Missouri River Recovery Program

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Missouri River Recovery Management Plan and Environmental Impact Statement

COMMERCIAL SAND AND GRAVEL DREDGING ENVIRONMENTAL CONSEQUENCES ANALYSIS TECHNICAL REPORT

December 2016

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Commercial Sand and Gravel Dredging 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 Commercial Sand and Gravel Dredging Environmental Consequences Analysis Technical Report is to provide supplemental information on the Commercial Sand and Gravel Dredging analysis and results in addition to the information presented in the MRRMP-EIS. Additional details on the National Economic Development (NED) methodology and results are provided in this technical report. No Regional Economic Development (RED), Other Social Effects (OSE), or Environmental Quality (EQ) analyses was undertaken for Commercial Sand and Gravel Dredging.

1.1 Summary of Alternatives

The MRRMP Draft EIS evaluates the following Management Plan alternatives. A detailed description of the alternatives is provided in the Draft EIS, Chapter 2, but the following provides a summary of the alternatives:

- **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 will be evaluated including consideration for the effects of each action or alternative on a wide range of human considerations. 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 effects to human considerations evaluated in the MRRMP-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 MRRMP-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. The USACE planning accounts evaluated for thermal power include NED, RED, and OSE.

1.3 Approach for Evaluating Commercial Sand and Gravel Dredging Consequences of Missouri River Recovery Management Plan

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 lead to changes to the benefits and costs associated with commercial sand and gravel dredging. This figure also shows the intermediate factors and criteria that were applied in assessing the NED, RED, and OSE consequences to navigation**.**

Dredging operations are connected to the Missouri River and are affected by river flows, water surface elevation and sediment conditions. When river flows are too low or too high, the movement of sediment on the river can be affected. Too low or too high flows may restrict access to materials in the river, which could decrease the supply and possibly increase the cost of sand and gravel to end users if the local demand exceeds the local supply and sand or gravel needs to be hauled from more distant sources. A significant decrease in the overall amount of sediment in the river could mean a decline in the availability of materials to extract and an alternative source would need to be located.

Six commercial dredging companies operate in the lower Missouri River. Evaluating potential effects of proposed alternatives to the commercial sand and gravel industry is included as a consideration for the Missouri River Management Plan.

An analysis of the effects of flow-based alternatives for the Missouri River Management Plan was conducted to determine if the alternatives would have an effect on the average annual rate of sediment accumulation in selected reaches of the lower Missouri River.

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.

CHANGES IN: Physical Components of Missouri River Watershed

- Water storage in system
- River flows and water surface elevation
- River channel dimensions
- Sediment conditions

Leads To

CHANGES IN: Commercial Sand Dredging Performance (locations- St. Joseph, Missouri to Hermann, Missouri)

- Availability of materials
- Access to materials
- Transport of materials

Leads To

CHANGES IN: Commercial Sand Dredging Activity

- Dredging Costs
- Production level

Leads To

CHANGES IN: Benefits

- National Economic Development (NED) – The NED benefits will be captured under navigation and transportation savings
- Regional Economic Development (RED) – Economic output/sales, income, employment by industry and region
- Other Social Effects (OSE)- Changes in community well-being and related impacts resulting from alternative sources of dredging

Figure 1. Flow Chart Showing How Physical Components of River Affect Analysis of Commercial Sand and Gravel Dredging

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 commercial sand and gravel dredging, is then described, as well as the subsequent steps to assess the NED, RED, and OSE impacts. Figure 2 shows the overall methodology used to evaluate the environmental consequences to commercial sand and gravel dredging from Management Plan alternatives. A set of metrics were developed in evaluating human considerations (HC) impacts from the Management Plan alternatives. For commercial sand and gravel dredging operations, the change in sediment accumulation rate from St. Joseph, Missouri

to Hermann, Missouri were evaluated. The results were used to evaluate impacts to commercial sand and gravel dredging.

