Missouri River Recovery Program

DRAFT

Missouri River Recovery Management Plan and Environmental Impact Statement

CULTURAL RESOURCES ENVIRONMENTAL CONSEQUENCES ANALYSIS TECHNICAL REPORT

December 2016

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Cultural Resources Environmental Consequences Analysis

Technical Report

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1.0 Introduction

The USACE in cooperation with the USFWS are developing a Missouri River Recovery Management Plan and Draft Environmental Impact Statement (MRRMP Draft EIS). The purpose of the MRRMP Draft EIS is to develop a management plan that includes a suite of actions that removes or precludes jeopardy status for the piping plover, the interior least tern, and the pallid sturgeon using USACE authorities.

The purpose of the Cultural Resources Environmental Consequences Analysis Technical Report is to provide supplemental information on the cultural resources analysis and results in addition to the information presented in the MRRMP-EIS. Additional details on the Environmental Quality (EQ) methodology and results are provided in this technical report. The Other Social Effects (OSE) impacts are presented in the MRRMP-Draft EIS, Chapter 3, Cultural Resources, Environmental Consequences section. No National Economic Development (NED) or Regional Economic Development (RED) analyses were undertaken for cultural resources.

1.1 Summary of Alternatives

The MRRMP Draft EIS evaluates the following Management Plan alternatives. Detailed description of the alternatives is provided in the Draft EIS, Chapter 2.

- **Alternative 1 – No Action.** This is the no-action alternative, in which the Missouri River Recovery Program (MRRP) would continue to be implemented as it is currently, including a number of management actions associated with the MRRP and BiOp compliance. Management actions under No Action include creation of early life stage habitat for the pallid sturgeon and emergent sandbar habitat (ESH), as well as a spring plenary pulse. The construction of habitat will be focused in the Garrison and Gavins reaches for ESH (an average rate of 107 acres per year) and between Ponca to the mouth near St. Louis for early life stage habitat (3,999 additional acres constructed).
- **Alternative 2 – USFWS 2003 Biological Opinion Projected Actions.** This alternative represents the USFWS interpretation of the management actions that would be implemented as part of the 2003 Amended BiOp Reasonable and Prudent Alternative (USFWS, 2003). Whereas No Action only includes the continuation of management actions USACE has implemented to date for BiOp compliance, Alternative 2 includes additional iterative actions and expected actions that the USFWS anticipates would ultimately be implemented through adaptive management and as impediments to implementation were removed. Considerably more early life stage habitat (10,758 additional acres constructed) and ESH (an average rate of 3,546 acres per year) would be constructed under Alternative 2 than under Alternative 1. In addition, a spring pallid sturgeon flow release would be implemented every year if specific conditions were met. Alternative 2 would also modify System operations to allow for summer flows that are sufficiently low to provide for early life stage habitat as rearing, refugia, and foraging areas for larval, juvenile, and adult pallid sturgeon.
- **Alternative 3 – Mechanical Construction.** The USACE would only create ESH through mechanical means at an average rate of 391 acres per year across the entire system. This amount represents the acreage necessary to meet the bird habitat targets after accounting for available ESH resulting from system operations. The average annual construction amount includes replacing ESH lost to erosion and vegetative growth, as well as constructing new ESH. An additional 3,380 acres of early life stage habitat for the

pallid sturgeon would be constructed under Alternative 3. There would not be any reoccurring flow releases or pulses implemented under this alternative.

- **Alternative 4 – Spring ESH Creating Release.** The USACE would mechanically construct ESH annually at an average rate of 240 acres per year across the entire system. This amount represents the acreage necessary to meet the bird habitat targets after accounting for available ESH resulting from implementation of an ESH-creating reservoir release in the spring. Alternative 4 would be similar to Alternative 1 (current operations), with the addition of a spring release designed to create ESH for the least tern and piping plover. An additional 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 4.
- **Alternative 5 – Fall ESH Creating Release.** The USACE would mechanically construct ESH annually at an average rate of 309 acres per year across the entire system. This alternative is based on Alternative 1 (current operations), with the addition of a release in the fall designed to create sandbar habitat for the least tern and piping plover. An additional 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 5.
- **Alternative 6 – Pallid Sturgeon Spawning Cue.** The USACE would mechanically construct ESH annually at an average rate of 303 acres per year across the entire system. In addition, the USACE would attempt a spawning cue pulse every three years in March and May. These spawning cue pulses would not be started or would be terminated whenever flood targets are exceeded. An additional 3,380 acres of early life stage habitat for the pallid sturgeon would be constructed under Alternative 6.

1.2 USACE Planning Accounts

Alternative means of achieving species objectives were evaluated including consideration for the effects of each action or alternative on a wide range of human considerations (HC). Human considerations to be evaluated in the MRRMP-EIS alternatives are rooted in the economic, social, and cultural values associated with the natural resources of the Missouri River. The HC effects evaluated in the MRRMP Draft EIS are required under the National Environmental Policy Act and its implementing regulations (40 CFR Parts 1500-1508). The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) also served as the central guiding regulation for the economic and environmental analysis included within the MP-EIS. Further guidance that is specific to USACE is described in Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, which provides the overall direction by which USACE Civil Works projects are formulated, evaluated, and selected for implementation. These guidance documents describe four accounts that were established to facilitate evaluation and display the effects of alternative plans:

- The national economic development (NED) account displays changes in the economic value of the national output of goods and services expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation.
- The regional economic development (RED) account registers changes in the distribution of regional economic activity (i.e. jobs and income).
- The environmental quality (EQ) displays non-monetary effect of significant natural and cultural resources.

- The other social effects (OSE) account registers plan effects from perspective that are relevant to the planning process, but are not reflected in the other three accounts. In a general sense, OSE refers to how the constituents of life that influence personal and group definitions of satisfaction, well-being, and happiness are affected by some condition or proposed intervention.

The accounts framework enables consideration of a range of both monetary and non-monetary values and interests that are expressed as important to stakeholders, while ensuring impacts are not double counted. Because impacts to Cultural Resources are not expressible in monetary terms impacts to Cultural Resources are evaluated only under the EQ and OSE accounts.

1.3 Approach for Evaluating Environmental Consequences of Missouri River Recovery Management Plan

The USACE Planning Guidance Notebook (ER 1105-2-100) defines cultural resources in terms of "historic properties" as follows:

> "An historic property is any prehistoric or historic district, site, building, structure or object included in or eligible for inclusion on the National Register of Historic Places (National Register). Such properties may be significant for their historic, architectural, engineering, archeological, scientific or other cultural values, and may be of national, regional, state, or local significance. The term includes artifacts, records, and other material remains related to such a property or resource. It may also include sites, locations, or areas valued by Native Americans, Native Hawaiians and Alaska Natives because of their association with traditional religious or ceremonial beliefs or activities."

Evaluation of the environmental consequences of the Management Plan to cultural resources requires an understanding of how the physical conditions of the river would change under each of the Management Plan alternatives. Cultural resource sites are primarily affected by river flows, reservoir levels, channel movement, and river-floodplain connectivity. River flows and geomorphologic changes could influence erosion, deposition of sediment, and river-floodplain connectivity. Changes in river flows and reservoir elevations could impact cultural resource sites through burial, inundation, exposure, erosion, and flooding all of which could affect exposure to vandalism or degradation of the resources. Some risk of cultural resource loss will continue under any future scenario. The purpose of this analysis is to measure how these risks to cultural resources might differ across alternative plans when compared to the No Action Alternative.

The conceptual flow chart shown in Figure 1 demonstrates, in a stepwise manner, how changes to the physical conditions of the Missouri River and its floodplain can lead to changes to the fundamental objectives associated with cultural resources. This figure also shows the intermediate factors and criteria that were applied in assessing consequences to cultural resources.

The analysis of changes in river stages (relative to cultural resource site elevations) and river flows uses USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) data for the period of record between 1931 and 2012 to assess when and how often fluctuating water levels affect Cultural resources. The following sections in this report provide further details on the methodology.

CHANGES IN: Physical Components of Missouri River Watershed

- River Flows
- Reservoir Elevations
- Movement of the river channel across floodplain
- River Channel Dimensions
- Flood Risk Management Infrastructure and Operations (dams, levees, channel)

Leads To

CHANGES IN: Conditions that Affect Cultural Resources

- Riverbank and reservoir shoreline erosion
- Land disturbances
- Accessibility/exposure of cultural resource sites

Leads To

CHANGES IN: Sustainability and Preservation of Cultural Resources

- Destruction from erosion
- Damage from site looting and vandalism
- Destruction from activity related to construction or maintenance for other business lines (flood-risk management infrastructure, mitigation sites, etc.)
- Activity required to preserve cultural resources or mitigate for loss

Leads To

CHANGES IN: Benefits

- Environmental Quality (EQ) – Preservation of cultural resources, prevention of unmitigated losses

Leads To

CHANGES IN: Benefits

- Other Social Effects (OSE) – Sense of place, community cohesion, opportunities for discovery and learning, etc.

