" with AR, which would assign DEQ the lead agency role for CFR Site remedy implementation. The Consent Decree establishes how the State will assume the lead agency responsibility for remedy and restoration, and how EPA and NPS will oversee the cleanup.

What Does the Consent Decree Say?

The CFR Site Consent Decree describes obligations and responsibilities for each of the three parties.

Remedy Implementation

AR will pay $83.3 million, plus interest, into a dedicated interest-bearing account managed by the State of Montana, for CFR Site remedy implementation. If costs exceed $83.3 million plus interest paid and earned, EPA can bill AR for the next $9.4 million. AR would have a limited ability to contest that billing. In the State/AR companion Consent Decree, the State agreed to use excess NRD funds from a prior settlement between AR and the State of Montana at another site to refund AR, if AR is called on to pay any portion of the $9.4 million.

If cleanup costs exceed $92.7 million, plus paid or earned interest (the initial $83.3 million, plus the additional $9.4 million), all three parties (EPA, the State, and AR) are liable for costs in a "round robin" fashion. EPA and the State have carefully calculated the expected costs for the CFR Site remedy, including a 20 percent premium for the $92.7 million estimate.

Oversight of the Remediation

AR will pay $1.7 million to EPA into a special account for use in oversight of DEQ's implementation of the remedy. The CFR Site Consent Decree, and an accompanying Superfund Memorandum of Agreement (MOA), provide a detailed description of EPA oversight of the State's work. This cooperative agreement includes approval by EPA (and NPS for remedy work done at the Grant-Kohrs Ranch) of all design and work plans, as well as end-of-work certifications.

Payment for Interim Costs

Interim costs are those incurred by EPA and the DOJ for the CFR Site and the U.S. vs. Atlantic Richfield Company litigation from July 2002 to the effective date of this Consent Decree. AR will pay $6.2 million to EPA for these interim costs.

DOI Past Response Costs and NRD

AR will pay an additional $3.35 million to DOI for NRD claims. DOI will provide approximately $700,000 of this to DEQ for implementation of the Federal Restoration Plan at the Grant-Kohrs Ranch. Up to $350,000 of the DOI NRD settlement will be used by BLM for restoration actions on BLM-managed parcels along the upper Clark Fork River. Because of the relative scale of the work and its geographic location, BLM will implement this work itself. The remainder of the settlement will reimburse DOI for assessments and ensure DOI oversight of future work.

Deep plow tilling and incorporation of lime is an effective tailings remediation tool.

State Natural Resource Resolution on Other Sites

AR will make a $72.5 million payment, plus interest, to the State for reimbursement of the State's past NRD costs (totaling $4.5 million) and ongoing restoration costs at the CFR Site, the Anaconda Uplands Restoration Site, and the Butte Area One Groundwater Site. The money will be divided among the three sites and managed by the State in dedicated interest-bearing accounts. The State will spend $26.724 million (plus interest) for the CFR Site; $13.226 million (plus interest) for the Anaconda Uplands Restoration Site; and $28.05 million (plus interest) for the Butte Area One Site. The Consent Decree incorporates State NRD Restoration Plans for each of these sites.

Responsibility for Anaconda Company Smelter Site

DEQ will perform response actions, using the $13.226 million NRD fund, for property owned by the State at the adjacent Anaconda Smelter NPL Site, under EPA oversight and in accordance with the EPA remedy selected for those properties. Again, the CFR Site Consent Decree and the MOA provide a detailed description of EPA's oversight and approval of the State's work.

AR will pay $500,000 to EPA for oversight of the State's Anaconda work.

What are the Next Steps at the CFR Site?

DEQ has begun to develop the Remedy and Restoration Workplan. The Workplan will contain a schedule of cleanup activities and will set forth the general framework for the entire project. If all goes well during Workplan development this spring, a small scale pilot project could begin on State-owned property in 2008.

Within the next few months, EPA and DEQ representatives will be providing landowner notebooks to the various property owners impacted by the cleanup. These notebooks will contain information to help landowners understand how the cleanup will affect them and how they can contribute to the cleanup process. The notebooks are the byproduct of the RipES evaluation that EPA and its contractor, CH2M HILL, performed in 2006 and 2007.

As the lead agency, DEQ will be meeting with landowners early in the design phase to gain an understanding of landowner concerns and issues. DEQ will work with landowners to coordinate cleanup activities with landowner operations to minimize impacts to the extent practicable.

EPA and the Natural Resources Conservation Service office in Deer Lodge will also assist landowners in understanding remedy components and examining how remedy activities can be implemented with the least amount of impact to the landowner. In addition, the Clark Fork River Technical Advisory Committee is funded by EPA to assist landowners in understanding some of the more complex technical issues.

Large scale cleanup activities are not expected until 2009. The cleanup is expected to take 10 to 12 years.

What is the Basic Plan for Cleanup?

Cleanup activities will focus on Reach A of the River, 43 river miles between Warm Springs Ponds and just upstream of Garrison. Reach B extends from immediately upstream of Garrison, where the Little Blackfoot River enters the Clark Fork, to downstream of Drummond. Very little cleanup will be conducted in Reach B. No cleanup activities are proposed for Reach C, which runs from Drummond to the Milltown Reservoir Sediments operable unit.

Repository at Opportunity Ponds

Removed wastes and soils from the CFR Site cleanup and the State-owned property cleanup at Anaconda will be placed and disposed at Opportunity Ponds. Having one waste repository site meets the need for secure, long-term storage that can be maintained through time.

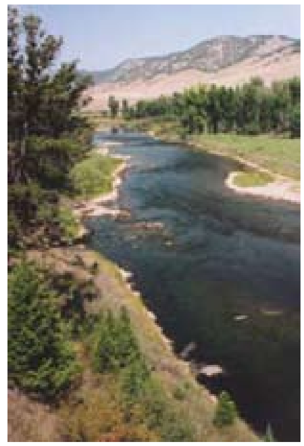
Safety and Dust Control

As DEQ develops the Remedy and Restoration Workplan, DEQ will attempt to minimize use of the East Side Road to transport contaminated sediments to Opportunity Ponds. DEQ and its contractors will emphasize public safety in carrying out the remedy, and will perform road maintenance and upgrades necessary to safely manage truck transport of contaminated materials within the operable unit.

Potential Downstream Impacts

DEQ will conduct extensive monitoring within the Clark Fork River as they implement the cleanup. The U.S. Geological Survey (USGS) also conducts monitoring at several locations along the river above and below Milltown dam.

Reach A: Deer Lodge Valley, View from Garrison looking upstream.



Reach B: (left) Clark Fork Valley; view near Drummond as valley narrows.

Reach C: Bearmouth Canyon; river bordered by steep rock walls.

Some short-term effects from contaminant removal may occur, especially when work along and within the river itself occurs. DEQ plans to design the project to minimize these effects and will use the monitoring data to determine if additional controls are needed during remedial action.

EPA and the State will establish temporary water quality standards for downstream water and the project is expected to meet these standards. If it doesn't, EPA and DEQ have the ability to enact measures, such as best management practices, to ensure project compliance with these standards. The monitoring data will be made accessible to the public throughout the project's duration.

For More Information

Visit our web site, or one of the information repositories listed below.

http://www.epa.gov/region08/superfund/mt/milltowncfr/cfr/

Hearst Free Library
4th and Main Street
Anaconda, MT 59711
Phone: 406-563-6932

Montana Tech
1300 West Park
Butte, MT 59701
Phone: 406-496-4281

EPA Records Center
10 West 15th Street
Helena, MT 59626
406-457-5046

EPA Butte Office
155 West Granite
Butte, MT 59701
Phone: 406-782-3838

Mansfield Library
University of Montana
Missoula, MT 59812
Phone: 406-243-6860

Powell County Planning Office
409 Missouri Street
Deer Lodge, MT 59722
Phone: 406-846-3680

Missoula City/County Library
301 East Main Street
Missoula, MT 59802
Phone: 406-721-2665

Grant-Kohrs Ranch
266 Warren Lane
Deer Lodge, MT 59722
Phone: 406-846-2070

To request a copy of the entire CD, please contact Kris Knutson, EPA, at 1-866-457-5021 or by E-mail at knutson.kristine@epa.gov

Overland runoff from exposed tailings and impacted soils, upper Clark Fork River, 1997.

Submit your comments on the settlement agreement

ES012008001BOI

By mail:

Assistant Attorney General
Environment and Natural Resources Division

U.S. Department of Justice
P.O. Box 7611
Washington, D.C. 20044-7611

Ref: United States vs. Arco
Clark Fork River Site
DOJ Ref #90-11-2-430

By e-mail:

Pubcomment-ees.enrd@usdoj.gov

Ref: United States vs. Arco
Clark Fork River Site
DOJ Ref #90-11-2-430

For more information, contact:

Wendy Thomi
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10 W. 15th St.; Suite 3200
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If you want to be added to or removed from the CFR Site mailing list, please contact Gladys Hiett, 406-457-5034, or e-mail her at Hiett.Gladys@epa.gov.

U.S. ENVIRONMENTAL PROTECTION AGENCY
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Appendix C. Data Sources and Analyses

Data Sources and Analyses

This section describes data and analyses used to estimate quantities, costs, and other numeric values used in the Strategic Plan. Analyses were completed in GIS and therefore methods are described in those terms and specific GIS tools are italicized in the text. Data sources are listed in Table A3-1.

Table A3-1. Data sources used in the Strategic Plan.

