STUDY 1.0 SEDIMENTATION

The Project is located in Nance and Platte counties, where water is diverted from the Loup River and routed through the 35-mile-long Loup Power Canal, which empties into the Platte River near Columbus. The Project includes various hydraulic structures, two powerhouses, and two regulating reservoirs. The portion of the Loup River from the Diversion Weir to the confluence with the Platte River is referred to as the Loup River bypass reach.

When water is diverted from the Loup River, it enters the 2-mile-long Settling Basin. The Settling Basin is designed for very slow flow velocity to allow heavier sediment materials to settle out of the water before it enters the Upper Power Canal. A Sluice Gate Structure adjacent to the Diversion Weir is operated periodically to mobilize accumulated sediment in front of the Intake Gate Structure. This process conveys sediment into the Loup River bypass reach. As documented in the PAD, a Hydraulic Dredge removes approximately 1 million to 1.5 million tons of sediment from the Settling Basin annually. It has been suggested that the removal of sediment resulting from Project dredging operations at the Settling Basin may affect sediment transport in the Loup River bypass reach and the Platte River downstream of the Tailrace Canal. In addition, a U.S. Army Corps of Engineers (USACE) report on ice jam formation in the Lower Platte River states that changes in sediment regime due to Project operations may have impacted ice formation and transport processes (USACE, July 1994).

This study will evaluate the physical effects of Project operations on sediment transport within the Loup River bypass reach and the Platte River downstream of the Tailrace Canal.

1. GOALS AND OBJECTIVES OF STUDY

"Describe the goals and objectives of each study proposal and the information to be obtained;" 18 CFR §5.11(d)(1)

The goal of the sedimentation study is to determine the effect, if any, that Project operations have on stream morphology and sediment transport in the Loup River bypass reach and in the Lower Platte River. In addition, the goal is to compare the availability of sandbar nesting habitat for interior least terns (*Sterna antillarum*) and piping plovers (*Charadrius melodus*) to their respective populations and to compare the general habitat characteristics of the pallid sturgeon (*Scaphirhynchus albus*) in multiple locations.

The objectives of the sedimentation study are as follows:

1. To develop a sediment budget from existing data sources.
2. To characterize sediment transport in the Loup River bypass reach and in the Lower Platte River through effective discharge calculations.

3. To characterize stream morphology in the Loup River bypass reach and in the Lower Platte River by reviewing existing literature on channel aggradation/degradation and cross sectional changes over time.
4. To determine if a relationship can be detected between sediment transport parameters and interior least tern and piping plover nest counts (as provided by the Nebraska Game and Parks Commission [NGPC]).
5. To compare the availability of sandbar nesting habitat to interior least tern and piping plover nest counts on the Lower Platte River and to compare these results to the relationship of interior least tern and piping plover nest counts and the availability of sandbar habitat in the Missouri River downstream of Gavins Point Dam.
6. To determine if sediment transport is a limiting factor for pallid sturgeon habitat in the Lower Platte River below the Elkhorn River.
7. To investigate the relationship between sedimentation and ice jam flooding.

2. RELEVANT RESOURCE MANAGEMENT GOALS

"Address any known resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied;" 18 CFR §5.11(d)(2)

The U.S. Fish and Wildlife Service (USFWS) is responsible for the conservation and management of migratory, threatened, and endangered fish and wildlife resources under a number of authorities, including the Endangered Species Act of 1973 (16 USC 1531 et seq.), the Fish and Wildlife Coordination Act (16 USC 661 et seq.), the Bald and Golden Eagle Protection Act (16 USC 703-712, as amended), and the Migratory Bird Treaty Act (16 USC 703-712, as amended). Compliance with all of these statutes and regulations is required to be in compliance with the National Environmental Policy Act (NEPA) (42 USC 4321-4347).

In addition, the Nebraska Department of Natural Resources (NDNR) has resource goals related to sedimentation because of its potential effects on ice jam formation and related flooding.

3. BACKGROUND AND EXISTING INFORMATION

"Describe existing information concerning the subject of the study proposal, and the need for additional information;" 18 CFR §5.11(d)(3)

3.1 Relevance to Threatened and Endangered Species

The proposed study area includes the Loup River bypass reach and the Lower Platte River from the confluence with the Loup River to the U.S. Geological Survey (USGS) gage at Louisville (see Section 5, Study Area and Study Sites).