Figure 1. Flow Chart of Inputs Considered in Cultural Resource Impact Evaluation

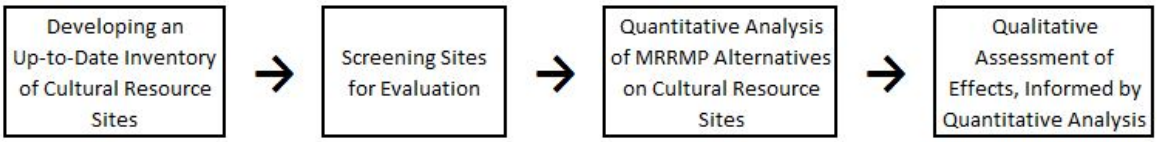


Figure 2. Environmental Consequences Approach for Cultural Resources

The one-time spawning cue test (Level 2) release that may be implemented under Alternatives 3, 4, and 5 was not included in the hydrologic modeling for these alternatives because of the uncertainty of the hydrologic conditions that would be present if implemented. Hydrologic modeling for Alternative 6 simulates reoccurring implementation (Level 3) of this spawning cue over the wide range of hydrologic conditions in the POR. Therefore, the impacts from the potential implementation of a one-time spawning cue test release would be bound by the range of impacts described for individual releases under Alternative 6.

2.0 Methodology and Assumptions

The methodology includes a summary of assumptions and risk and uncertainty considerations. The initial step in the process, evaluating the relationship between river conditions and cultural resource sites, is then described, as well as the subsequent steps to assess the EQ and OSE impacts.

2.1 Assumptions

The primary impacts to cultural resource sites from the MRRMP-EIS alternatives would be related to modifications of flow and changes in reservoir pool elevations that could change the magnitude and frequency of risk of erosion or vandalism and looting. The analysis was based on an assumption that cultural resource sites that are typically submerged (or partially submerged) face a greater risk of exposure to vandalism and looting as well as erosion when river/pool elevations decrease. Modeled impacts to cultural resource sites that are typically above (or partially above) the normal river/reservoir surface level elevation are subject to greater risk of erosion when river/pool elevations increase. More simply, cultural resource sites (whether located on reservoirs or riverine reaches) were sensitive to changes in water-surface elevations.

The assumptions that were necessary due to the large number of cultural resource sites in the study area and sensitivity about the type and location of these sites include:

1. Cultural resource sites are equally susceptible to damage/vandalism/looting. In reality, some sites would be more/less resistant to damage from waves and erosion, and some sites will be more/less accessible and desirable targets for looters/vandals.
2. Cultural resource sites are equally damageable at all times of the year. Submerged sites on the mainstem reservoirs may, in fact, be at greater risk during the recreation season. Or maybe more at risk during winter seasons, due to physical erosion from ice cracking, snow runoff, etc.

3. Cultural resource sites of each type (e.g. sites above normal pools and sites below normal pools) are given equal weight in the calculation (to other cultural resource sites of the same type) of the overall average risk. In reality, the cultural value placed on the protection of all sites might not be equal. For example, many people would identify the protection of sites with human remains to be more important than the protection of other sites.
4. All calculations are based on known cultural resources site information. It is understood that there are many unknown cultural resource sites existing on the landscape, as well as important cultural resources that do not necessarily meet the definition of a cultural resource site used in this study. The inventory of known cultural resource sites used in the analysis is intended to serve as a representative sample, indicating which Management Plan alternatives have greater or lesser impacts to cultural resources in general.
5. The modeling efforts focused on changes in H&H modeling outputs: river flows, river stages, and reservoir elevations. The model is unable to evaluate changes in other physical aspects of the river that could impact cultural resources (e.g., sedimentation, geomorphology).
6. The analysis uses data from the Hydrologic Engineering Center's River Analysis System (HEC-RAS) modeling of the river and Reservoir System Simulation (ResSim) modeling of the reservoir system. The analysis assumes that the HEC-RAS and ResSim models reasonably estimate river flows and reservoir levels over the 82-year period of record under each of the Management Plan alternatives as well as Alternative 1 (No Action).

While imperfect, the use of these assumptions allowed for analysis that shows (broadly) which Management Plan alternatives are better or worse for the protection of cultural resources.

2.2 Risk and Uncertainty

Risk and uncertainty are inherent with any model that is developed and used for water resource planning. Much of the risk and uncertainty with the overall Management Plan is associated with the operation of the Missouri River system and the extent to which flows and reservoir levels will mimic conditions that have occurred over the 82-year period of record. Unforeseen events such as climate change and weather patterns may cause river and reservoir conditions to change in the future and would not be captured by the H&H models or carried through to the cultural resources model described is this document. The Project Delivery Team has attempted to address risk and uncertainty in the Management Plan by defining and evaluating a reasonable range of plan alternatives that include an array of management actions within an adaptive management framework for the Missouri River. All of the alternatives were modeled to estimate impacts to cultural resources.

Another source of uncertainty associated with the cultural resources analysis is predicting how cultural resources would react to long-term changes in river and reservoir conditions. To address this long-term change uncertainty, project-team archeologists have made assumptions on impacts based on past professional experience and observations on similar long-term adverse effects to cultural resources. Some of these conditions have not occurred in the recent past and therefore represent the anticipated impacts to cultural resources under a hypothetical situation.

2.3 Evaluation Methodology

The purpose of the cultural resources analysis is to link H&H modeling efforts, which simulate river operations of the Missouri River under each of the Management Plan alternatives, with the analysis necessary to estimate the environmental consequences to cultural resource sites along the reservoirs and riverine sections of the Missouri River. This analysis used Microsoft Excel® to evaluate potential effects of changes in reservoir elevations and river stages on cultural resource sites. For cultural resources impacts, the analysis evaluated the number of days and number of sites where cultural resources are at greater-than-normal risk to either erosion or vandalism as a result of changes in reservoir elevations or river stage. The outputs below are then summed and presented by reservoir or riverine reaches within specific geographic areas.

Three measures were used to measure greater-than-normal risk to cultural sites:

1. **Site-Days** *[The Primary Metric]:* This is the total number of days in each year over the 82-year period of record that cultural resource sites were at greater-than-normal risk along a riverine reach or reservoir of the Missouri River. If more than one site was at greater-than-normal risk on a given day, the total number of sites at risk for that day was reflected in this statistic. For example, if 4 out of 11 submerged sites were under greater-than-normal risk in Lake Sakakawea from December 2 to December 3, of the modeled 1951 year, then there were a total of eight site-days under greater-than-normal risk on Lake Sakakawea for over those two days.
2. **Average-Days**: This is the average number of days each year that a site was under greater-than-normal risk. This statistic was obtained by taking the total site-days in a given time-period and reach or reservoir and dividing that number by the maximum number of sites impacted under any alternative in that reach or reservoir. Each alternative's denominator is the same value, which is the maximum number of sites impacted under any alternative, in that reach or reservoir. For consistency, this same denominator value was used for all alternatives, because there are some sites in the inventory that are not affected by one or more alternative. These average-days statistics are calculated for each type of site (e.g., sites above normal pool, sites below normal pool, etc.) for each reservoir and the riverine reaches of each state along the Missouri River mainstem.
3. **Sites**: This is the total number of sites of each type impacted in any year in a reach or reservoir regardless of the amount of time that each site was impacted. For example, if there are two submerged cultural resource sites that are impacted on Lake Sakakawea in the modeled 2010 year and one is impacted for 2 days at greater-than-normal risk and the other is impacted for 75 days at greater-than-normal risk then the total number of submerged sites impacted in Lake Sakakawea in the modeled 2010 year would be two sites.