SPATIAL DATA	DESCRIPTION	SOURCE
Aerial imagery	1955 black and white	USGS Scanned orthorectified, and mosaicked by MapCon Mapping, Salt Lake City
	2006 high resolution, color	Provided by EPA & MT DEQ
	2011 high resolution, color	Provided by EPA & MT DEQ
	2019 NAIP	USDA NAIP 2019
LiDAR	2019	Quantum Spatial, 2020. Accessed via the Montana State Library
Cross Sections	2019 Reach A channel cross sections	River Design Group collected to support hydraulic analysis for Reach A.
Banklines	1955	CDM & AGI 2013. Developed as part of Geomorphology and Hydrology of Reach A Report
	2006	CH2M Hill, 2008 provided by EPA & MT DEQ
	2011	CDM & AGI 2013. Developed as part of Geomorphology and Hydrology of Reach A Report
	2019	CFC & UMW, Developed for Strategic Plan, digitized using NAIP 2019 imagery and 2019 LiDAR
Turnover polygons	2006 to 2011	CDM & AGI 2013. Developed as part of Geomorphology and Hydrology of Reach A Report
	2006 to 2019	Geum & AGI, Developed for Strategic Plan
	2011 to 2019	Geum & AGI, Developed for Strategic Plan
	1955 to 2019	Geum & AGI, Developed for Strategic Plan
Clark Fork River centerline	2019 channel centerline	Geum, Developed for Strategic Plan
RipES	Slicken and Impacted Areas	EPA 2008, Record of Decision
Channel Migration Zone	50 year Mean	Geum & AGI, Developed for Strategic Plan
	50 year 90th percentile	Geum & AGI, Developed for Strategic Plan
	100 year Mean	Geum & AGI, Developed for Strategic Plan
	100 year 90th percentile	Geum & AGI, Developed for Strategic Plan
Geomorphic Sub-reaches	Geomorphic subreaches of Phase A based on amount of migration	AGI, Developed for Strategic Plan
Migration Vectors	2006 to 2011	CDM & AGI 2013. Developed as part of Geomorphology and Hydrology of Reach A Report
	2006 to 2019	AGI, Developed for Strategic Plan
	1955 to 2019	AGI, Developed for Strategic Plan
Phase Polygons	Polygons of Reach A Phases (1-22) capturing 100 year floodplain and	Based on CH2MHill 100 year floodplain and revised by Geum & AGI, Developed for Strategic Plan

SPATIAL DATA	DESCRIPTION	SOURCE
	extended to capture channel migration up to 2019	
Phase Breaks	Polylines representing start/stop boundaries along the Clark Fork River for Reach A Phase (1-22)	DEQ Remedial Design, updated 2021.
Soil Pits	Depth of contamination (1400ppm)	Phase 4B, DEQ, collected as part of remedial investigation (2014-2015) Phase 7, DEQ, collected as part of remedial investigation (2014, 2016) Phases 8 & 9, DEQ, collected as part of remedial investigation (2015-2016) Phases 13 & 14, DEQ, collected as part of remedial investigation (2016) Phases 10, 11,12 & 17 – 22, NRDP collected as part of Data gaps investigation (2020)

Turnover – Risk of Entraining Tailings

A channel and floodplain turnover analysis was completed using the 2006 and 2019 bankline datasets. The 2006 channel banklines had been digitized from high resolution aerial imagery by CH2MHill for the Environmental Protection Agency (EPA) (digitizing resolution unknown). The 2019 channel banklines were recently digitized by Clark Fork Coalition (CFC) and the University of Montana Western (UMW) using USDA NAIP imagery and 2019 LiDAR.

Both bankline datasets were attributed to indicate whether an individual polygon was part of the main channel, or an island in the respective year. The two datasets were *unioned* to create a new Turnover shapefile and a new attribute was added characterizing the 2011 status and the 2019 status of individual polygons. For example, a polygon in the Turnover shapefile may have been labeled “2006 channel to 2019 island” representing a depositional polygon and floodplain gain between 2006 and 2019. Polygons outside of the 2006 channel spatially occupied by the 2019 channel were labeled “2006 floodplain to 2019 channel” and represent erosion and floodplain loss between 2006 and 2019.

The “Turnover” shapefile was then *intersected* with the Phase polygons shapefile. The Phase polygons shapefile is based on the 100-year floodplain shapefile prepared by CH2MHill for the (EPA) that had been previously segmented by Geum Environmental Consulting, Inc. (Geum) using the Reach A phases (1 through 22). Some areas of the 100-year floodplain boundary were manually expanded to include the 2019 channel boundary which occasionally occupied areas beyond the 100-year floodplain boundary, typically along high terraces. Phase 4A was also added as a subphase to Phase 4.

A 2019 Clark Fork River centerline was created using the 2019 channel polygon and the centerline was divided into phases to provide a channel length by phase. Where the Clark Fork River occupied two channel paths, only the larger, main channel was included in the channel centerline and length.

Using the acres of erosion by phase output from the Turnover shapefile and the length of river miles by phase, normalized values representing acres of erosion by river mile by phase was calculated. These values represent geomorphic stability by phase and inform the proposed sequencing for remediation.

Streambank length by Phase – Streambank Treatments

The 2019 channel polygon shapefile was converted to a polyline shapefile and *intersected* with the Phase polygon shapefile that is segmented into Reach A phases. The output shapefile was a polyline providing streambank length in feet by phase. The sum of banklines by phase was used in the cost analysis to estimate length of streambank treatments within each phase.

Channel Migration Analysis – Base Removal Extents

A channel migration zone (CMZ) for the 2019 channel was developed using lateral channel migration data between 1955 and 2019 and included as part of the base removal extents that will remove contamination at a high risk of entrainment.

Data sources included bank lines created from ortho-rectified 1955 imagery (CDM and Applied Geomorphology 2013) and 2019 banklines digitized by the University of Montana Western and the Clark Fork Coalition using United States Department of Agriculture's National Agricultural Imagery Program (NAIP) imagery and 2019 Light Detection and Ranging (LiDAR) data. To develop the updated CMZ, a total of 1,791 migration vectors were created. These migration vectors quantify the lateral distance between the 1955 bankline and the 2019 bankline, and the direction of migration. Generally, migration vectors were located in areas of active bank movement, such as outer bends, and were spaced approximately 50 feet apart. Reach A was divided into 49 geomorphic subreaches (including remediated phases) that represent sections of the river with similar fluvial geomorphic conditions, and migration vectors were analyzed statistically within those subreaches.

First, the average (mean) length of migration vectors was calculated for each subreach. This mean length was converted to an annual migration rate and multiplied by 100 to estimate a projected channel migration distance over the next 100 years. This migration distance was applied uniformly to both left and right 2019 riverbanks to produce a buffer around the channel. This buffer results in an area that represents the CMZ.

Adjustments were then made to certain areas of the CMZ based on geomorphic interpretation. For example, steep, high terraces that lack contaminated sediments were removed from the CMZ. As another example, the CMZ often did not encompass the center area of meander tabs. Some of these tabs are at risk of avulsion, which would cause a mass erosion of contaminated sediments into the river. Therefore, the CMZ was expanded to include the entire meander tab when its dimensions indicated a relatively high risk of avulsion. Generally, meander tabs with an avulsion ratio of 5 or greater (the length of the channel divided by the length of the avulsion path or distance across the tab) were added to the CMZ. Thirty-seven meander tabs were included in the CMZ.

RipES Slickens and Impacted Areas

An analysis of previously mapped RipES Slickens and Impacted areas was performed to quantify slickens inside and outside of the CMZ shapefile by phase to estimate additional removal areas outside the CMZ by Phase.

RipES slickens and impacted areas digitized by CH2M Hill were *unioned and* polygons that were spatially located inside the 2019 channel were quantified and removed from the slickens and impacted layers.

RipES slickens and impacted areas were *unioned* with each CMZ shapefile and polygons inside the CMZ and outside the CMZ were quantified.

Acres of combine slickens and impacted areas outside of the CMZ were compared to total acres within the CMZ to estimate the potential additional removals outside the CMZ. For example, a Phase with total CMZ acreage of 80 acres and with 20 acres of slickens and impacted areas outside of the CMZ has the potential for 25 percent additional contaminated sediment removal outside the CMZ.

Contaminated Sediment Removal and Backfill Estimates

To support cost estimating, Geum performed raster-based GIS analyses to estimate contaminated sediment removal and backfill volumes in unremediated phases of CFROU. These estimates were based on sample pit data, the 100yr mean CMZ boundary, and a Q1.5 relative elevation model (REM). These data and the removal and backfill analyses are described in greater detail below.

Soil Pit Sampling Data

Soil test pit data were collected within each phase at different sampling densities. Phases 4, 7, 8, 9, 13 and 14 were collected at approximately 125 ft intervals as part of design investigations, and Phases 10, 11, 12 and 17 – 22 were collected at a lower density (~10% of the 125 ft interval density) sufficient to estimate volumes of contaminated sediments within each Phase. A summary of these methods and results is provided in Geum (2021) and summarized below.