The Loup and Platte rivers have characteristics typical of braided river channels (Donofrio, 1982). A braided river is defined as a river channel in which have been deposited bars and islands around which the river flows. It has been shown that, for a given discharge, braided channels slope more steeply than meandering channels. Braiding occurs when the discharge fluctuates frequently, when the river cannot carry its full sediment load, where the river is wide and shallow, where banks may be easily eroded, and where there is copious bedload. The position of the bars is changeable; sediment may be entrained by scour at channel junctions and then be re-deposited down-channel as flows diverge again and new channels are cut by overbank flooding (Mayhew, 2004). The braiding in the channels allows for the development of emergent sandbar habitat. High sandbars and wide channels are common on the Lower Platte River (Ziewitz et al., 1992).

It has been speculated that some aspects of Project operations may affect wildlife habitat through possible material changes in the sediment transport regime in the Loup River bypass reach and the Lower Platte River. Emergent sandbar habitat in braided channels is important to a variety of life stages of fish and wildlife, including interior least tern, piping plover, and pallid sturgeon, three species that are Federally listed as threatened or endangered.

Sandbar habitat in the Loup and Platte rivers is considered primary habitat for interior least terns and piping plovers and is used by these birds for breeding, nesting, loafing, and foraging. These birds migrate to the Nebraska rivers in mid-April to early June, with breeding, nesting, and egg-laying commencing in mid-May to early July (USFWS, September 1990 and June 28, 1994). After chicks have fledged in mid- to late August, interior least terns and piping plovers abandon the habitat and migrate to their wintering grounds along the Gulf of Mexico.

Riverine nesting areas of interior least terns and piping plovers are sparsely vegetated sand and gravel bars within a wide unobstructed river channel. Nesting locations are usually at higher elevations and away from the water's edge because nesting is typically initiated when river flows are high and small amounts of sand are exposed. Interior least terns and piping plovers have been observed to nest on sandbar habitats with less than 25 percent vegetative cover and an abundance of bare or sparsely vegetated sand and gravel (Sidle and Kirsch, 1993) with an average area of 1.45 hectares and at an average height of 0.49 meters (Ziewitz et al., 1992).

The interior least tern is pisivorous, feeding in shallow waters of rivers, streams, and lakes, along sandbars and sandy shores. Interior least terns usually feed close to their nesting sites but have been known to travel up to 3.2 kilometers to fish. Fish prey is small sized, usually between 2 and 8 centimeters long. Interior least terns are believed to be opportunistic feeders, exploiting any fish within an edible size range (USFWS, September 1990). Piping plovers feed primarily on exposed beach substrates by pecking for invertebrates at, or less than, 1 centimeter below the surface.

Piping plovers are believed to be opportunistic feeders, consuming a variety of invertebrate genus and species.

The pallid sturgeon is considered to be a large turbid river species. The habitat used by different life stages of this species varies widely. Historically, most rivers comprising the range of the pallid sturgeon were characterized by shallow channels with shifting sandbars. The Lower Platte River still retains this type of habitat over most of its length. Pallid sturgeon have been captured in the Platte River up to the confluence with the Elkhorn River. Pallid sturgeon in the Lower Platte River use areas associated with the downstream ends of sandbars and in deeper channels along the edge of sandbars (Peters and Parham, 2008). The amount and accessibility of habitat is related to discharge. High-discharge events produce flow velocities that scour deeper channels and deposit sandbars, which create and maintain the habitats favored by pallid sturgeon. Pallid sturgeon have been found to use the deepest water available in the Platte River, using depths ranging from 0.33 to 1.27 meters, with average column velocities in the range of 0.52 to 0.82 meters per second (Peters and Parham, 2008). Many studies have noted the preponderance of use of sand substrate by pallid sturgeon. In the Platte River, average percentages of sand, silt, and gravel at pallid sturgeon telemetry contacts were 99.9 percent, 0.4 percent, and 0 percent, respectively (Peters and Parham, 2008).