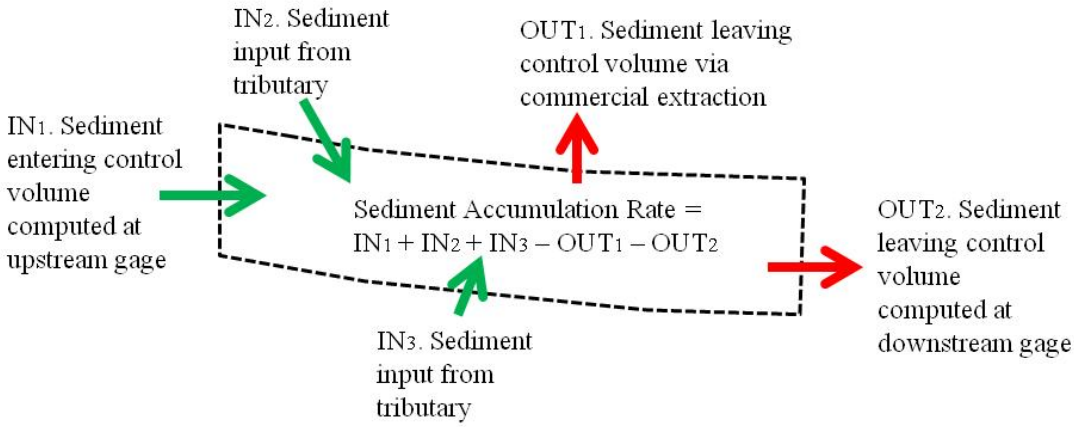

Figure 2. Sediment Accumulation Rate Methodology

Table 1 identifies the metric for commercial sand and gravel dredging that has been calculated and presented in this technical report.

Table 1. Commercial sand and gravel dredging metrics

Objective / Location	Metric	Units	Description	Directionality
Commercial Sand Dredging	Average annual change in sediment accumulation rate at specific gage	Average annual tons/year	Sediment accumulation equals the sum of all bed material load entering a reach minus the sum of all bed material load leaving a reach.	High

The approach to evaluate the effects to the commercial sand and gravel dredging industry associated with the availability of material assumes that a higher rate of sediment accumulation is a benefit to commercial sand and gravel dredgers. The metric for commercial sand and gravel dredging is the change in sediment accumulation rate, expressed in tons per year, under a no-action alternative and under the Management Plan proposed alternatives. The approach is based on measured sediment loads and daily flows, not coupled geomorphic modeling (alteration of the geometry of the channel), and these simplifications preclude the use of this analysis beyond a high-level understanding and ranking of flow-based alternatives. The basic equation is that sediment accumulation equals the sum of all sediment entering a reach minus the sum of all sediment leaving a reach.

Table 2 identifies the definition of metrics for commercial sand and gravel dredging that has been calculated and presented in this technical report.

Table 2. Commercial Sand and Gravel Dredging Metric Definitions

Flow Scenario	St. Joseph Gage (tons/year)	Kansas City Gage (tons/year)	Kansas River and Platte River (tons/year)	Current allotted Dredging permits (2016 Permit) (tons/year)	Change in Accumulation Rate	Difference from Base (%)	
						St. Joseph to Kansas City	Kansas City to Hermann
Base	XX tons/year	XX tons/year	XX tons/year	XX tons/year	+/- XX tons/year	XX%	XX%
Alt_1	XX tons/year	XX tons/year	XX tons/year	XX tons/year	+/- XX tons/year	XX%	XX%
Alt_2	XX tons/year	XX tons/year	XX tons/year	XX tons/year	+/- XX tons/year	XX%	XX%

A quantitative analysis of the change in average annual sediment accumulation rates was conducted to evaluate the impacts associated with significant change in the average annual sediment accumulation rate as a result of the Management Plan alternatives.

This analysis uses preliminary flow data and sediment data. Flow release scenarios were produced in the Management Plan ResSim model, then routed downstream by the Management Plan Unsteady HEC-RAS Model. Each alternative includes a permutation of historical data that spans from March 1, 1930 to December 31, 2012. This includes using existing channel geometry for each alternative. This model is not able to evaluate changes in geometry. Based on engineering judgment and knowledge of the river, the likely effect of altering the geometry would be a localized effect, not impacting the overall sediment accumulation rate.

The sediment data was derived from unpublished work which David Heimann (USGS) provided in support of Management Plan sediment modeling. Heimann interpolated daily suspended sediment loads and sediment loads < 0.0625 mm at each of the following gages from 1993 to 2013:

a. Missouri River at St. Joseph, Missouri
b. Platte River at Sharps Station, Missouri
c. Kansas River at Desoto, Kansas
d. Missouri River at Kansas City, Missouri
e. Grand River near Sumner, Missouri
f. Chariton River near Prairie Hill, Missouri
g. Missouri River at Hermann, Missouri

The sediment data provided by Heimann in support of the Management Plan sediment modeling is not a stand-alone product and did not go through the standard USGS review process.