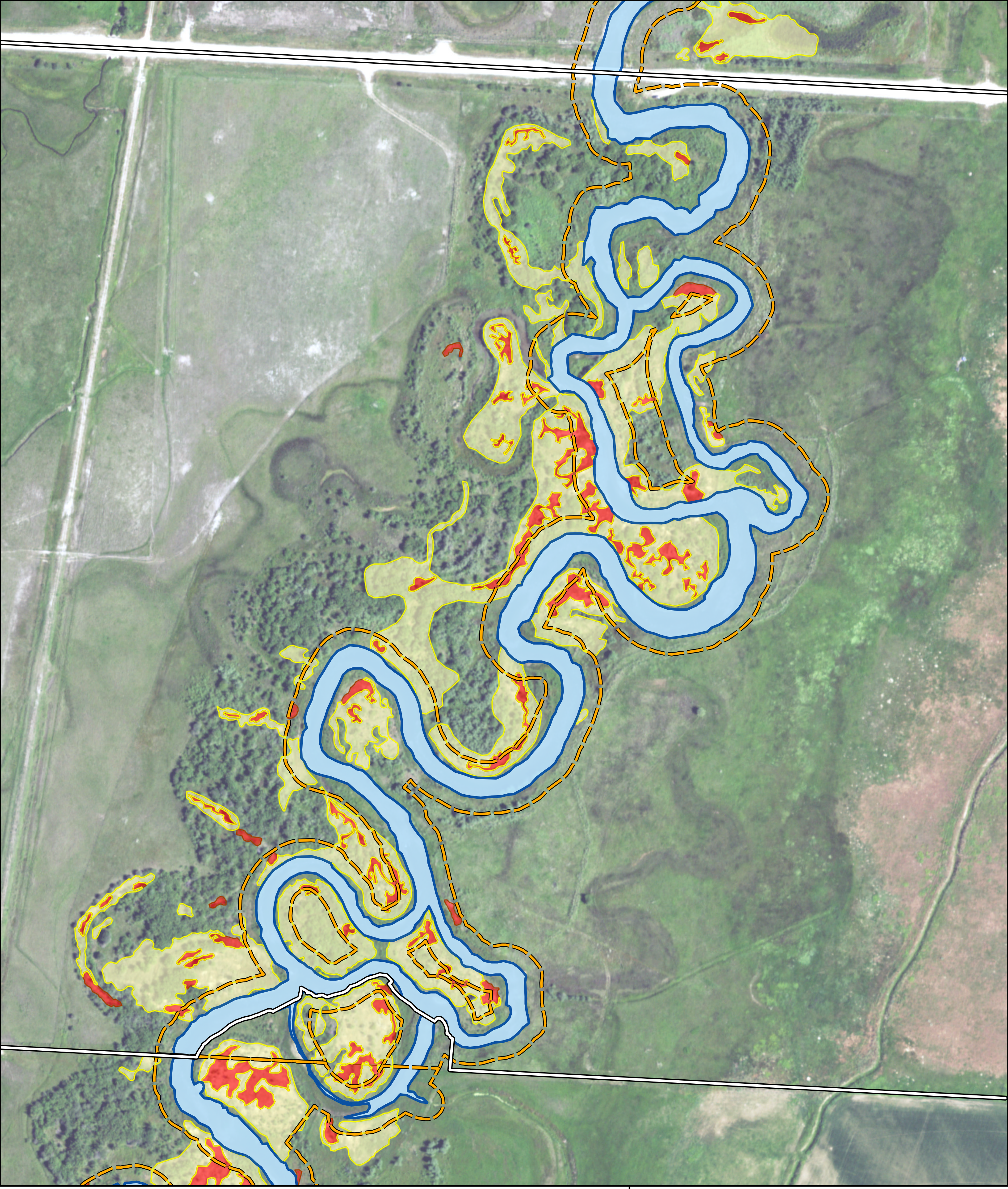
Contaminated Sediment Removal Volume Estimates

The ESRI ArcGIS *Spline Interpolation with Barriers* geoprocessing tool was executed to create an interpolated raster surface representing the maximum depth of total COCs >1400 or 1260 mg/kg for each phase using the total extent of pit sampling data. This interpolation method was chosen because it is well-suited for generating "gently varying surfaces such as…pollution concentrations," (ESRI tool documentation, 2021), and based on its ability to mirror actual removal volumes for completed phases (as described in *Upper Clark Fork Soil Sampling Analysis* (Geum, 2020)). The resulting 'depth of contamination surface' was then clipped to exclude the 2019 Clark Fork River channel, and volume estimates were calculated using *Zonal Statistics* tool, which summarizes removal depth pixel values within the extents of the 100yr Mean CMZ for each phase.

Floodplain Backfill Volume Estimates

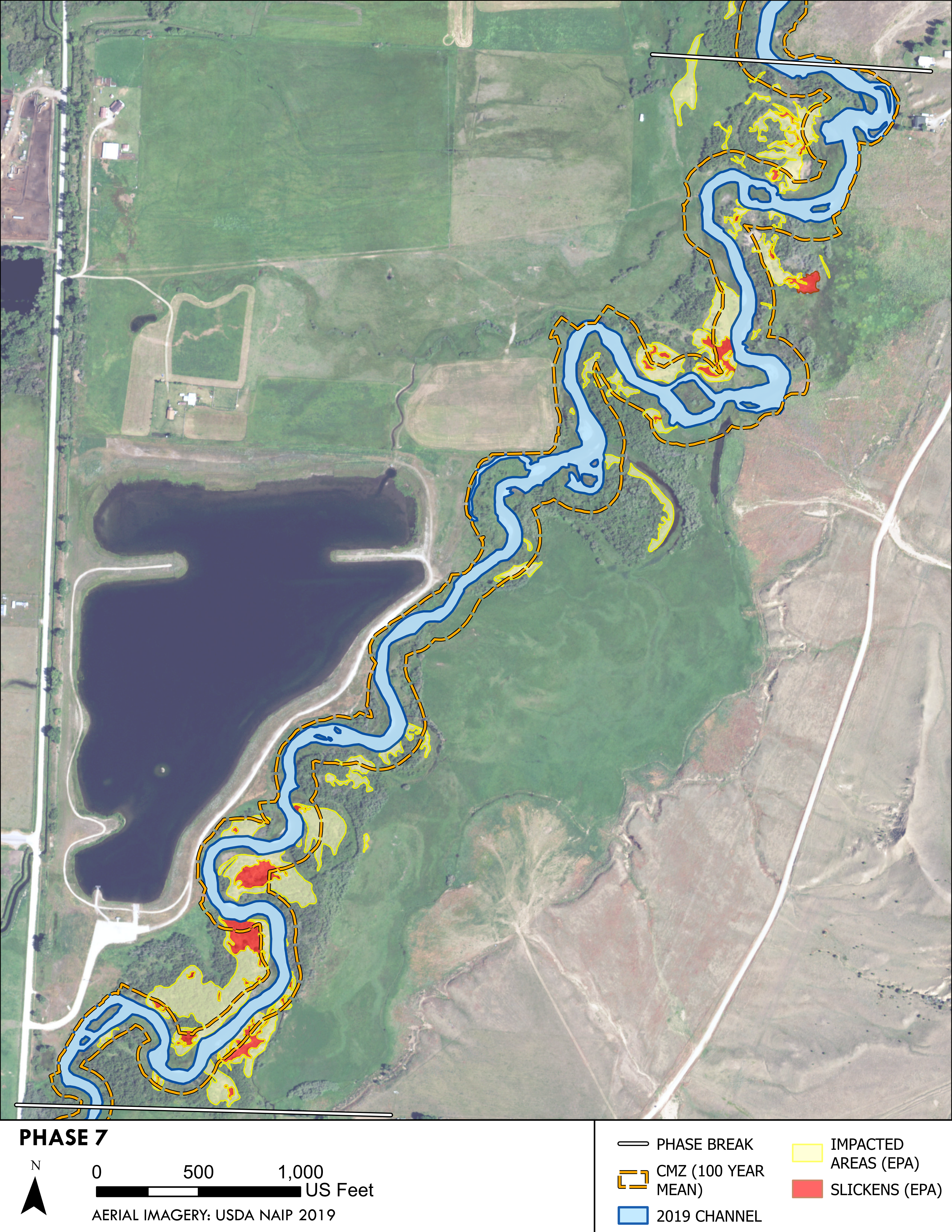
Backfill volume estimates were developed by subtracting the 'depth of contaminants' surface (described above) from the 2019 LiDAR to create a conceptual remedial floodplain surface that represents the ground surface after contaminated sediments are removed. The difference between this remedial surface and the elevation of the Q1.5 water surface elevation represents the estimated backfill volume. The Q1.5 water surface elevation was derived from hydraulic cross-sections developed by River Design Group (RDG 2021). These cross sections were used to create a continuous raster surface covering the entire CFROU floodplain, using the *Create TIN*, and *TIN to Raster* tools. The remedial floodplain surface was then subtracted from the Q1.5 water surface plane to create a surface representing the difference between the removal surface and the Q1.5 water surface. Backfill volume estimates were calculated using the *Zonal Statistics* tool, which summarizes the backfill depth pixel values within the extents of the 100yr Mean CMZ boundary for each phase. Backfill estimates are based solely on these data outputs, and no additional manipulation of the data was done to account for scenarios that may influence actual backfill quantities such as preservation features (which may not receive backfill during actual restoration), or existing ground tie-ins (which may require additional backfill). Thus, these volumes are estimates for purposes of planning and actual volumes will be determined during design for each Phase.