3.2 Existing Sediment and Stream Morphology Information

Both the Loup and Platte rivers are considered braided rivers; therefore, sediment transport is an important factor in retaining their natural characteristics (Donofrio, 1982). There have been numerous sedimentation and geomorphology studies on the central Platte River but limited study on the Lower Platte River and Loup River. One report, prepared by the Missouri River Basin Commission (September 1975), includes a sediment yield analysis of the Platte River Basin, which includes the Loup River Basin. A selection of studies and reports that will be used to gather data include:

- Chen, Rus, and Stanton, 1999, "Trends in Channel Gradation in Nebraska Streams, 1913-95," U.S. Geological Survey Water-Resources Investigations Report 99-4103.
- Ginting and Zelt, 2008, "Temporal Differences in Flow Depth and Velocity Distributions and Hydraulic Microhabitats Near Bridges of the Lower Platte River, Nebraska, 1934-2006," USGS Scientific Investigations Report 2008-5054.
- Ginting, Zelt, and Linard, 2008, "Temporal Differences in the Hydrologic Regime of the Lower Platte River, Nebraska, 1895-2006," USGS Scientific Investigations Report 2007-5267.

- Marlette and Walker, 1968, "Dominant Discharges at Platte-Missouri River Confluence" in the *Journal of the Waterways and Harbors Division*, Proceedings of the American Society of Civil Engineers.
- Missouri River Basin Commission, 1972, "Platte River Basin Sediment Budget."
- Missouri River Basin Commission, September 1975, "Platte River Basin—Nebraska, Level B Study, Land Conservation and Sedimentation."
- Rus, Dietsch, and Simon, 2003, "Streambed Adjustment and Channel Widening in Eastern Nebraska," U.S. Geological Survey Water-Resources Investigations Report 03-4003.
- U.S. Department of the Interior, Bureau of Reclamation, April 2004, "The Platte River Channel: History and Restoration."
- U.S. Department of the Interior, Bureau of Reclamation, August 2000, "Physical History of the Platte River in Nebraska."

3.3 Flow and Gage Data

Flow data from USGS and NDNR gage stations will be used for this sedimentation study. Each gage station is accompanied by the associated rating curves and velocity and cross-sectional data used to create the rating curves. Flow data that will be used for this study include:

- USGS Gage 06793000, Loup River near Genoa, NE – Available discharge and gage height data from April 1, 1929, to current includes daily and 30-minute interval data.
- USGS Gage 06792500, Loup River Power Canal near Genoa, NE – Available discharge and gage height data from January 1, 1937, to current includes daily and 30-minute interval data.
- NDNR Gage 00082100, Loup River Power Canal Return [Tailrace Canal] at Columbus, NE – Available discharge and gage height data from October 1, 2002, to current includes daily and 15-minute interval data.
- USGS Gage 06794500, Loup River at Columbus, NE – Available daily discharge and gage height data from April 1, 1934, to October 10, 1978. This gage was restarted by NDNR on September 23, 2008.
- USGS Gage 06774000, Platte River near Duncan, NE – Available discharge and gage height data from May 3, 1895, to current includes daily and 30-minute interval data.

- USGS Gage 06796000, Platte River at North Bend, NE – Available discharge and gage height data from April 1, 1949, to current includes daily and 30-minute interval data.
- USGS Gage 06796500, Platte River at Leshara, NE – Available discharge and gage height data from June 29, 1994, to current includes daily and 30-minute interval data.
- USGS Gage 068010000, Platte River near Ashland, NE – Available discharge and gage height data from September 1, 1928, to current includes daily and 30-minute interval data.
- USGS Gage 06805500, Platte River at Louisville, NE – Available discharge and gage height data from June 1, 1953, to current includes daily and hourly interval data.