2.3.1 Geographic Scope and Screening

The total area of study used in the analysis was the mainstem of the Missouri River from Fort Peck Reservoir in Montana to the mouth of the Missouri River in St. Louis, Missouri. Figure 3 below provides a map overview the entire study area, and describes the Missouri river channel, the river floodplain, and each of the mainstem reservoirs all of which are key geographic regions in this study For the purpose of this study, all recorded archeological sites located within the bluffs of the Missouri River floodplain were identified.The analysis was categorized between sites located on the federally managed lakes (Reservoir Sites), and sites located within the

riverine environment of the Missouri River flood plain (Riverine Sites). The analysis for each of the mainstem reservoirs included all of the historic properties and archaeological sites located on federal land within the individual reservoir project. The Riverine sites were subdivided by state as each State Historic Preservation Office (SHPO) maintains its own individual database of cultural resource sites. For riverine reaches the geographic extent were as follows:

Montana: The relevant riverine setting on the Missouri River flows from Fort Peck Dam to the border of Montana and North Dakota. This section includes all cultural resources within the Missouri River Flood plain contained within the expanse, excluding sites counted in one of the reservoirs, until approximate river mile 1586 at which point the river enters North Dakota.

North Dakota: The North Dakota Section of the Missouri River includes all cultural resource sites on both sides of the river, excluding sites located at Lake Sakakawea or Lake Oahe, from the states southern border with South Dakota, river mile 1232, to the states Western border with Montana, approximate river mile 1586.

South Dakota: The Missouri River enters the State of South Dakota at the border of South and North Dakota, river mile 1232. This section includes cultural resources contained on both banks of the Missouri River floodplain, excluding sites located at Lake Oahe, Lake Sharpe, Lake Francis Case, and Lewis and Clark Lake, until approximate river mile 875, at which point only the Northern portion of the flood plain along the left descending bank is included in the state of South Dakota. Near Sioux City, IA, approximate river mile 734, the Missouri River exits South Dakota.

Nebraska: The Missouri River makes up a portion of the Northern and Eastern Border of Nebraska. This section includes Cultural Resource sites located along the right descending bank from approximately 5 miles south of the Fort Randall Dam, river mile 875, continuing to the borders of Iowa, Nebraska, and South Dakota, river mile 734, and then downstream to the border of Kansas and Nebraska, river mile 490, .

Iowa: The Iowa section of the Missouri River includes Cultural Resource sites located along the left descending bank from the borders of Iowa, Nebraska, and South Dakota in Sioux City, river mile 734, to the border of Iowa and Missouri, river mile 555.

Kansas: The Kansas section of the Missouri River includes Cultural Resource sites located on the right descending bank from the border of Kansas and Nebraska, river mile 490, to the confluence with the Kansas River at Kansas City, river mile 366.

Missouri: The Missouri section of the Missouri River includes Cultural Resource sites located on the left descending bank from the Iowa and Missouri border, river mile 555, to Kansas City, river mile 366, and both banks from Kansas City to the rivers confluence with the Mississippi River in St. Louis, MO.

Table 1 shows the total number of cultural resource sites located within riverine settings by state and the six mainstem reservoirs along the Missouri River before sites were screened during model analysis. Due to the sensitive nature cultural resource site location information, the results of this analysis are reported in aggregate, as averages for each of the six reservoirs and as averages across riverine reaches of each state.

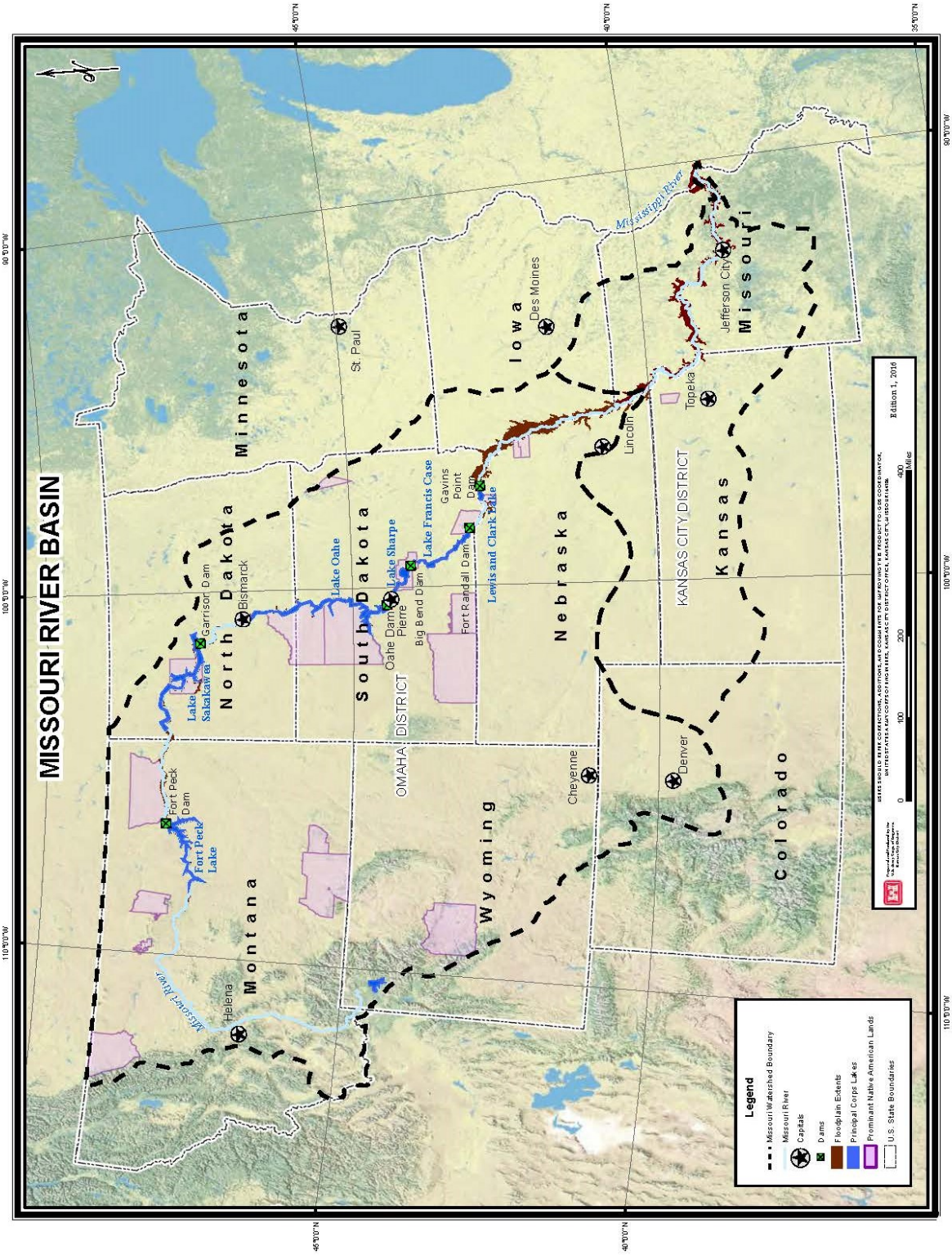


Figure 3. Map of Area of Analysis

Table 1. Total Number of Cultural Resource Sites Considered by Geographic Region

Geographic Area	Number of Sites
Fort Peck Lake	53
Lake Francis Case	359
Lewis and Clarke Lake	57
Lake Sakakawea	838
Lake Sharpe	333
Lake Oahe	1,047
Montana Riverine Sections	136
South Dakota Riverine Sections	13
North Dakota Riverine Sections	444
Nebraska Riverine Sections	661
Missouri Riverine Sections	1,800
Kansas Riverine Sections	72
Iowa Riverine Sections	336

2.3.2 Development of Measures for the Analysis of Cultural Resources

Effects to cultural resources of the Missouri River in reservoir settings was estimated by modeling the status of the site relative to current, normal reservoir operational elevation levels (No Action alternative) and comparing these to the operational elevation levels of the proposed alternatives. Critical thresholds were established for sites both above, and below normal operation elevation levels. For sites above normal pool elevation the critical threshold is three feet below the site. Sites more than three feet above normal operating level are at greater risk of erosion or damage from waves. For sites that are typically submerged below the minimum-normal pool elevation, the critical threshold is a pool elevation of one foot above the top of the site (or lower). These sites are considered to be at greater-than-normal risk of exposure to wave action, looting, or other damage when the pool elevation falls below this critical threshold. For sites spanning the normal range of pool elevations, there are two critical thresholds: the bottom and the top of the normal pool elevation range. If pool rises or falls outside this range, portions of the site could be subject to greater-than-normal risk of erosion or exposure. Table 2 details the specific metrics used in this analysis.