Appendix D. Channel Migration Zone and RiPES Slickens/Impacted Areas by Phase



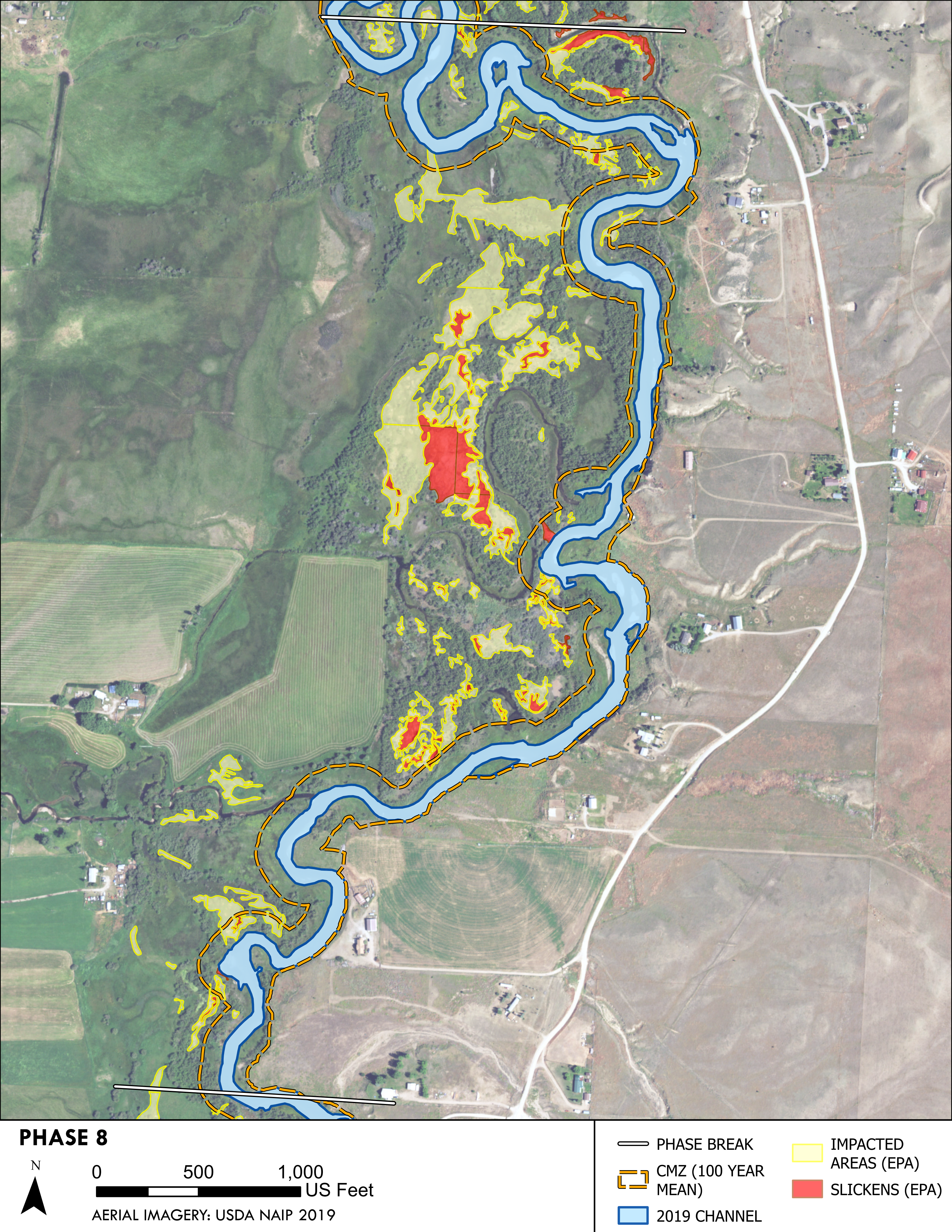
PHASE 4B

N
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)



PHASE 7

N
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)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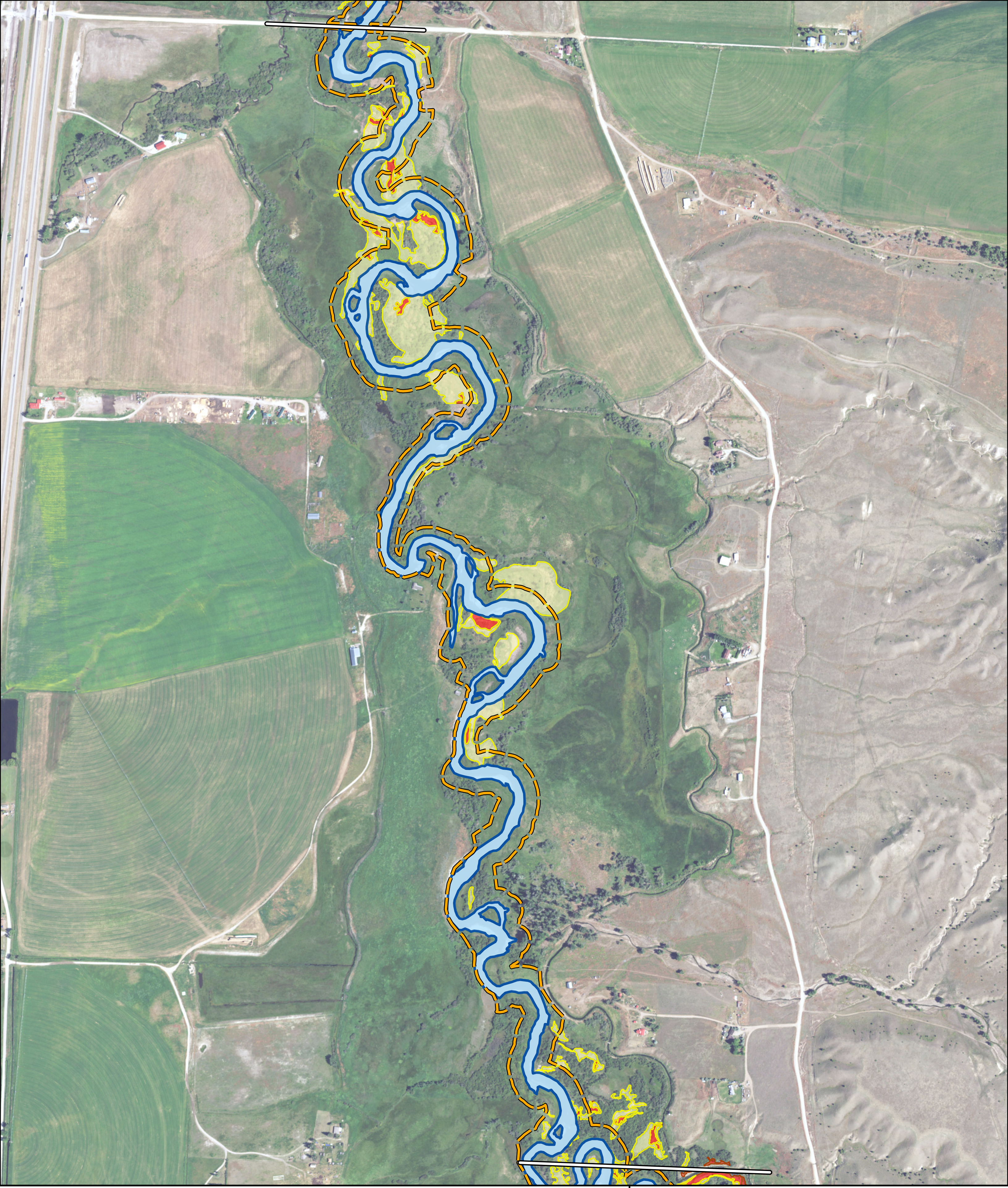
N
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)



PHASE 9

N

0 500 1,000

US Feet

AERIAL IMAGERY: USDA NAIP 2019

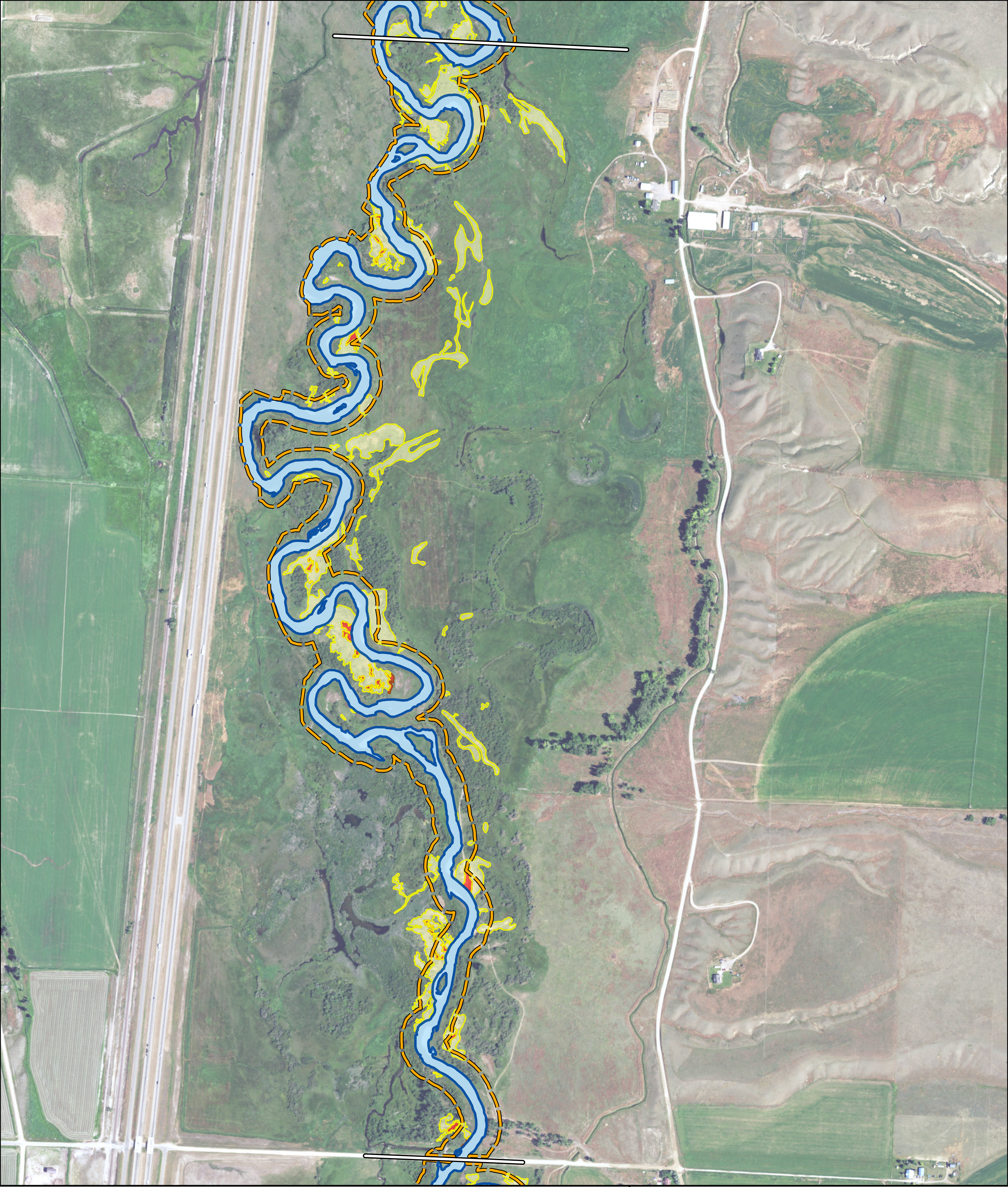
PHASE BREAK

CMZ (100 YEAR MEAN)

2019 CHANNEL

IMPACTED AREAS (EPA)

SLICKENS (EPA)