4. PROJECT NEXUS

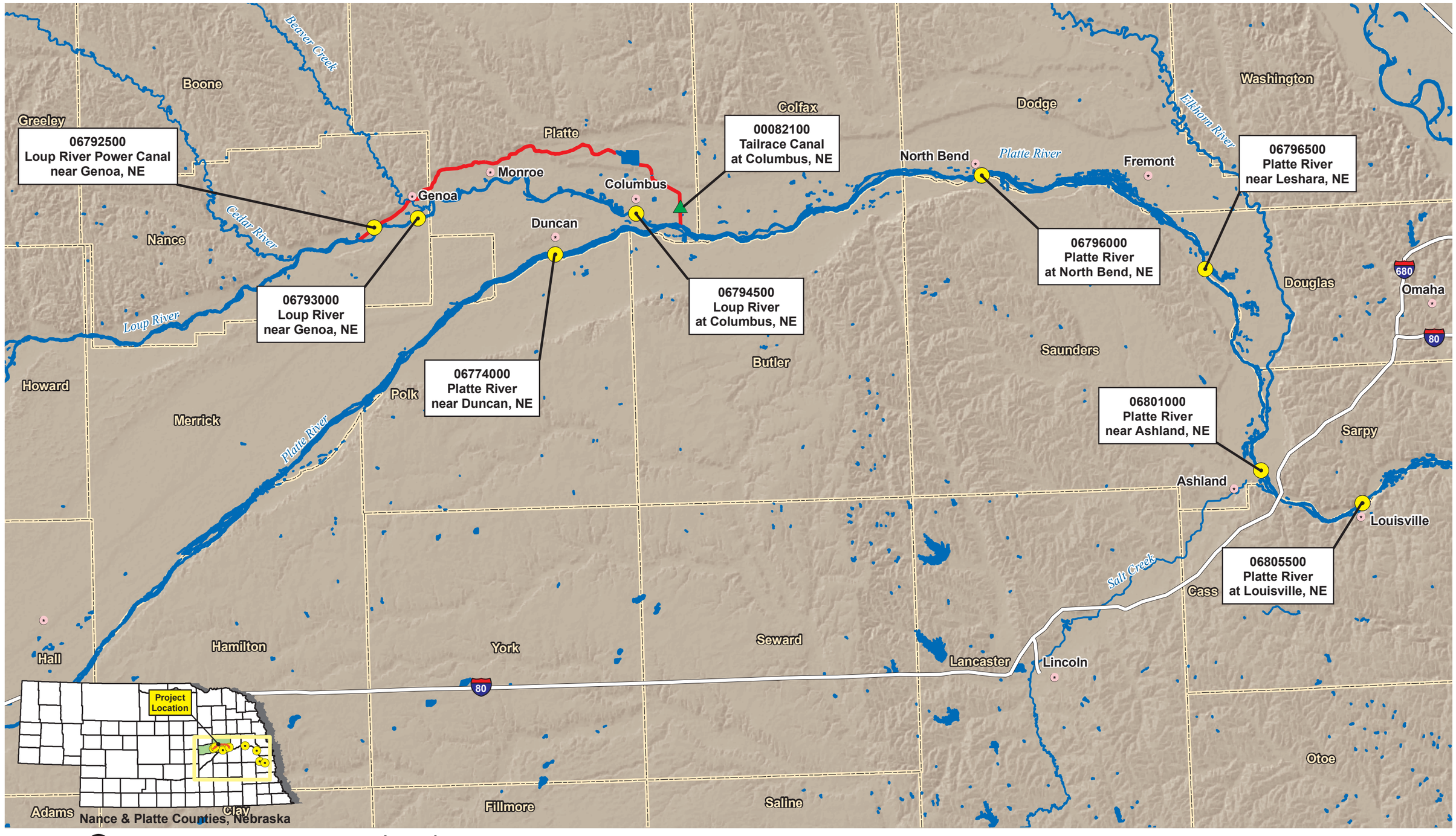
"Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied;" 18 CFR §5.11(d)(4)

A portion of the flow and sediment in the Loup River is diverted to the Loup Power Canal. The remaining portion of the flow and sediment continues down the Loup River bypass reach. The majority of the total sediment diverted settles out in the Settling Basin. A lesser quantity of finer sediments settles out in the canal segments and regulating reservoirs. The balance of sediment remains in suspension and is conveyed through the Project to the Lower Platte River. Project operations have reduced the amount of sediment in the Platte River downstream of the Tailrace Canal. Sediment is dredged from the Settling Basin to the North and South Sand Management Areas. The sediment dredged to the South Management Area eventually returns to the Loup River bypass reach. The majority of sediment dredged to the North Sand Management Area is removed from the system. Sediment removal during Project operations may affect characteristics of the Loup River bypass reach and the Platte River downstream of the Tailrace Canal.

5. STUDY AREA AND STUDY SITES

The proposed study area includes the Loup River bypass reach and the Lower Platte River from the confluence with the Loup River to the USGS gage at Louisville.

Figure 1-1 shows the extent of the study area and the study sites. The study sites will be those gages listed in Section 3.3, Flow and Gage Data, as well as a point upstream of the Diversion Weir. Flow at the Diversion Weir will be synthesized by using USGS Gage 06793000 on the Loup River near Genoa and USGS Gage 06792500 on the Loup Power Canal near Genoa. Conveyance losses between the gages and the point upstream of the Diversion Weir will be determined and applied appropriately.