Table 2. Reservoir Analysis Metrics

Reservoir Conditions	Measure	Description
1 – Number of days reservoir elevations are one foot above the site or lower for sites that are below normal reservoir pool elevations (summed across all applicable sites)	Number of site-days	This metric is an estimate of the number of days in a year that reservoir elevations are one foot above the cultural resource site or lower for sites that are below normal reservoir pool elevations. Once water elevations are at least one foot or lower than the top of a cultural resource site for sites that are below the normal pool elevation for the reservoir, the site is considered to be at greater-than-normal risk for vandalism. The focus of this metric is on greater-than-normal risk to cultural resource sites.
2 – Number of days reservoir elevations are three feet or less from the bottom of sites that are above normal pool elevations (summed across all applicable sites)	Number of site-days	This metric is an estimate of the number of days in years that reservoir elevations are at least 3 feet or less from the bottom of a cultural resource site for sites that are above normal pool elevations for the reservoir. Once water elevations are at least 3 feet or less from the bottom of a cultural resource site for sites that are above the normal pool elevation for the reservoir, the site is considered to be at greater-than-normal risk for erosion. The focus of this metric is on greater-than-normal risk to cultural resource sites.
3 – Number of days reservoir elevations are above or below the normal operating elevations of the reservoir for sites that span the normal operating elevation range of the reservoir (summed across all applicable sites)	Number of site-day	This metric is an estimate of the number of days in a year that reservoir elevations are either above or below the normal operating range of pool elevation for a reservoir. Once reservoir elevations are outside of the normal range, sites that have elevations spanning this range can be subject to greater-than-normal risk of vandalism or erosion. The focus of this metric is on greater-than-normal risk to cultural resource sites.

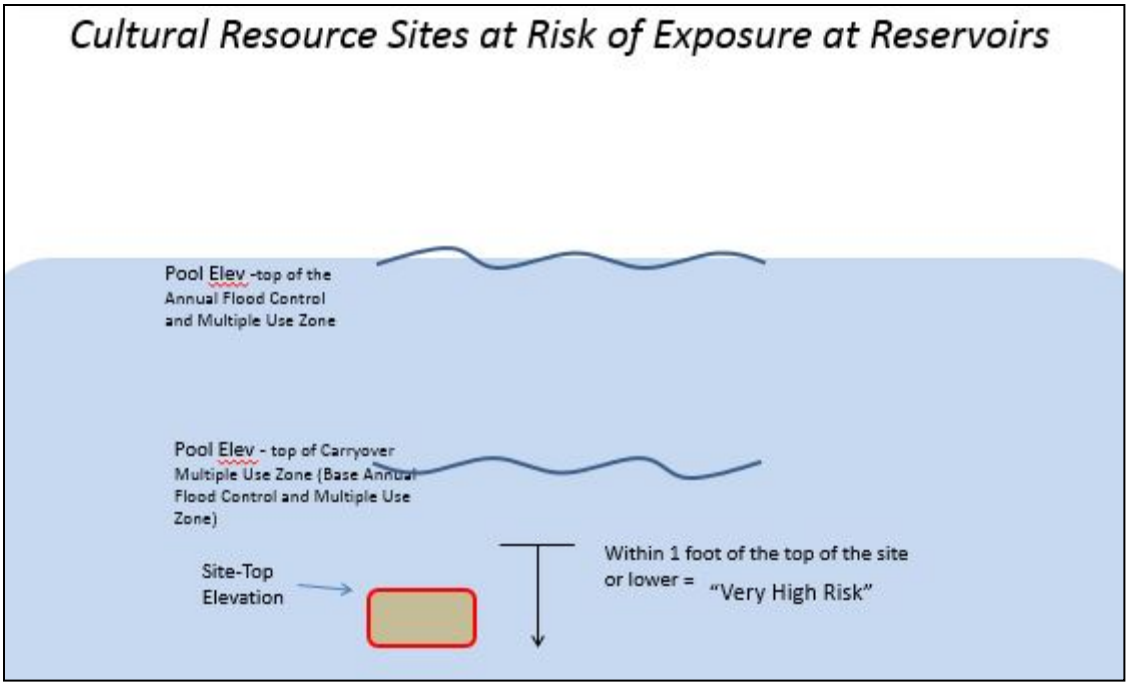


Figure 4. Reservoir Metric: Sites Below Normal Range of Pool Elevations at Reservoirs

Sites that are typically submerged below normal pool elevations are at "Very High Risk" of exposure to looting/vandalism on days when the pool elevation falls (below normal) to within one foot of the top of the site or lower. When the pool elevation is more than one foot higher than the top of a site of this type, the site is at relatively low risk. For simplicity, the Environmental Consequences chapter of the EIS referred to site-days of "Very High" risk as "site-days of greater-than-normal risk" for sites below the normal range of pool elevations.

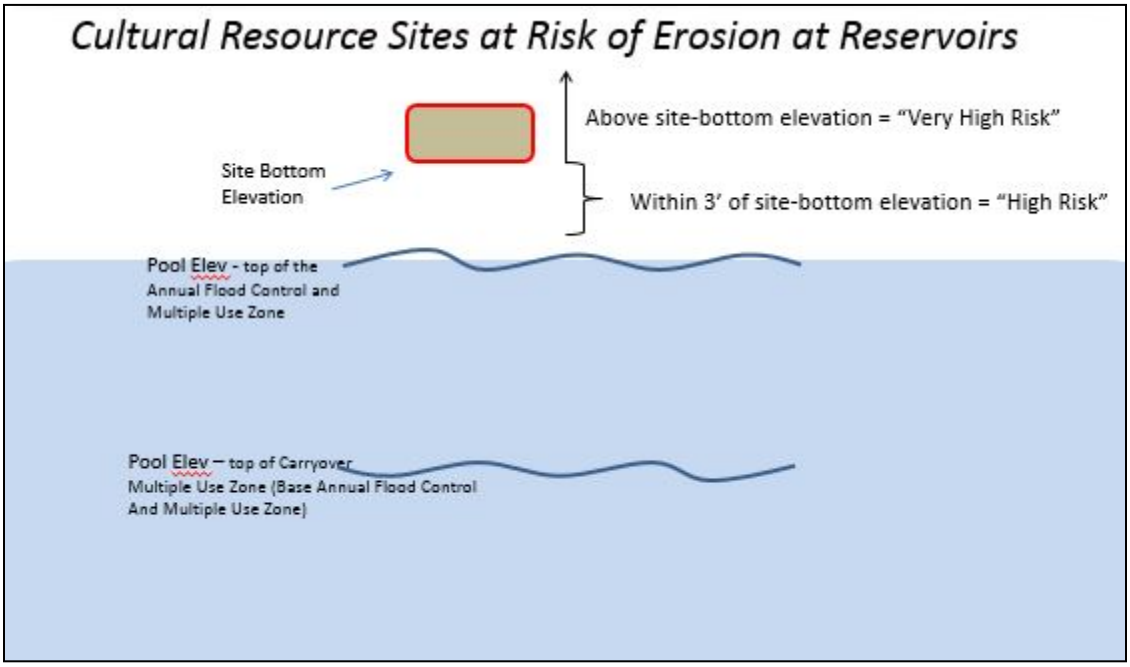


Figure 5. Reservoir Metric: Sites Above the Normal Range of Pool Elevations at Reservoirs

A site that is typically above normal pool elevations is at “High Risk” of erosion on days when the pool elevation rises to within three feet of the bottom of the site. If the pool elevation rises further, to the point where the pool elevation is as high as (or higher than) the elevation of the bottom of the site, the site would be at “Very High Risk.” When the pool elevation is more than three feet lower than the bottom of a site of this type, the site is at relatively low risk. For simplicity the Environmental Consequences chapter of the EIS combined site-days of “High” and “Very High” risk as “site-days of greater-than-normal risk” for sites above the normal range of pool elevations.