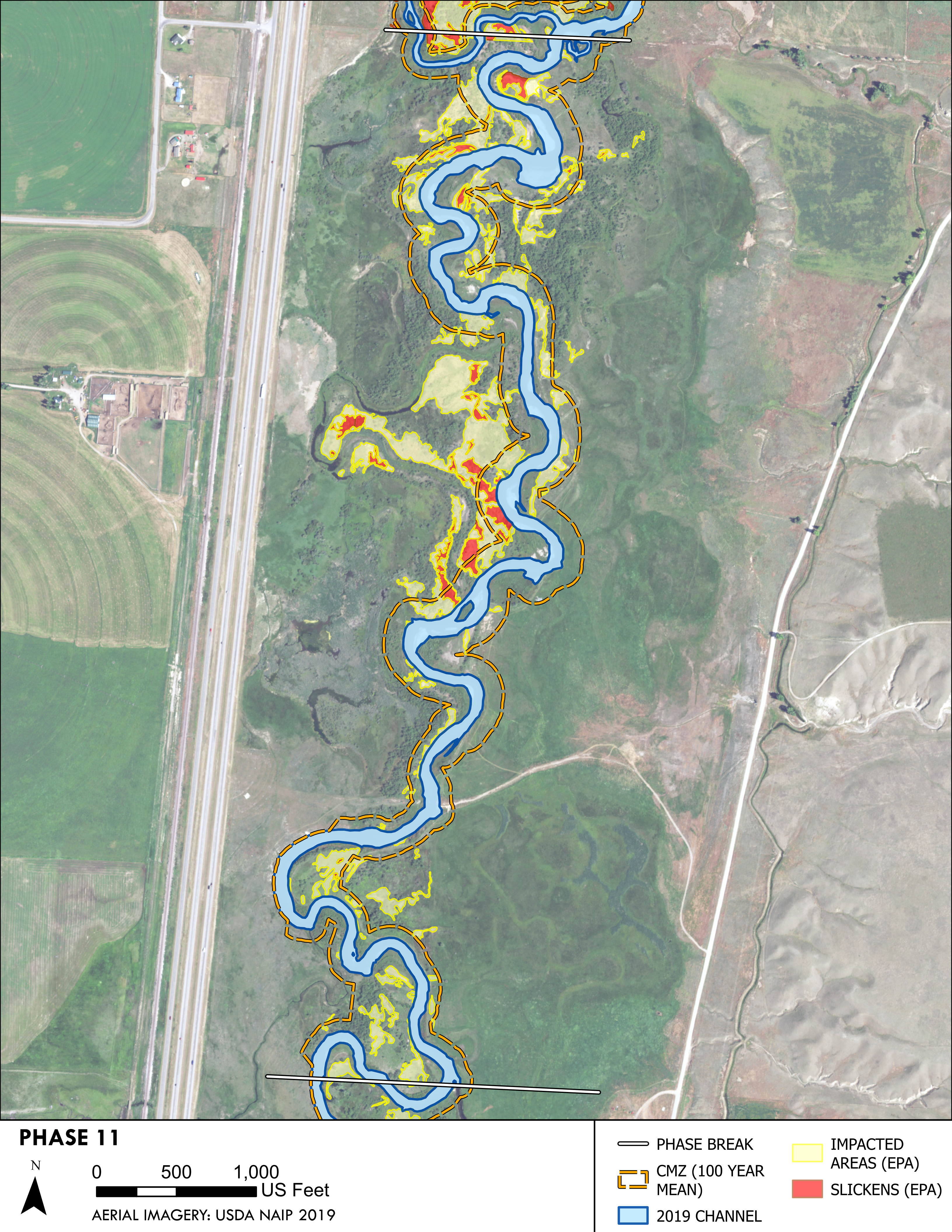
PHASE 10

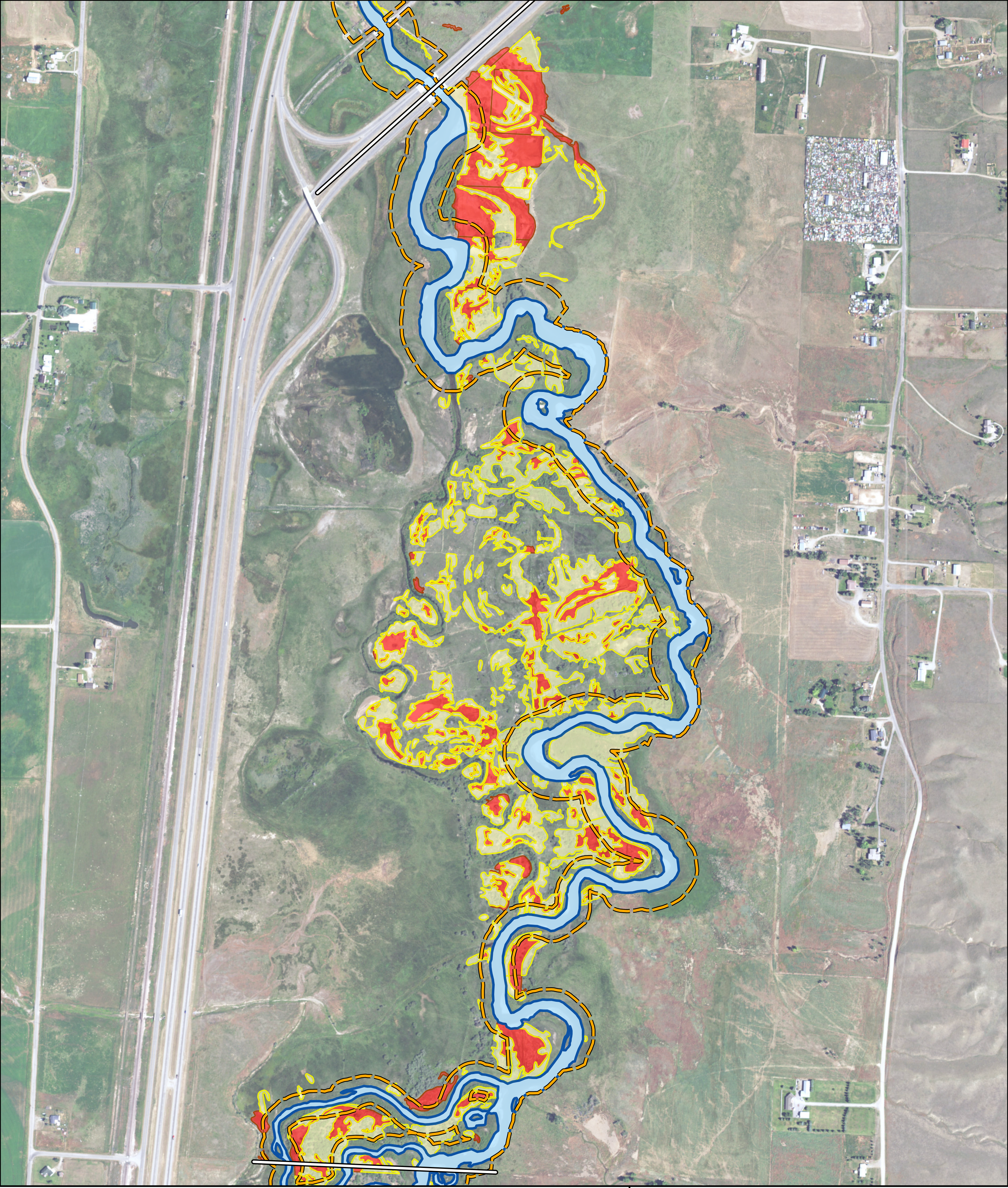
N

0 500 1,000
US Feet

AERIAL IMAGERY: USDA NAIP 2019

PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)


PHASE 11
N
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)