06792500
Loup River Power Canal
near Genoa, NE
06793000
Loup River
near Genoa, NE
06774000
Platte River
near Duncan, NE
00082100
Tailrace Canal
at Columbus, NE
06794500
Loup River
at Columbus, NE
06796000
Platte River
at North Bend, NE
06796500
Platte River
near Leshara, NE
06801000
Platte River
near Ashland, NE
06805500
Platte River
at Louisville, NE
Beaver Creek
Cedar River
Loup River
Platte River
Elkhorn River
Salt Creek
Greeley
Boone
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Howard
Merrick
Hall
Hamilton
Polk
Platte
Monroe
Genoa
Columbus
Duncan
Colfax
Butler
York
Fillmore
Seward
Saline
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County
Loup Power District Hydro Project
Sedimentation Study Area
Loup River Hydroelectric Project
FERC Project No. 1256
Proposed Study Plan
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6. PROPOSED METHODOLOGY

"A detailed description of the study and the methodology to be used;" 18 CFR §5.11(b)(1)

"Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers any known tribal interests;" 18 CFR §5.11(d)(5)

The methodology for the sedimentation study includes eight tasks, described below.

Task 1 Data Collection and Evaluation

Sedimentation studies relevant to this study will be researched. USGS flow, stage, and rating curve data will be collected. Cross sectional measurements performed by USGS to create the rating curves will be obtained and reviewed. One cross section will be surveyed at a point upstream of the Diversion Weir. District sediment (dredging and stockpiling) records will also be analyzed. Interior least tern and piping plover population and habitat information will be obtained from NGPC (for the Lower Platte River) and from USACE (for the Missouri River below Gavins Point Dam).

Task 2 Sediment Budget

An updated sediment budget will be determined based on the sediment budget and sediment yield analysis completed by the Missouri River Basin Commission in September 1975. In that report, the Platte River Basin was divided into subwatersheds, one of which was the Loup River Basin. Annual sediment yields for each subwatershed were calculated by determining the sediment production from all erosion processes (sheet and rill, gully, and streambank). The sediment yield analysis was then used to create an annual sediment budget for the river system.

Since 1975, various studies have provided updated sediment load estimates on the sediment budget completed by the Missouri River Basin Commission. Information from these studies will be used to revise the sediment budget as appropriate. Updated information includes the sediment load upstream of the Loup River confluence at Duncan (U.S. Department of the Interior, Bureau of Reclamation, August 2000) and District dredge records, which are recorded and summarized annually.

Task 3 Effective Discharges

This methodology follows the procedure described in Hey's "Channel Response and Channel Forming Discharge: Literature Review and Interpretation" (1997). The median discharge is the discharge associated with the 50 percent exceedance on the flow duration graph while the effective discharge is the flow, or range of flows, that transports the greatest amount of sediment.

Flow Frequency Curves

Annual and seasonal flow frequency curves will be generated for each gage site listed in Section 5, Study Area and Study Sites, for Project operations and alternative conditions. The analysis will be limited to years in which adequate interior least tern and piping plover population information exists. The flow frequency curve that will be used in this analysis is a plot of the mean daily discharge on the x-axis and flow frequency (number of days a particular ranked and grouped mean daily discharge occurred) on the y-axis.

Sediment Discharge Rating Curves

Sediment discharge rating curves will be generated at each study site to coincide with the flow frequency curves for Project operations and alternative conditions. A sediment discharge rating curve shows sediment (both bed load and suspended load) in units of weight per unit of time versus discharge on a log-log scale. Analyses performed by Leopold and Maddock (1953), Yang (1974), Hey (1997), and others show a relationship between sediment discharge and water discharge through the use of known values such as channel slope, width, and shear stress.

There are several well-established methods describing this relationship. However, Yang (1974) showed that for the Middle Loup River, the Unit Stream Power method and the modified Einstein method both adequately predicted sediment discharge. This sedimentation study will use the Unit Stream Power method to plot sediment discharge rating curves. This method employs a relationship between the rate of energy expenditure and rate of sediment transport. Variables used in this method include velocity, slope, sediment particle gradation, and viscosity. The data to support these variables will come from the USGS rating curve surveys and the sediment information sources listed in Section 3.2.