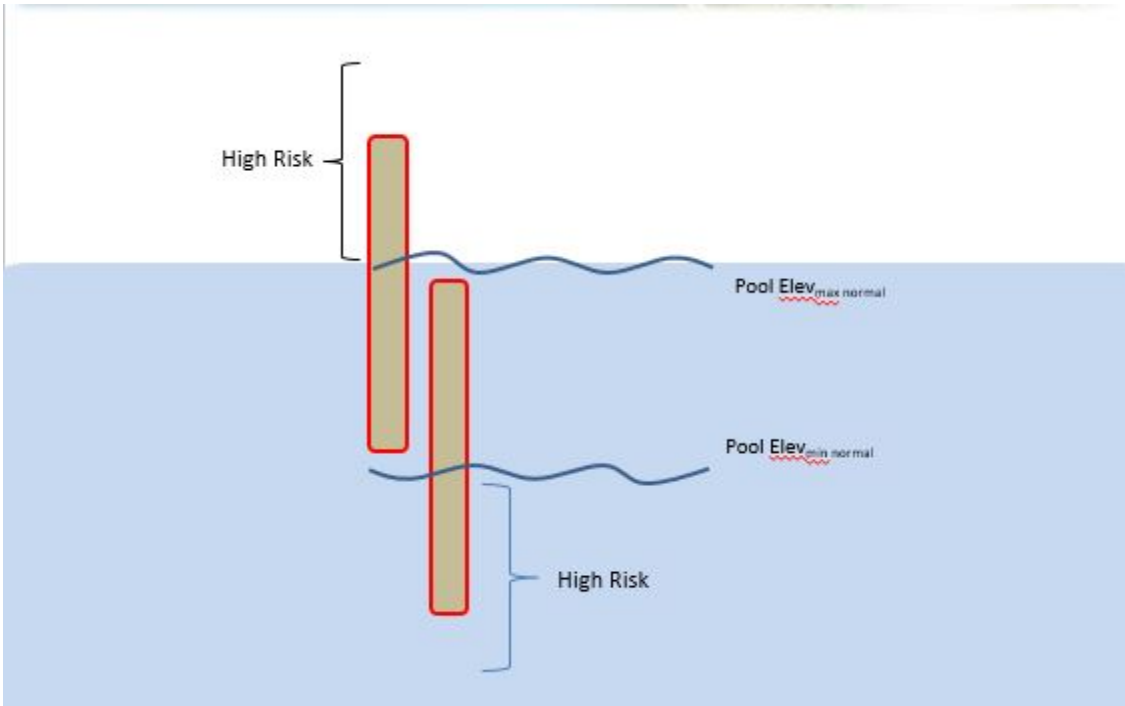


Figure 6. Reservoir Metric: Sites which Span the Normal Range of Pool Elevations at Reservoirs

A site that spans (or partially spans) the normal range of pool elevations is at relatively greater risk on days when pool elevations fall below the normal range of pool elevations (exposing part of the site that is typically submerged) or when pool elevations rise above the normal range of pool elevations (subjecting the higher part of the site to increased erosion risk). When the pool elevations are within their normal range, the site is considered to be at relatively low risk, because at least part of the site is relatively safe from exposure and/or erosion. Note: While these sites that span (or partially span) the normal range of pool elevations were evaluated in the model, only sites that are *entirely* above or *entirely* below the normal range of pool elevations were ultimately used in the assessment of cultural resources in the Environmental Consequences chapter of the EIS. Because sites that partially or completely span the normal range of pool elevation would be impacted similarly to sites completely outside of the normal range of pools, and the PDT’s archeologists had greater certainty in the relationship between pool elevations and risk for sites entirely above or entirely below normal pools, impacts to sites spanning or partially spanning the normal range of pool elevations were not presented in the EIS.

How well the cultural resources of the Missouri River in riverine settings are protected can be estimated by modeling the cumulative risk to all known sites in the inventory and determining

how frequently water-surface elevations rise above or fall below critical thresholds. For example, cultural resource sites that are typically above the river's surface face an increased risk of erosion when river stages increase. Table 3 below details the specific metric used in this analysis.

Table 3. Riverine Analysis Metric

River Conditions	Measure	Description
1 – Number of days riverine stages are below the bottom of sites (summed across all applicable sites)	Number of site-days	This metric is an estimate of the number of days in a year that water from the river reaches sites. Once water elevations are above the bottom of a cultural resource site (or above the top of a levee protecting a site), then the site is considered to be at greater-than-normal for erosion. The focus of this metric is on greater-than-normal risk to cultural resource sites.

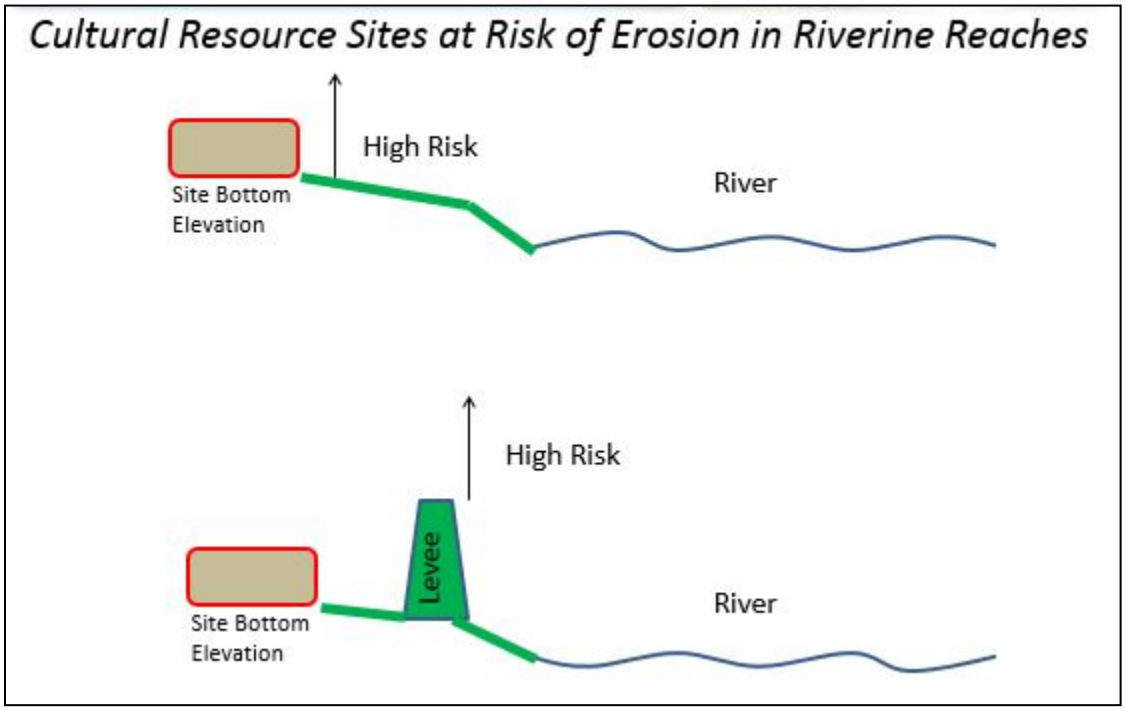


Figure 7. Riverine Metrics: Sites located in Riverine Reaches

A site in a riverine reach that is not behind a levee will be at relatively "high risk" of erosion on days when river stage rises higher than the bottom of the site (i.e. floodwater reaching the site). A site in a riverine reach that is behind a levee will only be at relatively "high risk" of erosion when river stage rises higher than the top of the levee, overtopping the levee and flooding the floodplain. These sites are otherwise at relatively low risk when river stage is lower than these critical thresholds. For simplicity, the Environmental Consequences chapter of the EIS referred to site-days of "High" risk as "site-days of greater-than-normal risk" for sites riverine reaches.

The Cultural resources information used to conduct this analysis was obtained from existing inventories. Within the mainstem reservoir system USACE Omaha District maintains an inventory of sites that has been developed based upon Archaeological survey of nearly all of these federal lands in compliance with sections 110 and 106 of the National Historic Preservation Act. USACE obtained location data for sites on non-federally owned lands in riverine settings from the various State Historic Preservation Office's (SHPO) in the basin. Inventories of sites on non-federally owned lands are less common, and consequently the inventories from the SHPO's are typically less complete. As discussed above, it is expected that although the total number of sites is likely much larger, these "unrecorded" cultural resource sites would be impacted by management plan alternatives in a similar manner to sites included in this analysis.

After the collection of archaeological sites inventory data, sites that had previously been formally determined to be ineligible for the National Register of Historic Places (NRHP) were removed from further analysis, unless the ineligible site had associated human remains. Further, sites at elevations that were higher or lower than any foreseeable changes to the minimum and maximum operational water levels under any of the management plan alternatives were also screened from further modeling analysis.

2.4 Environmental Quality Methodology

The impacts to cultural resources correspond to impacts to community character, heritage, sense of place, history, and identity of local, regional, and tribal communities, as well as state and national identity. Preservation and protection of cultural resources could provide opportunities for future discovery and learning but could also contribute to social benefits, such as sense of place and community cohesion.

Environmental Quality (EQ) displays non-monetary effects on significant natural and cultural resources. The non-monetary value of EQ resources "shall be based upon technical, institutional, and public recognition of the ecological, cultural and aesthetic attributes within the study area." (ER 1105-2-100) Effects to environmental quality were assessed based on projected increases/decreases in risk to cultural resource sites within the study area, calculated as site-days over the eighty-two year period of record. Risk to cultural resources sites were concluded to come from erosion due to active river processes and from vandalism and looting. The period of record used for this analysis is based on daily observed water surface elevations recorded on the federal lakes, and on the Missouri River at specific monitoring points for the years of 1931 to 2012.