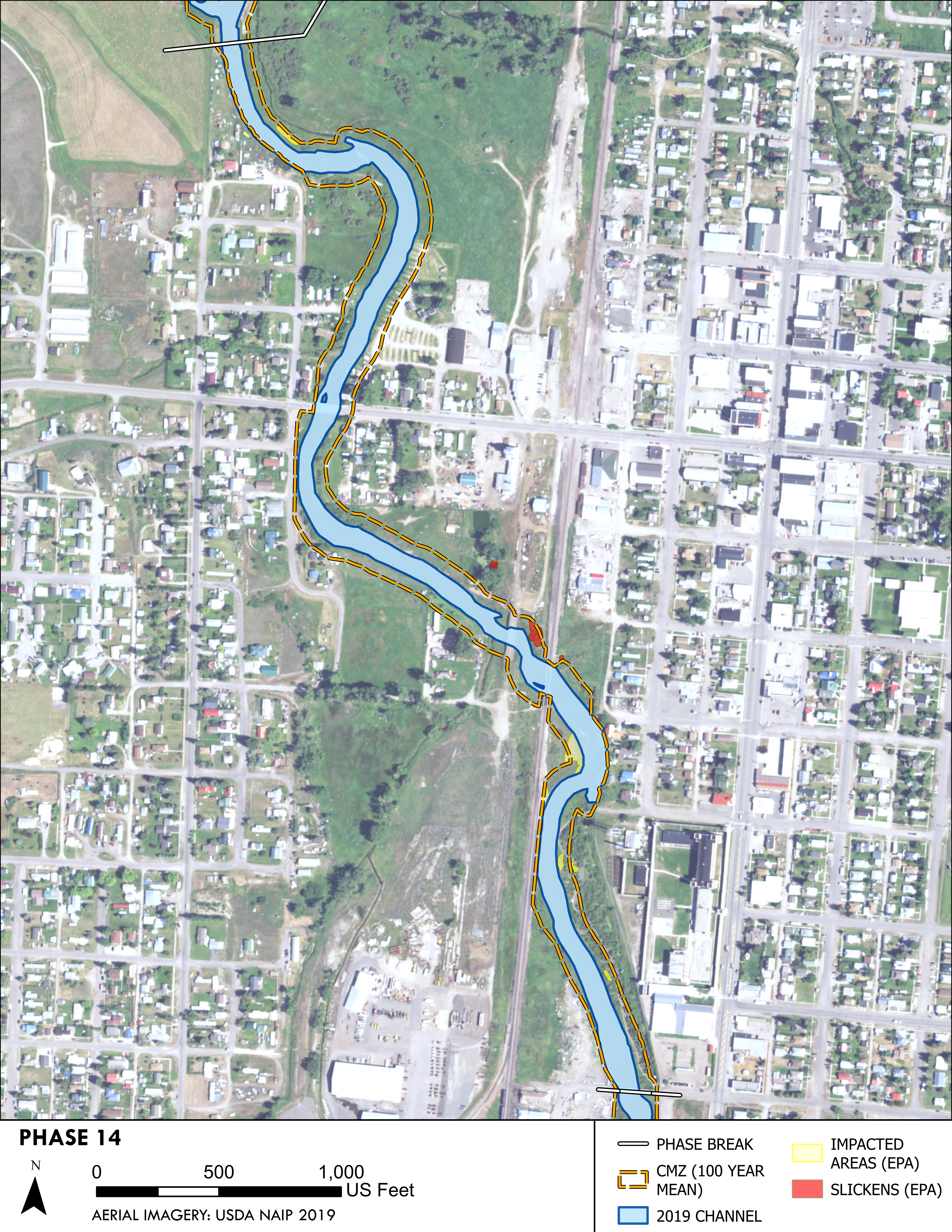


PHASE 12

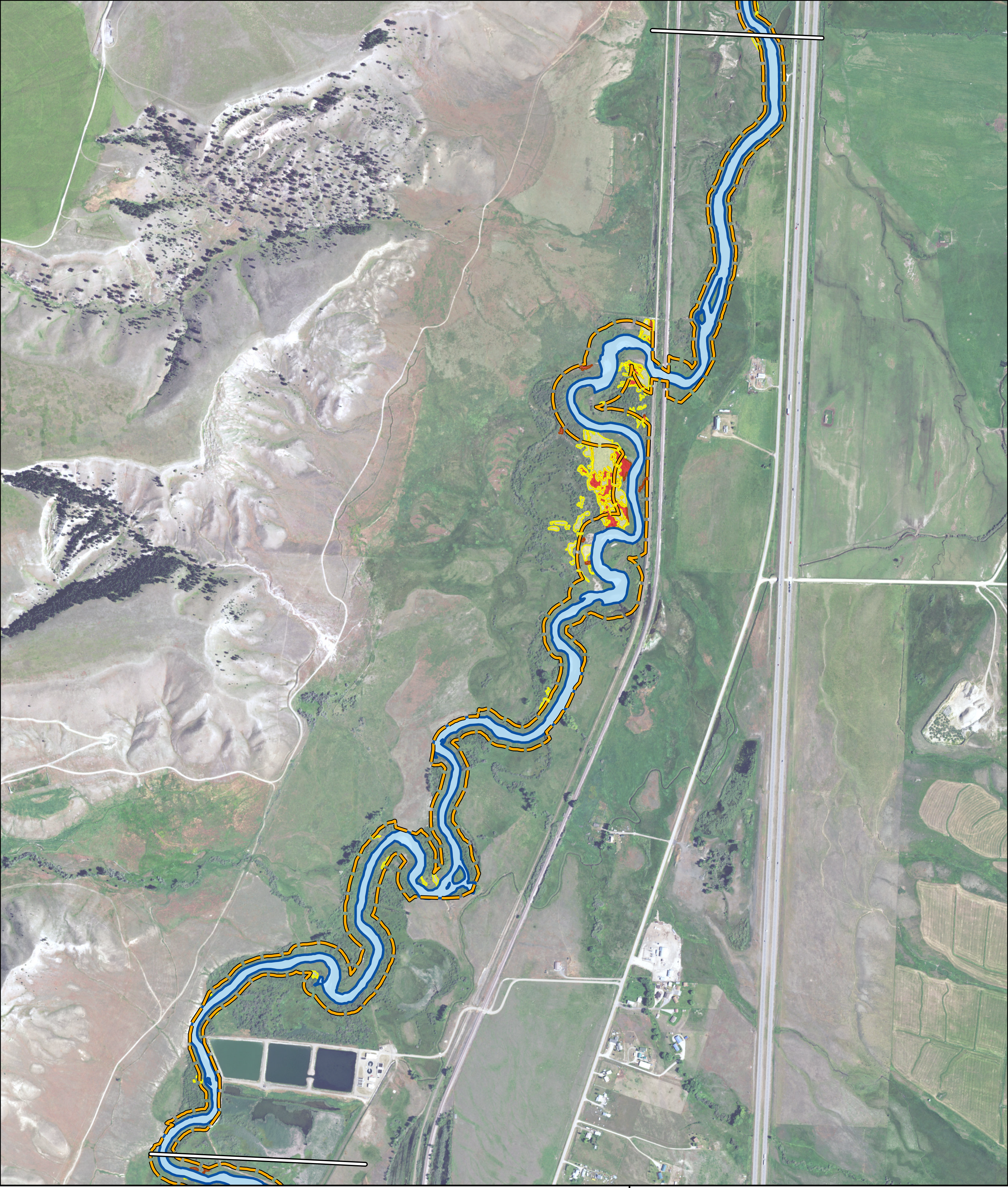
N
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)

PHASE 13

AERIAL IMAGERY: USDA NAIP 2019



PHASE 14
N
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)



PHASE 17

N

0 500 1,000 US Feet

AERIAL IMAGERY: USDA NAIP 2019

PHASE BREAK

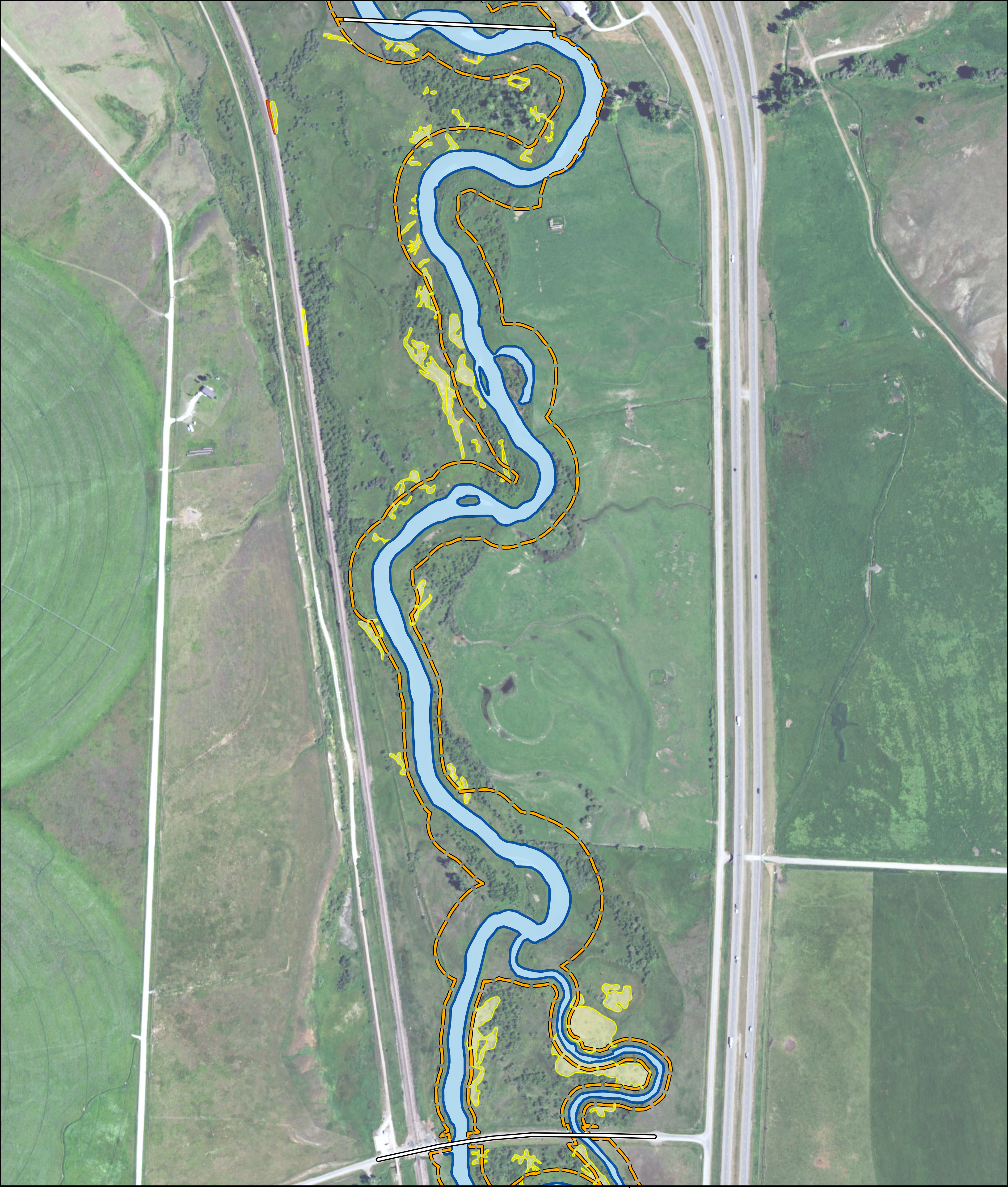
CMZ (100 YEAR MEAN)

2019 CHANNEL

IMPACTED AREAS (EPA)

SLICKENS (EPA)


PHASE 18
N
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)



PHASE 19

N

0 500 1,000 US Feet

AERIAL IMAGERY: USDA NAIP 2019

PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)