Effective Discharge and Collective Sediment Discharge

Effective discharge is defined as the flow that transports the bulk of the sediment in a channel. It is found by developing a collective sediment discharge curve. A collective sediment discharge curve is developed by combining the flow frequency and sediment discharge rating curves developed in the previous tasks. The flow corresponding to the peak of the collective sediment discharge curve is the effective discharge. The area under the collective discharge curve is the total sediment transported during the period of analysis. The collective discharge curve can be developed on a daily, monthly, seasonal, or annual basis.

Exhibit 3.1 illustrates the concept of using the flow and sediment rating curves to create the collective sediment discharge curve. The collective sediment discharge curve can also show trends in sediment loading if the loading is flow- or supply-limited or if the system is in a state of quasi-equilibrium.

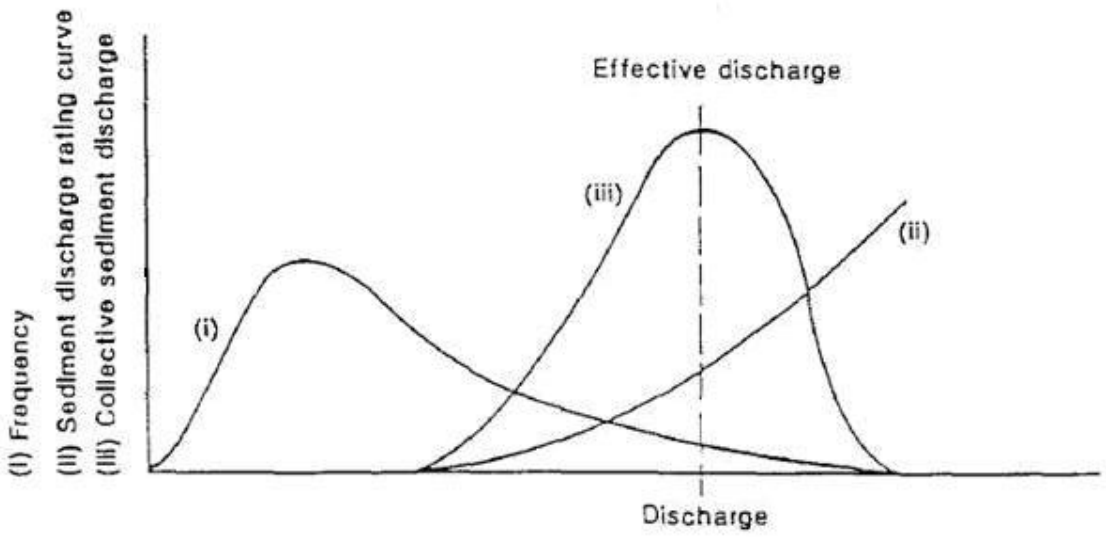

Exhibit 3.1. Effective discharge determination from typical sediment rating and flow duration curves. (Hey, 1997)

A sensitivity analysis will be performed around the variability of the parameters used in the creation of the sediment discharge rating curves and how varying each parameter affects the outcome of the effective discharge calculation.

Effective discharge and collective sediment discharge will be determined for each study site for Project operations and alternative conditions. The period examined will correspond with years in which adequate interior least tern and piping plover population information exists.

Task 4 Stream Channel Morphology

Stream morphology information measured and reported by USGS will be reviewed and evaluated. The stream morphology information includes channel cross sectional area changes, channel aggradation/degradation changes, and the rate at which these changes, if any, occur over time. Based on this information and the results of Task 3, Effective Discharges, the Loup River bypass reach and the Lower Platte River will be characterized as aggrading, degrading, or in quasi-equilibrium. If the channel morphology information shows that the Loup River bypass reach and Lower Platte River are in quasi-equilibrium, then it will be concluded that Project operations do not adversely impact channel morphology. If the channel morphology information shows that the Loup River bypass reach and Lower Platte River are not in quasi-equilibrium, Project operations will be evaluated to determine to what extent, if any, the Project may affect channel morphology as compared to alternative conditions.