By adding the number of days all sites in a geographic area were at greater-than-normal risk, the model was able to calculate the total site-days cultural resource sites would be at greater-than-normal risk for each management alternative and the no action alternative in each of the geographic regions within the study area. This allowed for the comparison of the management alternatives relative the No Action alternative to determine which alternatives would have greater or lesser average impacts to cultural resources. These metrics resulted in a comparative output across numerous flow events.

3.0 Environmental Quality Results

3.1 Summary of Impacts

As described above, this analysis differentiated two categories of cultural resource sites. Reservoir sites were sites located on federal fee-owned lands of the six USACE managed Missouri River mainstem reservoirs. Riverine sites were all sites located within the bluff-to-bluff Missouri River floodplain that were not already included from USACE managed Missouri River mainstem reservoir sites. Screening of sites located within the study area indicated variable impacts to cultural resource sites, but most alternatives impact the same individual sites. See Tables 4, and 5 for a summary of individual cultural resource sites impacted by each alternative. These modeled impacts are related to fluctuations in water levels which would result in greater risk either from erosion or access that correlates to greater likelihood of looting. In general, the more water levels fluctuate, the greater the degree and magnitude of impacts to cultural resource sites. The primary differences between the MRRMP alternatives were observed changes when sites were subject to greater risk, rather than differences in the number of sites affected or total number of site-days of impacts (Table 6). That is to say impacts occur at the same sites and nearly the same magnitude across all alternatives with only small changes in total impacts relative to the No Action Alternative. Further identification of specific sites may need to be undertaken in order to better understand impacts to specific cultural resource sites should management actions under the Adaptive Management (AM) Plan require significant modifications to water storage and releases within the system. A qualitative description of increases and decreases to risk in each geographic area for all alternatives is presented below based on comparison with the no action alternatives. In general, minimal differences were noted in the average number of site-days in which sites were exposed to changes in risk compared to the No action alternative across all alternatives in all geographic locations. In a mean-average year there is little change among lake alternatives and very minor changes in risk for some sites on the riverine reaches. Noteworthy differences will be addressed below.

Table 4. Maximum Number Affected Sites Over All Years (Outside Normal Pool Elevation)

Location	Location Relative to Normal Pool Elevation	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Fort Peck Lake	Above	11	11	11	11	22	11
	Below	6	5	6	6	6	6
Lake Francis Case	Above	166	166	166	166	124	166
	Below	30	30	30	30	30	30
Lake Oahe	Above	215	215	215	215	215	215
	Below	175	175	175	191	175	175
Lake Sakakawea	Above	382	382	382	382	382	382
	Below	58	59	58	59	58	59
Lewis and Clark Lake	Above	28	28	28	28	28	28
	Below	3	3	3	3	3	3
Lake Sharpe	Above	8	8	8	8	8	8
	Below	16	16	16	16	16	16

Table 5. Maximum Number of Affected Floodplain Sites Over All Years

Location	Montana	Nebraska		Iowa		Kansas		Missouri	
Levee status	No Levee	Protected	No Levee	Protected	No Levee	Protected	No Levee	Protected	No Levee
Alternatives 1, 3–5	5	24	126	121	54	4	21	196	939
Alternative 2	5	24	126	121	53	4	21	196	939
Alternative 6	5	24	134	121	54	4	21	196	939

Note: Neither North Dakota nor South Dakota had inventoried cultural resource sites in riverine settings of the study area that may be impacted.

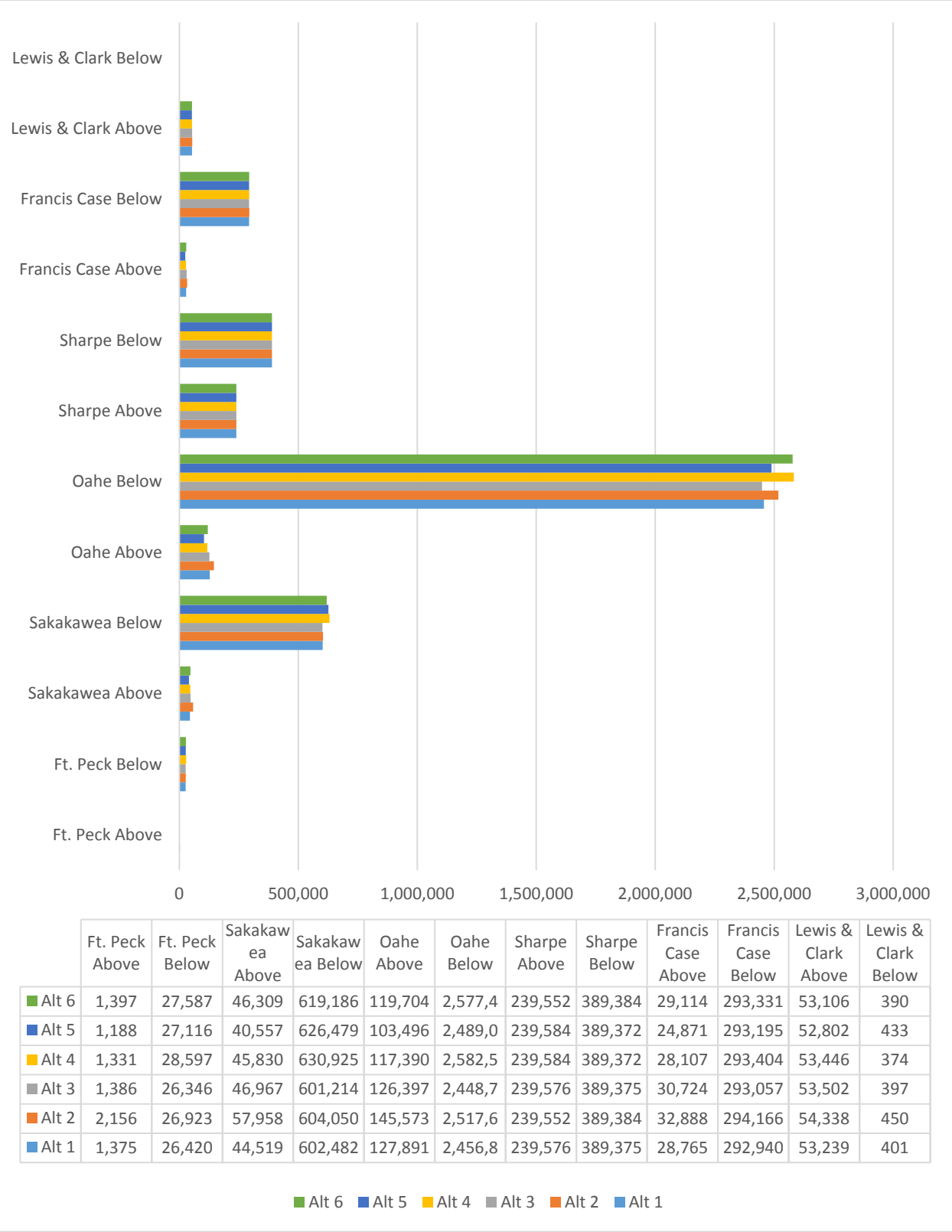
Table 6. Summary of Mean Site-Days of Impact

Geography	Sum of average Site-Days No Action	Difference Relative to No Action				
		Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
Reservoir Sites	51,998	1,235	(75)	1,794	296	1,618
Riverine Sites	13,466	(71)	(6)	23	(12)	13