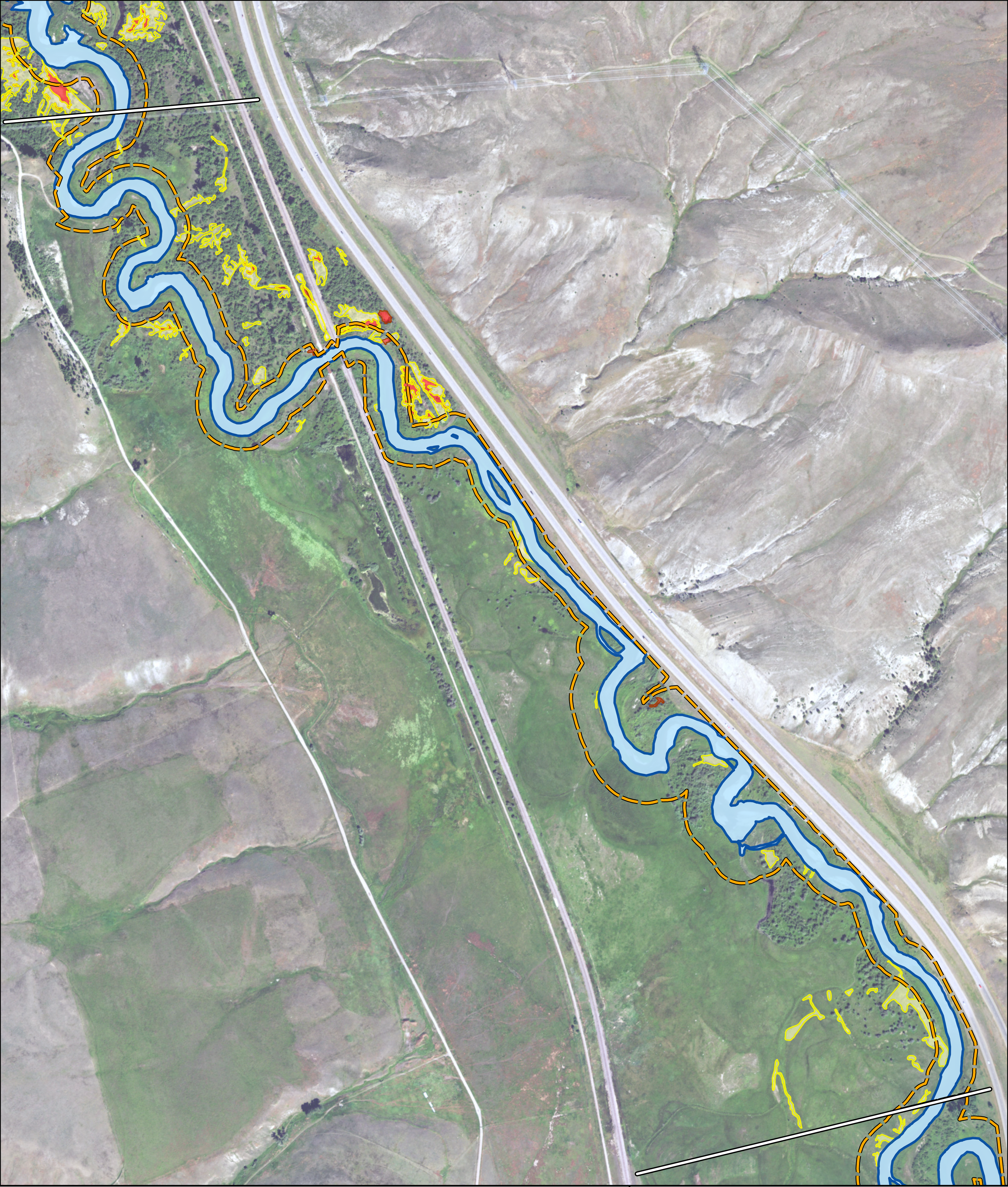
PHASE 20

N

0 500 1,000
US Feet

AERIAL IMAGERY: USDA NAIP 2019

PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)



PHASE 21

0 500 1,000 US Feet

AERIAL IMAGERY: USDA NAIP 2019

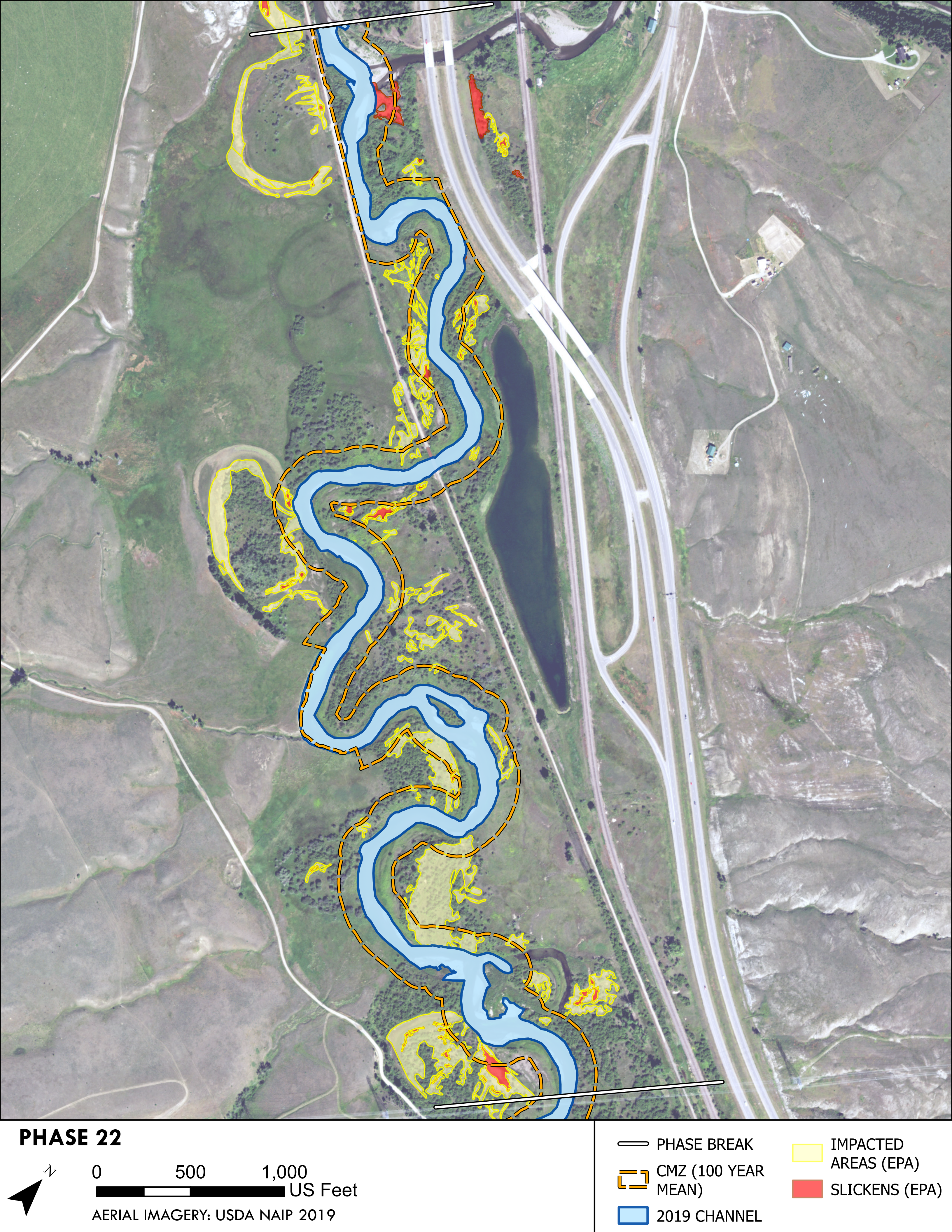
PHASE BREAK

CMZ (100 YEAR MEAN)

2019 CHANNEL

IMPACTED AREAS (EPA)

SLICKENS (EPA)



PHASE 22
0
500
1,000
US Feet
AERIAL IMAGERY: USDA NAIP 2019
PHASE BREAK
CMZ (100 YEAR MEAN)
2019 CHANNEL
IMPACTED AREAS (EPA)
SLICKENS (EPA)

Appendix E. Example Decision Criteria for Addressing Avulsions

MEMORANDUM

TO: CFR Phase 3 Project Team

FROM: Beau Downing

DATE: October 1, 2021

SUBJECT: Phase 3 Avulsion (Meander Cutoff) Channel Realignment

Background

Two river meanders on the Clark Fork River, within the Upper Clark Fork River Operable Unit Reach A Phase 3 remedial area, are at imminent risk of meander cutoff through an avulsion pathway, and represents a significant shift toward a transient and unstable channel configuration. The planform adjustment poses a risk to planned or completed remedial actions and warranted an evaluation to determine if the river channel could be realigned to a more stable configuration to protect the work while maintaining appropriate hydraulic and sediment transport capacity.

Meander Evolution

Meander cutoffs occur when a meander bend reaches a length (and subsequently lower slope) that can no longer efficiently move the water and sediment supply from upstream. In instances where a flood or floods of sufficient magnitude occur, flow across the meander tab or neck can lead to progressive or immediate cutting off the transport deficient meander. The cutoff channel, by shortening channel length (and subsequently increasing slope), represents an increased energy gradient, often more than what is necessary to effectively transport the water and sediment supplied from upstream. As a result, these channels are inherently unstable, and lead to accelerated lateral and downstream bank erosion as the stream begins the process of lengthening the channel to regain equilibrium. In instances of meander cutoff, both the abandoned channel and the newly formed channel represent unstable channel planform configurations.

CFROU Phase 3 Meander Cutoffs (Avulsions) Evaluation

As mentioned above, two meander cutoffs are at imminent risk of being cutoff, or the cutoff has already begun. NRDP, with Tetra Tech as the design engineer, evaluated the following to determine in channel realignment at these locations was warranted:

Maintain Current Channel Alignment

1. Protective measures required to keep the channel in its current alignment
    a. Reinforced meander tabs or meander necks to stabilize avulsion pathways

Natural Resource Damage Program
State of Montana
Dept. of Justice
P.O. Box 201425
1301 East Lockey
Helena, MT 59620-1425
Phone: 406-444-0205
Fax: 406-444-0236
nrdp@mt.gov

    b. Bank treatments required to protect against erosion at the downstream and upstream end of avulsion pathways.
2. Sediment transport capacity of the existing meander
    a. Are the channel slope and channel dimensions able to transport the predicted sediment load?
3. Risk to adjacent meanders and streambanks if left in the current channel alignment
4. Risk to existing in channel habitat.

Realign Channel

1. Is there a new channel alignment that provides the slope, channel dimensions, and planform that provides near and long-term stability that protects the work?
    a. Are the channel slope and channel dimensions able to transport the predicted sediment load?
2. Can similar habitat features be created to those being lost by realignment
3. Does the new alignment fit the pattern and profile of existing stable reaches?