Task 5 Interior Least Tern and Piping Plover Nesting and Sediment Transport Parameters

Available interior least tern and piping plover nesting population information will be plotted against sediment transport parameters calculated in Task 3, Effective Discharges. The plots will be evaluated to determine if a relationship can be detected. If no relationship can be detected through this analysis, the conclusion will be made that the effective discharge and total sediment transported have no material effect on interior least tern and piping plover populations. If a relationship is found, the degree to which Project operations affect the determining parameter will be reviewed.

Task 6 Interior Least Tern and Piping Plover Populations and Habitat in the Lower Platte River and Other Rivers

Data on interior least tern and piping plover nesting exist for both the Lower Platte River and the Missouri River downstream of Gavins Point Dam. Similarly, data exist on the amount of sandbar habitat for these two areas. Interior least tern and piping plover populations will be compared to the availability of sandbar habitat in both rivers. Because the availability of sandbar habitat normally increases following high flows, flows in the two reaches will be used to help establish when increases in sandbar habitat have occurred. The intent is to determine whether availability of sandbar nesting habitat is limiting interior least tern and piping plover populations in the Lower Platte River. If sandbar nesting habitat is found to be limiting, the degree to which Project operations affect the formation of sandbar habitat will be reviewed in context with Task 3, Effective Discharges, and Task 5, Interior Least Tern and Piping Plover Nesting and Sediment Transport Parameters.

Task 7 Pallid Sturgeon Habitat

Because pallid sturgeon also use the upper Missouri River and the Yellowstone River, existing information will be gathered on the use of these rivers by pallid sturgeon and the corresponding habitat characteristics (flow, sediment transport, temperature, morphology) of these rivers, including a qualitative assessment of sandbar abundance. These habitat characteristics will be compared to those of the Lower Platte River below the confluence with the Elkhorn River. The intent is to determine if there is a differentiating factor between the upper Missouri River and the Yellowstone River habitats and the characteristics of the Lower Platte River below the confluence with the Elkhorn River. If a differentiating factor is sandbar habitat, then Project effects on sandbar habitat will be reviewed in context with the results of Task 3, Effective Discharges, and Task 5, Interior Least Tern and Piping Plover Nesting and Sediment Transport Parameters, to determine if a change in Project operations could materially affect sandbar formation in the Lower Platte River below the confluence with the Elkhorn River.

Task 8 Sediment Impacts on Ice Jam Flooding

A potential link between sediment and ice transport will be evaluated. Frazil ice[1] transport can be described in a similar manner as low density bed load transport according to Shen and Wang (1995) and Beltaos (1995). Therefore, any flow regime changes relative to alternative conditions that could lead to a change in bed load transport could alter frazil ice transport in the channel. Total sediment transport analyses from Task 3, Effective Discharges, will be reviewed. This information will be used to qualitatively evaluate the potential for increased severity of ice jam flooding.

7. CONSULTATION WITH AGENCIES, TRIBES, AND OTHER STAKEHOLDERS

This study plan was developed based on discussions with agencies prior to submittal of the PAD. The District will work with agencies to resolve any issues or concerns during the course of the study plan meetings prior to preparation of the revised study plan.

8. WORK PRODUCTS

"Provisions for periodic progress reports, including the manner and extent to which information will be shared; and sufficient time for technical review of the analysis and results;" 18 CFR §5.11(b)(3)

The intended work product for the sedimentation study is a study report. The study report will document the existing and past sediment regime in the Loup River bypass reach and the Platte River downstream of the Tailrace Canal. Along with the study report, a database of the data gathered and used in the analysis will be available.

Updates regarding the hydrocycling study will be included in the study progress reports to be submitted to FERC in December 2009, March 2010, and June 2010.

9. LEVEL OF EFFORT AND COST

"Describe considerations of level of effort and cost, as applicable." 18 CFR §5.11(d)(6)

It is estimated that the sedimentation study will cost approximately $340,000. This work will be completed by qualified water resources engineers and biologists.

[1] Frazil ice, also known as slush ice because of its appearance, is formed only in turbulent supercooled water. Frazil ice is most often seen in early to mid-winter and can accumulate to form an ice cover or an ice jam (USACE, July 1994).

10. SCHEDULE

"A schedule for conducting the study;" 18 CFR §5.11(b)(2)

"The potential applicant's proposed study plan must also include provisions for the initial and updated study reports and meetings provided for in §5.15." 18 CFR §5.11(c)

The sedimentation study is scheduled to begin in the fourth quarter of 2009, and the final study report is to be submitted in the third quarter of 2010.

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