3.2 Impacts to Cultural Resources in Reservoir Settings

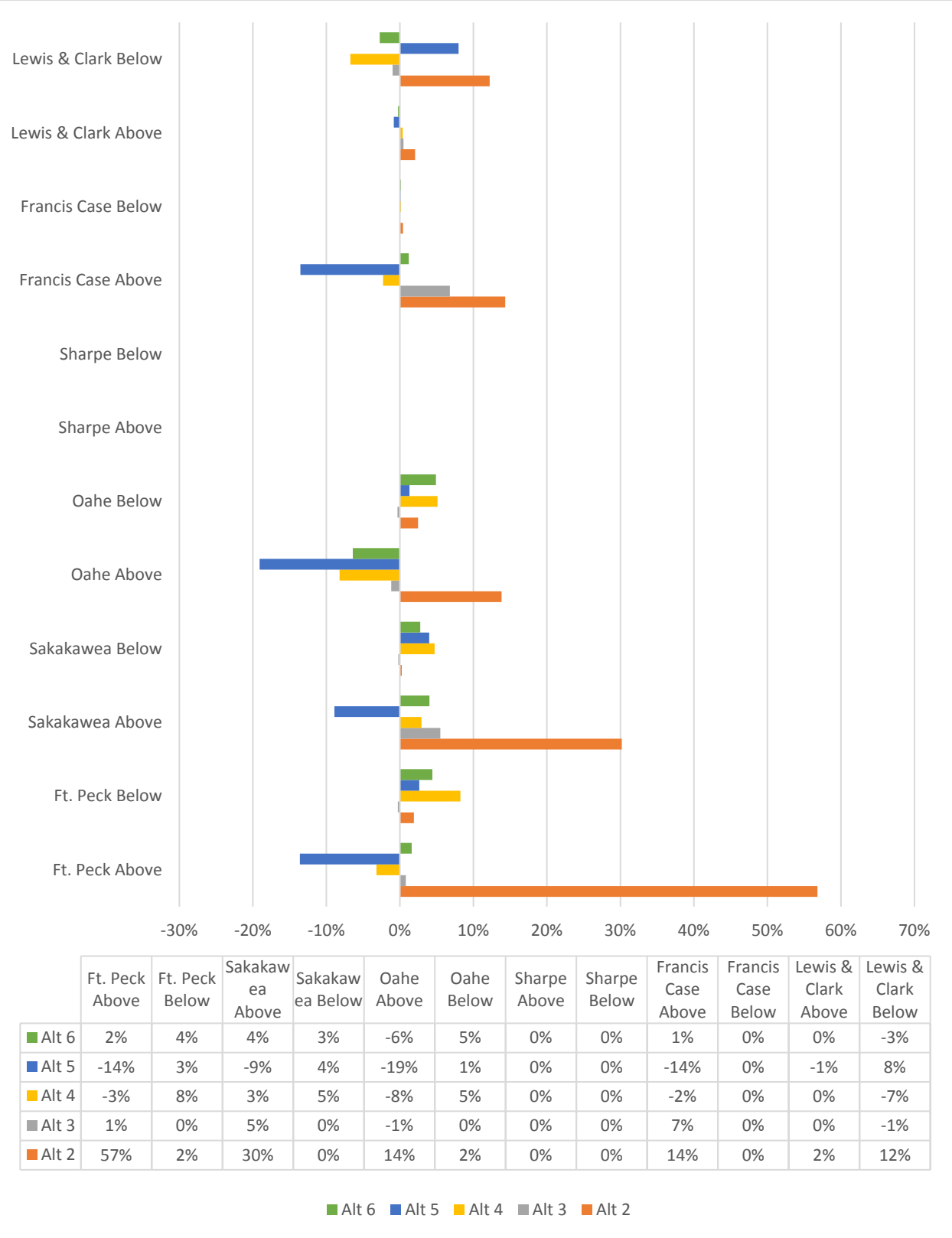
As stated above, impacts to cultural sites in reservoir settings show relatively small differences in overall average risk across all alternatives. The model results indicated that the greatest differences between alternatives (in terms of average risk) would be at Lake Sakakawea and Lake Oahe, likely because these lakes have the largest number of known archaeological sites that could be affected by changes in management of the Missouri River. Fort Peck Lake, Lake Sharpe, and Lewis and Clark Lake would have very minimal differences, as they have fewer sites affected by changes in lake management.

Modeled results for Alternative 2 generally show the greatest increases in risk compared to other alternatives, including increases to risk in all site categories on all lakes. Modeled results for Alternative 3 show the least change in risk (compared to the No Action alternative), with very limited increases and decreases to average risk. Modeled results for Alternative 5 generally show increases in risk to sites below the minimum-normal pool level and decreases in risk for sites above the maximum-normal pool level. Modeled results for Alternatives 4 and 6 show relatively large increases (relative to the No Action Alternative) in site-days of risk for sites below minimum-normal pool elevation at Lake Oahe and only small differences (relative to the No Action Alternative) otherwise.



	Ft. Peck Above	Ft. Peck Below	Sakakawea Above	Sakakawea Below	Oahe Above	Oahe Below	Sharpe Above	Sharpe Below	Francis Case Above	Francis Case Below	Lewis & Clark Above	Lewis & Clark Below
Alt 6	1,397	27,587	46,309	619,186	119,704	2,577,4	239,552	389,384	29,114	293,331	53,106	390
Alt 5	1,188	27,116	40,557	626,479	103,496	2,489,0	239,584	389,372	24,871	293,195	52,802	433
Alt 4	1,331	28,597	45,830	630,925	117,390	2,582,5	239,584	389,372	28,107	293,404	53,446	374
Alt 3	1,386	26,346	46,967	601,214	126,397	2,448,7	239,576	389,375	30,724	293,057	53,502	397
Alt 2	2,156	26,923	57,958	604,050	145,573	2,517,6	239,552	389,384	32,888	294,166	54,338	450
Alt 1	1,375	26,420	44,519	602,482	127,891	2,456,8	239,576	389,375	28,765	292,940	53,239	401

Figure 8. Summary of Total Site-Days of Greater-than-Normal Risk in Reservoir Settings over the 82-Year Period-of-Record



	Ft. Peck Above	Ft. Peck Below	Sakakawea Above	Sakakawea Below	Oahe Above	Oahe Below	Sharpe Above	Sharpe Below	Francis Case Above	Francis Case Below	Lewis & Clark Above	Lewis & Clark Below
Alt 6	2%	4%	4%	3%	-6%	5%	0%	0%	1%	0%	0%	-3%
Alt 5	-14%	3%	-9%	4%	-19%	1%	0%	0%	-14%	0%	-1%	8%
Alt 4	-3%	8%	3%	5%	-8%	5%	0%	0%	-2%	0%	0%	-7%
Alt 3	1%	0%	5%	0%	-1%	0%	0%	0%	7%	0%	0%	-1%
Alt 2	57%	2%	30%	0%	14%	2%	0%	0%	14%	0%	2%	12%

Figure 9. Summary of Percentage Difference of Site-Days of Greater-than-Normal Risk in Reservoir Settings

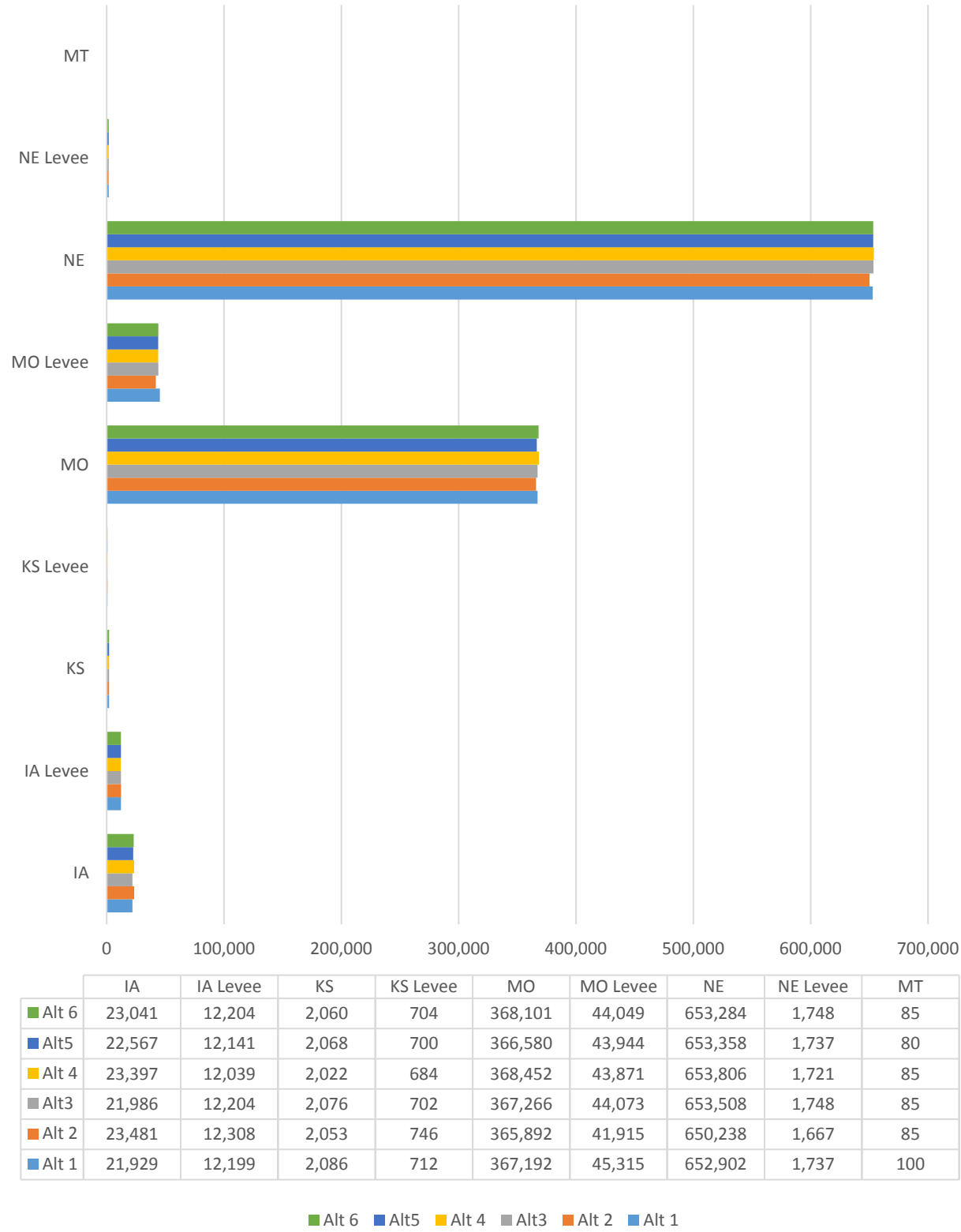
3.3 Impacts to Cultural Resources in Riverine Settings