<u>CFROU Phase 3 Channel Realignment Design</u>

After evaluating the existing meanders and proposed channel realignment configurations it was determined that realigning the channel at or near both meander cutoffs was warranted. The existing channel planform at these meanders isn’t sustainable for the long-term and carried significant risk to the work. The chosen channel alignments represent stable alignments and channel dimensions that will provide efficient sediment and water transport while creating similar habitat features to the sections of channel being eliminated.

Appendix F. State Coordination, Cooperation and Project Management

This Strategic Plan does not replace or supersede the CD or SMOA for the CFROU or the Revised Restoration Plan for the Clark Fork River Aquatic and Riparian Resources.

STATE COORDINATION, COOPERATION AND PROJECT MANAGEMENT

1. ln order to be cost-effective, create efficiencies, and to better remediate and restore the CFROU Site and its environment, DEQ and NRDP shall endeavor to integrate, to the extent practicable, the implementation of remediation and restoration as a single project at the Site.

2. DEQ and NRDP will coordinate with each other to implement the response and restoration actions within the CFROU. This coordination will include reasonable notice of, and an opportunity to participate in, any scheduled meetings with third parties related to the CFROU, or any significant site activities. Reasonable prior notice will be given seven (7) days in advance. If a meeting needs to be scheduled on shorter notice, the Project Managers will use their best efforts to contact their counterparts and will determine the counterpart's availability prior to scheduling the meeting. Neither of the DEQ and NRDP will be liable for the contracts, acts, errors, or omissions of the other Party, or its agents, employees, contractors, or agencies entered, committed, or performed with respect to or in the performance of this Strategic Plan.

3. DEQ will be the lead agency and assign a Project Manager to coordinate with the NRDP Project Manager in the implementation of the remedial actions. DEQ Project Manager will be the main contact with EPA on CFROU remedial and restoration in lieu of remediation activities. As agreed between DEQ and NRDP in the development of Phase/Action-Specific Integration Plans, the DEQ Project Manager will manage specific remedial and restoration projects and actions.

4. NRDP will assign a Project Manager to coordinate with DEQ Project Manager in the implementation of the integrated remediation and restoration actions. As agreed to by DEQ and NRDP in the development of Phase/Action-Specific Integration Plans the NRDP Project Manager will manage specific remedial and restoration projects and actions.

5. DEQ and NRDP, respectively, shall consult with and keep each other informed of all significant issues, decisions, public press communications, and actions pertaining to the design, implementation, or other issues pertaining to the remedial and restoration actions at the CFROU Site. The DEQ and NRDP Project Managers will communicate regularly to review work status and resolve any existing or anticipated technical issues and coordinate on major decision points including: the scope of work to be performed, project management procedures and contracts, project design and construction specifications,

access issues, and community involvement activities. DEQ and NRDP commit to using best efforts to resolve site management issues at the Project Manager level.

6. Overall Program Management of the remediation and restoration provided for in this Strategic Plan shall be led by DEQ and NRDP supervisors, namely of the AML & CS Supervisor, DEQ, and the Restoration Program Chief, NRDP (collectively, the Program Managers). The two should work towards establishing consensus. All budgets, budget modifications, design reports, construction plans, bid packages and other significant documents and issues affecting the work to be performed at the CFROU under the CD, and this Strategic Plan shall be approved by the Program Managers. If decisions on major project elements cannot be reached at the Program Manager level, then a Dispute Resolution process will be utilized (see below).

7. The Project and Program Managers shall be briefed by assigned agency legal staff on any legal issues stemming from the Consent Decree or contract and bid package development.

8. DEQ and NRDP shall jointly review and update a forward-looking project budget per the Strategic Plan and annual budgets as required by the CFROU Consent Decree. These budgets will help the agencies make annual spending decisions.

9. Phase/Action-Specific Integration Agreement. DEQ and NRDP shall develop, in coordination, a specific agreement for all phases and actions required to implement the integrated remedial and restoration actions. This agreement helps to better define specific roles and responsibilities to streamline work planning and improve communication between the two organizations. The agreement shall provide an overall roadmap for a specific phase(s) or action to be implemented such as who will lead the activities (DEQ or NRDP).

10. DEQ and NRDP will strive to ensure design continuity between construction phases and integration of remediation and restoration using design criteria referenced in the Strategic Plan.

11. DEQ and NRDP will follow State Procurement law and processes for procurement and contracting.

12. DEQ and NRDP will work cooperatively on the development of phase or other project designs and Remedial Action Work Plan(s) construction bid packages. DEQ or NRDP will be the owner of contracts as determined in the Phase/Action-Specific Agreement. DEQ and NRDP must approve of designs and bid packages prior to advertisement.

13. If DEQ or NRDP, in consultation with DEQ or NRDP, determines a modification to a particular construction contract is warranted, DEQ or NRDP will draft the necessary changes through the work directive/ change order process. DEQ and NRDP Project Managers shall

work to ensure alignment and agreement on proposed changes prior to submitting to Program Managers for approval.

14. DEQ and NRDP will make best efforts to provide comments on documents within a reasonable timeframe unless otherwise agreed between DEQ and NRDP project managers. When a document is submitted for review, DEQ or NRDP may request a shorter time frame for review and will use best efforts to provide comments within the requested time frame.

15. Unless otherwise specifically stated, DEQ and NRDP shall provide the other one electronic copies of any plans, work plans, reports, specifications, or other document.

16. DEQ and NRDP will jointly be involved in media contacts, press releases, and all other public information sharing. Each agency shall consult with the other before issuing press releases and shall, as soon as practical, inform the other of all press contacts.

DISPUTE RESOLUTION

17. This dispute resolution process pertains to disputes between DEQ and NRDP that cannot be resolved by the Project and Program Managers, regarding the implementation of the CFROU remediation and integrated restoration and require escalation to higher levels of Authority to make final decisions.

18. If a dispute arises between-the DEQ and NRDP regarding the implementation of the CFROU remediation and integrated restoration that cannot be resolved at the Program Manager level, the disputing party shall identify the dispute to the other party in writing. DEQ and NRDP shall attempt to resolve the dispute in a timely manner informally and may prepare reports or letters in response to the identification of the dispute as appropriate. If the dispute is not resolved, the DEQ WMRD Division Administrator and the NRDP Program Manager shall attempt to resolve the dispute. The DEQ WMRD Division Administrator may involve the DEQ Director at their discretion. If the dispute cannot be resolved, then either NRDP or DEQ may refer the matter to the appropriate contact at the Governor's office for final resolution.

DEPARTMENT OF ENVIRONMENTAL QUALITY

Katie G-Forba 3/20/2023

Katie Garcin-Forba, Superfund, AML, Construction Bureau, Bureau Chief Date

Logan Dudding 03/20/2023

Logan Dudding, Senior Environmental Manager Date

NATURAL RESOURCE DAMAGE PROGRAM

Douglas H. Martin
Digitally signed by Douglas H Martin
Date: 2023.03.20 09:54:08 -06'00'

Douglas Martin, Restoration Program Chief Date

Brian Bartkowiak 3/20/2023

Brian Bartkowiak, NRDP Project Manager Date

Appendix G. Remedial Action Objectives from the Record of Decision

Remedial Action Objectives from the Record of Decision (ROD) (EPA 2004) as summarized in the Explanation of Significant Differences (DEQ and EPA 2015)

The ROD includes performance standards and remedial goals for the CFR OU.

The Remedial Action Objectives (RAOs) for floodplain tailings and impacted soils are:

- Prevent or inhibit ingestion of arsenic-contaminated soils/tailings where ingestion or contact would pose an unacceptable health risk.
- Prevent or reduce unacceptable risk to ecological (including agricultural, aquatic, and terrestrial) systems degraded by contaminated soils/tailings.

The ROD elaborates on the floodplain tailings and impacted soils RAOs:

Successful reclamation of land contaminated by mining activities within the Clark Fork River OU is defined as establishing plant communities capable of stabilizing soils against wind and water erosion, reducing transport of COCs to groundwater and surface water, and compliance with ARARs or replacement standards, in perpetuity. Goals of the plant community are to establish a permanent vegetative cover to accomplish the following:

- Minimize direct contact with arsenic, thus reducing the potential risk of human exposure to acceptable risk-based levels.
- Provide geomorphic stability to streambanks, thus minimizing release of COCs to the river.
- Improve agricultural production by reducing or eliminating phytotoxic conditions, thus providing for multiple land uses.
- Minimize surface water erosion and COC transport to surface water through methods described in the Selected Remedy.
- Minimize transport of COCs to groundwater.
- Minimize wind erosion and movement of contaminated soils onto adjacent lands, thus eliminating human, agricultural, and wildlife exposure.
- Remediate contaminated soils to be compatible with the existing and anticipated future land use with minimal future maintenance activities.

The groundwater RAOs are:

- Return contaminated shallow groundwater to its beneficial use within a reasonable time frame.
- Comply with State groundwater standards, including nondegradation standards.
- Prevent groundwater discharge containing arsenic and metals that would degrade surface waters.

The groundwater standards include arsenic (10 ug/l), cadmium (5 ug/l), copper (1,300 ug/l), iron (300 ug/l), lead (15 ug/l), and zinc (2,000 ug/l).

The surface water RAOs require compliance with surface water standards. Montana DEQ-7 copper total recoverable standards have been waived in the ROD to federal ambient water quality criteria for copper, due to technical impracticability. The surface water standards include arsenic

(340 ug/l – acute, 150 ug/l – chronic, 10 ug/l – human health), cadmium (2.1 ug/l @ 100 mg/l hardness – acute, 0.27 ug/l@ 100 mg/l hardness - chronic), copper (13 ug/l – acute, 9 ug/l – chronic, 1300 ug/l – human health), lead (81 ug/l @ 100 mg/l hardness - acute, 3.2 ug/l @ 100 mg/l hardness - chronic, 15 ug/l – human health), and zinc (119 ug/l @ 100 mg/l hardness - acute, 119 ug/l @ 100 mg/l hardness - chronic, 2,000 ug/l – human health).