Calculations: The analysis procedure followed these steps and is depicted in Figure 3 below:

1. Subtract the load < 0.0625 mm from the total suspended load to compute a daily suspended bed material load.

2. Compute a flow/load rating curve by plotting a best-fit power curve function through coupled bed material load and daily flow values for each of the mainstem gages. Due to

the unique circumstances of the 2011 flood event, 2011 was excluded to avoid biasing the long-term flow/load rating curves. These rating curves are plotted in Figure 3.

3. Compute a series of daily sediment loads for each flow alternative using the rating curves and the daily flow values provided by the HEC-RAS modeling for the period of record flow (1930 to 2012) adjusted for the various alternatives.

4. Divide by the number of days and multiply by 366 to produce an average annual sediment load at each mainstem gage.

5. Compute reasonable averages for tributary inputs and dredging extraction rates. Tributary inputs were computed as the average daily load (1993 to 2013) multiplied by 366. Dredging extraction rates were taken as the rates specified in the 2016 permit renewal. These values remain constant among alternatives and are only used to provide a more realistic transformation from a sediment flux difference at a gage to the desired metric of sediment accumulation rate.

6. Compute the sediment accumulation rate for each flow alternative as the sum of all sediment entering the reach minus the sum of all sediment leaving the reach.

   a. SSJ + SKR + SPR – DSJ – DKC – SKC = SARSJtoKC

   b. SKC + SGR + SCR – DWAV – DJC – SHER = SARKCtoHE

Abbreviation	Definition
S	average annual sediment accumulation rate
D	annual dredging rate
SAR	sediment accumulation rate for a given reach
SJ	Saint Joseph
KR	Kansas River
PR	Platte River
KC	Kansas City
GR	Grand River
CR	Chariton River
WAV	Waverly
JC	Jefferson City
HER	Hermann

7. Compute the change in sediment accumulation compared to the base condition.

   a. $(SAR_{Alt\text{-}i} – SAR_{Alt\text{-}0})/ SAR_{Alt\text{-}0}$

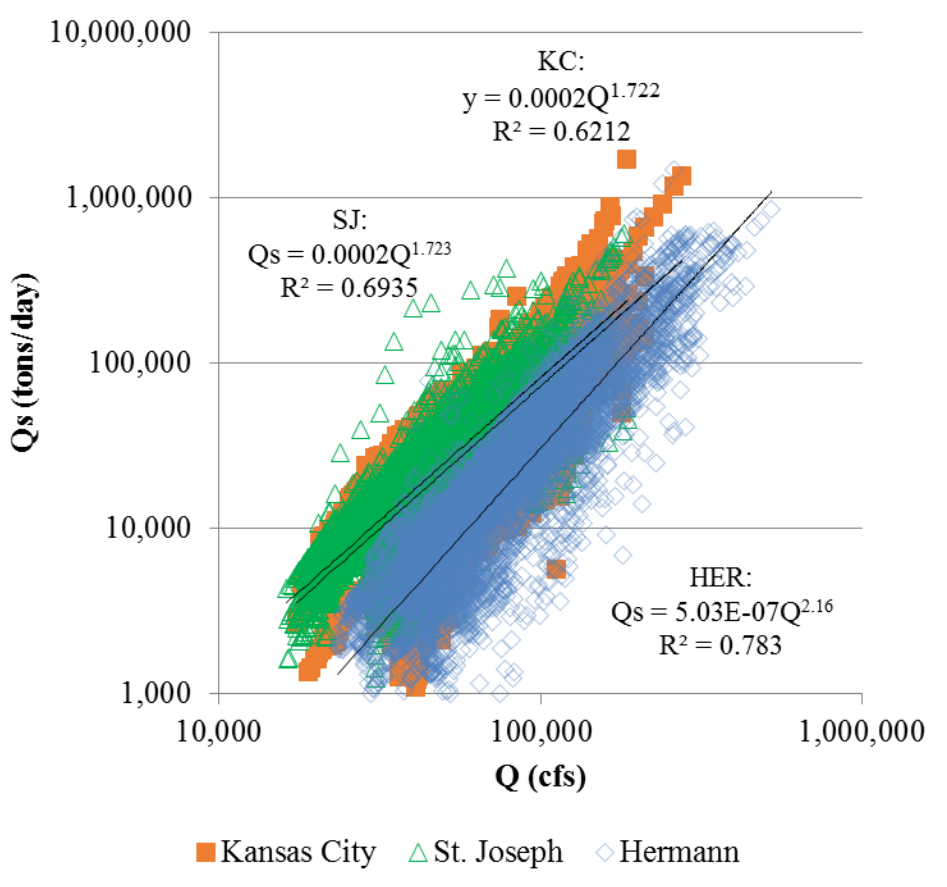

Figure 3. Rating Curves at Missouri River Mainstem Gages

Commercial sand and gravel dredging occurs in the lower Missouri River. There are five segments defined by the U.S. Army Corps of Engineers Regulatory 404 Permit process. The following segments are where dredging occurs:

Commercial Sand and Gravel Dredging Segments
St. Joseph (RM 391 to 498)
Kansas City (RM 357 to 391)
Waverly (RM 250 to 357)
Jefferson City (RM 130 to 250)
St. Charles (RM 0 to 130)

For the commercial sand and gravel dredging analysis, the following reaches were evaluated, St. Joseph, Missouri to Kansas City, Missouri and Kansas City, Missouri to Hermann, Missouri.

2.1 Assumptions/Limitations for Analysis

The dredging reaches do not line up precisely with the gage locations.

This is an approximate analysis for use in preliminary screening which makes use of simplifications and generalizations. This analysis is set up in a sediment budget format, but it is

in fact a ranking tool not a sediment budget. A sediment budget compares sediment sources, sinks, and fluxes for a concurrent period of time. This analysis compares the impact of varying the flow regime over the full period of record. It includes non-concurrent tributary and dredging data to provide a reasonable transformation from a flux difference at gages to a sediment accumulation rate. The tonnages for tributary inputs are averages based on twenty years of sediment loads, not the full period of record, and the dredging extraction is based on the 2016 permitted amounts, not on historic rates. This analysis also incorporates the simplification that the channel geometry does not alter the flow/sediment relationship, either through geomorphic feedbacks or through mechanical habitat creation. Due to these limitations, the actual numbers for accumulation rate are approximate. However, the direction, order-of-magnitude, and relative ranking of alternatives are deemed sufficient for a screening of flow-based alternatives. This type of analysis cannot be performed on geometric alternatives. Numerical modeling is suggested for more detailed analysis.

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 HEC-RAS models or carried through to the navigation model described is this document. The project 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 commercial sand and gravel dredging industry.

2.3 National Economic Development Methodology

National Economic Development (NED) effects are defined as changes in the net value of the national output of goods and services. In the case of commercial sand and gravel dredging, the conceptual basis for the NED impacts analysis is society's willingness to pay for the increase or decrease in the value of goods attributable to the commercial sand and gravel dredging industry. The measurement of national economic effects can be based on the estimated change in transportation costs. Given that the proxy analysis shows negligible differences between alternatives in terms of sediment accumulation rate, the analysis of NED impacts to commercial sand and gravel dredging focuses on a change in costs to transportation and change in the cost to operate and maintain the navigation channel from a federal perspective. The results and methodology of the navigation analysis can be found in the "Navigation Impact Analysis Technical Report" available online.

2.4 Regional Economic Development Methodology

The Regional Economic Development (RED) commercial sand and gravel dredging evaluation will use the inputs from the NED commercial sand and gravel dredging evaluation, navigation and transportation savings to evaluate if there are any impacts to the economic output/sales, income, employment by industry and region.

Since IMPLAN® is a revenue-based model, the input is the change in the value of sales, income, and employment by industry and region, which will be obtained from the NED

commercial sand and gravel dredging evaluation. The change in the value of sales, income and employment is run through the appropriate sector in IMPLAN®. The RED commercial sand and gravel evaluation will coordinate closely with the NED navigation evaluation and resources lead.

The study areas for the regional economic analysis will be defined based on the locations of commercial sand and gravel dredgers affected. The local study areas will likely be counties or groupings of counties where the commercial dredging industry is located. The state study areas will be defined consistent across all resource topics. The direct effects will be calculated based on how the study areas are defined.

2.5 Other Social Effects Methodology

Changes in commercial sand and gravel dredging operations have a potential to cause other types of effects on individuals and communities in terms of individual and community well-being, as well as traditional ways of life. The commercial sand and gravel dredging analysis will use the results of the NED and RED analysis to determine appropriate impacts to the other social effects (OSE) account. The consequence evaluation for commercial sand and gravel dredging for other social effects will not involve a modeling effort. Any changes to these areas of concern that would occur under Management Plan alternatives will be examined to the extent possible. The OSE analysis will be a qualitative description of the impacts that will allow for comparison of impacts among alternatives. Inputs necessary for determining impacts to OSE would be the outputs of the RED and NED commercial sand and gravel dredging evaluation, which will provide a sense of the magnitude of the monetary impacts to the nation or to the regional area. A qualitative description will be provided, based on the scale of the impacts and the information available.