Similar to cultural resource sites located above maximum-normal pool elevation at a reservoir, cultural resource sites located along river banks or in riverine floodplains are also subject to increased risk of erosion when river elevations rise during periods of high water. Unlike reservoir sites, which are located on federal fee owned land, most of the sites in riverine settings are on land that is not federally-owned.

Unprotected cultural resource sites located close to river banks are subject to the most risk of erosion, relative to other riverine sites. Depending on their proximity, these sites may be subject to erosion on a daily basis or during relatively-minor high-water events. Erosion impacts these cultural resources by destroying cultural materials and degrading intact cultural deposits. The exposure of these sites along shorelines may lead to both intentional and unintentional damage. Cultural materials exposed by erosion may be more obvious to the public and could lead to greater risk of vandalism and looting.

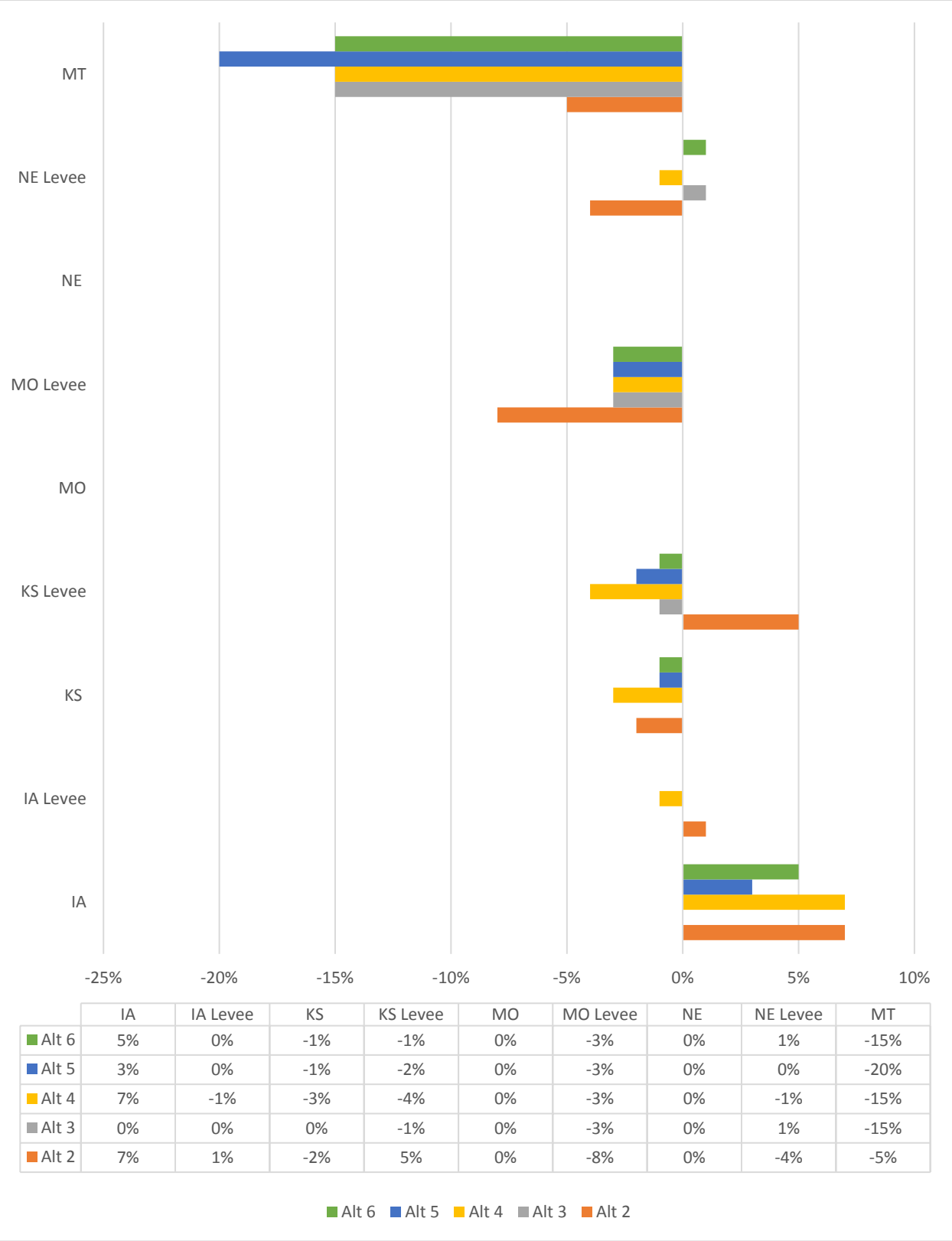
Screening efforts indicate that, outside of the mainstem reservoir system, Montana had modeled impacts on five known riverine sites during the POR, and North and South Dakota had no known sites impacted. Of the lower basin states, Missouri has the most known riverine sites affected by high water over the modeled 82-year POR.

Known cultural resource sites in the riverine reaches would be subject to relatively small changes in risk based on the proposed alternatives. The total number of sites impacted, number of years impacts would occur, and the total number of site-days of greater-than-normal risk to cultural resource sites in riverine reaches varied little among alternatives. Modeled results generally showed small decreases in site-days of greater-than-normal risk for Alternatives 2-6 (relative to the No Action alternative), except for sites located in the state of Iowa (specifically sites in areas without levees).



	IA	IA Levee	KS	KS Levee	MO	MO Levee	NE	NE Levee	MT
Alt 6	23,041	12,204	2,060	704	368,101	44,049	653,284	1,748	85
Alt5	22,567	12,141	2,068	700	366,580	43,944	653,358	1,737	80
Alt 4	23,397	12,039	2,022	684	368,452	43,871	653,806	1,721	85
Alt3	21,986	12,204	2,076	702	367,266	44,073	653,508	1,748	85
Alt 2	23,481	12,308	2,053	746	365,892	41,915	650,238	1,667	85
Alt 1	21,929	12,199	2,086	712	367,192	45,315	652,902	1,737	100

Figure 10. Summary of Site-Days of Greater-than-Normal Risk in Riverine Settings over the 82-Year Period-of-Record



	IA	IA Levee	KS	KS Levee	MO	MO Levee	NE	NE Levee	MT
Alt 6	5%	0%	-1%	-1%	0%	-3%	0%	1%	-15%
Alt 5	3%	0%	-1%	-2%	0%	-3%	0%	0%	-20%
Alt 4	7%	-1%	-3%	-4%	0%	-3%	0%	-1%	-15%
Alt 3	0%	0%	0%	-1%	0%	-3%	0%	1%	-15%
Alt 2	7%	1%	-2%	5%	0%	-8%	0%	-4%	-5%

Figure 11. Summary of Percentage Difference of Site-Days of Greater-than-Normal Risk in Riverine Settings

4.0 Literature Cited

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USACE (2000): ER (Engineering Regulation) 1130-2-540, "Chapter 6, Cultural Resources Stewardship" (15 November 1996). This regulation provides guidance for stewardship of cultural resources on Corps owned land.

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