2.6 Environmental Quality Methodology

According to Principles and Guidelines (1983), the environmental quality (EQ) account shows effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot be measured in monetary terms. Any impacts to commercial sand and gravel dredging from alternatives proposed by the MRRMP-EIS that may cause changes to the EQ account are covered under the OSE account. Examples include the potential change in emissions that could occur due to any alternation of current commercial sand and gravel dredging activity.

3.0 NED Evaluation Results

Tables 3 and 4 present the results of this analysis. The sign has been switched on the % change so that positive represents more sediment accumulation (beneficial to the dredgers) and a negative percent change represents less sediment accumulation (adverse impact to the commercial sand and gravel dredging industry).

Table 3. Sediment Accumulation in the St Joseph and Kansas City Dredging Reaches

Flow Alternative	SJ Gage (tons/year)	KC Gage (tons/year)	KR and PR (tons/year)	Dredging (2016 Permit) (tons/year)	Accumulation Rate (tons/year)	Diff from Alt 1 (%)
Alt 1	8,161,794	10,248,020	1,485,666	870,000	-1,470,560	0.0%
Alt 2	8,241,709	10,319,943	1,485,666	870,000	-1,462,568	0.5%
Alt 3	8,153,726	10,240,629	1,485,666	870,000	-1,471,237	0.0%
Alt 4	8,204,128	10,286,243	1,485,666	870,000	-1,466,448	0.3%
Alt 5	8,168,972	10,248,748	1,485,666	870,000	-1,464,110	0.4%
Alt 6	8,188,693	10,270,746	1,485,666	870,000	-1,466,387	0.3%

Table 4. Sediment Accumulation in the Waverly and Jefferson City Dredging Reaches

Flow Alternative	KC Gage (tons/year)	HER Gage (tons/year)	GR and CH (tons/year)	Dredging (2016 Permit) (tons/year)	Accumulation Rate (tons/year)	Diff from Alt 1 (%)
Alt 1	10,248,020	11,615,722	1,416,608	3,408,000	-3,359,094	0.0%
Alt 2	10,319,943	11,673,463	1,416,608	3,408,000	-3,344,912	0.4%
Alt 3	10,240,629	11,601,641	1,416,608	3,408,000	-3,352,404	0.2%
Alt 4	10,286,243	11,666,158	1,416,608	3,408,000	-3,371,307	-0.4%
Alt 5	10,248,748	11,600,266	1,416,608	3,408,000	-3,342,910	0.5%
Alt 6	10,270,746	11,624,197	1,416,608	3,408,000	-3,344,843	0.4%

3.1 NED Conclusions

All flow scenarios have negligible effects (less than a 1.0 % change) on the sediment accumulation. Table 5 includes overall results from St. Joseph, Missouri to Hermann, Missouri.

Table 5. Summary for St. Joseph to Hermann, Missouri

Flow Alternative	St. Joseph to Hermann	
	Accumulation Rate (tons/year)	Difference from Alt 1 (%)
Alt 1	-4,829,654	0.0%
Alt 2	-4,807,480	0.5%
Alt 3	-4,823,641	0.1%
Alt 4	-4,837,756	-0.2%
Alt 5	-4,807,020	0.5%
Alt 6	-4,811,230	0.4%

4.0 RED Evaluation Results

Because all flow scenarios have a negligible effect on the sediment accumulation (less than a 1.0% change), a detailed RED Evaluation was not conducted.

5.0 OSE Evaluation Results

Because all flow scenarios have a negligible effect on the sediment accumulation (less than a 1.0% change), a detailed OSE Evaluation was not conducted.

6.0 EQ Evaluation Results

Because all flow scenarios have a negligible effect on the sediment accumulation (less than a 1.0% change), a detailed EQ Evaluation was not conducted.

7.0 Literature Cited

USACE 2011. United States Army Corps of Engineers Missouri River Bed Degradation Final Environmental Impact Statement (EIS), February 2011

USACE 2011a. United States Army Corps of Engineers Record of Decision for Authorization of Commercial Sand and Gravel Dredging on the Lower Missouri River, March 2011

USACE 2015. United States Army Corps of Engineers Memorandum for Record, Department of the Army Combined Decision Document for Permit Application NWK-2011-00361, NWK-2011-00362, NWK-2011-00363, NWK-2011-00364, MVS-2011-0177, MVS-2011-00178, December, 2015 (for the 2016 thru 2020 permit cycle).